June 11, 1940. F. FARRELL 2,203,863

ELECTRIC SWITCH

Filed April 28, 1937 2 Sheets-Sheet 1

Fig. 1.

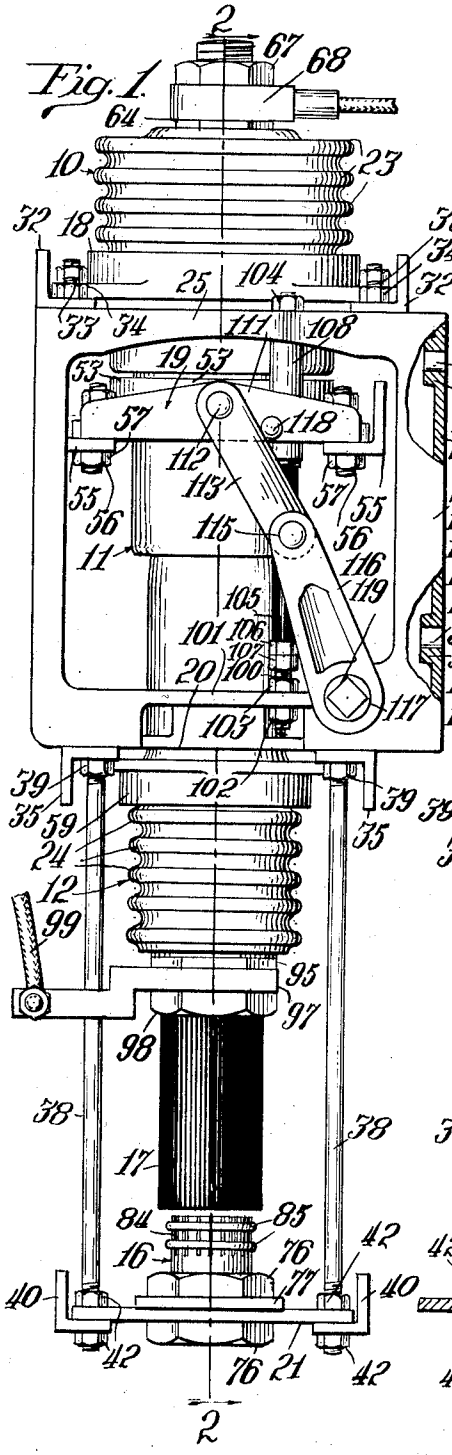

Fig. 2.

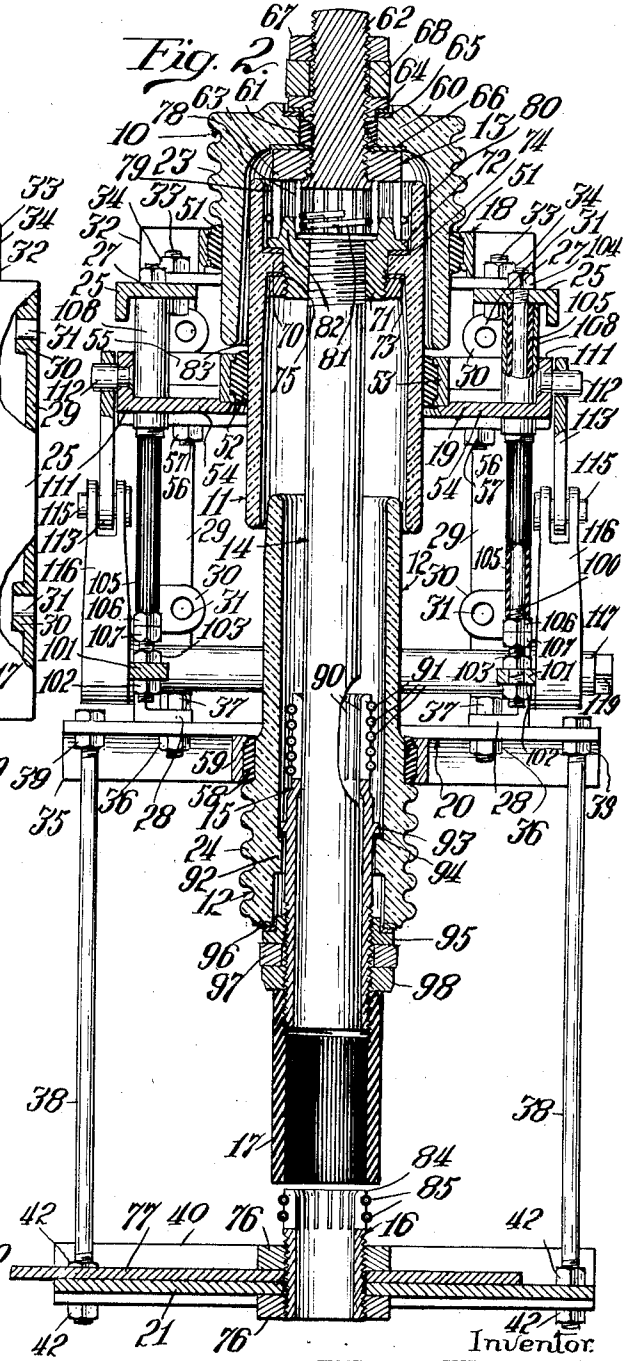

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Fig. 4.

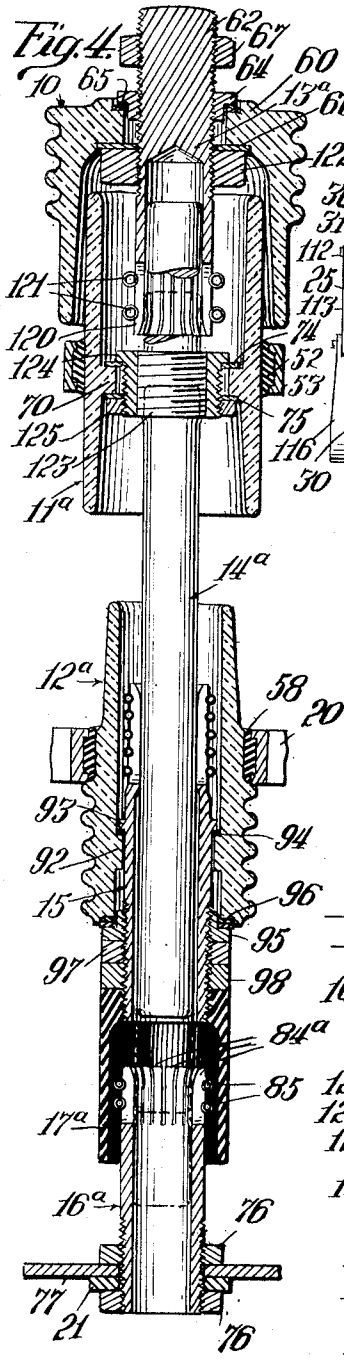


Fig. 3.

