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DESCRIPTION



SWITCH GEAR

TECHNICAL FIELD

The present invention relates to a test terminal structure of a composite insulation vacuum switching apparatus (switch gear) having a vacuum vessel molded therein which accommodates a plurality of switches including main-circuit switches each having a circuit-breaking portion and a circuit-disconnecting portion for connecting and disconnecting a bus side and a load side, and ground switches each for connecting and disconnecting the load side and a ground conductor.

BACKGROUND TECHNOLOGY

In general, switch gears are used for applications of distributing electric power received from a bus to a variety of kinds of load equipment, other electric rooms, etc., and they are constructed such that within an external box formed of a ground metal, there are properly arranged internal equipment such as a circuit main switch for connecting and disconnecting between bus side conductors and load side conductors, ground switches for grounding the load side conductors, control equipment necessary for supervisory control, etc., together with connection conductors such as the bus side conductors used for connection with the bus, and the load side conductors used for connection with transmission cables coupled to loads.

Among these switch gears, there has been known one which, as disclosed in Japanese Patent Publication No. 7-28488 for example, is

provided with a functional unit having major internal equipment in the form of main circuit switches and ground switches constructed integrally with part of connection conductors, the functional unit being disposed in an external box so as to allow simple connection only by connecting between buses and transmission cables.

Fig. 8 is a constructional view illustrating essential portions of a conventional switch gear described in, for example, the above-mentioned Japanese Patent Publication No. 7-28488, and Fig. 9 is a circuit diagram of the switch gear illustrated in Fig. 8.

In Figs. 8 and 9, a vessel 100 is formed of a ground metal, and has an SF_6 gas (insulating gas) sealingly filled therein. Bushings 92a for connection with transmission cables and bushings 92b for connection with external buses are air-tightly mounted on and extend through the surrounding wall of the vessel 100. In addition, first, second and third switches 50, 51 and 52 as well vacuum arc-extinguishing chambers 90 are provided in the vessel 100.

Three bus side branch conductors 61 are supported by corresponding support insulators 110, respectively, disposed in the vessel 100, and connected with the unillustrated external three-phase buses of the corresponding phases, respectively, through the bushings 92b. These bus side branch conductors 61 are connected with the first switches 50 through the switching devices (not shown) in the corresponding vacuum arc-extinguishing chambers 90, respectively.

Intermediate conductors 60 are disposed in the vessel 100 while being fixedly supported by the corresponding support insulators 111,

respectively. The first switches 50 are connected with intermediate conductors 60, respectively, so that they are branched by the intermediate conductors 60 in two directions and connected with the second and third switches 51 and 52.

Six load side conductors 92 are arranged to extend through the vessel 100 while being supported by the bushings 92a, respectively. Here, note that the six load side conductors 92 together constitute two sets of three-phase load side conductors. The second switches 51 are connected with external transmission cables (not shown) through one set of load side conductors 92, and the third switches 52 are also connected with other external transmission cables through another set of three-phase load side conductors 92.

The first switches 50 are each provided with a swing electrode 50b which is caused to swing about a shaft 50a by means of an operation mechanism (not shown) through a metal link 80 and an insulation link 70. The swing electrode 50b is constructed in such a manner that it takes, according to its swung position, a closing position at which an output electrode of a switching device (not shown) in the vacuum arc-extinguishing chamber 90 is connected with a corresponding stationary electrode protruded from an intermediate electrode 60 at a position thereof corresponding to the output electrode, a grounding position at which the swing electrode 50b is connected with a corresponding grounding conductor 100a, and a disconnecting position which is an intermediate position between the closing position and the grounding position, with the swing electrode 50b being separated or spaced from the stationary electrode and

the grounding conductor 100a.

The second switches 51 are each provided with a swing electrode 51b which is caused to swing about a shaft 51a by means of an operation mechanism (not shown) through a metal link 80 and an insulation link 70. The swing electrode 51b is constructed in such a manner that it takes, according to its swung position, a closing position at which a load side conductor 92 is connected with a corresponding stationary electrode protruded from an intermediate electrode 60 at a position thereof corresponding to the load side conductor 92, a grounding position in which the swing electrode 51b is connected with a corresponding grounding conductor 100b, and a disconnecting position which is an intermediate position between the closing position and the grounding position, with the swing electrode 51b being separated or spaced from the stationary electrode and the grounding conductor 100b.

