

DESCRIPTION

INSULATION BUS SYSTEM AND METHOD OF COUPLING BUS UNITS THEREOF

TECHNICAL FIELD

The present invention relates to an insulation bus system configured by coupling between a plurality of electric equipment arranged adjacently with an insulation bus and a method of coupling bus units thereof.

BACKGROUND ART

FIG. 12 is a schematic diagram for explaining a procedure for coupling between switching boards 30 arranged in multiple in a conventional gas-insulated switching gear with an insulation bus 31.

In this example, when a bus portion 33 is coupled to a lead-in bushing 32 protruding from an upper surface of the switching board 30, the switching board 30 to which the bus portion 33 is to be coupled is moved to one side of the plurality of switching boards 30 where the bus portions 33 have been already coupled to the lead-in bushings 32, and then the bus portion 33 is coupled to the lead-in bushing 33.

In this case, for example, when the bus portion 33 of an optional one is required to be taken out from the plurality of arranged switching boards 30, there arises a problem in that all the switching boards 30 on one side of the bus portion 33 have to be moved to one direction and during the movement, each of the bus portions 33 must also be disassembled from the respective lead-in bushings 32.

FIG. 13 is a schematic diagram for explaining another procedure for coupling with the insulation bus 31 between the plurality of arranged switching boards 30 in the conventional gas-insulated

switching gear.

In this example, the insulation bus 31 which has been composed by coupling the bus portions 33 to the lead-in bushings 32 by a predetermined length of arranged switching boards, is coupled to upper surfaces of the arranged switching boards 30 at one time.

In this case, when an optional one is required to be taken out from the plurality of arranged switching boards 30, there arises a problem in that the whole of the insulation bus 31 has to be disassembled from the switching boards 30.

Furthermore, when a length of arranged switching boards becomes long due to a number of arranged switching boards of the gas-insulated switching gear, there arises another problem in that, in installing the insulation buses 31, each of the lead-in bushings 32 is required to undergo correct positioning with respect to the respective switching boards 30 and the installation work is also difficult.

DISCLOSURE OF THE INVENTION

The present invention, which has been made to solve the aforementioned problems, has an object to provide an insulation bus system and a method of coupling bus units thereof which, in the case of taking out an optional casing from juxtaposed casings, allow the casing to be taken out without disassembling the rest of the casings and also enable easy positioning of bus conductor axis lines in installing electric equipment.

An insulation bus system according to the present invention includes: a T-shaped bushing having an internal conductor mounted on each casing of a plurality of electric equipment juxtaposed; a plurality of bus units arranged between the adjacent T-shaped bushings, the bus units having bus conductors whose axis lines are aligned with each other; a coupling conductor that is movable in a direction of the axis line in the T-shaped bushing and has a coupling hole on both sides, the coupling hole being detachably attachable

and slidable with respect to an end portion of the bus conductor; an insulation plug inserted into a hole formed in the T-shaped bushing; fastening means for fastening the coupling conductor to the internal conductor; a flange provided on the T-shaped bushing side of each of the bus units; and coupling means for coupling a pair of the bus units sandwiching the T-shaped bushing through the T-shaped bushing by penetrating into each of the flanges of the pair of the bus units.

Also, a method of coupling bus units of an insulation bus system according to the present invention includes the steps of: sliding, with the insulation plug opened, the coupling conductors through the hole toward an end portion of one of the bus conductors to move in one direction and then moving the other bus unit to be coupled so that the axis lines of the bus conductors are aligned with each other; after that, sliding the coupling conductor through the hole toward end portions of each of the one bus conductor and the other bus conductor to move so that the adjacent bus conductors are coupled to each other; next, fastening the coupling conductor to the internal conductor with the bolt; subsequently, inserting the through bolt into a pair of the flanges to thread the through bolt to the nut so that the pair of the bus units are coupled through the T-shaped bushing; and inserting the insulation plug into the hole of the T-shaped bushing to fix the insulation plug to the T-shaped bushing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of gas-insulated switching gear according to Embodiment 1 of the present invention;

FIG. 2 is a cross-sectional view taken along the line II-II of FIG. 1;

FIG. 3 is a perspective view of a contact of FIG. 2;

