

INSULATION SWITCHING APPARATUS FILLED WITH ELECTRICALLY INSULATING GAS

The present invention relates to an insulation switching apparatus employing an envelope which encloses therein at least two open type switches and a closed type switch such as a vacuum circuit breaker and is filled with one or more insulating gases so as to prevent one of the open-type switches from being affected owing to high-temperature arced gases resulting from cutting-off operation of the other open-type switch.

As is generally known, an insulation switching apparatus includes a plurality of switches in an envelope filled with electrically insulating gas, such as composite gases. In such insulation switching apparatus, it is desirable to minimize the total size of the apparatus by reducing the distance between at least two adjacent switches, without causing short-circuit between the two adjacent switches. One such small-sized insulation switching apparatus has been disclosed in Japanese Patent Second Publication (Tokko Showa) No. 4-35966. Fig. 9 is a schematic illustration of a prior art insulation switching apparatus described in the above Japanese document. Referring now to Fig. 9, the insulation switching apparatus includes an envelope 4 filled with electrically insulating gases, a first closed-type switch 1 such as a vacuum switch tube, a second open-type switch 2 which includes a stationary connection terminal 12, a stationary earthing terminal 8 attached to the envelope 4 and a rotatable blade 10, and a third open-type switch 3 which includes a stationary connection terminal 13, a stationary earthing terminal 9 attached to the envelope 4 and a rotatable blade 11. Reference numerals 5, 6 and 7 designate bushings, respectively. In the case that the respective rotatable blades 10 and 11 are held horizontal, a main circuit is maintained closed. In the case that the two blades 10

and 11 are held vertical, the main circuit is connected to earth. When the two blades 10 and 11 are held in their neutral positions between horizontal and vertical positions, the switching apparatus is conditioned neutral. As seen in Fig. 9, the second switch 2 is arranged below the first switch 1 in such a manner as to offset slightly to the right side, while the third switch 3 is arranged below the first switch 1 in such a manner as to offset slightly to the left side. The first switch 1 is connected to a load through an electric conductor disposed in the bushing 5. The second switch 2 is connected to a power receiving circuit through an electric conductor disposed in the bushing 6, while the third switch 3 is connected to a power receiving circuit through an electric conductor disposed in the bushing 7. In this manner, a T-shaped branch circuit would be constructed. The conventional switching apparatus shown in Fig. 9 serves as an earthing switch as well as a circuit breaker. The closed-type switch means that a pair of electrical contacts are sealed in an air-tight fashion by way of a closed envelope so as to prevent arced gases created by cut-off operation of the other switch from being introduced into an electric arcing region defined between a pair of electrical contacts disposed in the enclosure of the closed-type switch. In such a closed-type switch, since electrical contacts are essentially sealed by a closed envelope, the closed-type switch can insure a sufficient dielectric strength against transiently remaining arced gases, while maintaining a relative distance to the other switch to a minimum. In contrast, the open-type or non-closed-type switch means the opposite type to the closed-type switch. In such a non-closed-type switch, arced gases can be discharged to the outside thereof, when current flow is blocked by cut-off operation of the switch.

When a main circuit is established, i.e. the first, second and third switches 1, 2 and 3 are all conditioned in their closed positions, a loop current flows across the second and third switches 2 and 3, and a load current flows across the first switch 1. Under these conditions, when one open-type switch 2 is

opened to release the loop, electric arc is produced between the movable blade 10 and the stationary connection terminal 12 as the loop current is blocked. As a result, arced gases heated by the electric-arc are discharged and diffused. Even though the

5 diffused arced gases reaches to the first switch 1, the first switch 1 exhibits a high dielectric strength enough to be proof against transiently staying arced gases, because of the closed-envelope. In addition, since the distance between the two adjacent open-type switches 2 and 3 is set to a minimum distance necessary for

10 insulation between the adjacent switches 2 and 3, the total width of the insulation switching apparatus can be shortened to $2/3$, as compared with a conventional switching apparatus not including a closed-type switch substantially midway between a pair of open-type switches. However, in case that the first switch 1 consists of