The third switches 52 are each provided with a swing electrode 52b which is caused to swing about a shaft 52a by means of an operation mechanism (not shown) through a metal link 80 and an insulation link 70. The swing electrode 52b is constructed in such a manner that it takes, according to its swung position, a closing position at which a load side conductor 92 is connected with a corresponding stationary electrode protruded from an intermediate electrode 60 at a position thereof corresponding to the load side conductor 92, a grounding position in which the swing electrode 52b is connected with a corresponding grounding conductor 100c, and a disconnecting position which is an intermediate position between the closing position and the grounding position, with the

swing electrode 52b being separated or spaced from the stationary electrode and the grounding conductor 100c.

In this manner, with the conventional switch gear, the first, second and third switches 50, 51 and 52 composed of a main circuit switching portion, which serves to connect and disconnect between the bus side branch conductors 61 and the load side conductors 92, and a ground side switching portion for grounding the load side conductors 92, are accommodated in the vessel 100 together with the bus side branch conductors 61 and the load side conductors 92, thus achieving a reduction in size of the switch gear. The conventional switch gear is applied to such a use in which electric power received from external buses is delivered to varying kinds of load equipment and the like by connecting the bus side branch conductors 61 with the external buses through the bushings 92b, and by connecting the load side conductors 92 with the transmission cables through the bushings 92a.

In the conventional switch gear as constructed above, though not illustrated, bushings with test terminals inserted therethrough are mounted on and passed through the wall surface of the vessel 100, and those ends of the test terminals which are extended into the interior of the vessel 100 are connected to the grounding conductors 100a, 100b and 100c. Using these test terminals, withstand voltage tests of the transmission cables are performed.

As referred to above, with the conventional switch gear, since the bushings having the test terminals inserted therethrough are mounted through the vessel 100 in which the insulation gas is sealingly filled, there

arises a problem that an installation space for the bushings is needed, thereby increasing the volume of the vessel 100 and hence the cost of production.

Moreover, in cases where gas-filled switches in which arcs occur are provided in the vessel 100, there also comes up another problem in that due to the test terminals which are normally grounded, it is necessary to design the structure in consideration of ground faults in the vessel 100, thus further enlarging the size of the apparatus.

In addition, the SF_6 gas is an emission regulation object for the prevention of global warming, and hence new issues in handling and management occur. This poses a further problem in that the costs will be increased at the times of production, maintenance and abandonment of the equipment.

DISCLOSURE OF THE INVENTION

The present invention is intended to obviate the above-mentioned problems and has for its object to provide a switch gear which is capable of effectively using the space of a vessel, reducing the size and cost, and improving reliability and safety.

A switch gear according to the present invention, wherein a stationary side main circuit contact and a movable side main circuit contact are disposed in a vacuum vessel, and wherein main circuit conductors connected with the stationary side main circuit contact and the movable side main circuit contact, respectively, are arranged to pass through a wall of the vacuum vessel, comprises: a ground conductor arranged to pass through the wall of the vacuum vessel and having one end thereof movable toward and

away from at least one of the main circuit conductors so as to contact therewith and separate therefrom; an operation mechanism connected through an insulating member with the other end of the ground conductor which extends from the vacuum vessel; and a ground/test terminal connected with the other end of the ground conductor extending from the vacuum vessel for relative displacement.

Moreover, the vacuum vessel is connected to ground, and the ground/test terminal is insulated from the vacuum vessel.

In addition, one end of the ground/test terminal and the other end of the ground conductor are connected with each other through a flexible conductor, and connection portions of the ground conductor and the flexible conductor are surrounded by a cylindrical insulating barrier.

Further, the vacuum vessel comprises a metallic tank molded by an insulating resin, and the ground/test terminal is insulated from the tank and molded with the insulating resin integrally with the tank.

Furthermore, one end of the ground/test terminal is formed into a ring-shaped configuration so as to surround the ground conductor, and the flexible conductor is connected with the ring-shaped one end of the ground/test terminal.

Still further, the ground conductor is air-tightly and elastically arranged to pass through a bottomed cylindrical flange which is attached to the tank in an insulating manner, and a ring-shaped insulating elastic member is interposed between the ring-shaped one end of the ground/test terminal and the flange.

Besides, a space between the insulating member and the insulating

barrier is sealed up by an elastic insulating member.

