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GAS INSULATED SWITCHING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a switchgear or a switching device of a metal-enclosed type, and in particular to the configuration of the main circuit.

Fig. 14 and Fig. 15 show a conventional high-potential switching device disclosed for example in Japanese Patent Kokai Publication No. H2-290111. As illustrated, a switching device 1 comprises main bus bars 2, branch bus bars 3, switching units 4, branch conductors 5, cable connection bushings 6, and cable connectors 7. The main bus bars 2, the branch bus bars 3, the switching units 4, and the branch conductors 5 are housed or enclosed in a unit-enclosing box 8. The switching units 4 are each comprised of disconnectors 40 and vacuum circuit breakers 50.

The configuration will next be described.

The main circuit comprises the main bus bars 2 extending through the unit-enclosing boxes 8, and the branch bus bars 3 connected to the main bus bars 2, as well as to circuits each comprising the switching units 4, the branch conductors 5, and the bushings 6.

Fig. 14 and Fig. 15 show an example in which four circuits are provided and the switching units 4 are in four stages. For the purpose of making the device compact, it is

a general practice to dispose the switching units in multiple stages.

Because in the conventional switching device, a plurality of unit circuits are configured in multiple stages as described above, a large space is required for disposition and wiring the branch bus bars 2 and branch conductors 5. Moreover, since the plurality of circuit cables are connected via bushings 6 and cable connectors 7 to the switching units 4 and branch conductors 5 oriented horizontally in the depth direction (right-left direction in Fig. 15) and arranged or juxtaposed vertically, an additional space is necessary for allowing the cables to bend. In addition, with the multiple stage arrangement, different circuits are present together, so the maintenance and exchange are difficult. Moreover, since switching units 4 which are arranged in multiple stages are all contained together, the cost of production of the container is high.

SUMMARY OF THE INVENTION

The invention has been made to eliminate the above-described problems, and its object is to reduce the length of the bus bars and reduce the space for wiring, to facilitate maintenance and exchange, and to lower the cost of the switching device.

A switching device according to the invention comprises

a plurality of metal-enclosed, gas-insulated switching units (30) having gas-insulated containers concatenated with each other and aligned in a first direction:

bus bars (20) extending in said first direction and through said switching units (30);

each of said switching units (30) having:

circuit breakers (50) respectively coupled with said bus bars and extending in a second direction orthogonal to said first direction, and juxtaposed with each other in a third direction orthogonal to said first and second directions;

cable connection bushings (9) respectively connected to first ends of said circuit breakers (50) and extending through a wall of said each of switching units (30); and

disconnectors (40) juxtaposed with each other in said third direction and respectively coupling second ends of the circuit breakers (50) with said bus bars (20),

said disconnectors being disposed along a first plane perpendicular to said first direction, said circuit breakers being disposed along a second plane perpendicular to said first direction, and said first and second planes are at different positions in said first direction.

In the switching device according to the invention, the gas-insulated containers are provided for the respective unit circuits, so that the cost of the containers is low, and the bus bar wiring can be made the shortest. Moreover, if the bus bars are disposed in the middle in the second direction and the bushings are oriented in the second direction, the bushings can be disposed either of two positions on opposite sides with respect to the bus bars.

This improves the adaptability of the switching device to the environment, specifically the components or conductors to which the switching units are to be connected. Furthermore, since the container is provided for each unit circuit, addition or change of unit circuits is easy.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing a switching device of an embodiment of the invention in which four switching units are concatenated with each other.

Fig. 2 is a skeleton diagram showing the switching device of Fig. 1.

Fig. 3 is a front view of a container for each switching unit.

Fig. 4 is a plan view of the container.

Fig. 5 is a left side view of the container.

Fig. 6 is a sectional view along line VI-VI in Fig. 4 and Fig. 5.

Fig. 7 is a sectional view along line VII-VII in Fig. 4 and Fig. 5.

Fig. 8 is a sectional view showing a switching unit forming the switching device of Fig. 1.

Fig. 9 is a perspective view showing how a disconnecter and a circuit breaker are connected to each other and to a bus bar and a bushing.

Fig. 10 is a schematic sectional view along line X-X in FIG. 1.

Fig. 11 is a skeleton diagram showing the interconnection of the circuit breakers, the disconnectors, the bushings and the bus bars in each switching unit.

Fig. 12 is a schematic diagram showing a switching device comprising four switching units concatenated with each other and contained in an enclosing box and mounted on a floor.