FIG. 4 is a perspective view of a flange piece of a flange of FIG. 2;

FIG. 5 is an exploded perspective view of vicinities of the flange of FIG. 2;

FIG. 6 is a perspective view of vicinities of the flange of FIG. 2;

FIG. 7 is a cross-sectional view of an end portion of a through bolt of FIG. 2;

FIG. 8 is a cross-sectional view during coupling of bus units of FIG. 2;

FIG. 9 is a cross-sectional view of gas-insulated switching gear according to Embodiment 2 of the present invention;

FIG. 10 is a perspective view of a coupling conductor of FIG. 9;

FIG. 11 shows the coupling conductor of FIG. 10 as seen from one direction thereof;

FIG. 12 is a schematic diagram for explaining a procedure for coupling with an insulation bus between a plurality of arranged switching boards of a conventional technique; and

FIG. 13 is a schematic diagram for explaining another procedure for coupling with an insulation bus between a plurality of arranged switching boards of the conventional technique.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, preferable embodiments of the present invention will be described with reference to the drawings. However, in each of the embodiments, identical members and portions, or equivalent members and portions will be described with the same reference numerals.

Embodiment 1

FIG. 1 is a top plan view of an insulation bus system according to Embodiment 1 of the present invention and FIG. 2 is a cross-sectional view taken along the line II-II of FIG. 1.

An insulation bus system according to the present invention

includes: a T-shaped bushing 2 having an internal conductor 2a mounted on each casing 1 of gas-insulated switching gear of an electric apparatus; a plurality of bus units 3 arranged between the adjacent T-shaped bushings 2, the bus units having bus conductors 3a whose axis lines are aligned with each other; a coupling conductor 4 that is movable in a direction of the axis line in the T-shaped bushing 2 and has a coupling hole 4a on both sides, the coupling hole being detachably attachable and slidable with respect to an end portion of the bus conductor 3a; an insulation plug 5 inserted into a truncated cone-shaped hole 2d formed in the T-shaped bushing 2; a screw 6 as fastening means for fastening a coupling conductor 4 to the internal conductor 2a; a flange 8 provided on the T-shaped bushing 2 side of each bus unit 3; and coupling means for coupling a pair of bus units 3 sandwiching the T-shaped bushing 2 through the T-shaped bushing 2 by penetrating into each of the flanges 8 of the pair of bus units 3.

The T-shaped bushing 2 has its internal conductor 2a encapsulated with an insulation material such as an epoxy resin and has its surface coated with a thermally sprayed metallic surface 2b, the surface not being involved in interface insulation. The internal conductor 2a is connected to a cylindrical electric field reducing shield portion 2c on its end portion. The internal conductor 2a has its end portion penetrating into the electric field reducing shield portion 2c.

The bus unit 3 includes the bus conductor 3a, an internal conductive layer 3b covering the peripheral surface of the bus conductor 3a through a conductive adhesive, an insulation layer 3c covering the internal conductive layer 3b, and an outer conductive layer 3d covering the insulation layer 3c. The insulation layer 3c is made of insulation rubber such as EPDM (Ethylene Propylene Diene Monomer) or silicon rubber and is exposed on both end surfaces of the insulation layer 3c, resulting in an insulation interface

for achieving interface insulation. The internal conductive layer 3b and the outer conductive layer 3d are made of conductive rubber which is obtained by adding graphite powder to the rubber used for the insulation layer 3c.

The insulation plug 5 is of a truncated cone-shape and includes an internal conductive layer 5a on the screw 6 side, an insulator body 5b, and an outer conductive layer 5c. The insulator body 5b is made of insulation rubber such as EPDM or silicon rubber, resulting in insulation interface for achieving interface insulation on its peripheral surface. The internal conductive layer 5a and the outer conductive layer 5c are made of conductive rubber which is obtained by adding graphite powder to the rubber used for the insulator body 5b.

The coupling conductor 4 includes a pair of the coupling holes 4a through which the end portion of the bus conductor 3a is slidable. The coupling hole 4a has a groove 4b formed in its internal circumferential wall. As shown in FIG. 3, a contact 7 made of an annular coil spring is provided in the groove 4b, thereby enabling electrical coupling between the coupling conductor 4 and the bus conductor 3a more securely.