Further, a U-shaped connection terminal is arranged perpendicular to an axial direction of the ground conductor with one end thereof being connected with the other end of the ground terminal, and the flexible conductor is connected with the other end of the connection terminal.

Further, a flanged portion is formed along a circumferential edge of the insulating member so as to extend therefrom toward the insulation barrier, and the flanged portion has an inner diameter greater than an outer diameter of the insulation barrier, and the insulating member is arranged in such a manner that when the ground conductor is in contact with the main circuit conductor, the flanged portion overlaps a tip portion of the insulation barrier in an axial direction of the ground conductor.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional side view diagrammatically illustrating the construction of a switch gear according to embodiment 1 of the present invention.

Fig. 2 is a circuit diagram of the switch gear according to the embodiment 1 of the present invention.

Fig. 3 is a view diagrammatically illustrating essential portions of a switch gear according to embodiment 2 of the present invention.

Fig. 4 is a cross sectional side view diagrammatically illustrating essential portions of a switch gear according to embodiment 3 of the present invention.

Fig. 5 is a cross sectional side view diagrammatically illustrating essential portions of a switch gear according to embodiment 4 of the present

invention.

Fig. 6 is a view diagrammatically illustrating essential portions of a switch gear according to embodiment 5 of the present invention.

Fig. 7 is a cross sectional side view diagrammatically illustrating essential portions of a switch gear according to embodiment 6 of the present invention.

Fig. 8 is a constructional view illustrating essential portions of a conventional switch gear.

Fig. 9 is a circuit diagram of the conventional switch gear.

BEST MODE FOR CARRYING OUT THE INVENTION

Now, preferred embodiments of the present invention will be described in detail while referring to the accompanying drawings.

Embodiment 1.

Fig. 1 is a cross sectional side view schematically illustrating the construction of a switch gear according to embodiment 1 of the present invention. Here, a switch gear of a single phase is shown.

In Fig. 1, a vacuum vessel 1 includes a metallic tank 2, cylindrical insulating members 3a through 3d formed of insulating ceramics and each hermetically or air-tightly brazed or joined to an outer edge of a corresponding one of a plurality of openings formed through the opposite end surfaces of the tank 2, flanges 4a through 4d each configured in the shape of a bottomed cylinder and air-tightly secured to the corresponding insulating members 3a through 3d, and an insulating resin 5 which serves to mold the tank 2, the insulating members 3a through 3d and the flanges 4a through 4d into an integral unit. The interior of the vacuum vessel 1 is

maintained at a vacuum, and the outer surface of the insulating resin 5 is subjected to a conductive treatment and is covered with a conductive layer 19 which is connected to ground.

A main circuit contact side stationary conductor 10, which constitutes a main circuit conductor, is air-tightly secured to the vacuum vessel 1 in such a manner as to pass through the flange 4a and the insulating resin 5. The stationary conductor 10 has one end extended into the interior of the vacuum vessel 1, which constitutes a stationary contact 8a of the main circuit contact 8, and the other end extended to the exterior of the vacuum vessel 1 and connected to a main bus 6. A movable rod 14 is air-tightly mounted on the vacuum vessel 1 through the flange 4b and the bellows 16 in alignment with the stationary conductor 10 in such a manner that it is movable reciprocatingly along an axial direction of the stationary flange 10. A main circuit contact side movable conductor 11 is fixedly secured through an insulating rod 15 to one end of the movable rod 14 which extends to the interior of the vacuum vessel 1 in alignment therewith. The other end of the movable conductor 11 opposing the stationary contact 8a constitutes a movable contact 8b of the main circuit contact 8.

A ground contact side stationary conductor 12, which constitutes a main circuit conductor, is air-tightly secured to the vacuum vessel 1 in such a manner as to pass through the flange 4c and the insulating resin 5. The stationary conductor 12 has one end extended into the interior of the vacuum vessel 1, which constitutes a stationary contact 9a of a ground contact 9, and the other end extended to the exterior of the vacuum vessel 1 and connected to a transmission cable 7. A ground contact side movable conductor 13,

which constitutes a ground conductor, is air-tightly mounted on the vacuum vessel 1 through the flange 4d and the bellows 17 in alignment with the stationary conductor 12 in such a manner that it is movable reciprocatingly along an axial direction of the stationary conductor 12. One end of the movable conductor 13 extending into the interior of the vacuum vessel 1 constitutes a movable contact 9b of the ground contact 9. The main-circuit-contcact-side movable conductor 11 and the ground contact side stationary conductor 12 are electrically connected with each other through a first flexible conductor 18 which is formed of a copper thin plate for example.