15 a vacuum switch tube, a vacuum circuit breaker or a vacuum interrupter, surface creepage will take place along the cylindrical surface of the insulating vacuum envelope of the switch tube, owing to a portion of arced gases produced by cut-off operation of the respective open-type switch 2 and 3 and

20 scattering onto the cylindrical surface of the vacuum envelope. In this case, dielectric withstanding voltage characteristics of the vacuum envelope can be degraded. Accordingly, there is a possibility of short-circuit between electrodes of the vacuum switch tube. In case a vacuum switch tube serves as a closed-

25 type switch arranged in the vicinity of a plurality of open-type switches, there is a drawback that the distance between the closed-type switch and the open-type switch as well as the distance between the two adjacent open-type switches must be set relatively long. The total size of the apparatus tends to be

30 enlarged.

The insulation switching apparatus usually includes an envelope enclosing therein a plurality of closed-type switches such as vacuum interrupters in addition to a plurality of open-type switches. The conventional insulation switching apparatus

35 equipped with a plurality of vacuum interrupters is shown in

Figs. 10 and 11. Referring to Figs. 10 and 11, the insulation switching apparatus includes three vacuum interrupters 1 respectively operable in three different phases and disposed in a closed tank or envelope 4 by way of an insulating frame 1f. Each vacuum interrupter 1 includes an axially extending upper movable electrical terminal 1a having an electrical contact at the inner end thereof and an axially extending lower stationary electrical terminal 1b having an electrical contact at the inner end thereof. The outer end of the stationary terminal 1b is connected through a coil 1d to an electrical inductor 14a which extends towards the exterior of the envelope 4 in such a manner as to penetrate the insulation bushing 14. On the other hand, the movable terminal 1a is connected to an electrical conductor 1e, so that the outer periphery of the terminal 1a is slidably received by a ring-shaped contact 1c firmly attached to the inductor 1e. A rotatably operating shaft 1g equipped with a linkage is mounted on the envelope 4. The operating shaft 1g is connected to the movable terminal 1a through the linkage, so that the rotational movement of the shaft 1g causes the axial movement of the terminal 1a. As best seen in Fig. 11, the envelope 4 has a substantially rectangular flanged end 4a in such a manner as to be widely opened at its rightmost end (viewing Fig. 10). As shown in Fig. 10, the opening end 4a is hermetically covered by a lid 4c, in such a manner that the lid 4c is detachably fitted onto the flanged end 4a via a packing seal 4b in an air-tight fashion, by means of bolts 4d. When assembling the conventional insulation switching device shown in Figs. 10 and 11, parts of the device are usually assembled together in accordance with the following order.

First of all, the insulation frames 1f, the vacuum interrupters 1, the inductors 1e, the bushings 14, the inductors 14a, the coil 1d, and the operating shaft 1g equipped with the linkage are inserted into the envelope 4 through the opening end 4a and mounted on the envelope, in that order. Subsequently, predetermined performance tests are made to check various

functioning of the device. After completion of the tests, the lid 4c is fitted onto the flanged end 4a via the packing 4b. Thereafter, the envelope 4 is filled with electrically insulating gases.

In the previously-noted conventional insulation switching device, many parts of the device are inserted from one side of the envelope, and in addition the working space is limited to a relatively narrow opening area. In consideration of three conditions, namely an efficiency of hand-working, the total size of the switching device, and a rigidity of the envelope of the device, the opening area of the envelope is limited to a minimum dimension necessary for a relatively smooth hand-working without any difficulty. Actually, such hand working is troublesome owing to the limited working space. For this reason, the size of the envelope cannot be extremely minimized. Necessarily, an efficiency of assembly task is lowered. As set forth above, in the above conventional insulation switching device, it is difficult to automatically assemble the device. Additionally, the conventional switching device suffers from the drawback that a large number of parts are required, because the device requires an additional part such as a packing seal 4b as well as essential parts such as vacuum interrupters or the like. The flanged end 4a is ordinarily formed such that a rectangular thin-metal frame is welded onto the opening end of the envelope 4 in a gas-tight fashion. As is well known, electric welding at the opening end may produce excessive welding distortion. Such a flanged end structure itself requires a skilled task, thereby resulting in a long weld time.