A pair of the bus units 3 is coaxially coupled by the flange 8, a through bolt 9 and a nut 10. As shown in FIGS. 4 to 6, the flange 8 is composed of a pair of horseshoe-shaped flange pieces 11. The flange piece 11 includes a through hole 11a into which the bolt 9 penetrates and a coupling hole 11b and a screw hole 11c for coupling a pair of the flanges 8. Each end portion of a pair of the opposed bus units 3 is surrounded with a pair of the flanges 8 in which each bolt 11d is inserted into the coupling hole 11b and threaded in the screw hole 11c.

The coupling means is composed of the through bolt 9 and the nut 10, as shown in FIG. 7, and a shoulder of the through bolt 9 is in contact with a washer 20 on which the nut 10 is put to thread

it to an end portion of the through bolt 9, resulting in coupling between the bus units 3 through the T-shaped bushing 2 and achieving interface insulation where insulation interface of the T-shaped bushing 2 and insulation interface of the bus unit 3 are brought into pressure contact with each other through insulating grease.

In addition, at this time, the junction portions of the bus conductors 3a and the coupling conductor 4 are covered by the internal conductive layer 5a, the electric field reducing shield portions 2c, and radially enlarged portions A of the internal conductive layers 3b, whereby the electric field of the junction portion is reduced or shielded.

The insulation plug 5 is press-fitted into the hole 2d by a retainer plate 12 and a bolt 13 through insulation grease, enabling interface insulation. At this time, the internal conductive layer 5a automatically contacts a top portion of the screw 6, resulting in formation of an electric field reducing shield portion for the top portion of the screw 6 and the portion adjacent to the hole 2d of the electric field reducing shield portion 2c.

Now, a coupling procedure of the bus unit 3 in the above-mentioned insulation bus system will be described.

First, in FIG. 8, with the insulation plug 5 opened, the coupling conductor 4 is manually slid through the hole 2d toward the end portion of one of the bus conductors 3a to move in the direction of the arrow B, and then the other bus unit 3 to be coupled is moved in the direction of the arrow C so that the axis lines of the bus conductors 3a to be coupled are aligned with each other. This work is performed for each bus unit 3 between the adjacent T-shaped bushings 2. Further, at this time, the bus unit 3 has been already provided with the flanges 8.

After that, the coupling conductor 4 is manually slid through the hole 2d toward the end portion of the other bus conductor 3a to move in the direction of the arrow D, and then the adjacent bus

conductors 3a are coupled with each other. This work is also performed for each bus unit 3.

Next, the coupling conductor 4 is fastened to the internal conductor 2a with the screw 6.

Subsequently, the through bolt 9 is inserted into the through hole 11a and threaded in its end portion by the nut 10 through the washer 20, resulting in coupling between the adjacent bus units 3 through the T-shaped bushing 2.

Lastly, the insulation plug 5 is inserted into the hole 2d of the T-shaped bushing 2 through insulation grease and the bolt 13 is threaded into the upper part of the T-shaped bushing 2 through the retainer plate 12 to fix the insulation plug 5 to the T-shaped bushing 2.

In addition, in the insulation bus system, a decoupling work of the bus unit 3 should be performed in reverse order of the above-mentioned work.

As described above, the insulation bus system according to this embodiment, provided is the coupling conductor 4 that is movable in a direction of the axis line in the T-shaped bushing 2 and has the coupling holes 4a detachably attachable and slidable on both sides with respect to each end portion of the bus conductors 3a, whereby an optional one can be taken out of the casings 1 without moving the rest when the optional one is taken out from the juxtaposed casings 1.

In addition, when gas-insulated switching gear is installed, insertion of the end portion of the bus conductor 3a into the coupling hole 4a automatically allows axis lines of the adjacent bus conductors 3a to be aligned with each other, thereby enabling easy alignment of the axis lines.

Embodiment 2

FIG. 9 is a cross-sectional view of a main part of gas-insulated

switching gear according to Embodiment 2 of the present invention.

