

Title of the Invention

Switchgear and its interlocking test method

Field of the Invention

5 The present invention relates to a switchgear provided with a switch having both breaking and disconnecting functions, as well as an interlocking test method for the switchgear.

Background Art

10 The switchgear is a device which performs closing (passage) and breaking of an electric current in a power transmission system and a switch used therein functions to close and break a main electric current. Among various switchgears, a vacuum-insulated switchgear, in comparison with the
15 conventional SF₆ (sulfur hexafluoride) gas insulated switchgear, uses no SF₆ gas that exhibits a global warming potential of about 23,900 times as high as CO₂, and is thus an environment fitting type next generation switchgear.

 Above all, a three-position type switchgear having both
20 breaking and disconnecting functions is advantageous in that it can attain the reduction in size of the device. As a three-position type switchgear having both breaking and disconnecting functions there is known, for example, one described in Patent Document 1 (Japanese Patent Laid Open No.
25 2008-104338). Patent Document 1 discloses a switchgear

including vacuum double-break three-position type circuit breaker (CB)/ disconnecting switch (DS), as well as a protective relay.

The protective relay functions to issue a breaking command
5 to the switch and thereby break an excess current, when the excess current is detected on a load side. In the switchgear including the protective relay, it is necessary to conduct an interlocking test periodically to check whether the protective relay and the circuit breaker are normally interlocked with
10 each other and whether the circuit breaker can perform the breaking operation in accordance with the command provided from the protective relay.

Summary of the Invention

15 In the vacuum double-break three-position type circuit breaker/disconnecting switch described in Patent Document 1, a single switch is endowed with both breaking function and disconnecting function, and when conducting an interlocking test for the protective relay and the three-position type circuit
20 breaker/disconnecting switch, the protective relay can only issue a breaking command. Nevertheless, since the three-position type circuit breaker and disconnecting switch are in a breaking position as a start position, it has so far been impossible to conduct an interlocking test to check whether
25 the three-position type circuit breaker/disconnecting switch

perform a breaking operation in a normal manner against the command issued by the protective relay.

A first object of the present invention is to provide a switchgear which makes it possible to conduct an interlocking
5 test between a three-position type switch having both breaking and disconnecting functions and a protective relay. A second object of the present invention is to provide an interlocking test method for a three-position type switch having both breaking and disconnecting functions and a protective relay in the
10 aforesaid switchgear.

To achieve the first object, the switchgear of the present invention comprises a three-position type switch having both breaking and disconnecting functions, a protective relay adapted to provide a breaking or disconnecting command to the
15 switch, a switch-over unit for switching over between the case where the command provided from the protective relay is a breaking command and the case where the command provided from the protective relay is a disconnecting command, a bus bar for the supply of electric power to the switch, and a cable for
20 the supply of electric power from the switch to a load side.

To achieve the second object of the present invention, the interlocking test method of the present invention is for testing interlocking between a protective relay and a three-position type switch in a switchgear with the following
25 elements. Namely, the switchgear comprises a three-position

type switch having breaking and disconnecting functions, a protective relay adapted to provide a breaking or disconnecting command to the switch, a bus bar for the supply of electric power to the switch, a cable for the supply of electric power from the switch to a load side, and a switch-over unit capable of switching over between the case where the command provided from the protective relay is a breaking command and the case where the command provided from the protective relay is a disconnecting command. In such a switchgear, the method comprises the following steps: operating the three-position type switch from a closing state to a breaking state; after that, operating the switch-over unit so that the command provided from the protective relay is a disconnecting command; then, in accordance with the disconnecting command provided from the protective relay, disconnecting the three-position type switch; and through the above-mentioned steps, testing interlocking between the protective relay and the three-position type switch in the switchgear.

By achieving the first object by the present invention with the above-mentioned switchgear arrangements, it becomes possible to provide a switchgear which makes an interlocking test possible between a three-position type switch having both breaking and disconnecting functions and a protective relay.

By achieving the second object by the present invention with the above-mentioned method, it becomes possible to conduct

an interlocking test between a three-position type switch having both breaking and disconnecting functions and a protective relay in the switchgear.

5 Brief Description of the Drawings

Fig. 1 is a sectional side view for explaining an entire construction of a switchgear according to a first embodiment of the present invention.

Fig. 2 is a simplified circuit diagram for explaining the
10 embodiment with respect to functions of the switchgear performed in the period of electric power supply from a bus bar to a load.

Fig. 3 is a simplified circuit diagram for explaining in what procedure an interlocking test associated with the first embodiment is conducted.

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Detailed Description of the Embodiments

An embodiment of the present invention will be described below.