It would, in view of the above disadvantages, therefore be desirable to be able to provide a small-sized insulation switching apparatus with an envelope filled with electrically insulating gases and enclosing therein a plurality of switches in such a manner as to prevent one of the switches from being affected by arcing gases produced during cut-off operation of the other switch (also referred to below as "arced gases").

It would also be desirable to be able to provide a small-sized insulation switching apparatus with an envelope filled with electrically insulating gases and enclosing therein a plurality of switches, so that the distance between the two adjacent switches is shortened to a minimum while insuring a performance of each switch.

It would also be desirable to be able to provide an improved insulation switching apparatus with a small sized high-rigidity envelope filled with electrically insulating gases, which can provide a high efficiency of assembling and assure easy performance tests, and insure a high quality of the product irrespective of a skilled degree.

It would also be desirable to be able to provide an envelope structure of an insulation switching apparatus with an envelope filled with electrically insulating gases, which is optimally suitable for automatic assembly for the apparatus.

The present invention provides switching apparatus comprising a gas-tight sealed envelope which encloses a closed-type switch connectable to an electric load and a pair of open-type switches respectively connectable to a power receiving circuit and which is to be filled with electrically insulating gas, the closed-type switch and open-type switches being arranged adjacent to each other, and gas-flow guiding means for inducing a designated flow of arcing gases produced when at least one of the open-type switches is cut off to block current flow therethrough, so as to prevent undesirable arcing gas flow towards the closed-type switch and towards the other open-type switch, wherein the gas-flow guiding means comprises a pair of electric-arc-extinguishing guides respectively associated with the open-type switches and arranged between adjacent switches, the arc-extinguishing guide associated with one open-type switch defines a pocket temporarily capturing the arcing gases and having an opening facing away from the closed-type switch and the other open-type switch for inducing the designated flow of the arcing gases, so as to prevent the arcing gases from flowing

towards the closed-type switch and the other open-type switch, and each arc-extinguishing guide includes arc-extinguishing parallel metal plates disposed in the said pocket to effectively extinguish an arc produced by cut-off operation of the associated open-type switch.

The arc extinguishing metal plates may be arranged in parallel with each other at regular intervals and in addition the arc extinguishing metal plates may comprise a plurality of inverted V-shaped iron plates, each having an inverted V-shaped groove to efficiently receive and extinguish the produced electric-arc.

The gas-tight sealed envelope may comprise a pair of U-shaped members welded to each other in a gas-tight fashion to provide a gas-tight sealed hexahedral tank such that a cutting plane defining the U-shaped section of one U-shaped member is perpendicular to a cutting plane defining the U-shaped section of the other U-shaped member. The U-shaped members are assembled as the gas-tight sealed tank, after mounting electrical parts including the closed-type switch such as a vacuum _____

interrupter and the open-type switches such as a load-break switch with an earthing mechanism and a disconnecting switch with an earthing mechanism, on either one of the U-shaped members. Preferably, at least one of the U-shaped members may
5 include a sputter-protecting flanged portion which is formed along the edge of the U-shaped member, in such a manner as to be bent towards the inside at a right angle to the edge, thereby preventing a scatter of sputter caused by welding one of the U-shaped members to the other from reaching to the electrical
10 parts disposed in the envelope. The sputter-protecting flanged portion is integrally formed with one U-shaped member by bending.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective view illustrating a gas-tight sealed envelope of an insulation switching apparatus
15 according to the invention.

Fig. 2 is a cross-sectional view illustrating the insulation switching apparatus of the embodiment.

Fig. 3 is an illustration of an electric-arc extinguishing guide
20 employed in the switching apparatus, taken along the line III-III of Fig. 2.

Fig. 4 is a cross-sectional view taken along the line IV-IV of Fig. 2.

Fig. 5 is a side view illustrating the switching apparatus of
25 the embodiment, partly sectioned.

Fig. 6 is an exploded perspective view illustrating a modification of the envelope of the switching apparatus.

Fig. 7 is a cross-sectional view illustrating the insulation switching apparatus with the modified envelope.