Moreover, a portion of the insulating resin 5 is configured into a cylindrical shape so as to surround the ground contact side movable conductor 13 extending from the flange 4d, thereby to constitute an insulating barrier 20. A ground/test terminal 21 is integrally molded into the insulating resin 5 with one end thereof extending into the insulating barrier 20. That end of the ground/test terminal 21 which extends into the insulating barrier 20 is electrically connected with the movable contact 13 through a flexible conductor in the form of a second flexible conductor 22, which is formed of a copper thin plate for example. A ground conductor 27 is connected with the other end of the ground/test terminal 21 (the ground/test terminal 21 is connected to ground). Here, note that the ground/test terminal 21 is arranged in a spaced-apart relation with respect to the conductive layer 19.

A movable rod 14 is connected with a main circuit contact switching mechanism 23 through a linkage (not shown). The ground contact side movable conductor 13 is connected with a ground contact switching

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mechanism 24 through a linkage (not shown). Here, it is to be noted that an insulating member in the form of an insulation rod 25 is disposed between the movable contact 13 and an operation rod 24a of the ground contact switching mechanism 24 so as to ensure electrical insulation between the ground contact side and the switching mechanism side. The main circuit contact switching mechanism 23 and the ground contact switching mechanism 24 are housed in a grounded metallic frame 26. Moreover, a shield 29 is disposed so as to surround the main circuit contact 8, whereby the interior of the tank 2 is prevented from being contaminated by the metallic vapour generated by arcs in the tank 2.

Now, an example of the method of assembling the switch gear will be described below.

At first, the flanges 4a and 4c are joined to the tank 2 through the insulating members 3a and 3c, respectively, and the main circuit side stationary conductor 10 and the ground contact side stationary conductor 12 are adjusted in their positions and joined to the flanges 4a and 4c, respectively. Also, the main circuit side movable conductor 11 and the movable rod 14 are connected through the insulation rod 15. In addition, the flange 4b is joined to the tank 2 through the insulating member 3b. Then, the movable conductor 11 is inserted in the tank 2, and the movable conductor 11 thus inserted and the stationary conductor 12 are connected with each other by means of the first flexible conductor 18. Thereafter, the position of the movable conductor 11 is adjusted, and the movable rod 14 is connected with the flange 4b through the bellows 16. Subsequently, the flange 4d is joined to the tank 2 through the insulating member 3d.

Subsequently, the assembly thus formed and the ground/test terminal 21 are disposed in position in a metal mold and then integrally molded with the insulating resin 5 to provide a molded body. Thereafter, the molded body is subjected to a conductive treatment so that a conductive layer 19 is formed on the surface of the insulating resin 5. In addition, the ground contact side movable conductor 13 is inserted into the tank 2 through the flange 4d. After the position of the movable conductor 13 is adjusted, the movable conductors 13 is joined to the flange 4d through the bellows 17 in the vacuum atmosphere. Subsequently, the movable conductor 13 and the ground/test terminal 21 are connected with the second flexible conductor 22, thus providing the switch gear as shown in Fig. 1.

Next, reference will be had to the operation of the switch gear.

In the normal operation, the main circuit contact switching mechanism 23 is operated to move the movable rod 14 in a downward direction in Fig. 1, whereby the movable contact 8b is brought into abutting engagement with the stationary contact 8a to close the main circuit contact 8. Similarly, the ground contact switching mechanism 24 is operated to cause the movable conductor 13 to travel in an upward direction in Fig. 1, thus moving the movable contact 9b away from the stationary contact 9a to open the ground contact 9. As a result, the main bus 6 is electrically connected with the transmission cable 7 through the stationary conductor 10, the movable conductor 11, the first flexible conductor 18 and the stationary conductor 12, as shown in (a) of Fig. 2, so that electric power supplied from the main bus 6 is distributed to a variety of kinds of load equipment by way of the transmission cable 7. At this time, the electrical insulation between the

main circuit and the vacuum vessel 1 is secured by the insulating members 3a, 3c, whereas the electrical insulation between the vacuum vessel 1 and ground is secured by the insulating member 3b, 3d, with the result that the tank 2 becomes an intermediate potential.

