(12) UK Patent (19) GB (11) 2606290 (13) B

(45) Date of B Publication 16.04.2025

(54) Title of the Invention: Gas-insulated switchgear and cable withstand voltage testing method for gas-insulated switchgear

(51) INT CL: ***H02B 13/035*** (2006.01) ***H02B 1/16*** (2006.01) ***H02B 13/065*** (2006.01) ***H02B 13/075*** (2006.01)

(21) Application No: **2208527.8**

(22) Date of Filing: **06.03.2020**

Date Lodged: **10.06.2022**

(86) International Application Data:
PCT/JP2020/009689 Ja 06.03.2020

(87) International Publication Data:
WO2021/176687 Ja 10.09.2021

(43) Date of Reproduction by UK Office **02.11.2022**

(56) Documents Cited:
JP 070222315 A **JP 2002374605 A**
Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 181463/1987 (Laid- open NO. 086414/1989) (NISSEN ELECTRIC CO., LTD) 08 June 1989
Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 111120/1981 (Laid-open No. 022008/1983) (KPUASU KOUGYOUSHO KK) 10 February 1983
Microfilm of the specification and deawings annexed to the request of Japanese Unitility Model Application No. 121906/1989 (Laid-open NO. 063014/1991) (MEIDENSHA CORP.) 20 June 1991

(58) Field of Search:
As for published application 2606290 A viz:
INT CL **H02B**
Other: **Public JP utililty model applns (examined 1922-1996),(unexamined 1971-2020); JP utility models (regst specs 1996-2020),(public regst applns 1994-2020)**
updated as appropriate