Fig. 8 is a side view illustrating the switching apparatus of
30 the modification, partly sectioned.

Fig. 9 is a schematic plan view illustrating a prior art insulation switching apparatus.

Fig. 10 is a partially cross-sectional view illustrating a prior
35 art insulation switching apparatus.

Fig. 11 is a view in the direction of the arrows taken along the line XI-XI of Fig. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, particularly to Figs. 1 through 5, there is shown an insulation switching apparatus including three sets of switches, each set consisting of a central switch 24 arranged essentially in the center of an envelope, an upper-right switch 29 and a pair of lower-right and lower-left switches 34. The envelope of the switching apparatus comprises a substantially U-shaped upper member 15 and a substantially U-shaped lower member 16, as described later. The respective sets are operable in three different phases. In the embodiment, the central switch 24 consists of a closed-type switch such as a vacuum circuit breaker. As best seen in Fig. 2, the central switch 24 has an axially extending upper movable electrical terminal 24a and an axially extending lower stationary electrical terminal 24b. The movable electrical terminal 24a is connected to one end of a pivotally movable lever 27 via a linkage in such a manner as to be axially movable in accordance with the rotational movement of an operating shaft 26 rotatably attached to the envelope. A return spring 25 is connected to the other end of the lever 27, for applying a proper moment to the lever so as to normally bias the movable terminal 24a in an axially upward direction wherein the central switch is cut off, when the operating shaft 26 is free to rotate. The movable terminal 24a is slidably received by a ring-shaped contact portion of an electrical conductor 28. The conductor 28 is connected through the upper-right switch 29 to one end of a horizontally extending electrical conductor 30. As best shown in Fig. 5, the lengths of the conductors 30 in the respective phases are different from each other. The other end of each conductor 30 is connected through an intermediate electrical conductor 31 to a substantially cylindrical electrical conductor 33 coaxially buried in an insulation bushing 32. The upper-right switch 29 is comprised of an open-type disconnecting switch with an earthing mechanism.

The disconnecting switch 29 includes a pivotal blade 29a, a stationary terminal or electrical contact 29b attached onto the conductor 28, a stationary earthing terminal or electrical contact 29c, a pivotal lever 29e having a driven connection with a drive shaft 29d, and a connecting rod 29f arranged for interconnecting the blade 29a and the lever 29e. Returning to Fig. 2, each switch 34 also consists of a load-break switch with an earthing mechanism having almost the same construction as the upper-right switch 29. The lower-right load-break switch 34 is arranged below the central switch 24 with a slight offset to the right side, while the lower-left load-break switch 34 is arranged below the central switch 24 with a slight offset to the left side. The offset of the right load-break switch is set to be equivalent to the offset of the left load-break switch. In addition, the lower-right and lower-left load-break switches 34 are symmetrical to the central vacuum circuit breaker 24. The respective load-break switch 34 includes a pivotal blade 34a, a stationary terminal or electrical contact 34b connected to the stationary terminal 24b of the vacuum circuit breaker via an electrical conductor 37 firmly secured onto the stationary terminal 24b, a stationary earthing terminal or electrical contact 34c, a pivotal lever 34e having a driven connection with a drive shaft 34d, and a connecting rod 34f arranged for interconnecting the blade 34a and the lever 34e. On end of the blade 34a is pivotable between the two stationary terminals 34b and 34c to come into contact with one of the terminals 34b and 34c. The pivotal end of the blade 34a is connected to a substantially cylindrical electrical conductor 36 coaxially buried in an insulation bushing 35. The central switch 24 is connected through the upper-right disconnecting switch 29 to an electrical load. On the other hand, each lower load-break switch 34 is connected through the cylindrical conductor 36 to a power receiving circuit. The previously-noted construction of the insulation switching apparatus of the embodiment is similar to that of the well-known insulation switching apparatus.