[First Embodiment]

20 This embodiment will now be described with reference to Figs. 1 to 3. A switchgear 100 according to this embodiment is roughly composed of a vacuum double-break three-position type switch 1 having breaking and disconnecting functions, a bus bar 101 for the supply of electric power to the vacuum
25 double-break three-position type switch 1, a cable 102 for the

supply of electric power from the vacuum double-break three-position type switch 1 to a load side, a vacuum earthing switch 104, an operating unit 103 adapted to provide an operating force for switching operation of the vacuum double-break three-position type switch 1 and switching operation of the vacuum earthing switch 104, a protective relay 2 adapted to provide a breaking command to the vacuum double-break three-position type switch 1 in case of emergency, and a control panel 10.

10 The vacuum double-break three-position type switch 1 is mainly composed of a vacuum container 114 having a vacuum interior, two pairs of opposed movable electrodes 105 and fixed electrodes 106, movable conductors 112 connected to the movable electrodes 105 respectively, fixed conductors 113 connected to the fixed electrodes 106 respectively, a connecting conductor 107 for connecting the two movable conductors with each other, an arc shield for shielding an arc at the time of switch from closing to breaking, and bellows for making the movable conductors 112 operable while maintaining the vacuum of the vacuum container 114.

20 The vacuum earthing switch 104 is composed of a vacuum container 124 having a vacuum interior, a movable electrode 110 and a fixed electrode 111 opposed to each other, a movable conductor 122 connected to the movable electrode 110, a fixed conductor 123 connected to the fixed electrode 111, an arc shield

for shielding an arc at the time of switch from closing to breaking, and bellows for making the movable conductor 122 operable while maintaining the vacuum of the vacuum container 124. By closing the vacuum earthing switch 104 the interior of the switchgear 100 can be made a ground potential.

The vacuum double-break three-position type switch 1 and the vacuum earthing switch 104 are integrated with a molded solid insulator. On a load side of the vacuum double-break three-position type switch 1, a current transformer 120 is installed for detecting an electric current flowing on the load side. When an excess current flows on the load side, it can be detected by the current transformer 120.

A circuit configuration which provides breaking and disconnecting commands will now be described with reference to Figs. 2 and 3. The switchgear 100 is equipped with: a command issuing means 5 which is disposed on the outside of a panel surface of the switchgear to issue a breaking command and a disconnecting command with an operation of a normally used push-button; and a protective relay 2 used in case of emergency, for example, upon generation of an excess current on a load side, the protective relay 2 being capable of sending a breaking command to the vacuum double-break three-position type switch 1. The command issuing means 5 can send commands to a closing-to-breaking coil 7 for switching from closing to breaking, a breaking-to- disconnecting coil 8 for switching

from breaking to disconnecting, and a closing coil 9, whereby closing, breaking and disconnecting operations can be performed. In a normal condition, the vacuum double-break three-position type switch 1 is operated with a command provided from the command
 5 issuing means 5 on the basis of operation of the aforesaid push-button.

In addition, the circuit of the switchgear 100 is configured to provide a command from the protective relay 2 to the breaking-to-disconnecting coil 8. The switchgear 100 is also
 10 equipped with a circuit switch-over unit 6 for switching over between a circuit for transmission of a command from the protective relay 2 to the closing-to-breaking coil 7 and a circuit for transmission of a command from the protective relay 2 to the breaking-to- disconnecting coil 8. The circuit
 15 switch-over unit 6 is also disposed within the control panel 10. That is, in the example being considered, a command provided from the protective relay 2 is sent to the closing-to-breaking coil 7 when the switch 1 is in closing position before being switched over, so that the closing-to-breaking coil 7 only reacts
 20 and the command provided from the protective relay 2 becomes a breaking command. Then, when the switch 1 is in the breaking position after being switched over, a command is provided from the protective relay 2 to only the breaking-to-disconnecting coil 8, so that the command provided from the protective relay
 25 2 becomes a disconnecting command. The protective relay 2 and

the command issuing means 5 output the same electric signal.

In the switchgear 100, the operating unit 103 operates so as to move the vacuum double-break three-position type switch 1 from the closing position to the breaking position when the closing-to-breaking coil 7 receives a command from the protective relay 2 or from the command issuing means 5. That is, the closing-to-breaking coil 7 functions as a breaking command receiving means. Further, the operating unit 103 operates so as to move the vacuum double-break three-position type switch 1 from the breaking position to the disconnecting position when the breaking-to-disconnecting coil 8 receives a command from the protective relay 2 or from the command issuing means 5. That is, the breaking-to-disconnecting coil 8 functions as a disconnecting command receiving means. The closing-to-breaking coil 7 and the breaking-to-disconnecting coil 8 react with the same command, whereby the operating unit 103 starts the breaking or disconnecting operation. The breaking-to-disconnecting coil 8 is adapted to react only when the vacuum double-break three-position type switch 1 is in its breaking position. This is for preventing the occurrence of a malfunction in the event of erroneous transfer of a command to the switch despite the switch being not in the breaking position.