In this embodiment, the coupling conductor 21 includes an intermediate portion having a C shape in cross-section as shown in FIGS. 10 and 11 and the screw 6 is threaded into the internal conductor 2a of the T-shaped bushing 2, whereby the coupling conductor 21 is in close contact with an end portion of the bus conductor 3a. Consequently, in this embodiment, the groove 4b and the contact 7 required in Embodiment 1 can be omitted.

In addition, the coupling conductor may be divided into two members along the axial direction or the coupling conductor may include an intermediate portion having a C shape in cross-section while being clamped with a clamp on its opening side.

Furthermore, in Embodiment 1 and Embodiment 2 above, the description is focused on the gas-insulated switching gear as electric equipment; however, needless to say, the present invention is not limited to such apparatuses and it can be applied to switching boards displaced in plants or buildings and insulation bus systems for transformers.

INDUSTRIAL APPLICABILITY

As described above, the present invention is suitably applied to an insulation bus unit configured by connecting, with an insulation bus, between a plurality of casings of electric equipment juxtaposed.

CLAIMS

1. An insulation bus system, comprising:

a T-shaped bushing having an internal conductor mounted on each casing of a plurality of electric equipment juxtaposed;

a plurality of bus units arranged between the adjacent T-shaped bushings, the bus units having bus conductors whose axis lines are aligned with each other;

a coupling conductor that is movable in a direction of the axis line in the T-shaped bushing and has a coupling hole on both sides, the coupling hole being detachably attachable and slidable with respect to an end portion of the bus conductor;

an insulation plug inserted into a hole formed in the T-shaped bushing;

fastening means for fastening the coupling conductor to the internal conductor;

a flange provided on the T-shaped bushing side of each of the bus units; and

coupling means for coupling a pair of the bus units sandwiching the T-shaped bushing through the T-shaped bushing by penetrating into each of the flanges of the pair of the bus units.

2. The insulation bus system according to claim 1, further comprising a circumferentially extending groove formed in an internal wall surface of the coupling hole, the groove being provided with a contact for electrically coupling between the bus conductor and the coupling conductor.

3. The insulation bus system according to claim 2, wherein the contact is made of an annular coil spring.

4. The insulation bus system according to claims 1 to 3, wherein the coupling conductor has a C shape in cross-section.

5. The insulation bus system according to any one of claims 1 to 3, wherein the fastening means comprises a screw.

6. The insulation bus system according to any one of claims 1 to 3, wherein the coupling means comprises a through bolt and a nut.

7. The insulation bus system according to any one of claims 1 to 3, wherein the insulation plug is covered with a retainer plate through which a screw is threaded into the T-shaped bushing to fix the insulation plug to the T-shaped bushing.

8. The insulation bus system according to any one of claims 1 to 3, wherein the electric apparatus comprises a gas-insulated switching gear.

9. A method of coupling bus units of an insulation bus system that includes: a T-shaped bushing having an internal conductor mounted on each casing of a plurality of electric equipment juxtaposed; a plurality of bus units arranged between the adjacent T-shaped bushings, the bus units having bus conductors whose axis lines are aligned with each other; a coupling conductor that is movable in a direction of the axis line in the T-shaped bushing and has a coupling hole on both sides, the coupling hole being detachably attachable and slidable with respect to an end portion of the bus conductor; an insulation plug inserted into a hole formed in the T-shaped bushing; a bolt for fastening the coupling conductor to the internal conductor

through the hole; a flange provided on the T-shaped bushing side of each of the bus units; and a through bolt and a nut for coupling a pair of the bus units sandwiching the T-shaped bushing through the T-shaped bushing by penetrating into each of the flanges of the pair of the bus units, the method comprising the steps of:

sliding, with the insulation plug opened, the coupling conductors through the hole toward an end portion of one of the bus conductors to move in one direction and then moving the other bus unit to be coupled so that the axis lines of the bus conductors are aligned with each other;

after that, sliding the coupling conductor 4 through the hole toward end portions of each of the one bus conductor and the other bus conductor to move so that the adjacent bus conductors are coupled to each other;

next, fastening the coupling conductor to the internal conductor with the bolt;

subsequently, inserting the through bolt into a pair of the flanges to thread the through bolt to the nut so that the pair of the bus units are coupled through the T-shaped bushing; and

inserting the insulation plug into the hole of the T-shaped bushing to fix the insulation plug to the T-shaped bushing.