Moreover, at the time of inspection for maintenance, the main circuit contact switching mechanism 23 is operated to drive the movable rod 14 in the upward direction in Fig. 1, whereby the movable contact 8b is caused to move away from the stationary contact 8a to open the main circuit contact 8. Similarly, the ground contact switching mechanism 24 is operated to move the movable conductor 13 in the downward direction in Fig. 1, thereby placing the movable contact 9b into abutting engagement with the stationary contact 9a to close the ground contact 9. In addition, the ground conductor 27 is detached from the ground/test terminal 21. Consequently, the main bus 6 is electrically separated or disconnected from the transmission cable 7, and the ground/test terminal 21 is electrically connected with the transmission cable 7 through the second flexible conductor 22, the movable conductor 13 and the stationary conductor 12, as shown in (b) of Fig. 2. Thereafter, the power supply 28 is connected with the ground/test terminal 21, and a withstand voltage test of the transmission cable 7 is done.

Thus, according to this embodiment 1, the ground/test terminal 21 is arranged outside the vacuum vessel 1, so that the ground contact side movable conductor 13 and the ground/test terminal 21 are connected with each other by means of the second flexible conductor 22 outside the vacuum vessel 1. With this arrangement, the structure inside the vacuum vessel 1 is simplified, and hence reliability is improved, while at the same time

achieving space-saving within the tank 2 and reducing the size and cost of the switch gear as well. In addition, since operations for connecting the ground contact side movable conductor 13 and the ground/test terminal 21 can be performed with ease and efficiency in a place outside of the vacuum vessel 1, productivity is improved, thus reducing the cost accordingly.

Moreover, since the flange 4d is connected with the tank 2 through the insulating member 3d, the tank 2 takes an intermediate potential, and what is grounded inside the vacuum vessel 1 is the ground contact side movable conductor 13 alone, and hence the grounded portions can be minimized. Thus, due to a simple structure that the flange 4d is connected with the tank 2 through the insulating member 3d, it is possible to achieve a construction which is effective to avoid ground faults without enlarging the size of the switch gear. Besides, the movable contact 9b of the ground contact 9 can be arranged at a sufficient distance from the main circuit contact 8, thereby reducing the influence of arcs.

In addition, since an SF_6 gas is not employed which is an emission regulation object, the handling and management of such an SF_6 gas become unnecessary, thus making it possible to reduce the cost accordingly.

Further, the ground/test terminal 21 is molded integrally with the tank 2 by means of the insulating resin 5, and upon molding, the insulation barrier 20 is formed as a part of the insulating resin 5. With such an arrangement, assembling operations for the ground/test terminal 21 and the insulation barrier 20 become unnecessary, contributing a cost reduction accordingly.

Furthermore, since that portion of the ground contact side movable conductor 13 which is extended from the vacuum vessel 1 is surrounded by

the insulation barrier 20 so as to be accommodated in the frame 26, it is possible to miniaturize the switch gear.

Still further, though the other end of the ground contact side movable electrode 13 is extended outwardly of the vacuum vessel 1, the movable electrode 13 is at a ground potential in the normal operation, and a voltage is imposed to the movable electrode 13 only at the time of inspection for maintenance. Such an arrangement does not at all deteriorate reliability and safety of the switch gear in comparison with the prior art technology in which the entire construction is arranged inside a vessel.

Here, it should be noted that although in the above-mentioned embodiment 1, the insulation barrier 20 is formed in a cylindrical configuration, the shape of the insulation barrier is not limited to such a configuration, but instead may take any other configuration such as, for example, a hexagonal cylinder, a quadrangular cylinder, etc., as long as the connecting portions between the ground contact side movable conductor 13 and the second flexible conductor 22 are enclosed or surrounded by the insulation barrier.

Embodiment 2.

Fig. 3 is a view diagrammatically illustrating essential portions of a switch gear according to embodiment 2 of the present invention, in which (a) of Fig. 3 is a top plan view, and (b) of Fig. 3 is a cross sectional side view.