Fig. 13 is a perspective view showing the switching a switching device comprising four switching units mounted on a wall.

Fig. 14 is a skeleton diagram of a switching device in the prior art.

Fig. 15 is a side sectional view of the switching device of Fig. 14.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the invention will now be described with reference to the drawings.

A first embodiment of the invention will now be described with reference to Fig. 1 to Fig. 12.

As is best seen from Fig. 1, the illustrated switching device comprises a plurality of switching units 30, each having its own gas-insulated container 12. The switching

units 30 are concatenated with each other and aligned in a first direction, or the right-left direction in Fig. 1. In the illustrated embodiment, four switching units are concatenated. The containers 12 in the illustrated embodiment are rectangular, and are formed of a metal. As illustrated in a skeleton diagram of Fig. 2, the switching units 30 comprise disconnectors 40 connected to the bus bars 20, and circuit breakers 50 connected to the disconnectors 40 and the cable connection bushings 9. Although not illustrated as such, each of the switching units 30 comprises three bushings 9, three circuit breakers 50 and three disconnectors 40 for connection with three bus bars 20 to form three-phase circuits.

More particularly, the configuration of the container 12 is better seen in Fig. 3 to Fig. 7. In these figures, the components mounted in the container are not illustrated, but the walls of the container and beams fixed to the walls of the container are illustrated.

For the purpose of explanation, the side shown in the front in Fig. 3 is considered as the front side, the side shown in the front in Fig. 4 is considered as the top side, and the side shown in the front in Fig. 5 is considered as the left side. The front-rear direction is the above-mentioned first direction. The up-down direction is called a second direction, while the right-left direction is called

a third direction.

As illustrated, the container 12 is generally rectangular, having front and rear walls 102 and 104 opposite to each other and perpendicular to the first direction. The container 12 also has left and right side walls 106 and 108 opposite to each other and perpendicular to the third direction. The container 12 also has top and bottom walls 110 and 112 opposite to each other and perpendicular to the second direction.

Large circular openings 114 and 116 (Fig. 3, Fig. 6 and Fig. 7) are provided in the front and rear walls 102 and 104 for passage of bus bars 20. Openings 118, 120 and 122 are also provided in the top wall 110 (Fig. 4). The openings 118, 120 and 122 are for mounting cable connection bushings 9 to be described later. An inner top wall 111 is provided inside the top wall 110 to form a double-wall structure to thereby increase the rigidity (Fig. 6 and Fig. 7). Increasing the rigidity of the top wall is desired because bushings are mounted to the top wall, and a certain strength is therefore required of the top wall.

Inner side walls 107 and 109 are also provided inside the left and right side walls 106 and 108 (Fig. 6 and Fig. 7). The inner side walls are used for supporting first and second beams 124 and 126 extending in the right-left direction or third direction, as shown in Fig. 6. That is,

the first beam 124, in the form of a channel, extends in the right-left direction (third direction) and is fixed at both ends to the inner side walls 107 and 109. The second beams 126 has a rectangular cross section and also extends in the right-left direction (third direction) and is fixed at both ends to the inner side walls 107 and 109.

The front wall 102 of the leftmost switching unit 30, as seen in Fig. 1, is provided with a lid 14 to close the opening 114. Similarly, the rear wall 104 of the rightmost switching unit 30, as seen in Fig. 1 is provided with a lid 14 to close the opening 116.

In the embodiment described, lids 14 are provided to close the openings 114 and 116 in the front and rear walls positioned at the extremities (front and rear ends) of the concatenated switching units. As an alternative, a container having no opening on front or rear wall may be prepared, and used for the leftmost and rightmost switching units. What is essential is therefore that the front or rear walls adjacent with another, rear or front wall of an adjacent switching unit 30 has an opening for passage of the bus bars.

The front and rear walls of the adjacent containers (containers of the adjacent switching units) may be adjoined with each other, serving as flanges.

The bus bars 20 extend in the first direction and

through the switching units 30, as shown in Fig. 1.

In the illustrated embodiment, the bus bars 20 each comprise unit bus bars 10 for the respective switching units and the unit bus bars 12 are connected together by means of connection parts 10A such as conductors, bolts and nuts, to form the bus bars 20 when the switching units 30 are concatenated.