The insulation switching apparatus of the invention is different from the prior art insulation switching apparatus in that electric-arc extinguishing members 122 and 123 are respectively secured onto substantially L-shaped portions formed at right and left ends of the conductor 37 by means of bolts 124, in order to induce a designated flow of arced gases produced during cut-off of current flowing through the open-type switch 34. As clearly seen in Figs. 3 and 4, the right electric-arc extinguishing member 122 comprises a substantially U-shaped epoxy member which includes a front plate 122a, a back plate 122b arranged in parallel with the front plate 122a, and an upper plate 122c interconnecting the two parallel plates 122a and 122b. In addition, the left opening end of the U-shaped member included in the right arc extinguishing member 122 is closed by the vertically extending portion of the conductor 37. Likewise, the left electric-arc extinguishing member 123 comprises a substantially U-shaped epoxy member which includes a front plate 123a, a back plate 123b arranged in parallel with the front plate 123a, and an upper plate 123c interconnecting the two parallel plates 123a and 123b. The right opening end of the U-shaped epoxy member included in the left arc extinguishing member 123 is closed by the vertically downwardly extending portion of the conductor 37. Each U-shaped epoxy member functions as a gas-flow guiding member which prevents arced gases produced owing to cut-off operation of one of the open-type switches 34 from flowing towards the other open-type switch 34 and towards the closed-type switch 24. Additionally, each U-shaped epoxy member defines therein a pocket to permit a pivotal movement of the blade 34a of the load-break switch 34 into the pocket of the U-shaped epoxy member and to transiently capture the arced gases. The U-shaped epoxy member associated with one of the load-break switches 34 also includes an opening facing apart from the closed-type switch 24 and the other load-break switch 34, for inducing a designated flow of arced gases, so as to prevent the arced gases from flowing towards the closed-

type switch 24 and the other load-break switch 34. The right and left arc extinguishing members 122 and 123 are symmetrical to each other with respect to the central switch 24. As shown in Figs. 2 and 3, each arc extinguishing member also includes a plurality of electric-arc extinguishing parallel metal-plates 125 disposed in the pocket defined in the U-shaped epoxy member, so as to effectively extinguish electric-arc. As clearly seen in Fig. 2, the arc extinguishing metal plates 125 are arranged in parallel with each other at regular intervals in such a manner as to extend vertically. As seen in Figs. 2 and 3, the arc extinguishing metal plates 125 of the embodiment comprise four inverted V-shaped iron plates, each of which has a different length and has an inverted V-shaped groove. The V-shaped groove is formed to allow the rotational movement of the blade 34a into the pocket of the U-shaped epoxy member and in addition to efficiently receive and extinguish the produced electric-arc. Reference numeral 126 designates a terminal support for the stationary terminal 34b which includes a plurality of blade catchers. As clearly seen in Fig. 2, the upper blade catcher is the longest catcher in the plural catchers. The terminal support 126 includes a vertically elongated rectangular window or opening 126a, for permitting the free end of the blade 34a to come into contact with the stationary terminal 34b by the counterclockwise movement of the blade 34a. The insulation switching apparatus of the embodiment operates as follows.

When the central switch 24, the disconnecting switch 29, and the pair of load-break switches 34 are all conditioned in their closed positions, i.e. the movable terminal 24a is connected to the stationary terminal 24b in accordance with the clockwise movement of the operating shaft 26, the blade 29a is held in its substantially horizontal position to be in contact with the stationary terminal 29b, and each blade 34a is held in its substantially vertical position to be in contact with the stationary terminal 34b, a loop current flows across the respective load-break switches 34, while a load current flows across the central