In Fig. 3, a ground/test terminal 30 is formed at one end thereof with a ring-shaped connecting portion 30a, and is molded with an insulating resin 5. The ground contact side movable conductor 13 is inserted through an opening of the connecting portion 30a. A flexible conductor in the form of a

second flexible conductor 40 is formed by bending a flexible copper thin plate of a short length into a U-shaped configuration, then bending the opposite side legs thereof outwardly, and further perforating the central portion of the U-shaped configuration with an opening. The second flexible conductor 40 is mounted on the ground/test terminal 30 as follows. That is, the ground contact side movable conductor 13 is inserted through the opening in the second flexible conductor 40, and then the opposite side legs of the second flexible conductor 40 is brazed to the connecting portion 30a, and the second flexible conductor 40 is further brazed at its opening to the movable conductor 13 inserted therein.

Here, note that the construction of this embodiment 2 other than the above is similar to that of the above-mentioned embodiment 1.

According to this embodiment 2, since one end of the ground/test terminal 30 is formed into the ring-shaped connecting portion 30a, the arrangement of the second flexible conductor 40 can be arbitrarily changed as desired. That is, the connecting portion 30a is arranged so as to surround the ground contact side movable conductor 13, so that the second flexible conductor 40 can be connected with the connecting portion 30a at any rotational position of the second flexible conductor 40 rotated around the central axis of the movable conductor 13. At such a rotational position, the second flexible conductor 40 can be mounted to the connecting portion 30a while properly changing the arrangement of the second flexible conductor 40 according to the position of the frame 26. As a result, it is possible to ensure a proper insulation distance between the second flexible conductor 40 and the frame 26.

Embodiment 3.

Fig. 4 is a cross sectional side view diagrammatically illustrating essential portions of a switch gear according to embodiment 3 of the present invention.

In Fig. 4, a ground/test terminal 31 is formed at one end thereof with a bottomed cylindrical connecting portion 31a and is molded with an insulating resin 5. The ground contact side movable conductor 13 is inserted through an opening which is formed through the bottom center of the connecting portion 31a. An elastic member in the form of a ring 41 formed of insulating rubber is interposed between the inner peripheral wall surface of the connecting portion 31a and the outer peripheral wall surface of the flange 4d.

Here, note that the construction of this embodiment 3 other than the above is similar to the above-mentioned embodiment 2.

In this embodiment 3, when an assembly of the tank 2 and the flanges 4a through 4d, etc., assembled thereto, and the ground/test terminal 31 are arranged in position within a mold, a ring 41 is interposed between the outer wall surface of the connecting portion 31a and the inner wall surface of the flange 4d, and then integrally molded with the insulating resin 5. At that time, manufacturing variations in size of the tank 2, the insulating members 3a through 3d and the flanges 4a through 4d, and assembling variations in size after assemblage of the respective components can be absorbed due to the deformation of the ring 41, so that the assembly and the ground/test terminal 31 can be easily matched or adjusted in their positions and readily set with respect to the mold, thus improving productivity in

molding.

Embodiment 4.

In this embodiment 4, a space between the insulation rod 25 and the insulation barrier 20 is sealed up by an elastic (expandable and contractible) insulating member 42 formed of insulating rubber, as shown in Fig. 5.

Here, note that the construction of this embodiment 3 other than the above is similar to that of the above-mentioned embodiment 1.

According to this embodiment 4, since the space between the insulation rod 25 and the insulation barrier 20 is sealed up by the elastic insulating member 42, dielectric strength can be improved and a decrease in the surface dielectric strength of the insulators, which would otherwise result from contamination of these portions due to foreign matter in the air, can be suppressed.

Embodiment 5.

Fig. 6 is a view diagrammatically illustrating essential portions of a switch gear according to embodiment 5 of the present invention, and (a) of Fig. 6 is a top plan view thereof, and (b) of Fig. 6 is a cross sectional side view thereof.

In Fig. 6, a connection terminal 43 is formed into a U-shaped configuration, and is arranged perpendicular to the axial direction of the ground contact side movable conductor 13, with one side leg thereof being connected with the other end of the ground contact side movable conductor 13. Also, the second flexible conductor 22 is connected with the other side leg of the connection terminal 43.

Here, note that the construction of this embodiment 5 other than the

above is similar to that of the above-mentioned embodiment 1.

In the switch gear, the capability of carrying short-circuiting current is needed in the state where the ground contact 9 is closed. At this time, an electromagnetic repulsive force F generated by the short-circuit current acts on the ground contact 9 in a direction to push up the movable conductor 13 upwardly in (b) of Fig. 6.