Each of the switching units 30 is configured as shown in Fig. 8. As illustrated, it comprises three cable connection bushings 9, three unit bus bars 10, three disconnectors 40 and three high-potential vacuum circuit breakers 50 disposed in a container 12 and connected to form a three-phase circuit. The interconnection of a bushing 9, a circuit breaker 50, a disconnector 40 and a unit bus bar 10 for each phase can be represented as schematically illustrated in Fig. 11. Fig. 8 is a sectional view along one depth on the left part (to the left of the line SD) and at a different depth on the right part (to the right of the line SD). In the left part, parts of the circuit breakers 50 behind the disconnectors 40 are not illustrated for simplicity of illustration.

The circuit breakers 50 are respectively coupled with the unit bus bars 10 and extending in a second direction, or the up-down direction as seen in Fig. 8, orthogonal to the first direction, and juxtaposed with each other in a third

direction, or the right-left direction in Fig. 8, or the depth direction in Fig. 10, orthogonal to the first and second directions. Each circuit breaker 50 has a stationary contact at a first end thereof, and a movable contact at a second end thereof. In Fig. 8, the first and second ends of the circuit breaker 50 are the upper and lower ends, respectively.

The cable connection bushings 9 are respectively connected to first ends of the circuit breakers 50 and extends through a wall of the each of switching units 30. The cable connection bushings 9 are electrically connected to the stationary contacts of the circuit breakers 50, provided at the first ends thereof. The cable connection bushings 9 are connected with cables 13, as shown in Fig. 1.

In the second switching unit 30, with "second" being counted from the left in Fig. 1, the cable connection bushings 9 extend through the lower wall. This means, the circuit breakers are upside-down, compared with (opposite to) that illustrated in Fig. 8 and Fig. 9, and the first ends of the circuit breakers 50 are at the bottom of the container, and the cable connection bushings 9 are connected to the first ends of the circuit breakers which are at the bottom of the container. In other switching units (first, third and fourth switching units, as counted from the left in Fig. 1), the cable connection bushings 9 extend through

the upper wall.

The disconnectors 40 are juxtaposed with each other in the third direction and respectively couple movable contacts of the circuit breakers 50, provided at the second ends thereof, with the unit bus bars 10.

As mentioned above, each of the switching units 30 further comprises first and second beams 124 and 126 extending in the third direction. A first group of insulating supports 17 are mounted to the first beam 124 and support first contacts 42 of the disconnectors 40. A second group of insulating supports 11 are mounted to the second beam 126 and support second contacts 44 of the disconnectors 40 and the unit bus bars 10. The first and second contacts 42 and 44 of each disconnector 40 are connected with each other or disconnected from each other by a swinging motion of a rotatable contact 46 having one end rotatably supported by the first contact 42 and having the other, free end engageable with the second contact 44. That is, the rotatable contact 46 can selectively assume a first position as illustrated in solid line in Fig. 8 and a second position as illustrated in phantom line. In the first position, the first and second contacts 42 and 44 are not connected, while in the second position, the first and second contacts 42 and 44 are connected with each other.

The structures of the disconnector 40 and the circuit

breaker 44 are well known, so further details are not described.

The unit bus bars 10 are supported by the second contacts 44 of the disconnectors 40 which are fixed to the insulating supports 11.

Preferably, the unit bus bars 10 are disposed in the middle in the second direction, and the outer shape of a container 12 of each of the switching units 30 is substantially symmetrical with respect to the plane containing the centers of the unit bus bars 10 in the second direction. This permits turning any of the switching unit upside-down without affecting the connection of the unit bus bar 10 with the unit bus bars 10 of the adjacent switching unit 30. In other words, each of the switching units 30 can be oriented in either of two positions or attitudes without affecting the connection of the unit bus bars 10.

In the switching device configured as described above, bushings 9, the circuit breakers 50, the disconnectors 40 and the unit bus bars 10 forming a unit circuit are contained together in the gas-insulated container 12, and the stationary contacts of the circuit breakers 50 are directly connected to the conductors of the bushings 9. Moreover, the second contacts 44 of the disconnectors 40 are directly connected to the unit bus bars 10, and supported by the insulating supports 11. Accordingly, wirings such as

the branch bus bars 3 and the branch conductors 5 that are described with reference to the prior art can be omitted.

Moreover, a gas-insulated container 12 is configured for each unit circuit, so the size and cost of the container are reduced.

Furthermore, the unit bus bars 10 are disposed at substantially central positions in the vertical direction of the container 12, and the outer shape of the container 12 is substantially symmetrical with respect to the plane in which the bus bars are disposed, so that the container 12 can be oriented above or below the container. The work of wiring installation is therefore easy.

For addition or change of the unit circuit, each of the containers 12 can be removed and mounted separately, so that the work is easy.