Additional Fields
Other: **SEARCH-PATENT**

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FIG. 1

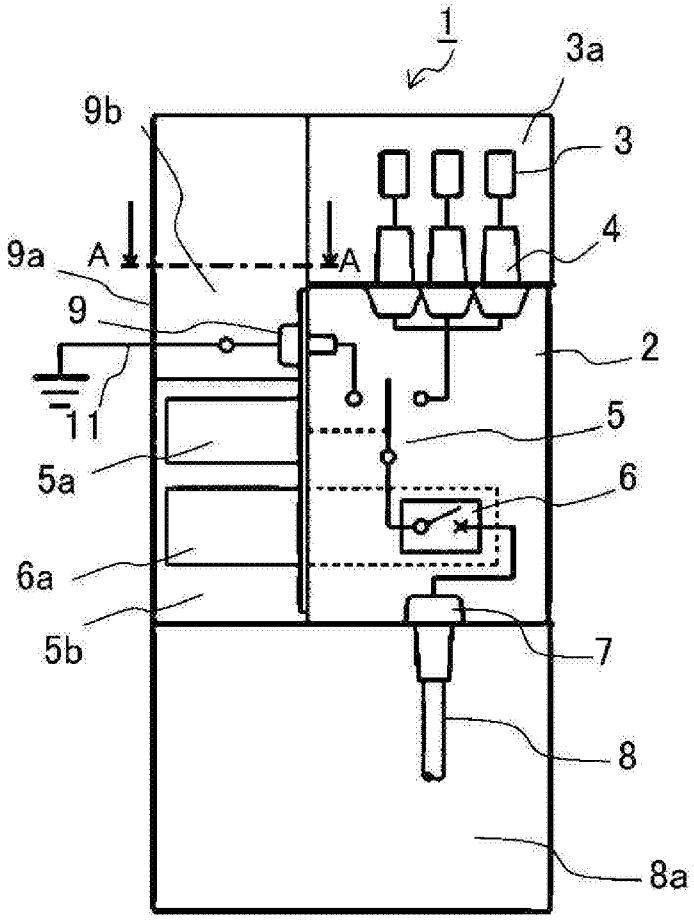


FIG. 2A

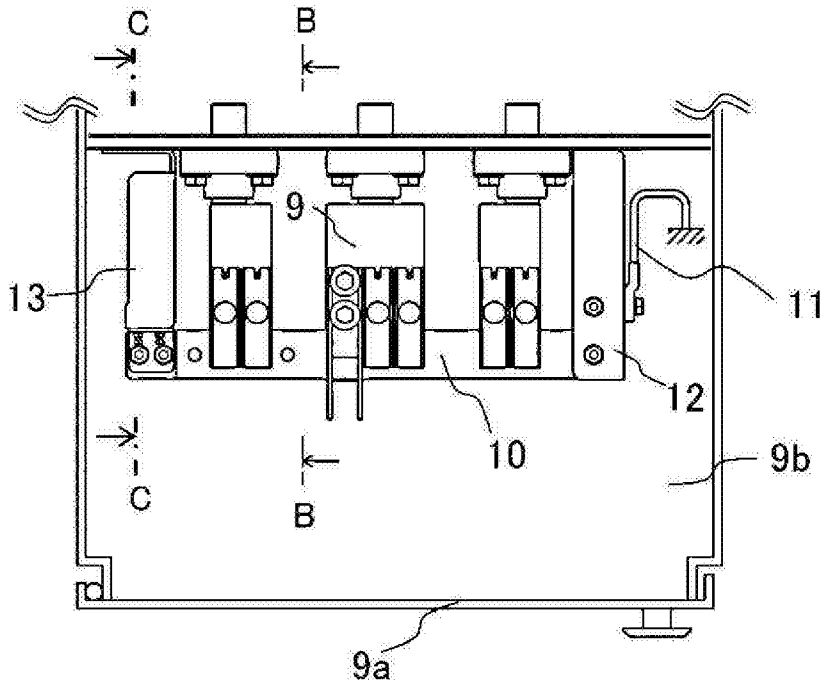


FIG. 2B

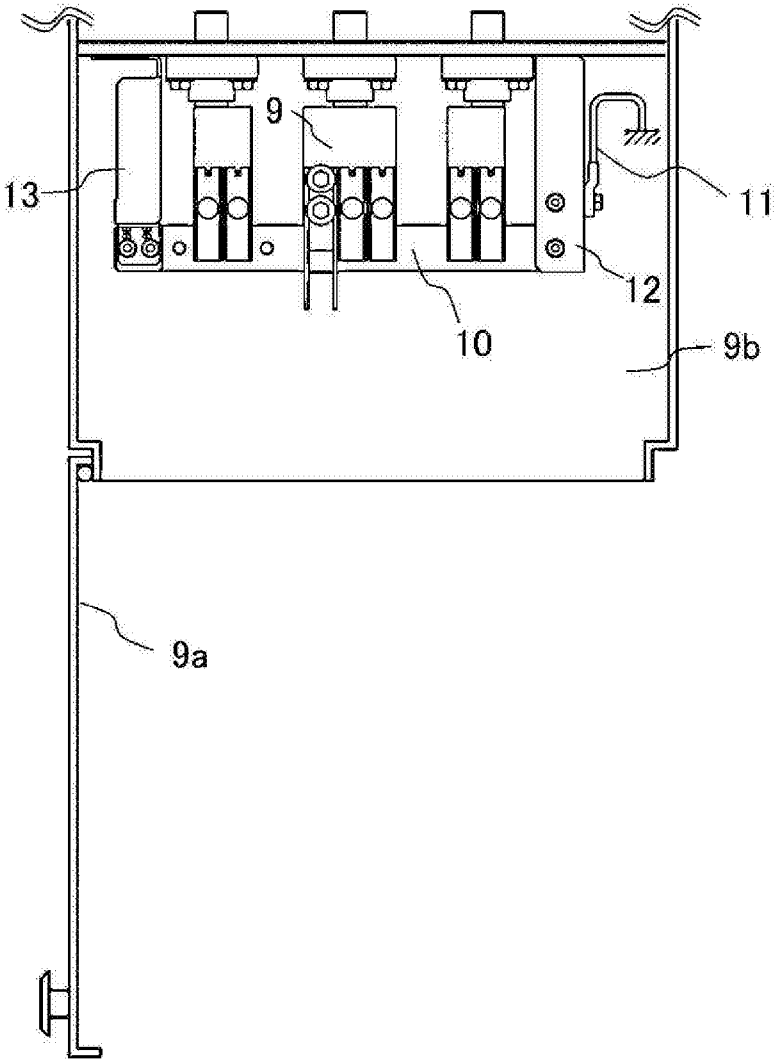


FIG. 2C

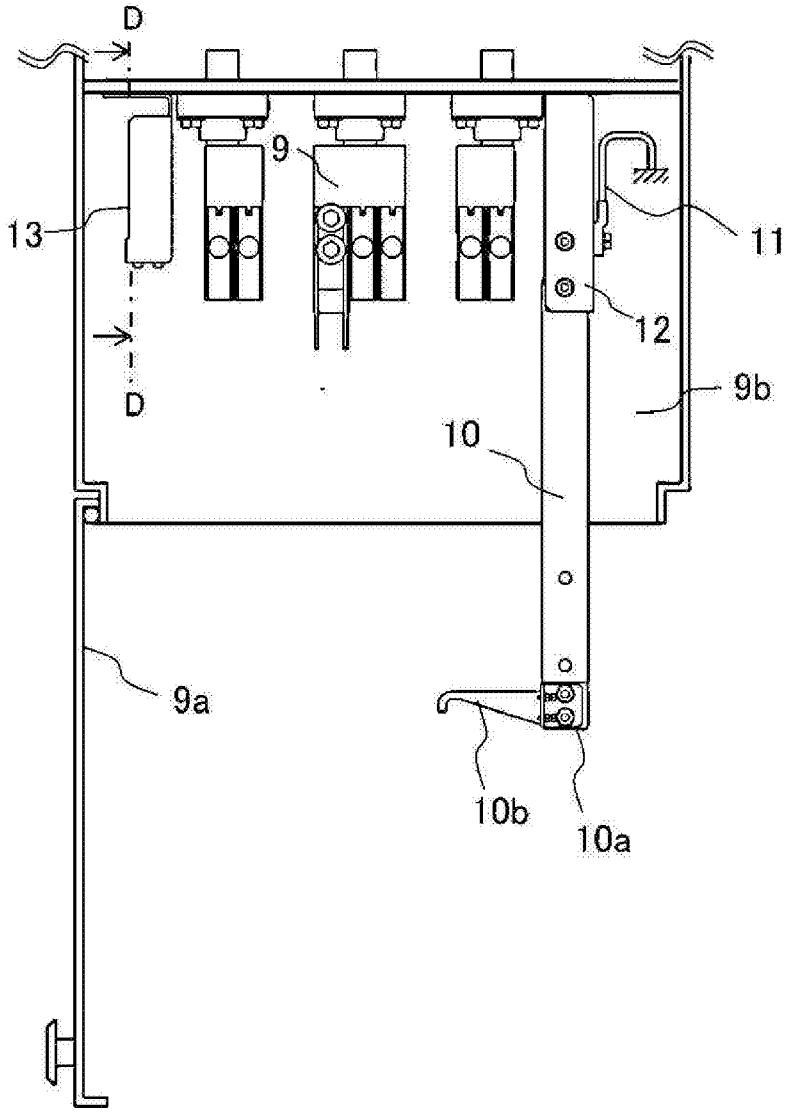


FIG. 3

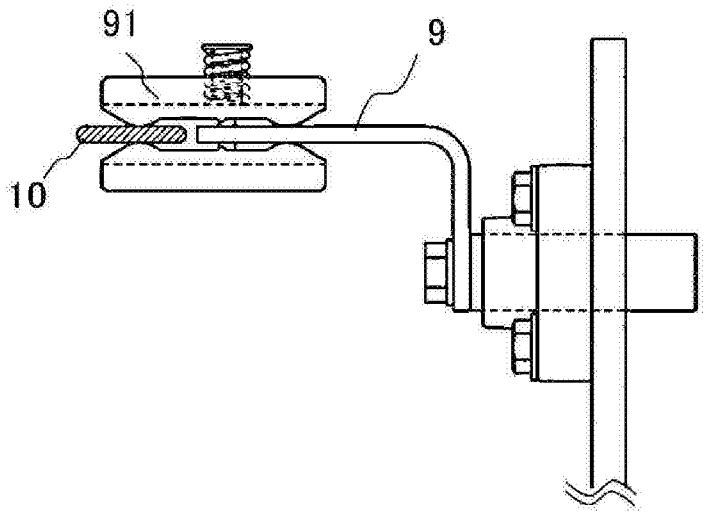


FIG. 4A

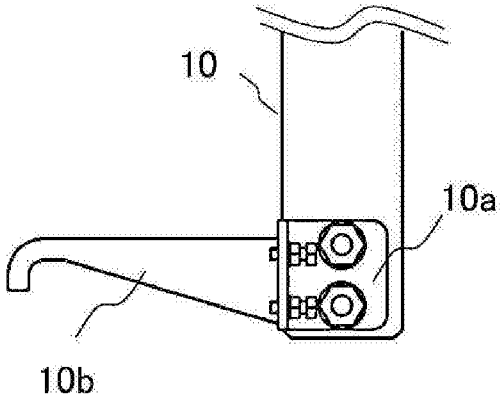


FIG. 4B

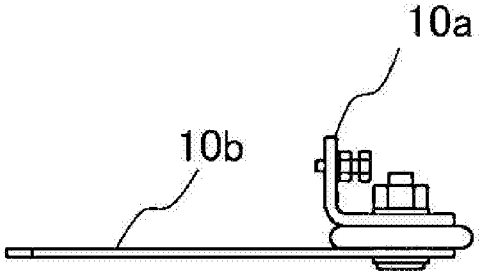


FIG. 5A

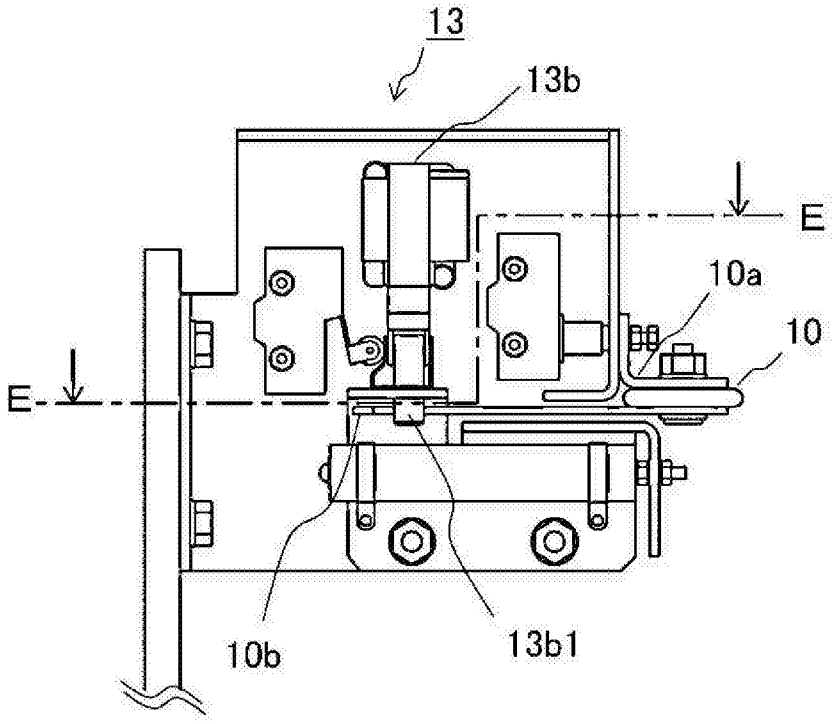


FIG. 5B

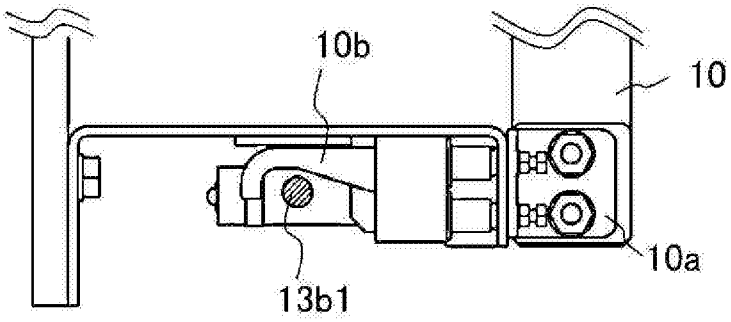


FIG. 6

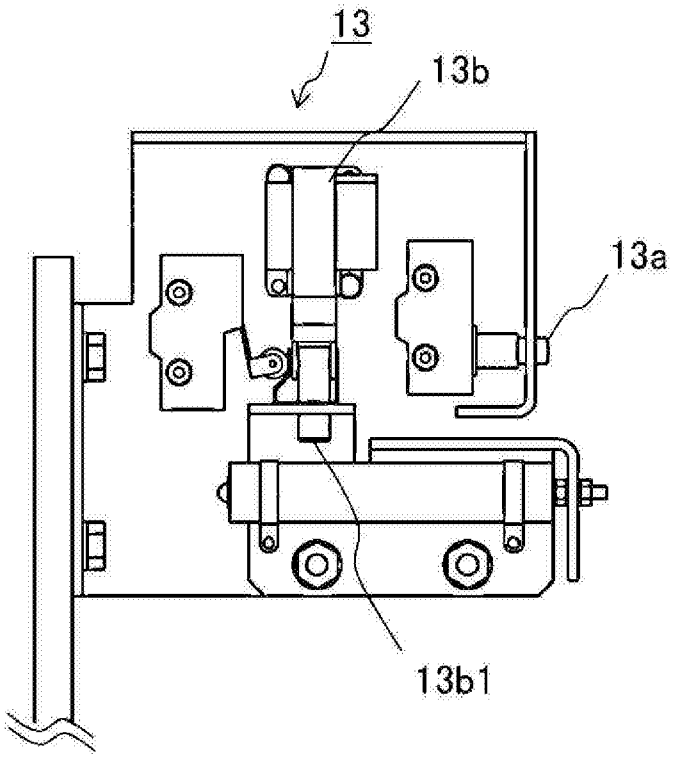


FIG. 7A

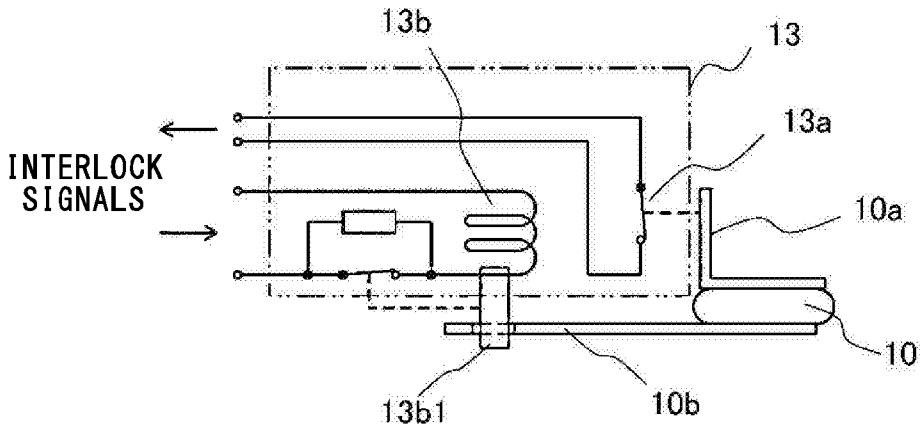


FIG. 7B

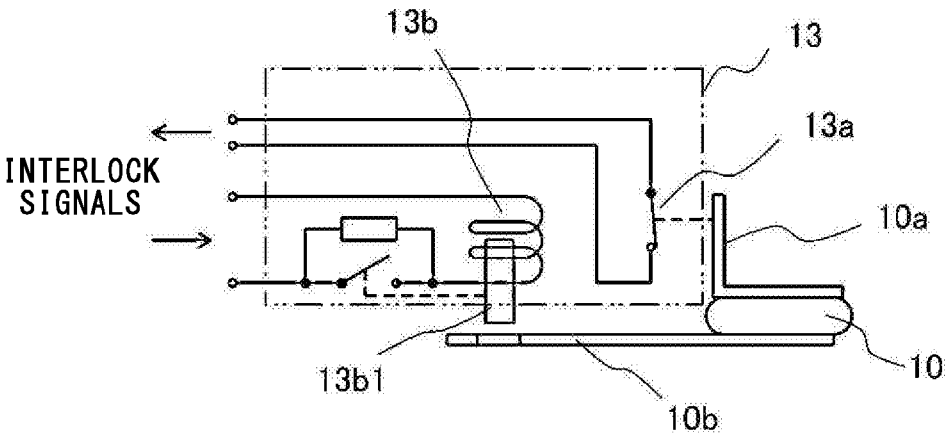


FIG. 7C

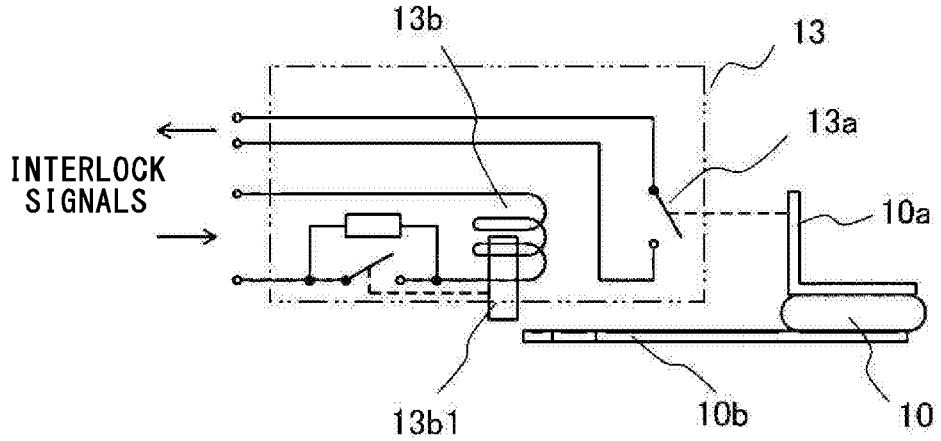


FIG. 7D

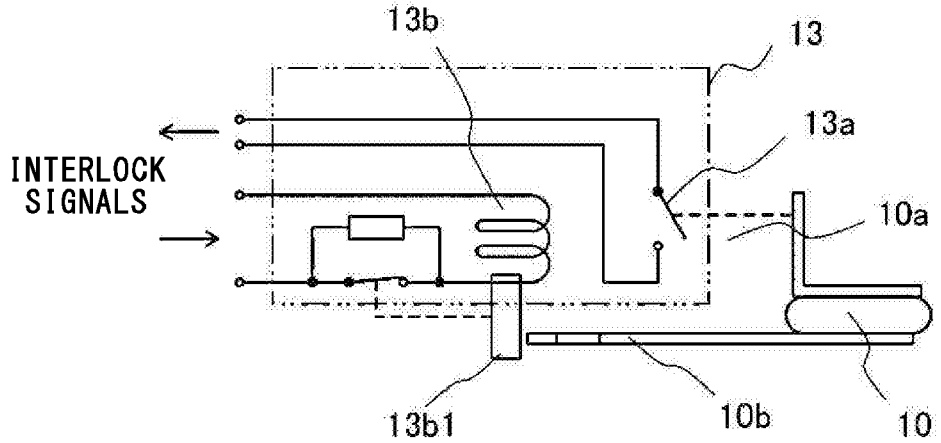


FIG. 8

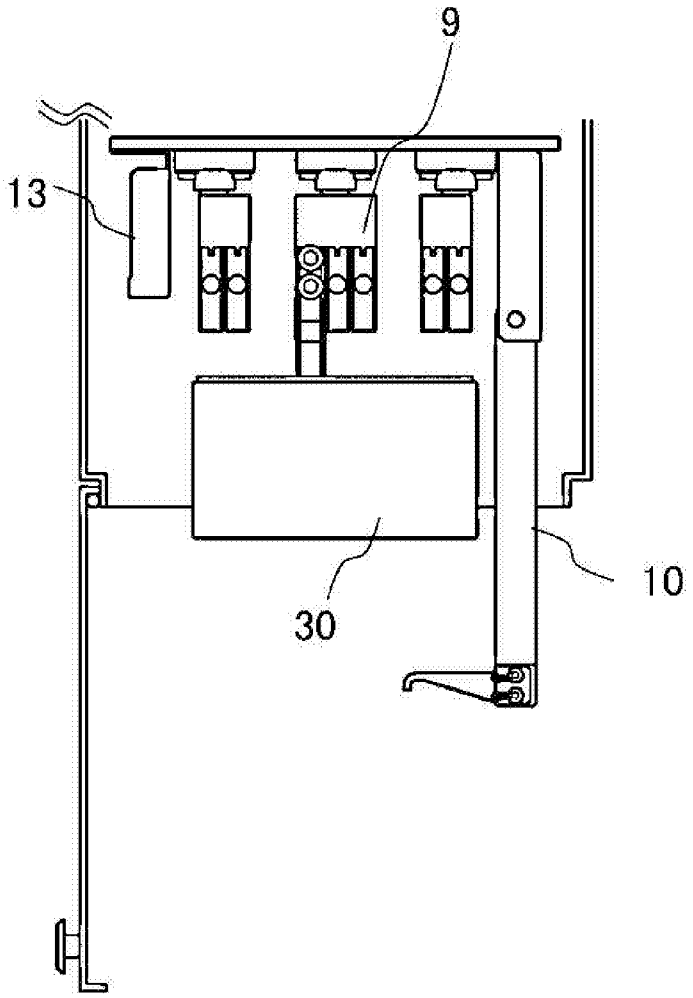


FIG. 9A

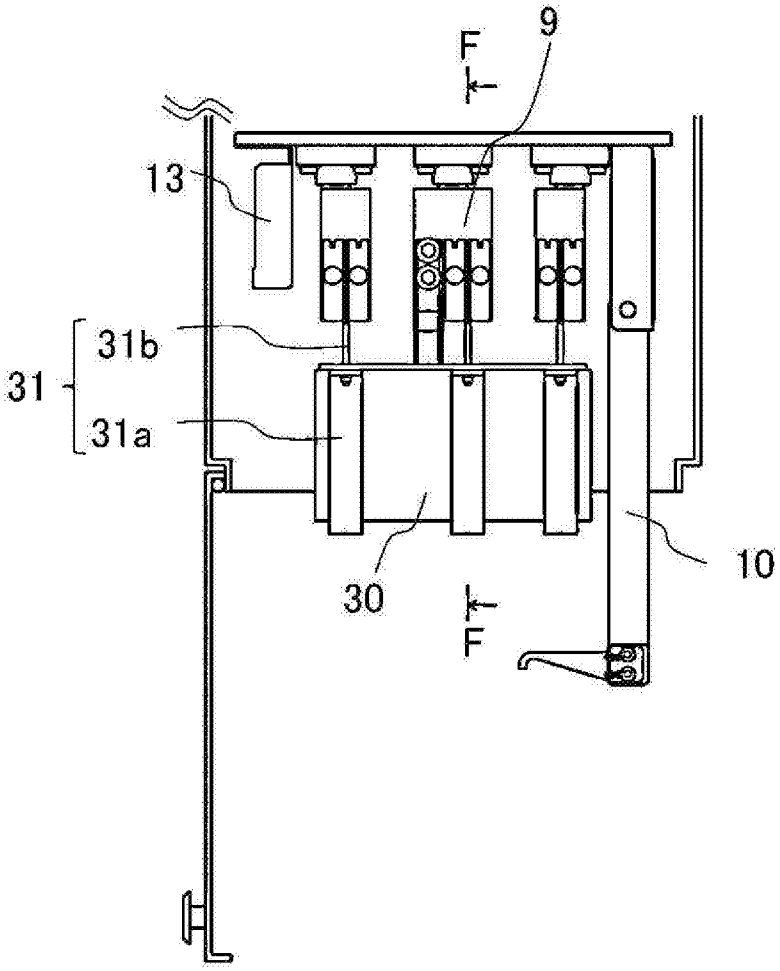


FIG. 9B

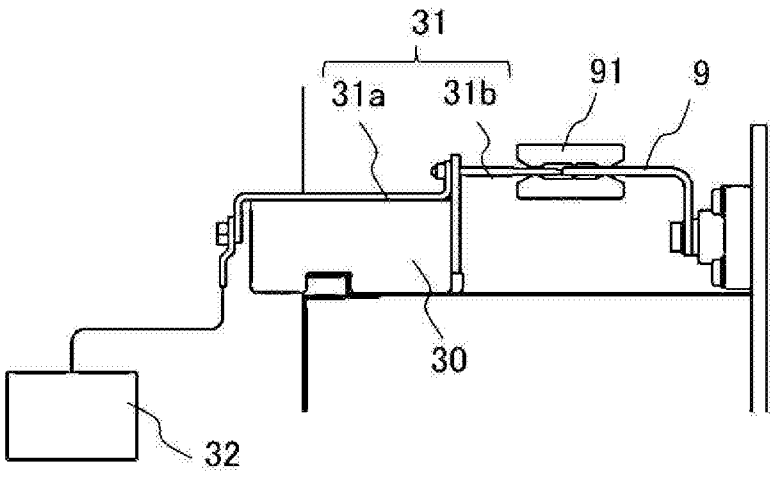


FIG. 10A

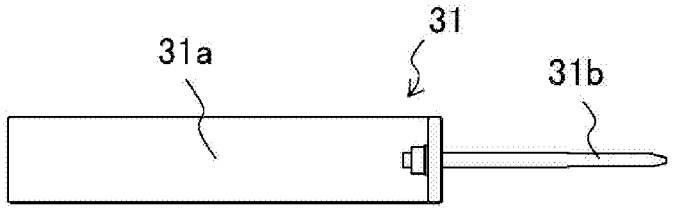
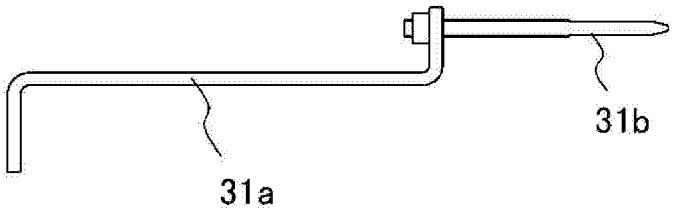


FIG. 10B



DESCRIPTION

TITLE OF THE INVENTION:

GAS-INSULATED SWITCHGEAR AND CABLE WITHSTAND VOLTAGE TESTING METHOD FOR GAS-INSULATED SWITCHGEAR

TECHNICAL FIELD

[0001] The present disclosure relates to a gas-insulated switchgear and a cable withstand voltage testing method for a gas-insulated switchgear.

BACKGROUND ART