In this embodiment 5, since the U-shaped connection terminal 43 is arranged perpendicular to the axial direction of the ground contact side movable conductor 13, short-circuiting current flows through the opposing legs of the U-shaped connection terminal 43 in opposite directions, so that a repulsive force f acts in a downward direction in (b) of Fig. 6. Thus, the electromagnetic force f acts in the direction to offset the electromagnetic repulsive force F, whereby the contact pressure required for closing the ground contact 9 can be decreased.

Embodiment 6.

In this embodiment 6, as shown in Fig. 7, a flanged or bent portion 44a is formed along the circumferential edge of an insulating member in the form of an insulation rod 44 so as to extend therefrom toward the insulation barrier 20. The flanged portion 44a has an inner diameter greater than an outer diameter of the insulation barrier 20. The insulation rod 44 is arranged in such a manner that upon closure of the ground contact 9, the flanged portion 44a overlaps the tip portion of the insulation barrier 20 in the axial direction of the ground contact side movable conductor 13.

Here, note that the construction of this embodiment 6 other than the above is similar to that of the above-mentioned embodiment 2.

According to this embodiment 6, since the space inside the insulation barrier 20 is shielded from the outside thereof by means of the insulation rod 44, dielectric strength can be improved and a decrease in the surface dielectric strength of the insulators, which would otherwise result from contamination of these portions due to foreign matter in the air, can be suppressed.

In this connection, it should be noted that though in the above-mentioned respective embodiments, it has been described that the main circuit contact and the ground contact for one phase is accommodated in the vacuum vessel 1, it goes without saying that the present invention can be applied a switch gear of a multi-phase construction. In this case, a plurality of main circuit contacts and ground contacts corresponding to the number of phases may be accommodated in the vacuum vessel 1.

As described above, according to the present invention, in a switch gear wherein a stationary side main circuit contact and a movable side main circuit contact are disposed in a vacuum vessel, and wherein main circuit conductors connected with the stationary side main circuit contact and the movable side main circuit contact, respectively, are arranged to pass through a wall of the vacuum vessel, the switch gear includes: a ground conductor arranged to pass through the wall of the vacuum vessel and having one end thereof movable toward and away from at least one of the main circuit conductors so as to contact therewith and separate therefrom; an operation mechanism connected through an insulating member with the other end of the ground conductor which extends from the vacuum vessel; and a ground/test terminal connected with the other end of the ground conductor

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extending from the vacuum vessel for relative displacement. With this arrangement, it is possible not only to reduce the size and cost of the switch gear, but also improve the reliability and safety thereof.

Moreover, since the vacuum vessel is connected to ground and the ground/test terminal is insulated from the vacuum vessel, there is no need for providing a bushing or the like, and hence the construction becomes simple.

In addition, one end of the ground/test terminal and the other end of the ground conductor are connected with each other through a flexible conductor, and connection portions of the ground conductor and the flexible conductor are surrounded by a cylindrical insulating barrier. With this arrangement, the insulation distance to the ground portions is reduced, thus making the construction compact.

Further, the vacuum vessel comprises a metallic tank molded by an insulating resin, and the ground/test terminal is insulated from the tank and molded with the insulating resin integrally with the tank. With this arrangement, the assembling of the ground/test terminal becomes unnecessary, and productivity can be improved.

Furthermore, one end of the ground/test terminal is formed into a ring-shaped configuration so as to surround the ground conductor, and the flexible conductor is connected with the ring-shaped one end of the ground/test terminal. This serves to increase the flexibility in the arrangement of the flexible conductor, and ensure a sufficient insulation distance to a frame which accommodates the operation mechanism.

Still further, the ground conductor is air-tightly and elastically

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arranged to pass through a bottomed cylindrical flange which is attached to the tank in an insulating manner, and a ring-shaped insulating elastic member is interposed between the ring-shaped one end of the ground/test terminal and the flange. With this arrangement, when the components of the vacuum vessel and the ground/test terminal are molded with the insulating resin, variations in size of the components can be absorbed by deformation of the insulating elastic member. Consequently, it becomes unnecessary to perform the operation of adjusting the positions of the components and the ground/test terminal within the mold with high precision, thus improving the workability of molding.