vacuum circuit breaker 24. Under these conditions, assuming that one of the open-type load-break switches 34, for example the lower-right load-break switch 34, is shifted to the open position, the opened lower-right load-break switch 34 interrupts the flow of loop current. Owing to cut-off of the loop current, electric arc is produced by metallic vapor boiled from electrodes defined by the longest blade catcher of the terminal 34b and the free end of the blade 34a. The produced electric-arc is in contact with a large number of arc extinguishing parallel metal plates 125 depending on an increase in the relative displacement of the free end of the blade 34a to the upper blade catcher of the terminal 34b and is consequently extinguished when the metallic vapor particles condense on the metal surfaces of the arc extinguishing parallel plates 125. Simultaneously, high-temperature arced gases are discharged and diffused. As set forth above, the substantially U-shaped epoxy gas-flow guiding member of the respective arc extinguishing member 122 and 123 functions to prevent the arced gases produced by cut-off of one of the open-type switches 34 from being diffused towards the other open-type switch 34 and towards the central vacuum circuit breaker 24, and to permit the arced gases to flow away from the switches 24 and 34. As will be appreciated from the above, the lower-left load-break switch 34 can be unaffected by transiently staying arced gases produced by cut-off operation of the lower-right load-break switch 34 at the aid of the right-side arc extinguishing member equipped with the U-shaped gas-flow guiding member and the electric-arc extinguishing plates. In addition to the above, the vacuum circuit breaker 24 is free from a surface creepage caused by a scattered arced gases on the cylindrical surface of the circuit breaker 24, since the arced gases cannot be diffused towards the vacuum circuit breaker 24 by way of the U-shaped gas-flow guiding member employed in the arc extinguishing member. Accordingly, the insulation switching apparatus according to the invention can highly minimize the distance between the two adjacent switches, consequently the

total size of the apparatus, without lowering dielectric strength of each switch, as compared with the prior art insulation switching apparatus.

In case that a closed-type switch, at least two open-type switches are aligned with each other in their vertical direction, a gas-flow guide of an electric-arc extinguishing member may be arranged in such a manner as to permit arced gases produced by cut-off operation of one of the switches to flow away from the other switches in the horizontal direction.

Referring to Fig. 1, there is shown a particular envelope structure according to the invention. The envelope of the invention includes a first envelope member consisting of a substantially U-shaped upper half 15 and a second envelope member consisting of a substantially U-shaped lower half 16. The first U-shaped envelope member 15 comprises three portions integrally formed with each other, namely an upper flat plate portion 15a, and a pair of side corrugated plate portions 15b arranged parallel to each other. The second U-shaped envelope member 16 comprises three portions integrally formed with each other, namely a bottom flat plate portion 16a, a front flat plate portion 16b, and a back flat plate portion 16c. Owing to such a U shape, each envelope member 15 and 16 exhibits a relatively high rigidity. As seen in Fig. 1, the first and second members 15 and 16 are assembled and coupled to each other so that a cutting plane defining the U-shaped section of the first member 15 and a cutting plane defining the U-shaped section of the second member 16 are perpendicular to each other. In more detail, the right-hand side U-shaped section (viewing Fig. 1) is joined to the inner wall of the front flat plate portion 16b, the left-hand side U-shaped section is joined to the inner wall of the back flat plate portion 16c, and the lower edge of each side corrugated plate portion 15b is joined to the bottom flat plate portion 16c. The respective joined portions are fitted in a gas-tight fashion by welding, to provide a single gas-tight sealed hexahedral envelope or tank. Actually, the eight sides of the

fitted pair are welded. The parallel side plate portions 15b are corrugated to assure a superior withstanding pressure performance enough to be proof against an internal pressure of the envelope. As shown in Figs. 2 and 5, a plurality of

5 substantially U-shaped reinforcements 17 such as channel materials are welded to the inner wall of the upper flat plate portion 15a of the first envelope member 15 so as to reinforce the envelope. For the same reason, the U-shaped reinforcements 17 are also welded to the inner walls of the front and back plate

10 portions 16b and 16c of the second envelope member 16. Returning to Fig. 1, a vertically standing elongated support 21 is welded onto the inner wall of the bottom plate portion 16a. A partition 18 is firmly secured to the support 21 by means of bolts 20, as seen in Fig. 5. A substantially U-shaped switch mounting

15 base 19 is disposed between the partition 18 and the back plate portion 16c and welded onto the inner wall surface of the bottom plate portion 16a. As seen in Fig. 2, a vertically extending insulation bracket 19a is firmly secured onto the upper surface of the base 19, to support both the two conductors 28 and 37 and

20 consequently to support the associated closed-type vacuum circuit breaker 24. As shown in Fig. 5, a backwardly and forwardly extending insulation beam 22 is arranged between the partition 18 and the back plate portion 16c. Vertically extending insulation beams 23 for three different phases are attached to

25 the horizontally extending insulation beam 22. As appreciated from Figs. 2 and 5, each movable blade 29a is pivotally mounted on the upper end of each insulation beam 23, in order to insulatingly support the conductors 30.