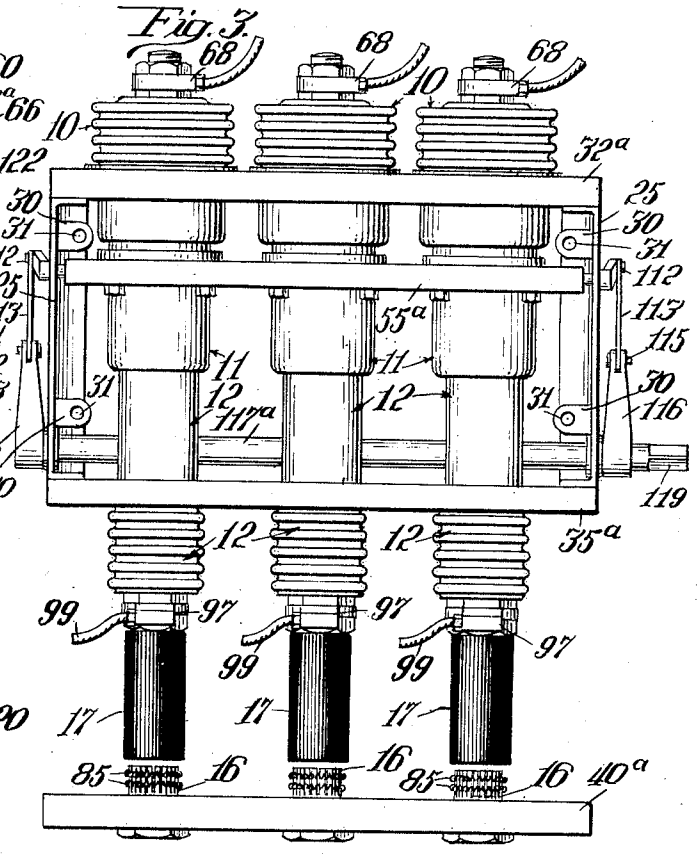


Fig. 5.

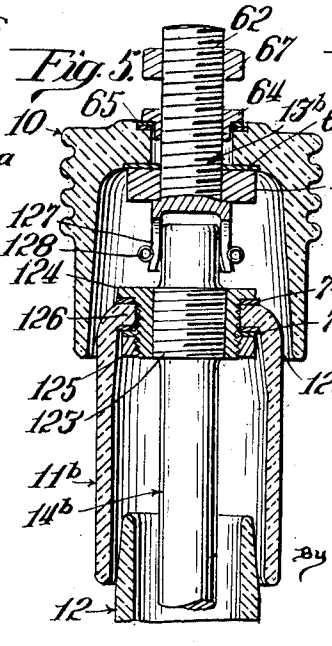
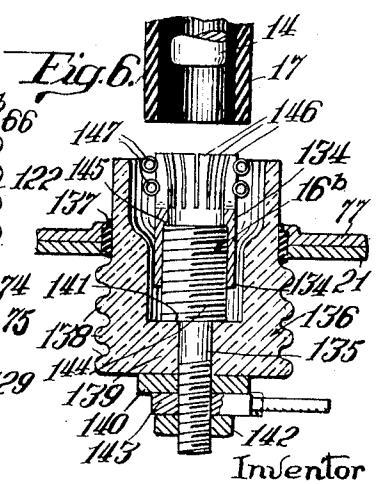


Fig. 6.



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UNITED STATES PATENT OFFICE

2,203,863

ELECTRIC SWITCH

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Application April 28, 1937, Serial No. 139,405

13 Claims. (Cl. 200—16)

The present invention relates to electric switches of the type wherein the contacts have a substantially rectilinear movement into and out of their circuit closing positions. A switch of this type is disclosed in my prior United States Patent No. 1,918,901, granted July 18, 1933. The present invention is an improvement upon the invention disclosed in said prior patent.

The principal object of the present invention is to provide a switch of the type mentioned with certain modified electric connections and with modifications in structure which suit it to additional conditions of service. Another object is to provide a switch which shall be efficient and satisfactory in operation while being at the same time simple in construction and economical to manufacture.

In carrying out my invention I preferably provide a switch structure wherein the cooperating contacts are located along a rectilinear axis and one of said contacts, at least, is movable along said axis into its different operative positions. Preferably, too, the contacts, or some of them, are located within insulating members which ordinarily partake of the relative movements of the switch contacts. These members preferably take the form of insulating tubes arranged in telescopic relation to each other. Novel toggle mechanism also serves to lock movable parts of the switch, which are adapted to occupy an elevated position, so that they cannot drop and thus accidentally close circuit as might occur were the locking toggle not provided. Preferably, too, the movable switch element is reciprocative along guides which are insulated, or composed of insulating material. By the use of such insulating guides, the dimensions of the switch for any given capacity may be considerably reduced over those forms wherein such insulation is not provided and air alone is relied upon as the dielectric.

The switch may be made up in any number of units by simply associating the units side by side upon a suitable frame.

The switch disclosed herein is especially useful as a disconnect switch. However, it need not be limited to that service.

The switch of the present invention is particularly useful in power systems in which it is adapted to carry heavy currents. It may be employed as a disconnect or isolator for breaking the continuity of the electrical circuit. In conjunction therewith the line which is disconnected from power may be grounded. The arrangement is such as to give substantially complete weather protection and yet give a visual indication of the open position when the operating connecting plunger is moved into engagement with the grounding contact and vice versa, when the plunger is in circuit closing position. Obviously, for indoor use the overlapping of the insulators with the sleeve need not be employed as weather protection is not necessary.