Besides, a space between the insulating member and the insulating barrier is sealed up by an elastic insulating member, whereby a deterioration in the surface dielectric strength due to contamination of the insulating portions in the air and attachment of foreign matter can be suppressed.

Further, a U-shaped connection terminal is arranged perpendicular to an axial direction of the ground conductor with one end thereof being connected with the other end of the ground terminal, and the flexible conductor is connected with the other end of the connection terminal. With this arrangement, an electromagnetic force generated in the connection terminal upon occurrence of short-circuiting current acts to offset an electromagnetic repulsive force which acts on the ground conductor to open the ground contact. As a result, the ground contact can be prevented from being opened.

Further, a flanged portion is formed along a circumferential edge of the insulating member so as to extend therefrom toward the insulation

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barrier, and the flanged portion has an inner diameter greater than an outer diameter of the insulation barrier, and the insulating member is arranged in such a manner that when the ground conductor is in contact with the main circuit conductor, the flanged portion overlaps a tip portion of the insulation barrier in an axial direction of the ground conductor. This arrangement serves to suppress a deterioration in the surface dielectric strength due to contamination of the insulating portions in the air and attachment of foreign matter.

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CLAIMS

1. A switch gear in which a stationary side main circuit contact (8a) and a movable side main circuit contact (8b) are disposed in a vacuum vessel (1), and in which main circuit conductors (10,12) connected with said stationary side main circuit contact (8a) and said movable side main circuit contact (8b), respectively, are arranged to pass through a wall of said vacuum vessel (1), characterized by comprising:

a ground conductor (13) arranged to pass through the wall of said vacuum vessel (1) and having one end thereof movable toward and away from at least one of said main circuit conductors (10,12) so as to contact therewith and separate therefrom;

an operation mechanism (24) connected through an insulating member (25,44) with the other end of said ground conductor (13) which extends from said vacuum vessel (1); and

a ground/test terminal (21,30,31) connected with the other end of said ground conductor (13) extending from said vacuum vessel (1) for relative displacement.

2. The switch gear as claimed in claim 1, characterized in that said vacuum vessel (1) is connected to ground, and said ground/test terminal (21,30,31) is insulated from said vacuum vessel (1).

3. The switch gear as claimed in claim 1 or 2, characterized in that one end of said ground/test terminal (21,30,31) and the other end of said ground conductor (13) are connected with each other through a flexible conductor

(22,40), and connection portions of said ground conductor (13) and said flexible conductor (22,40) are surrounded by a cylindrical insulating barrier (20).

4. The switch gear as claimed in any one of claims 1 through 3, characterized in that said vacuum vessel (1) comprises a metallic tank (2) molded by an insulating resin (5), and said ground/test terminal (21,30,31) is insulated from said tank (2) and molded with said insulating resin (5) integrally with said tank (2).

5. The switch gear as claimed in claim 3, characterized in that one end (30a,31a) of said ground/test terminal (30,31) is formed into a ring-shaped configuration so as to surround said ground conductor (13), and said flexible conductor (40) is connected with the ring-shaped one end (30a,31a) of said ground/test terminal (30,31).

6. The switch gear as claimed in claim 4, characterized in that said ground conductor (13) is air-tightly and elastically arranged to pass through a bottomed cylindrical flange (4d) which is attached to said tank (2) in an insulating manner, and a ring-shaped insulating elastic member (41) is interposed between the ring-shaped one end (31a) of said ground/test terminal (31) and said flange (4d).

7. The switch gear as claimed in claim 3, characterized in that a space between said insulating member (25) and said insulating barrier (20) is sealed up by an elastic insulating member (42).

8. The switch gear as claimed in claim 3, characterized in that a U-shaped connection terminal (43) is arranged perpendicular to an axial direction of said ground conductor (13) with one end thereof being

connected with the other end of said ground terminal (13), and said flexible conductor (22) is connected with the other end of said connection terminal (43).

9. The switch gear as claimed in claim 3, characterized in that a flanged portion (44a) is formed along a circumferential edge of said insulating member (44) so as to extend therefrom toward said insulation barrier (20), and the flanged portion (44a) has an inner diameter greater than an outer diameter of said insulation barrier (20), and said insulating member (44) is arranged in such a manner that when said ground conductor (13) is in contact with said main circuit conductor (10,12), said flanged portion (44a) overlaps a tip portion of said insulation barrier (20) in an axial direction of said ground conductor (13).