As illustrated in Fig. 5, a cover 37 is detachably attached to

30 the back plate portion 16c to covering three driving devices, namely a first driving device 38 having a driving connection with the shaft 29d for drivingly controlling the disconnecting switch 29, a second driving device 39 having a driving connection with the shaft 26 for drivingly controlling the vacuum circuit breaker

35 24, and a third driving device 40 having a driving connection

with the shafts 34d for drivingly controlling the load-break switches 34. Parts of the insulation switching apparatus of the embodiment are assembled together according to the following order.

5 Mounted on the second envelope member 16 and on the partition 18 are the insulation bushings 35, the conductors 36, the vacuum circuit breakers 24, the disconnecting switches 29, the load-break switches 34 and the like. Thereafter, predetermined tests are made to check various functioning of the
10 insulation switching apparatus. After completion of the desired tests, the second envelope member 16 is covered with the first envelope member 15, such that the U-shaped section of the first member 15 is perpendicular to the U-shaped section of the second member 16. The respective joined portions are welded in
15 a gas-tight fashion, thereby resulting in a single gas-tight sealed envelope. Subsequently, the driving devices 38, 39 and 40 are mounted onto the back plate portion 16c as illustrated in Fig. 5, and thereafter the cover 37 is attached to the back plate portion 16c. Finally, the sealed envelope which consists of the first and
20 second envelope members 15 and 16 integrally welded to each other, is filled with electrically insulating gases. In the envelope structure of the embodiment, there is enough working space, owing to the U-shaped section of the second envelope member 16. In fact, since the assembly task can be efficiently
25 performed in three directions, namely through the upper opening and through both side openings, working efficiency can be enhanced. Thus, such wide opening area enables automatic assembly of the insulation switching apparatus. In welding, since the relatively high-rigidity first and second envelope
30 members 15 and 16 are easily welded to each other without welding distortion, the envelope structure never requires a skilled task. Therefore, high quality products may be easily manufactured. Furthermore, since the gas-tight sealed envelope can be made of only two parts, namely upper and lower halves

15 and 16, without providing a packing seal, the number of parts can be reduced.

Referring now to Figs. 6, 7 and 8, there is shown a modification of the envelope structure of the insulation switching apparatus shown in Figs. 1, 2 and 5. The envelope structure of the modification illustrated in Figs. 6 through 8 is basically similar to that of the previously-noted embodiment illustrated in Figs. 1, 2 and 5. Therefore, the same reference numerals used in the embodiment of Figs. 1, 2 and 5 will be applied to the corresponding elements used in the modification of Figs. 6 through 8, for the purpose of comparison between the embodiment and the modification. The modification is different from the envelope structure of the embodiment illustrated in Figs. 1, 2 and 5, in that a protective hemmed or flanged portion 50 is provided for preventing sputter caused by welding from exerting a bad influence on important electrical parts, such as the vacuum circuit breaker 24, the disconnecting switch 29, the load-break switches 34, and the like. As seen in Fig. 6, the envelope of the modification includes a first envelope member consisting of a substantially U-shaped upper half 55 and a second envelope member consisting of a substantially U-shaped lower half 56. The first U-shaped envelope member 55 comprises three portions integrally formed with each other, namely an upper flat plate portion 55a, and a pair of side flat plate portions 55b arranged parallel to each other. The second U-shaped envelope member 56 includes three portions integrally formed with each other, namely a bottom flat plate portion 56a, a front flat plate portion 56b, and a back flat plate portion 56c. In the same manner as the previously-noted embodiment shown in Fig. 1, the first and second members 55 and 56 are assembled to each other so that the U-shaped section of the first member 55 and the U-shaped section of the second member 56 are perpendicular to each other, and that the inner wall of the first envelope member 55 is fitted onto the flanged portion of the second envelope member 56. As seen in Figs. 6 and 7, a plurality of substantially