[0002] A conventional gas-insulated switchgear has a voltage-application terminal for conducting a withstand voltage test or the like (see, for example, Patent Document 1). Patent Document 1 discloses that, in a normal state, a voltage-application terminal provided to a gas-insulated switch is used as a ground terminal, and at the time of a withstand voltage test, a test bushing is attached so as to cover the voltage-application terminal in a state in which insulation gas is sealed in a gas seal chamber formed in the bushing.

[0003] However, in a case of conducting a cable withstand voltage test or the like at the site after the gas-insulated switchgear is installed, a structure that allows voltage application to a cable to be easily performed is required.

In this regard, in the structure of Patent Document 1, a complicated work such as gas processing is needed at the site and the manufacturing cost for the test bushing is high.

[0004] Meanwhile, Patent Document 2 discloses a gas-insulated switchgear configured such that a ground switch is stored in a tank, a ground circuit led from the ground switch to the ground is led to the outside of the tank, a disconnection portion connected between the ground switch and the ground is provided, and a test terminal can be connected to a terminal provided on the ground switch side of the disconnection portion. Through operation of opening/closing the disconnector, the test terminal can be easily connected, whereby the test can be easily conducted.

CITATION LIST

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Laid-Open Utility Model Publication No. 3-63014

Patent Document 2: Japanese Laid-Open Patent Publication No. 7-222315

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] In Patent Document 2, three-phase blades of the disconnector rotate about a rotation shaft so that the

disconnector moves upward and is opened, but the rotation shaft remains near the terminal and therefore the insulation distance at the time of the withstand voltage test might be insufficient.

[0007] The present disclosure has been made to solve the above problem, and an object of the present disclosure is to provide a gas-insulated switchgear that allows connection of a test terminal using a simple structure while ensuring an insulation distance.

SOLUTION TO THE PROBLEMS

[0008] A gas-insulated switchgear according to the present disclosure includes: a ground-switch-equipped disconnector and a circuit breaker stored inside a tank; and a voltage-application terminal to be connected to the ground-switch-equipped disconnector so as to ground the ground-switch-equipped disconnector, the voltage-application terminal being provided outside the tank. One end of the circuit breaker is connected in an electrically connectable state to a cable outside the tank. The gas-insulated switchgear has a ground bar to be horizontally inserted and connected to the voltage-application terminal with one end of the ground bar as a pivot shaft so as to ground the voltage-application terminal via a ground conductor connected to the pivot shaft side of the ground bar.

[0009] A cable withstand voltage testing method for a gas-insulated switchgear according to the present disclosure is a cable withstand voltage testing method for the gas-insulated switchgear described above, the method including the steps of: connecting the ground-switch-equipped disconnector to the voltage-application terminal so as to ground the ground-switch-equipped disconnector; turning on the circuit breaker into a circuit-closed state, thus forming a circuit from the voltage-application terminal to the cable; horizontally pivoting and opening the ground bar from the voltage-application terminal, so as to move the ground bar away from the voltage-application terminal; and connecting a test tool to the voltage-application terminal and conducting a withstand voltage test for the cable.

EFFECT OF THE INVENTION

[0010] According to the present disclosure, it becomes possible to provide a gas-insulated switchgear and a cable withstand voltage testing method for a gas-insulated switchgear that allow connection of a test terminal using a simple structure while ensuring an insulation distance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] [FIG. 1] FIG. 1 is a side view showing the structure of a gas-insulated switchgear according to

embodiment 1, and shows a partial cross-section.