By changing the connections of the various contacts, the connecting plunger may be employed to ground either one of two lines or to ground them simultaneously if desired. The switch may also be employed to make a changeover of the line from one source of current to another without interruption or the transfer may be made with interruption of one line in advance of transfer to the other. Similarly, the two lines may be connected simultaneously or separately to a common supply connection.

One of the most important practical advantages of the present switch is the ability to make any of the above connections in a compact device which requires a minimum of space. This switch can be installed in situations which would not allow the installation of other forms of switches. It can be mounted directly in the run of the conductors and upon a grounded or insulated support. It will go into spaces and operate satisfactorily where no other form of switch can be used.

In addition to its compactness, it is substantially completely weatherproof.

An important operating characteristic resides in the use of a self-locking toggle for holding the contacts in the normal current conducting position. As will be described later, the preferred form of main contacts which are employed for continuously conducting heavy current when the switch is closed and hence should have minimum resistance, are of the type which are held in engagement under pressure which exerts a resilient reaction against the operating mechanism. This permits of a certain tolerance in the difference in position of the movable contacts relative to the stationary contacts and a certain permissible inequality between the contacts of either group, so that all three may be brought into contact and held resiliently in engagement even though they are slightly out of adjustment relative to the other group or even relative to each other. By the use of the toggle arrangement, these spring pressed contacts are held and locked firmly together, giving a reliable contact which requires minimum attention.

The various features and advantages of the

invention will be more fully understood upon reference to the following detailed description taken in connection with the accompanying drawings wherein preferred embodiments of the invention suited to single-phase and multi-phase circuits are shown.

In said drawings, Fig. 1 is a side elevation of a single-phase switch unit constructed and arranged in accordance with the present invention. Fig. 2 is a central vertical section through the same, the section being taken on a plane indicated by the line 2—2 of Fig. 1. Fig. 3 is a front elevation of three units mounted upon a single frame with suitable actuating mechanism thus providing a switch for a three-phase circuit. Fig. 4 is a central vertical section, similar to the central portion of Fig. 2, illustrating a modified construction wherein the intervening reciprocating contact bridges the circuit between the associated contacts when moving from one extreme position to the other. Fig. 5 is a similar section of the upper portion of a further modified structure. And Fig. 6 is a central vertical section through the lowermost contact mounted upon the frame with a suitable intervening insulator, this structure being a modification of the lowermost structure of Fig. 1. Throughout these views like characters refer to like parts.

Referring to said drawings in detail, and at first more particularly to the single-phase structure of Figs. 1 and 2, 10 designates an upper insulating member which takes the form of a socket or tube having an open lower end. This tubular member 10 cooperates with an intermediate insulating member 11 which also is preferably tubular in form. In turn the member 11 cooperates with a lower insulating tube 12. These tubes all have a common longitudinal axis, as will be apparent from a consideration of Fig. 2. Within these tubes, respectively, are an upper electric contact 13, an intermediate electric contact 14, and a lower electric contact 15. Below the contact 15 is an additional electric contact 16. These contacts are all in axial alignment. The three principal contacts of the switch are the contacts 13, 14 and 16. The contact 15 is auxiliary and is such as to provide connection with the intermediate contact 14, as will be apparent from the description hereinafter given. Between the contacts 15 and 16 and surrounding the space occupied or to be occupied by the contact 14, is an insulating tube 17. Ordinarily the tubes 10, 11 and 12 are composed of porcelain while the tube 17 is composed of Bakelite or other suitable insulating material.

The three tubes 10, 11 and 12 are mounted, respectively, in three frame members 18, 19 and 20. The insulating tube 17 is secured, as will be more fully pointed out hereinafter, to the lower end of the contact 15. As shown, the lower end of the tube 17 closely approaches the upper end of the contact 16. The contact 16 is in turn mounted upon a frame member 21. The frame members 18, 20 and 21 are relatively fixed while the frame member 19 carrying the intermediate insulating member 11 is movable. As clearly shown, the tubular insulating members 10, 11 and 12 are in telescopic relation to each other, the upper member 10 being of largest diameter, the intermediate member 11 of intermediate diameter, and the lower member 12 of smallest diameter. These tubes, as clearly shown, are aligned and in their telescopic operation the intermediate tube 11 passes into the upper tube 10 and the lower tube 12 passes into the intermediate tube 11. The reciprocating parts are made smooth and provided with sufficient clearance to prevent their engaging with each other when moved as described. The non-overlapping parts of the tubes have their outer surfaces preferably corrugated or otherwise formed so as to provide a superficial surface of greater length in order to increase the resistance to creepage losses of current over the surface of the tubes as is well known in the electric insulator art. As clearly shown, the insulating member 10 has the outer corrugated surface 23 and the tube 12 has a similar outer corrugated surface 24. In the former case the corrugations are all above the frame 18 and in the latter case they are all below the frame 20. The intermediate tube 11 does not have an outer corrugated surface but the latter is smooth so as to readily pass upward into the upper tube 10.

The main frame which carries the frame members 18, 20 and 21, includes, for the single-phase structure, two end frames 25 which are provided with upper flanges 27, lower flanges 28 and rear flanges 29. The latter are provided with bosses 30 in which are openings 31 for the passage of retaining bolts or other means for securing the frame against a vertical wall or like support.

Extending between the end frames 25 and at the top of the same, are transverse frame members 32 located one at the front and the other at the back of the end frames. The members 32 preferably take the form of angle irons and are secured to the upper flanges 27 of the end frames by suitable bolts 33 and nuts 34, the bolts passing through apertures provided in the associated flanges. Similarly, the lower flanges 28 of the end frames are provided with frame members 35. Again, these members take the form of angle irons and one is located at the forward edge of the frames and the other toward the rear. In this instance, suitable bolts 36 and associated nuts 37, the bolts passing through the flanges of the associated members, secure the parts together. The lower portion of the frame is provided by rods 38 which depend from the frame members 35 and support the structure which carries the lower contact frame member 21. The upper ends of the rods 38, of which there are four, are secured to flanges of the frame members 35, preferably by passing the same through apertures in the flanges and securing them in place by suitable nuts 39. At the lower end of the rods 38 there are end frame members 40 cooperating with the member 21. The latter in the embodiment illustrated is a plate. The members 40 preferably are angle irons. These angle irons 40 are connected to the plate 21, in the embodiment illustrated, by passing the rods 38 through apertures in the plate 21 and registering apertures in the horizontal flanges of the angle irons 40 and then securing the same in final position by tightening up the nuts 42 upon the rods. In this way a support is provided for the lower contact 16.