U-shaped reinforcements 17 are welded to the inner walls of the upper flat plate portion 55a and the parallel side plate portions 55b. As best seen in Fig. 8, the reinforcements 17 are also welded to the inner walls of the front and back plate portions 56b and 56c. In the envelope structure of the modification, the sputter-protecting flanged portion 50 is formed along the edge of each plate portion 56a, 56b and 56c, in such a manner as to be bent towards the inside at a right angle to the respective edge. The flanged portion 50 is integrally formed with the U-shaped envelope member 56 by bending a metal sheet. The envelope structure of the modification is superior to that of the embodiment of Fig. 1, in that right-angled sputter-protecting flanged portion 50 facilitates both fitting and positioning of the first envelope member 55 to the second envelope member 56 when welding the two members 55 and 56 to each other, and in addition the flanged portion 50 reliably prevents a scatter of sputter from reaching to the switches assembled in the envelope. In this manner, welding can be efficiently achieved without a skilled task. As is well known, sputter is such a factor as degrades dielectric withstanding voltage characteristics of switches. It is advantageous to certainly avoid a bad influence owing to sputter on important electrical parts enclosed in the envelope with the aid of the protective flanged portion 50. Additionally, the flanged portion contributes to a higher rigidity of the envelope.

Although the sputter-protecting flanged portion 50 is integrally formed with the second envelope member 56, the flanged portion 50 may be integrally formed with the first envelope member 55. Alternatively, the first and second envelope members 55 and 56 employ the flanged portion alternately.

While the foregoing is a description of the preferred embodiments carried out the invention, it will be understood that the invention is not limited to the particular embodiments shown and described herein, but that various changes and modifications

may be made without departing from the scope
invention as defined by the following claims. .

of this



Claims:-

1. Switching apparatus comprising a gas-tight sealed envelope which encloses a closed-type switch connectable to an electric load and a pair of open-type switches respectively connectable to a power receiving circuit and which is to be filled with electrically insulating gas, the closed-type switch and open-type switches being arranged adjacent to each other, and gas-flow guiding means for inducing a designated flow of arcing gases produced when at least one of the open-type switches is cut off to block current flow therethrough, so as to prevent undesirable arcing gas flow towards the closed-type switch and towards the other open-type switch, wherein the gas-flow guiding means comprises a pair of electric-arc-extinguishing guides respectively associated with the open-type switches and arranged between adjacent switches, the arc-extinguishing guide associated with one open-type switch defines a pocket temporarily capturing the arcing gases and having an opening facing away from the closed-type switch and the other open-type switch for inducing the designated flow of the arcing gases, so as to prevent the arcing gases from flowing towards the closed-type switch and the other open-type switch, and each arc-extinguishing guide includes arc-extinguishing parallel metal plates disposed in the said pocket to effectively extinguish an arc produced by cut-off operation of the associated open-type switch.

2. Switching apparatus as claimed in claim 1, in which the arc-extinguishing plates are arranged in parallel with each other at regular intervals and comprise a plurality of inverted V-shaped iron plates each having an inverted V-shaped groove to efficiently receive and extinguish the arc produced.

3. Switching apparatus as claimed in claim 1 or 2, in which the envelope comprises a pair of U-shaped members welded to each other in a gas-tight fashion to provide a gas-tight sealed hexahedral tank such that a cutting plane defining the



U-shaped section of one member is perpendicular to a cutting plane defining the U-shaped section of the other member, the U-shaped members having been assembled to form the sealed tank, after mounting electrical parts including the closed-type switch and the open-type switches on either one of the U-shaped members.

4. Switching apparatus as claimed in claim 3, in which at least one of the U-shaped members includes a sputter-protecting flanged portion which is formed along the edge of the U-shaped member, in such a manner as to be bent towards the inside at a right angle to the edge, thereby preventing a scatter of sputter, caused by welding one member to the other, from reaching the electrical parts disposed in the envelope.

5. Switching apparatus as claimed in claim 4, in which the sputter-protecting flanged portion is integrally formed with the associated U-shaped member by bending.

6. Switching apparatus as claimed in any preceding claim, in which the pocket is defined by a U-shaped epoxy member.

7. Switching apparatus substantially as described with reference to, and as shown in, Figures 1 to 5 or Figures 6 to 8 of the accompanying drawings.