[FIG. 2A] FIG. 2A is a view showing the structure of a terminal chamber in which voltage-application terminals are stored, in the gas-insulated switchgear according to embodiment 1, as seen from A-A direction in FIG. 1.

[FIG. 2B] FIG. 2B shows a state in which a door of the terminal chamber is opened in FIG. 2A.

[FIG. 2C] FIG. 2C shows a state in which a ground bar is opened in FIG. 2B.

[FIG. 3] FIG. 3 shows a connection state between the voltage-application terminal and the ground bar in the gas-insulated switchgear according to embodiment 1, and is a sectional view as seen from B-B direction in FIG. 2A.

[FIG. 4A] FIG. 4A is a plan view showing the structure of an end portion of the ground bar.

[FIG. 4B] FIG. 4B is a side view showing the structure of the end portion of the ground bar.

[FIG. 5A] FIG. 5A is a view showing the structure of an interlock device as seen from C-C direction in FIG. 2A.

[FIG. 5B] FIG. 5B is a view as seen from E-E direction in FIG. 5A.

[FIG. 6] FIG. 6 is a view showing the structure of the interlock device as seen from D-D direction in FIG. 2C.

[FIG. 7A] FIG. 7A illustrates operation of the interlock device in the gas-insulated switchgear according to

embodiment 1.

[FIG. 7B] FIG. 7B illustrates operation of the interlock device in the gas-insulated switchgear according to embodiment 1.

[FIG. 7C] FIG. 7C illustrates operation of the interlock device in the gas-insulated switchgear according to embodiment 1.

[FIG. 7D] FIG. 7D illustrates operation of the interlock device in the gas-insulated switchgear according to embodiment 1.

[FIG. 8] FIG. 8 illustrates a procedure for attaching test terminals to the voltage-application terminals of the gas-insulated switchgear according to embodiment 1.

[FIG. 9A] FIG. 9A illustrates the procedure for attaching the test terminals to the voltage-application terminals of the gas-insulated switchgear according to embodiment 1.

[FIG. 9B] FIG. 9B is a sectional view as seen from F-F direction in FIG. 9A.

[FIG. 10A] FIG. 10A is a plan view showing the structure of the test terminal to be attached to the voltage-application terminal of the gas-insulated switchgear according to embodiment 1.

[FIG. 10B] FIG. 10B is a side view showing the structure of the test terminal.

DESCRIPTION OF EMBODIMENTS

[0012] Embodiment 1

Hereinafter, the present embodiment will be described with reference to the drawings. In the drawings, the same reference characters denote the same or corresponding parts.

[0013] Embodiment 1

Hereinafter, a gas-insulated switchgear according to embodiment 1 will be described with reference to the drawings.

FIG. 1 is a right side view showing the structure of the gas-insulated switchgear according to embodiment 1. In FIG. 1, the gas-insulated switchgear 1 has a plurality of compartments inside a housing. Busbars 3 in a busbar chamber 3a are connected to conductors in a tank 2 via busbar bushings 4. In the tank 2, insulation gas is sealed, and a ground-switch-equipped disconnector 5 and a circuit breaker 6 connected to the ground-switch-equipped disconnector 5 are provided. The circuit breaker 6 is connected to a cable 8 in a cable chamber 8a via a cable bushing 7, and power is supplied from the cable 8 to a load. As long as connection from the circuit breaker 6 to the cable 8 is made in an electrically connectable state, for example, a disconnector may be further connected between the circuit breaker 6 and

the cable 8.

[0014] During operation of the gas-insulated switchgear 1, the ground-switch-equipped disconnector 5 is connected to the busbar 3 side. On the other hand, in a case of grounding the circuit breaker 6, the ground-switch-equipped disconnector 5 is opened from the busbars 3 and is connected to a voltage-application terminal 9 side outside the tank 2 so as to be grounded via a ground conductor 11.

In a control equipment chamber 5b in front of a housing of the tank 2, a controller 5a for controlling the ground-switch-equipped disconnector 5 and a controller 6a for controlling the circuit breaker 6 are stored. A door 9a of a terminal chamber 9b which is a compartment storing the voltage-application terminals 9 can be opened to perform connection of test tools such as a test terminal and a test power supply described later. The door 9a may serve also as a front door of the housing of the gas-insulated switchgear 1.

[0015] FIGS. 2A, 2B, 2C are views showing the structure of the terminal chamber 9b storing the voltage-application terminals 9, as seen from A-A direction in FIG. 1. FIG. 2B shows a state in which the door 9a is opened in FIG. 2A, and FIG. 2C shows a state in which a ground bar 10 is opened in FIG. 2B. In FIG. 2A, the ground bar 10 is connected to the voltage-application terminals 9 for three phases. One end of

the ground bar 10 is rotatably attached to a ground bar support member 12, and in a case of connecting to the voltage-application terminals 9, another end of the ground bar 10 is engaged in an interlock device 13. The ground conductor 11 is attached to the ground bar support member 12, and the ground bar 10 is grounded via the ground conductor 11.

[0016] FIG. 3 is a view as seen from B-B direction in FIG. 2A. A connection portion 91 of the voltage-application terminal 9 has a junction structure, and the ground bar 10 is connected by being inserted into the junction structure in the horizontal direction.

[0017] Normally, all the voltage-application terminals 9 for the three phases are grounded and short-circuited by the ground bar 10, and thus are used as ground terminals for the ground-switch-equipped disconnector 5. At the time of a withstand voltage test for the cable 8, the ground-switch-equipped disconnector 5 is closed to the voltage-application terminal 9 side, and the circuit breaker 6 is turned on (circuit breaker is closed). Then, the ground bar 10 is opened, and the voltage-application terminals 9 and test tools are connected. FIG. 2B shows a state in which the door 9a is opened after the ground-switch-equipped disconnector 5 is closed to the voltage-application terminal 9 side and the circuit breaker 6 is tuned on (circuit breaker is closed).

Subsequently, in FIG. 2C, engagement of the ground bar 10 on the interlock device 13 side is released, and the ground bar 10 is horizontally pivoted with the ground bar support member 12 side as an axis, so that the ground bar 10 is opened from the voltage-application terminals 9.

[0018] FIG. 4A is a plan view showing the structure of an end portion of the ground bar 10, and FIG. 4B is a side view showing the structure of the end portion of the ground bar. As shown in FIGS. 4A and 4B, an L-shaped fitting 10a protruding upward and an engagement fitting 10b having a hook-shaped end are attached to the end portion of the ground bar 10, and the end of the engagement fitting 10b is engaged in the interlock device 13.