A description will now be given about the importance of interlocking between the protective relay 2 and the vacuum

double-break three-position type switch 1. On condition that the protective relay 2 and the vacuum double-break three-position type switch 1 are interlocked with each other normally, in case that an excess current flows in the system for example in the event of an accident, the current transformer 120 disposed on the load side detects the excess current and let the protective relay 2 know the flowing of the excess current. Whereupon, the protective relay 2 issues a command to break the vacuum double-break three-position type switch 1, thus making it possible to prevent the excess current from flowing to the load side. On the other hand, when there is some trouble in connection with interlocking between the protective relay 2 and the vacuum double-break three-position type switch 1, it is impossible to prevent flowing of an excess current to the load side and thus a device connected to the load side cannot be protected properly. Therefore, it is necessary to check periodically whether the protective relay 2 and the vacuum double-break three-position type switch 1 are normally interlocked with each other or not.

20 A description will now be given about in a procedure of an interlocking test for the protective relay 2 and the vacuum double-break three-position type switch 1. The state before starting the interlocking test is in a normal energized state and an electric signal, which is a command provided from the protective relay 2, is transmitted to the closing-to-breaking

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coil 7. If an excess current flows in such a state, an electric signal as a command provided from the protective relay 2 is transmitted to the closing-to-breaking coil 7, thereby the coil 7 reacts based on the command and the operating unit 103 operates.

5 Consequently, a breaking operation is performed. In the interlocking test, first of all, the vacuum double-break three-position type switch 1 is moved to the breaking position to break (cut off) the electric current. The breaking command issued this time is not from the protective relay 2, but is

10 an ordinary breaking command provided from the command issuing means 5 on the basis of operation of the push-button. Next, the circuit of the gearswitch is switched over by the circuit switch-over unit 6 so that an electric signal provided from the protective relay 2 is transmitted to the

15 breaking-to-disconnecting coil 8 in the vacuum double-break three-position type switch 1. After switching over the circuit, a command provided from the protective relay 2 is transmitted to the breaking-to disconnecting coil 8 to move the vacuum double-break three-position type switch 1 from the breaking

20 position to the disconnecting position.

The following description is now provided about the contents capable of being checked by the above interlocking test. First of all, with the command issuing means 5 which issues a breaking or disconnecting command by the push-button

25 used normally, the vacuum double-break three-position type

switch 1 is moved to the breaking position to break the electric current. By so doing it is possible to make sure that the closing-to-breaking coil 7 can receive a command from the command issuing means 5 in a normal manner and that the operating unit 5 103 can perform the breaking operation in a normal manner upon receipt of the command. However, such a test is conducted using an ordinary breaking command, and with this test alone, it is impossible to make sure whether a normal command is being sent from the protective relay 2.

10 In this embodiment, therefore, after switching over the circuit by the circuit switch-over unit 6, a command provided from the protective relay 2 is transmitted to the breaking-to-disconnecting coil 8 to move the vacuum double-break three-position type switch 1 from the breaking 15 position to the disconnecting position. With this test, it is possible to make sure that a normal command is sent from the protective relay 2 to the breaking-to-disconnecting coil 8 and that the operating unit 103 can perform the disconnecting operation normally upon receipt of the command.

20 According to the first breaking operation test, it is possible to make sure that the closing-to-breaking coil 7 can receive a command from the command issuing means 5 in a normal manner and that the operating unit 103 can perform the breaking operation in a normal manner upon receipt of the command.

25 According to the last disconnecting operation test, based on

the operation of the protective relay 2, it is possible to make sure that the protective relay 2 sends a normal command to the breaking-to-disconnecting coil 8 and that the operating unit 103 can perform the disconnecting operation in a normal manner upon receipt of the command. As noted above, the protective relay 2 and the command issuing means 5 output the same electric signal; and the closing-to-breaking coil 7 and the breaking-to-disconnecting coil 8 react with the same command. By adding such conditions, the protective relay 2 can send a normal command also to the closing-to-breaking coil 7, and it is guaranteed that the operating unit 103 performs the breaking operation normally when the closing-to-breaking coil 7 receives the command.

With the construction described above, in the switchgear provided with a three-position type switch having both breaking and disconnecting functions, an interlocking test for the protective relay 2 and the three-position type switch can be done by following the above procedure.

In this embodiment, reference although has been made above to the double-break switch as an example, it goes without saying that no limitation is made thereto.