The insulating tube 10 may be secured within the frame member 18 in any suitable way. In the present instance this frame member has an opening through it which loosely fits over the outside of the tube 10 below the corrugations 23. When the tube is properly positioned in the frame 18, a filling of cement 51 serves to bind the parts together and hold the tube fixed within the frame 18 and in proper alignment with the axis of the structure. The tube 11 is similarly secured to the intermediate frame 19 by a similar filling 52. The frame 19 has a ring portion 53 which fits loosely over the exterior of the tube 11 and is secured

by the cement. The ring 53 is provided with lateral horizontal portions 54 which lie in a common plane and overlap portions of two transverse frame members 55, one located at the front of the structure and the other at the rear. These members 55 are preferably angle irons and the flat portions 54 of the frame 19 overlie the horizontal flanges of the angle irons and the parts are secured together by suitable bolts 56 and nuts 57. As pointed out more fully hereinafter the frame member 19 and the associated members 55 constitute a movable frame for raising and lowering the intermediate insulating tube 11 and the parts fixed to it. In like manner the lower insulating member 12 is secured by suitable cement 58 to a ring 59 forming part of the frame member 20. As clearly shown the insulating tubes are carefully aligned so that they may be telescoped by a simple to and fro movement of the central or intermediate frame and tube.

Each tube of the three mentioned has an electric contact associated with it and the parts are constructed so that the contacts may be secured to the respective insulating members. Thus in the case of the tube 10 the tube has a transverse portion 60 which in the present instance constitutes the end of the tube. This end 60 is apertured for the passage of the contact 13. A suitable cement filling 61 secures the contact in place when the parts are properly assembled. Thus in the case of the contact 13 there is a shank 62 and a head 63. The head is adapted to engage the inner face of the end 60 of the insulating tube 10 and a nut 64 screwed upon the outer threaded end of the shank 62 is used to clamp the contact to the head. Ordinarily a suitable washer 65 is located between the nuts 64 and the adjacent head 60 and a similar washer 66 is located between the head 63 and the inner wall of the end 60. It will be clear that when the parts are assembled and the nut 64 screwed down tight then the contact 13 will be properly placed. The outer end of the shank 62 also carries a nut 67. Between the nuts 67 and 64 the apertured end of a wire terminal 68 may be located. When the nut 67 is screwed down tight then the terminal is properly held in place and is in good electrical engagement with the contact 13.

When it comes to the intermediate contact 14 secured to the tube 11, then an inward projecting ring 70 formed upon the inside of the tube 11 cooperates with a head 71 which forms the head of the intermediate contact 14. The head 71 is provided with a ring 72 which is adapted to lie above the insulating ring 70. A nut 73 screwed on the lower portion of the head 71 cooperates with the other parts in securing the head to the insulating member. In this case intervening washers 74 and 75 are used to cushion the contacts between the metal flange 72 and the metal nut 73 in their action upon the intervening porcelain flange 70. At this point it may be noted that the head 71 is apertured and the aperture is threaded for the reception of the rod which constitutes the main element of the contact 14.

When it comes to the lowermost contact 16 the same is held in place by nuts 76 which are threaded upon the exterior of the contact and engaged with the frame plate 21 on the one hand and with terminal conductor bar 77 on the other hand. By tightening up the nuts 76 firm contact is made between the parts and current passing into the tubular contact 16 will pass to the other metal parts associated with it and particularly to the bar 77. As will be apparent later this terminal may be differently mounted. As here mounted it is in permanent mechanical and electrical engagement with the lower end of the frame of the switch. In some instances it may be desirable to insulate this contact as will be pointed out later.

It may be noted also that the upper end of the insulating tube 11 might be shaped somewhat differently. A modification in this respect is also referred to later on. In the structure before us as in the later modified structure the action of the intermediate tube 11 and the contact 14 which it carries when cooperating with the contact 13 and the tube 10 is that of a plug and socket. The lower elements constitute the plug and the other elements the socket.

When it comes to the form of the contacts which are carried within the different insulators, different contact arrangements may be employed. In the present instance there are cooperating elements on the head of the upper contact 13 and the head of the intermediate contact 14 and the latter which is in the form of a solid rod cooperates with a tubular contact at its lower end. In my aforesaid Patent No. 1,918,901 this arrangement is employed and this might obviously be used in the present case with slight modifications in structure to adapt the central tubular contact to the solid end contacts. But considering the structure disclosed in the form of the invention now under consideration it will be seen that the upper contact 13 has upon its head 63 two rows of spring fingers, an inner row 78 and an outer row 79. These fingers are preferably provided by cutting away the head 63 on its under side so as to provide concentric spaces and then slitting the resulting projections by longitudinal cuts so as to give the several fingers as shown and described. These fingers are also preferably curved so as to provide a bell-mouthed approach. A coiled outer spring 80 extends around the outer fingers 79 and tends to force them inward. A coiled expanding spring 81 extends helically around within the space behind the fingers 78 and engages the surfaces of these fingers and by its action tends to force them outward. The spring pressed fingers 78, 79, however, are sufficiently stiff, while yet laterally yielding, to provide the requisite space between them for the entrance of a cooperating ring 82 located upon the head 71 of the intermediate contact 14.

The ring 82 is in cross section shaped with outer and inner curved surfaces somewhat resembling the curves of a gear tooth. This ring, by reason of the curvature of its surfaces, readily enters into the space between the fingers 78 and 79 to make contact.