[0019] Next, the structure of the interlock device 13 will be described. FIG. 5A is a view showing the structure of the interlock device 13 as seen from C-C direction in FIG. 2A. FIG. 5B is a view as seen from E-E direction in FIG. 5A. FIG. 6 is a view as seen from D-D direction in FIG. 2C and shows a state in which the ground bar 10 is opened. As shown in the drawings, when the ground bar 10 is to be connected to the voltage-application terminals 9, the ground bar 10 is pivoted horizontally so that the L-shaped fitting 10a of the ground bar 10 comes into contact with a frame of the interlock device 13, thus serving as a stopper. On a surface of the frame of the interlock device 13 with which the L-

shaped fitting 10a comes into contact, an actuator of a micro switch 13a protrudes, thus serving as a sensor for detecting insertion of the ground bar 10 into the voltage-application terminals 9, i.e., a connected state and an opened state. A detected signal is outputted as an interlock signal to the controller 5a for controlling the ground-switch-equipped disconnector 5 and the controller 6a for controlling the circuit breaker 6.

[0020] When the ground bar 10 is inserted into the voltage-application terminals 9, the L-shaped fitting 10a comes into contact with the frame of the interlock device 13, thus pushing the actuator of the micro switch 13a protruding from the contact surface. In addition, the end of the engagement fitting 10b is engaged with a solenoid movable core 13b1 under a solenoid 13b. The solenoid 13b of the interlock device 13 receives interlock signals from the controller 5a for controlling the ground-switch-equipped disconnector 5 and the controller 6a for controlling the circuit breaker 6, and only in a state in which the circuit breaker 6 is turned on (circuit breaker is closed) and the ground-switch-equipped disconnector 5 is grounded, the solenoid 13b is excited so that the solenoid movable core 13b1 ascends. When the solenoid movable core 13b1 ascends, engagement of the end of the engagement fitting 10b is released, so that the ground bar 10 can be operated to be

opened from the voltage-application terminals 9. In a state other than the state in which the circuit breaker 6 is turned on (circuit breaker is closed) and the ground-switch-equipped disconnector 5 is grounded, the solenoid 13b is not excited, and therefore the state in which the solenoid movable core 13b1 is engaged with the end of the engagement fitting 10b is maintained and the ground bar 10 cannot be operated to be opened.

[0021] The details of operation of the interlock device 13 will be described with reference to FIGS. 7A to 7D.

FIGS. 7A to 7D show the relationship between the ground bar and the interlock device 13 having the micro switch 13a and the solenoid 13b. FIG. 7A shows a state in which the end of the engagement fitting 10b of the ground bar is engaged with the solenoid movable core 13b1. This is a normal state, e.g., a state in which the gas-insulated switchgear 1 is operating, and the ground bar 10 is inserted in the voltage-application terminals 9 and thus the voltage-application terminals 9 are grounded. In this state, the circuit breaker 6 is closed and the ground-switch-equipped disconnector 5 is connected to the busbars 3. Therefore, the solenoid 13b is not excited and the ground bar 10 cannot be operated to be opened. Thus, the grounded state of the voltage-application terminals 9 is prevented from being inadvertently released.

[0022] FIG. 7B shows a state in a case of conducting a cable withstand voltage test. In the case of conducting the cable withstand voltage test, the circuit breaker 6 is turned on (circuit breaker is closed) and the ground-switch-equipped disconnector 5 is connected to the voltage-application terminal 9 side, thus forming a circuit from the voltage-application terminal 9 to the cable 8. At this time, the solenoid 13b receives interlock signals from the controllers 5a, 6a and is excited. Thus, the solenoid movable core 13b1 ascends, so that the ground bar 10 can be operated to be opened.

[0023] When the ground bar 10 is opened, as shown in FIG. 7C, the micro switch 13a detects that the ground bar 10 is opened, and outputs an interlock signal indicating that the grounded state is released, to the controllers 5a, 6a. In the state in which the ground bar 10 is opened and the voltage-application terminals 9 are not grounded, operations of the ground-switch-equipped disconnector 5 and the circuit breaker 6 are not allowed by the controllers 5a, 6a, and thus the ground-switch-equipped disconnector 5 and the circuit breaker 6 cannot be inadvertently operated until the ground bar 10 is inserted again.

[0024] In a state in which the ground bar 10 is opened, for example, if the circuit breaker 6 is manually opened when the cable withstand voltage test is finished, as shown in

FIG. 7D, excitation of the solenoid 13b is canceled, so that the solenoid movable core 13b1 descends. Thus, it becomes impossible to insert and engage the end of the engagement fitting 10b with the solenoid movable core 13b1, i.e., the ground bar 10 cannot be operated. It is impossible to ground the voltage-application terminals 9, unless the circuit breaker 6 is turned on (circuit breaker is closed) and the ground-switch-equipped disconnector 5 is connected to the voltage-application terminal 9 side so that the solenoid 13b is excited again.

[0025] Next, the cable withstand voltage test will be described with reference to the drawings. FIG. 8 shows a state in which a base 30 formed by an insulating part is placed on the front side in front of the voltage-application terminals 9, when the ground bar 10 is opened in FIG. 2C. FIG. 9A shows a state in which test terminals 31 corresponding to the respective phases are placed on the base 30 shown in FIG. 8 and the test terminals 31 are inserted into the junctions of the connection portions 91 of the voltage-application terminals 9. FIG. 9B is a sectional view as seen from F-F direction in FIG. 9A. In FIGS. 8 and 9A, the ground conductor 11 is not shown. FIG. 10A is a plan view showing the structure of the test terminal 31, and FIG. 10B is a side view showing the structure of the test terminal 31. The test terminal 31 is made of a conductive material,

and has a plug portion 31b formed by a bar-shaped part and a power supply connection portion 31a formed by a plate-shaped part. As shown in FIGS. 9A and 9B, the plug portions 31b of the test terminals 31 are inserted into the junctions of the connection portions 91 of the voltage-application terminals 9, and the power supply connection portions 31a fixed on the base 30 are connected to a test power supply 32 outside the housing. At this time, it is necessary to ensure an insulation distance so as to withstand test voltage, for distances between the phases to which the test terminals 31 are connected, and distances between the terminal for each phase and ground metal parts such as the ground bar 10 and the housing. Predetermined voltage (DC voltage) is applied from the test power supply 32 to a cable, to conduct the withstand voltage test. When the cable withstand voltage test is finished, the test power supply 32 is detached from the test terminals 31, and the plug portions 31b of the test terminals 31 are pulled out from the connection portions 91 of the voltage-application terminals 9. Then, the base 30 placed in front of the voltage-application terminals 9 is removed, to prepare connection of the ground bar 10.

[0026] In the present embodiment, after the ground bar 10 for grounding the voltage-application terminals 9 is horizontally pivoted so as to move away from the voltage-application terminals 9, the test terminals 31 are connected

to the voltage-application terminals 9, to conduct the cable withstand voltage test. Thus, the insulation distance between the ground bar and each phase of the test terminals 31 can be ensured. In addition, in FIG. 2C, FIG. 9A, and FIG. 9B, a pivot shaft of the ground bar 10 and the ground bar support member 12 may be joined in such a manner that the ground bar 10 can be detached from the ground bar support member 12. Such a structure is effective for ensuring the insulation distance and facilitates operation in the withstand voltage test. Alternatively, a rail may be provided inside the ground bar support member 12 so that the ground bar 10 can be stored along the ground bar support member 12.