The switching device described above with reference to Fig. 1 to Fig. 11 may be contained in a unit-enclosing box 8 which are installed on a floor 100 as shown in Fig. 12. However, as illustrated in Fig. 13, the containers 12 each forming the unit circuit may be concatenated with each other and mounted on a wall 90, at a height where interference with activities of the human operators on the floor or installations on the floor is unlikely. This arrangement improves the space utilization efficiency.

In the embodiments described, the first direction and

the third directions are horizontal directions, and the second direction is the vertical direction. The invention is not limited to such specific direction, but is applicable to any situation where first, second and third directions are orthogonal to each other.

More specifically, in the embodiments described above, the bushings are oriented in the vertical direction. But this can be altered with the environment in which the device is installed. As long as the bushings are disposed in a direction perpendicular to the direction in which the bus bars extend, effects similar to those obtained by the above embodiments can be obtained.

As has been described according to the invention, a compact gas-insulated container is configured for each unit circuit, so the cost and the size can be reduced. Moreover, since the bushings are mounted in a direction (second direction) orthogonal to the direction (first direction) in which the bus bars extend, and the bus bars are disposed at the middle in the second direction, the cables can be connected at either of two opposite position, e.g., above or below the containers, and the space for the cables can be reduced.



CLAIMS:

1. A switching device comprising a plurality of metal-enclosed, gas-insulated switching units (30) having gas-insulated containers concatenated with each other and aligned in a first direction;
bus bars (20) extending in said first direction and through said switching units (30);
each of said switching units (30) having:
circuit breakers (50) respectively coupled with said bus bars and extending in a second direction orthogonal to said first direction, and juxtaposed with each other in a third direction orthogonal to said first and second directions;
cable connection bushings (9) respectively connected to first ends of said circuit breakers (50) and extending through a wall of said each of said switching units (30); and
disconnectors (40) juxtaposed with each other in said third direction and respectively coupling second ends of the circuit breakers (50) with said bus bars (20),
said disconnectors being disposed along a first plane perpendicular to said first direction, said circuit breakers being disposed along a second plane perpendicular to said first direction, and said first and second planes are at different positions in said first direction.
2. The switching device according to Claim 1, wherein each of said switching units (30) further comprises first and second beams (124, 126) extending in said third directions, a first group of insulating supports



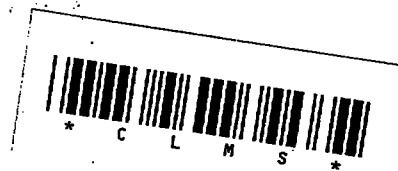
(17) mounted to said first beam and supporting first contacts (42) of said disconnectors (40) a second group of insulating supports (11) mounted to said second beam and supporting second contacts (44) of said disconnectors (40) and said bus bars (20).

3. The switching device according to Claim 2, wherein said bus bars (20) are supported by said second contacts (44) of said disconnectors (40).

4. The switching device according to Claim 1, wherein the outer shape of a container (12) of each of said switching units (30) is substantially symmetrical with respect to a plane containing the centers of the bus bars (20) in said second direction, whereby each of said switching units (30) can be oriented in either of two opposite attitudes without affecting the connection with the bus bars.

5. The switching device according to Claim 1, wherein said first direction and said third directions are horizontal directions.

6. The switching device according to Claim 1, wherein said bus bars (20) each comprise unit bus bars for the respective switching units, said unit bus bars being connected together to form said bus bars when the switching units are concatenated.



7. The switching device according to Claim 1, wherein each of said switching units (30) has a container (12) having a first pair of opposite walls (102, 104) perpendicular to said first direction; and said walls (102, 104) belonging to said first pairs of walls and adjacent to each other have an opening (114) for passage of the bus bars.
8. The switching device according to Claim 7, wherein the container (12) of each of said switching units further has a second pair of opposite walls (110, 112) perpendicular to said second direction and said cable connection bushings (9) in each of said switching units extend through one of the walls of said second pair.
9. The switching device according to Claim 8, wherein said container is rectangular.
10. The switching device according to Claim 7, wherein said first pairs (102, 104) of walls of adjacent switching units are adjoined with each other, thereby serving as flanges.



11. The switching device according to Claim 1, wherein said cable connection bushings (9) extend in said second direction, and said wall through which said cable connection bushings (9) is perpendicular to said second direction.
12. The switching device according to Claim 1, wherein the cable connection bushing (9) and the circuit breaker (5) connected to each other extend along a common straight line.