It will be apparent that when the intermediate contact 14 is in its uppermost position good electrical connection will be made between the heads 63 and 71 through the cooperating ring 82 and the associated contact fingers 78 and 79. When the contact 14 is moved downward then the circuit between the contacts 13 and 14 will be opened and any arc which may be formed between the contacts will be in a chamber formed inside of the tube 10 and bounded beneath by the receding insulating tube 11. Such a chamber will have access to the outside air through a narrow passage 83 formed between the tubes 10 and 11. This passage materially assists in extinguishing any arc as pointed out in my aforesaid patent.

When the contact 14 is moved to its lowermost position its lower end will pass into the tubular contact 16. This contact like the others is com-

posed of copper or other good electric conducting material. In order to make close engagement with the end of the rod of contact 14 the upper ends of the tube 16 are slitted so as to provide yielding fingers 84. These fingers are pressed inward by coiled springs 85 positioned in suitable depressions on the outer surfaces of the fingers 84 and acting thereupon the same as the coiled spring 80 upon the associated fingers 79. Obviously when the intermediate contact 14 is in its lowermost position it will make circuit only with the lowermost contact 16 and the auxiliary contact 15.

Coming now to the additional contact 15 we have a feature which distinguished the present invention from the prior art. This contact is also made up in the form of a tube having its upper end slitted so as to provide a series of spring fingers 90. These fingers are, like the fingers 79 and 84, spring pressed inward so as to provide good electrical contact with the rod of the intermediate contact 14. The coiled springs 91 which rest in depressions formed on the outer surfaces of the fingers 90 serve to bring about this good electrical contact, the operation being the same as in the case of the previously mentioned springs 80 and 85. The tubular contact 15 is located within the insulating tube 12 and is coaxial with the same and with the contact 14. The tube 12 is provided with an inner ring 92 which extends a short distance in from the wall of the tube. Cooperating with this ring is a flange 93 extending outward from the tubular contact 15. Between the ring 92 and flange 93 is a piece of rubber or like insulation 94 which serves to take up unevenness when the parts are drawn together to keep them in position. The accomplishment of this result is brought about by a nut 95 which is threaded onto the exterior of the tubular contact 15 near its lower end. Suitable cushioning material 96 between the upper face of the nuts 95 and the lower end of the insulating tube 12 takes care of unevenness in the parts which are drawn together. When the contact 15 is dropped into the open end of the tube 12 the flanges 92 and 93 come into action and the contact is brought to a stop in its proper location in the tube. Then when the nut 95 is applied it will firmly press against the lower end of the tube 12 and thus secure the tubular contact 15 in place within the insulating tube 12.

It now remains to connect up the contact 15 with a suitable outside terminal. This may be done in different ways. In the present instance a bar 97 is apertured so as to pass over the lower end of the tube 15 and this bar is pressed upward into firm engagement with the nut 95 by means of a nut 98. When this is accomplished the bar 97 is in good electrical contact with the contact member 15. As shown, the bar 97 may be connected with any suitable conductor, such as the conductor 99.

In this connection it may be noted that the insulating tube 17, which forms in a way an extension of the tube 12, is interiorly threaded so as to be screwed upon the lower end of the tubular contact 15. In this way the space between the lower end of the contact 15 and the upper end of the contact 16 is practically surrounded by an insulating material.

With the construction described it will be clear that the rod of the intermediate conductor 14 is always in engagement with the contact 15 and hence with the terminal bar 97. Thus the switch structure is provided with three terminal contacts, viz., the contacts 13, 15 (by way of 97) and 16. Obviously a switch of this structure may be variously connected. Indeed, there are so many possibilities in this connection that it seems needless to point out any particular ones. In some instances the contacts 13 and 16 may be connected to sources of electrical energy and the contact 15 may be connected with devices which are to be supplied from either of said sources, at one time from one and at another time from another. Again, the contacts normally in use during the active operation of the apparatus may be contacts 13 and 15 while the contacts 16 may be one connected to ground. In such case the breaking of circuit between the contacts 13 and 14 may be accompanied by connecting certain of the apparatus through contacts 15 and 16 to ground. These are merely suggestive uses.

In order to guide the intermediate tube 11 and its contained contact 14 in a truly rectilinear path I preferably provide guide rods 100 which are fixed in the frame of the switch. These rods are parallel to each other and to the axis upon which the several switch contacts are located. In the present instance each rod 100 extends between a flange 101 formed on the associated end member 25 and the upper flange 27 of said end member. Suitable retaining nuts 102 and 103 threaded upon the lower end of the rod serve to firmly secure the rod 100 to the flange 101. A head or nut 104 at the opposite end of the rod 100 bears downward upon the flange 27 of the end member and serves to hold that end of the rod in place. Before the rod is put into place in the structure an insulating tube 105 is slipped over the same. This sleeve or tube bears at its upper end against the under surface of the flange 27 and toward the lower end of the rod 100 has bearing against it a nut 106 which is threaded upon the rod and when turned up tight forces the tube 105 up against the flange 27 and thus firmly holds the tube in place upon the rod. A lock nut 107 may be used upon the rod to maintain the insulating tube in its position. On the outside of the insulating tube the sleeve 108 of the reciprocating frame 19 travels. This sleeve is secured to or forms part of the structure of the movable frame.

As shown there are two guide rods 100 with their insulating coverings 105 and there are likewise two cooperating sleeves 108. As a result of this construction the intermediate contact 14 is given proper reciprocations.

It will be seen that the reciprocations thus given to the intermediate portion of the switch will be in a right line. Thus contacts 13 and 14 will readily interfit when making and breaking circuit and likewise the lower end of the contact 14 and contact 16 will readily telescope when circuit is to be made or broken at that point. Of course, at all points in the travel of the intermediate contact 14, the latter will be in electrical engagement with contact 15.

For the purpose of actuating the intermediate frame 19 and its associated parts, certain toggle mechanism is employed. As shown, the intermediate frame 19 has at its ends upturned flanges 111 and these provide supports for laterally projecting pins 112 which serve as pivot pins for toggle member 113. As clearly shown, the members 113 in each instance are apertured near their upper ends for the passage of the pivot pins 112. Each toggle member 113 at its lower end is apertured for the passage of a pin 115. This is also a pivot pin and unites the lower end of the link 113 to the upper end of the toggle member 116 which is in the case of both toggles mounted upon a

shaft 117 suitably journaled at its ends in bearings formed in the end members 25. When the parts are in the position shown in Fig. 1 the toggle is just beyond dead center and the toggle member 113 engages a stop 118 upon the adjacent flange 111 of the reciprocating frame 19.