[0027] In addition, in the present embodiment, since the interlock device 13 for restricting grounding and opening operations of the ground bar 10 is provided, the grounded state and the opened state of the ground bar 10, and the controllers 5a, 6a for the ground-switch-equipped disconnector 5 and the circuit breaker 6, are coordinated with each other, whereby operation of the ground bar 10 or operations of the ground-switch-equipped disconnector 5 and the circuit breaker 6 are restricted. Thus, inadvertent operation can be avoided and short-circuit failure or the like can be avoided, whereby it becomes possible to provide a gas-insulated switchgear having high reliability.

[0028] In the above description, the solenoid 13b is provided to the interlock device 13, and the engagement fitting 10b having a hook-shaped end, of the ground bar 10, is engaged with the solenoid movable core 13b1, but the configuration is not limited thereto. Instead of having a hook shape, the end of the engagement fitting 10b may have a hole shape that allows engagement and release through ascending and descending of the solenoid movable core 13b1.

[0029] As a method for conducting the withstand voltage test for the cable 8 in the gas-insulated switchgear 1 according to the present embodiment, regarding the ground-switch-equipped disconnector 5 and the circuit breaker 6 present between the busbars 3 and the cable 8, first, the ground-switch-equipped disconnector 5 is opened from the busbars 3 and grounded via the voltage-application terminals 9, and the circuit breaker 6 is turned on (closed), to form a circuit from the voltage-application terminals 9 through the ground-switch-equipped disconnector 5 and the circuit breaker 6 to the cable 8. Thereafter, the ground bar for grounding the voltage-application terminals 9 is horizontally pivoted from the voltage-application terminals 9 in the terminal chamber so as to move away therefrom, and then test tools are connected to the voltage-application terminals 9. This structure enables switching to a withstand voltage test mode in a simple manner and ensures the insulation distance from

the voltage-application terminal 9 for each phase in the terminal chamber 9b, thus making it possible to easily conduct the withstand voltage test for the cable 8. In addition, in accordance with the closed/opened state of the ground bar 10, an interlock signal is generated to coordinate with the controllers 5a, 6a for the ground-switch-equipped disconnector 5 and the circuit breaker 6, thereby restricting operation of the ground bar 10 or operations of the ground-switch-equipped disconnector 5 and the circuit breaker 6. Thus, inadvertent operation during the withstand voltage test can be avoided, and short-circuit failure or the like can be avoided, whereby it becomes possible to provide a highly reliable withstand voltage testing method for the cable 8 in the gas-insulated switchgear.

[0030] Although the disclosure is described above in terms of various exemplary embodiments and implementations, it should be understood that the various features, aspects, and functionality described in one or more of the individual embodiments are not limited in their applicability to the particular embodiment with which they are described, but instead can be applied, alone or in various combinations to one or more of the embodiments of the disclosure.

It is therefore understood that numerous modifications which have not been exemplified can be devised without departing from the scope of the present disclosure.

For example, at least one of the constituent components may be modified, added, or eliminated. At least one of the constituent components mentioned in at least one of the preferred embodiments may be selected and combined with the constituent components mentioned in another preferred embodiment.

DESCRIPTION OF THE REFERENCE CHARACTERS

[0031] 1 gas-insulated switchgear
2 tank
3 busbar
3a busbar chamber
4 busbar bushing
5 ground-switch-equipped disconnector
5a controller
5b control equipment chamber
6 circuit breaker
6a controller
7 cable bushing
8 cable
8a cable chamber
9 voltage-application terminal
9a door
9b terminal chamber
10 ground bar

10a L-shaped fitting

10b engagement fitting

11 ground conductor

12 ground bar support member

13 interlock device

13a micro switch

13b solenoid

13b1 movable core

30 base

31 test terminal

32 test power supply

91 connection portion

CLAIMS

[1] A gas-insulated switchgear (1) comprising:

a ground-switch-equipped disconnector (5) and a circuit breaker (6) stored inside a tank (2); and

a voltage-application terminal (9) to be connected to the ground-switch-equipped disconnector (5) so as to ground the ground-switch-equipped disconnector (5), the voltage-application terminal (9) being provided outside the tank (2), wherein

one end of the circuit breaker (6) is connected in an electrically connectable state to a cable (8) outside the tank (2), and

the gas-insulated switchgear (1) has a ground bar (10) to be horizontally inserted and connected to the voltage-application terminal (9) with one end of the ground bar (10) as a pivot shaft so as to ground the voltage-application terminal (9) via a ground conductor (11) connected to the pivot shaft side of the ground bar (10).

[2] The gas-insulated switchgear (1) according to claim 1, wherein

an engagement fitting (10b) is provided at another end of the ground bar (10), the gas-insulated switchgear (1) further comprising an interlock device (13) with which the engagement fitting (10b) is engaged when the ground bar (10)

is connected to the voltage-application terminal (9).

[3] The gas-insulated switchgear (1) according to claim 2, wherein

the interlock device (13) includes a sensor (13a) for detecting whether the ground bar (10) is in a state of being connected to or opened from the voltage-application terminal (9).

[4] The gas-insulated switchgear (1) according to claim 3, wherein

the interlock device (13) transmits the state of the ground bar (10) detected by the sensor (13a), to a controller (5a) for the ground-switch-equipped disconnector (5) and a controller (6a) for the circuit breaker (6), and releases engagement of the engagement fitting (10b) in accordance with signals from the controllers (5a, 5b).

[5] The gas-insulated switchgear (1) according to claim 4, wherein

the interlock device (13) releases engagement of the engagement fitting (10b), when the ground-switch-equipped disconnector (5) is connected to the voltage-application terminal (9) and the circuit breaker (6) is in a circuit-closed state.

[6] The gas-insulated switchgear (1) according to any one of claims 1 to 5, wherein

the voltage-application terminals (9) are provided for three phases.

[7] The gas-insulated switchgear (1) according to any one of claims 1 to 6, wherein

in a state in which the ground bar (10) is opened, a test terminal (31) is connectable to the voltage-application terminal (9).

[8] A cable (8) withstand voltage testing method for the gas-insulated switchgear (1) according to any one of claims 1 to 6, the method comprising the steps of:

connecting the ground-switch-equipped disconnector (5) to the voltage-application terminal (9) so as to ground the ground-switch-equipped disconnector (5);

turning on the circuit breaker (6) into a circuit-closed state, thus forming a circuit from the voltage-application terminal (9) to the cable (8);

horizontally pivoting and opening the ground bar (10) from the voltage-application terminal (9), so as to move the ground bar (10) away from the voltage-application terminal (9); and

connecting a test tool (31, 32) to the voltage-application terminal (9) and conducting a withstand voltage test for the cable (8).