It will be seen that when the toggle is in this beyond-center position and in engagement with the stop 118 the frame 19 is held up with contacts 13 and 14 closed. Because of the position of the toggles at this time these contacts are located in engagement and it is obvious from the inspection of the toggles that the same is true. Because of this locking of the contacts by the toggles any workman having to do with the installation or the operation of the switch at any time can at once determine its electrical condition and therefore is in no danger of injury by reason of having to do with apparatus which he thought was in one condition when it was in fact in a different condition.

The toggle mechanism may be operated in different ways and may be variously controlled but since such forms no part of the present invention it will be needless to point out any mechanism of this kind. Suffice it to say that the end of the shaft 117 is squared as shown at 119 so as to receive the socket of a crank which may be used to throw the switch manually. In practice additional precautions may be taken and if desired the actuating arm of the switch may be locked as indicated in my prior Patent No. 1,918,901.

As previously stated a number of units such as described may be used according to the requirements of the circuit. It is only necessary to place the elements side by side upon suitable frame work to build up a switch of any desired number of units. By way of illustration I have shown in Fig. 3 a switch of the same construction as that heretofore described but differing only in that three of the units are mounted in the frame structure. Thus a three-phase switch is produced. When the number of units is increased then of course certain elements of the structure must be modified. Thus with the three units the upper insulating tubes 10 have their frames 18 secured to the front and rear frame members 32*a*. Since the frame must be longer in order to accommodate three insulators 10 it is necessary to replace the former frame members 32 by the longer frame members 32*a*. Similarly, the intermediate frame members 55 are replaced by the longer frame members 55*a*. Again, the frame members 35 associated with the insulating tubes 12 give way to the longer members 35*a*. Similarly the members 40 are replaced by the members 40*a* and the shaft 117 is replaced by the longer shaft 117*a*. In other respects the switch is practically the same and by reason of the full description heretofore given it seems unnecessary to go into the description of the three-phase switch with any greater particularity.

Obviously the circuit arrangement heretofore described may be variously modified in addition to the modification suggested by my prior Patent No. 1,918,901. Thus in certain switch structures it may be desirable to cause the extreme contacts to be brought into electrical communication with each other during the operation of passing from one extreme electrical condition to another. A circuit arrangement to accomplish this result is indicated in Fig. 4. As there shown the upper insulating tube 10 is associated with the modified insulating tube 11*a* and a modified insulating tube 12*a*. The tube 17 also gives way to a tube 17*a* of slightly larger diameter. This increase of diameter is necessary because of the projection of the contact 16*a* of greater length than the contact 16 into the interior of the tube 17*a*. The several tubes 10, 11*a*, 12*a* and 17*a* are mounted practically as the corresponding parts 10, 11, 12 and 17, respectively, heretofore described. In this arrangement the contacts 13*a*, 14*a* and 16*a* differ from the corresponding contacts 13, 14 and 16, respectively. The contact 15 remains the same.

The arrangement shown in Fig. 4 merely has the dimensions changed over the previous form of the invention in order to insure that the contact 14*a* when moving from its uppermost position to its lowermost position will bridge contacts 13*a* and 16*a*. The contact 14*a* is shown in Fig. 4 in full lines. The position so shown is the uppermost position of the contact 14*a* and its limits are designated *a*, *a*. Likewise the limits of the contact 14*a* in its intermediate or bridging position are shown by the dash lines *b*, *b*. Likewise the limits of the same contact in its lowermost position are shown by the dot and dash lines *c*, *c*.

The contact 13*a* is tubular in form. It has the same shank 62 as is present in the contact 13 but its contacting end is tubular and slitted so as to provide a number of fingers 120 held in spring pressing condition by the outside coiled springs 121. The shank is held in position in the end 60 of the member 10 through the action of the nut 64 and an additional nut 122 which takes the place of the head 63 of the former construction. By tightening up the nuts 64 and 122 against the intervening cushions 65 and 66 the terminal contact 13 may be held firmly in place. Obviously it is in alignment with the axis of the switch and in position to have its fingers 120 engaged by the upper end of the reciprocating contact 14*a*.

The contact 14*a* is in this instance a rod of suitable conducting material which has enlargement 123 at a point near its upper end, which enlargement is threaded exteriorly for the reception of a nut 124. This nut cooperates with a nut 125 and suitable intervening cushions 74, 75 to secure the contact 14*a* to the tube 11*a*. The nuts 124 and 125 act upon the flange 70 on the inner side of the tube 11*a* just as in the case of the preferred embodiment more fully described heretofore. In this instance the tube 11*a* is secured to the reciprocating frame in the same manner as heretofore described.

When it comes to the insulating tube 12*a* we have the same flange 92 as before and the same flange 93 upon the tubular contact 15 cooperates with the same nut 95 to secure the parts together. Again, there are cushions 94 and 96 located and operating as in the previous case. In this instance too the same conducting bar 97 is held in contact with the nut 95 by a nut 98. The tubular insulating extension 17*a* is also threaded onto the outside of the contact 15 as was the tube 17 in the prior construction. The tube 17*a* is, however, of larger interior diameter since it must accommodate the tubular contact 16*a* with its contact fingers 84*a* and their exterior coiled springs 85. The tubular contact 16*a* is secured to the frame parts just as the contacts 16 heretofore considered.

As previously indicated the intermediate tubular insulating member 11 need not be made in

the form shown in the earlier figures of the drawings but may be modified so that the contact which it carries will extend beyond the end of the insulating tube instead of terminating at a point inward from its end as illustrated in Fig. 1. Such a modification of this portion of the structure is illustrated in Fig. 5. As there shown the insulating tube **10** and **12** are the same as heretofore described. The intermediate tube, however, is modified as shown. The petticoat of the insulator **11***b* terminates at its upper end in an inwardly extending flange **126** which cooperates with the nuts **124** and **125** in firmly securing the tubular insulator **11***b* to the intermediate contact **14***b*. The contact **14***b* is in general the same as the contact **14***a* but is shorter. It has an enlarged portion **123** that is threaded on its outer surface for the reception of the nut **124**. The contact **14***b*, however, is made of a length suited to the requirements of the upper contact **13***b*.

As clearly shown the upper contact **13***b* has a shank **62** with associated nuts **64** and **122** which with intervening cushions **65** and **66** cooperate in the same way as the corresponding parts in Fig. 4 in securing the contact **13***b* to the insulator **10**. The contact **13***b* is provided at its lower end with a series of fingers **127** similar to the fingers **120** of Fig. 4 and these fingers are pressed inward by a coiled spring **128** which rests in depressions on the outer faces of the fingers. The fingers **127** are also curved outward and downward so as to provide a bell-mouth opening for the upper end of the intermediate contact **14***b*.

With this construction the contact **14***b* with its insulator **11***b* is somewhat more plug-like in appearance than the intermediate contacts of the other figures. The action, however, when the parts are moved to and fro, is the same in making and breaking circuit as before described, except that with the insulating member **11***b* providing a short annular passage **129** to atmosphere, the chamber in which the circuit is broken is more quickly opened directly to atmosphere through a wide opening. In the earlier figures the petticoats of the two insulators overlap to such an extent that considerable movement is required before the narrow outlet passage **83** is ineffective. The relation between the tubular insulators **11***b* and **12**, however, continues about as it does between the corresponding parts in the other figures.

Turning now to a consideration of the lowermost contact it will be noted that the same may be mounted in an insulator and have a connection which is separate and distinct from the frame of the switch. Such a contact is illustrated in Fig. 6. There the contact designated **16***b* is made up of a tubular portion **134** and a headed stem **135**. The insulator itself designated **136** is composed of porcelain or other suitable insulating material and is secured to the lower frame members **21** and **77** by suitable cement **137** interposed between the interior of the walls of the opening in the metal pieces **21** and **77** and the outer wall of the insulator just above the corrugations **138**. The manner of attaching the insulator **136** to its frame is the same as that employed in attaching the insulator **10** to its frame. As shown the insulator **136** has a head **139** which is apertured for the passage of the shank **135** of the contact **16***b*. The shank is threaded and secured in place by the nut **140**. The upper end of the shank has a shoulder **141** which cooperates with the nut **140** in securing the contact in place in the insulator. The nut **142** is used to hold an intervening terminal **143**. When the nut **142** is screwed down tight upon the shank **135** the terminal **143** is firmly held in place and connection is established with the tubular portion **134** of the contact **16***b*.

The interior of the lower tubular portion **134** of the contact **16***b* is threaded upon the upper end headed portion **144**. The downward movement of the tube **134** upon the head **144** is limited by a shoulder **145** upon a tube **134** engaging the upper edge of the head **144**. The upper end of the tube has flaring fingers **146** made up as heretofore described and these are held in place by coiled tension springs **147** bearing suitable recesses in the outer surfaces of the fingers **146**.

It will be noted that where the lower contact is insulated as shown in Fig. 6 the frame will be free from connection with this contact.

When considering the several contacts in the different forms it will be noted that these contacts are positioned along a linear axis. It will also be noted that although this axis is vertical in the drawings the switch itself may be positioned in various ways in all of which the axis would not be vertical but would occupy some other relation to the horizon. For convenience in designating the various contacts, and particularly in the claims, the contact **13** and those corresponding to it may be called "first" contact, the contact **14** and those corresponding to it, the "second" contact. The contact **16** and those corresponding to it, the "third" contact, and the contact **15**, and those corresponding to it, an "electric terminal." The latter in all the forms shown is in constant electrical engagement with the second contact but obviously the latter might be interrupted by non-conducting portions for certain purposes necessitated by the particular circuits for which the switch was used. In such case the terminal **15** might be out of circuit when engaging such insulating portions and would be if such portions were extensive enough to wholly insulate the terminal **15**.

From the modifications indicated it will be apparent that changes may be made in the various forms shown, to quite an extent without departing from the spirit and scope of the invention. I therefore aim to cover by the terms of the appended claims all the alterations and modifications which rightly come within the limits of the invention.

I claim:

1. In an outdoor high tension disconnecting switch of the class described, a stationary upper contact having an insulated line terminal comprising means for clamping and supporting the end of a line conductor, a stationary intermediate insulated line terminal, a stationary insulated lower contact, rigid supporting insulators for said line terminals, an axially movable elongated rodlike conductor in constant slidable electrical engagement with said intermediate terminal and adapted to engage selectively either of said contacts, a tubular insulator connected to said movable conductor and telescoping with said supporting insulators to render the switch weatherproof, means for guiding said elongated conductor independently of the contacts, a movable rocking shaft for reciprocating said elongated conductor, a rigid arm connected to said shaft and a link for connecting the arm and the tubular insulator, said arm and link forming a toggle when the conductor is moved into engagement with the upper contact to lock the conductor and said upper contact together.

2. In a heavy amperage high tension disconnect switch, a pair of spaced aligned contacts insulated from ground, a plunger movable into and out of engagement with said contacts one at a time, a stationary sleeve contact embracing said plunger, said sleeve having a line terminal for making connection between the plunger and a line conductor, insulating sleeves for the plunger and the sleeve contact and guiding means insulated from but mechanically rigid with the plunger for guiding the plunger independently of the insulating sleeves.

3. In a high tension switch of the class described, a metallic frame member provided with an upper and a lower and an intermediate shelf, an inverted cup shaped insulator rigidly mounted on the upper shelf and opening downwardly below the shelf, a stationary contact in said cup and having a line terminal supported by the cup above the shelf, said contact facing the open end of the cup, an insulating sleeve mounted in said intermediate shelf and extending partly above and partly below the same, a conducting plunger disposed in said sleeve, a second line terminal supported on said insulating sleeve, means for maintaining electrical connection between said second line terminal and said plunger, an insulating sleeve fastened to said plunger, said last named sleeve telescoping internally with the cup shaped insulators and externally with said first named sleeve, and a contact supported on said lower shelf and being engageable by said plunger when the same is moved downwardly.

4. The switch of claim 3 wherein a stationary metallic contact sleeve embracing said plunger is mounted on said insulating sleeve to maintain connection between said plunger and said intermediate terminal.

5. In a high tension switch, a frame having a pair of shelf members one above the other, an open ended insulating sleeve mounted on the upper shelf and extending through the same, an axially movable plunger reciprocable in said insulating sleeve, a metallic sleeve mounted on the lower end of said insulating sleeve and projecting up within said insulating sleeve, said metallic sleeve having spring fingers slidably engaging said plunger, a terminal connected to said metallic sleeve, a contact mounted on said lower shelf, said latter contact being engageable by said plunger.

6. The switch of claim 5 with a tubular insulating sleeve carried by the lower end of the metallic sleeve and extending to a point adjacent the contact on said lower shelf.

7. The switch of claim 5 with a telescopic insulator mounted on the plunger and cooperating with the insulating sleeve, means secured to said telescopic insulator and guided on the frame for operating said plunger.

8. In a switch, a frame member having an upper shelf, an intermediate shelf and a lower shelf, an insulated stationary contact mounted on the upper shelf and having a line terminal, a tubular telescopic contact mounted on the intermediate shelf and having a line terminal, a lower stationary contact mounted on the lower shelf, a rodlike telescopic contact slidable endwise in the tubular contact and engageable with the insulated contact and with the lower contact, a movable slide insulated from but mechanically connected to the rodlike contact and guided on the frame member, and means for shifting the slide to move the telescopic rodlike contact to engage and disengage at least one of the stationary contacts.

9. The combination of claim 8 wherein the rodlike contact and one of the stationary contacts are held in engagement under yielding resilient pressure, and said means comprises a toggle for locking the said contacts together.

10. In a switch of the class described, a main frame having a plurality of horizontal shelves, a hollow insulator mounted in the top shelf, said insulator opening downwardly and containing a contact element, a tubular insulator mounted in the next lower shelf in line with the first insulator and containing a contact sleeve, a rodlike contact element extending through said contact sleeve and in continuous electrical engagement therewith and adapted to be thrust into resilient engagement with said contact element, a tubular insulating sleeve telescoping with said hollow insulator and said tubular insulator and being anchored to the rodlike contact element, a movable frame having a vertical rectilinear guide mounted on the two upper shelves of the main frame, said movable frame being anchored to the tubular insulating sleeve, a cross shaft mounted on the second shelf adjacent the tubular insulator, a metallic arm rigid with the cross shaft, a link pivotally connected to the arm and to the movable frame, said link permitting the swinging metallic arm to shift the movable frame on said guide, said link and said arm cooperating to form a locking toggle extending in a generally vertical direction when the rodlike contact is forced into engagement with the contact element.

11. In a switch of the class described, a main frame having a plurality of horizontal shelves, a hollow insulator mounted in the top shelf, said insulator opening downwardly and containing a contact element, a tubular insulator mounted in the next lower shelf in line with the first insulator and containing a contact sleeve, a rodlike contact element extending through said contact sleeve and in continuous electrical engagement therewith and adapted to be thrust into resilient engagement with said contact element, a tubular insulating sleeve telescoping with said hollow insulator and said tubular insulator and being anchored to the rodlike contact element, a movable frame having a vertical rectilinear guide mounted on the two upper shelves of the main frame, said movable frame being anchored to the tubular insulating sleeve, a cross shaft mounted on the second shelf adjacent the tubular insulator, a metallic arm rigid with the cross shaft, a link pivotally connected to the arm and to the movable frame, said link permitting the swinging metallic arm to shift the movable frame on said guide, said link and said arm cooperating to form a locking toggle extending in a generally vertical direction when the rodlike contact is forced into engagement with the contact element, a bottom shelf, and a contact adapted to be engaged by said rodlike contact element when said metallic arm is swung downwardly to disconnect the rodlike element from the contact element.

12. An outdoor weather-protected switch for switching primary electric power circuits, comprising a metallic mounting frame for supporting the operating parts, said frame providing three shelves horizontally extending and vertically aligned, a hollow inverted cuplike insulator supported in the topmost shelf and containing a contact element within the cup and a connected terminal element outside the cup, an

insulating sleeve mounted in the second shelf in alignment with the first insulator, a sleeve contact supported within said insulating sleeve and having a terminal external of and carried on the sleeve, a stationary contact mounted on the lowermost shelf in alignment with the sleeve contact, a rodlike plunger element slidably mounted in the sleeve contact to make contact continuously therewith and having contact elements at its opposite ends for engaging the contact element and stationary contact, one at a time, movable means connected to the plunger for shifting the same, said means including an intermediate insulating sleeve adapted to telescope with the cuplike insulator and the insulating sleeve and an auxiliary frame, guiding rods having their ends mounted in said two upper shelves, and guide sleeves lying within the confines of the auxiliary frame for guiding the rodlike contact independently of the sleeve contact, said guide rods lying adjacent the sides of the intermediate insulating sleeve and being covered with insulation to avoid reducing the striking distance by the presence of the rods.

13. In combination, a metallic frame 32 having three shelves 18, 20, 21, an inverted cup insulator 10 stationarily mounted in the top shelf 18, a main switch contact 13 therein, a stationary sleeve insulator 12 mounted in the second shelf 20, a movable sleeve insulator 11 telescoping inside the cup insulator 10 and outside the stationary sleeve insulator 12 to provide a water-shedding exterior, a rodlike contact member 14 fixedly mounted in the movable sleeve insulator 11, a pair of guide rods 100 connecting the top 18 and second shelf 20, a movable frame 25 carrying the movable sleeve 11, said latter frame having guides 108 on said guide rods 100, a tubular sleeve and terminal member 15 anchored on the lower end of the stationary sleeve insulator 12, said last named member 15 comprising a tubular contact portion 96 lying inside the stationary sleeve insulator 12 and in slidable contact with the rodlike contact 14, an external line terminal 97 and a downwardly projecting tubular extension, a stationary contact 16 engageable by the lower end of the rodlike contact member 14, said last named contact 16 being mounted on the lower shelf 21, and a sleeve of insulation 17 coupled to said tubular extension and forming a continuation of the stationary sleeve insulator 12 for housing the rodlike contact 14 and forming a water shed for said stationary contact 16.

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