Although the switch in this embodiment uses vacuum insulation or solid insulation as an example, the present invention is applicable also to a switch using, for example, air insulation or gas insulation or a combination thereof with

vacuum insulation or solid insulation.

Furthermore, in this embodiment, reference although has been made above to the case where the protective relay 2 and the command issuing means 5 output the same electric signal
5 and where the closing-to-breaking coil 7 and the breaking-to-disconnecting coil 8 react with the same command, this is not always essential insofar as both closing-to-breaking coil 7 and breaking-to-disconnecting coil 8 can react with any signals provided from the protective relay 2 and the command
10 issuing means 5. Further, it goes without saying that no limitation is made to the electric signal, but there may be used any other type of signal; for example, optical communication may be used. In the case of the same electric signal or command, as explained above in this embodiment, it suffices for both
15 closing-to-breaking coil 7 and breaking-to-disconnecting coil 8 to react with one command. Thus, it is not necessary to provide for example plural constructions required for the reaction. This is more advantageous because the reduction of cost can be attained.

Claims

1. A switchgear comprising:
 - a three-position type switch having breaking and disconnecting functions;
 - 5 a protective relay adapted to provide a breaking or disconnecting command to the switch;
 - a switch-over unit for switching over between the case where the command provided from the protective relay is a breaking command and the case where the command provided from
 - 10 the protective relay is a disconnecting command;
 - a bus bar for the supply of electric power to the switch;
 - and
 - a cable for the supply of electric power from the switch to a load side.
- 15 2. The switchgear according to claim 1, further comprising a current transformer to measure an electric current flowing to the load side of the switch.
- 20 3. The switchgear according to claim 1 or claim 2, wherein the switch is vacuum-insulated and includes two pairs of fixed electrodes and movable electrodes.
4. The switchgear according to anyone of claims 1 to 3, further
- 25 comprising a breaking command receiving means adapted to receive

a breaking command to be provided to the switch, a disconnecting command receiving means adapted to receive a disconnecting command to be provided to the switch, a command issuing means adapted to provide commands to the breaking command receiving means and the disconnecting command receiving means, a first circuit wherein a command provided from the protective relay is provided to the breaking command receiving means, and a second circuit wherein a command provided from the protective relay is provided to the disconnecting command receiving means, and wherein the protective relay provides commands to the breaking command receiving means and the disconnecting command receiving means, and the circuit switch-over unit switches over between the first circuit wherein a command provided from the protective relay is provided to the breaking command receiving means and the second circuit wherein a command provided from the protective relay is provided to the disconnecting command receiving means, thereby the switchgear is configured to switch over between the case where the command provided from the protective relay is a breaking command and the case where the command provided from the protective relay is a disconnecting command.

5. The switchgear according to claim 4, wherein, the disconnecting command receiving means is configured to react with a command provided from the protective relay or the command issuing means only when the switch is in a breaking position.

6. The switchgear according to claim 4 or claim 5, wherein the protective relay and the command issuing means is configured to output the same command.

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7. The switchgear according to any of claims 4 to 6, wherein the breaking command receiving means and the disconnecting command receiving means is configured to react with the same command.

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8. An interlocking test method for a protective relay and a three-position type switch in a switchgear, the switchgear comprising a three-position type switch having breaking and disconnecting functions, a protective relay adapted to provide
15 a breaking or disconnecting command to the switch, a bus bar for the supply of electric power to the switch, a cable for the supply of electric power from the switch to a load side, and a switch-over unit for switching over between the case where the command provided from the protective relay is a breaking
20 command and the case where the command provided from the protective relay is a disconnecting command,

the method comprising the following steps: operating the three-position type switch from a closing state to a breaking state; after that, operating the switch-over unit so that the
25 command provided from the protective relay is a disconnecting

command; then, in accordance with the disconnecting command provided from the protective relay, disconnecting the three-position type switch; and through the above-mentioned steps, testing interlocking between the protective relay and
5 the three-position type switch in the switchgear.

9. An interlocking test method for a protective relay and a three-position type switch in a switchgear, the switchgear comprising a three-position type switch having breaking and
10 disconnecting functions, a protective relay adapted to provide commands to a breaking command receiving means and a disconnecting command receiving means described later, a command issuing means adapted to provide commands to the breaking command receiving means and the disconnecting command receiving
15 means, the breaking command receiving means adapted to receive a breaking command to be provided to the switch, the disconnecting command receiving means adapted to receive a disconnecting command to be provided to the switch, a circuit switch-over unit for switching over between a circuit wherein
20 a command provided from the protective relay is provided to the breaking command receiving means and a circuit wherein a command provided from the protective relay is provided to the disconnecting command receiving means, a bus bar for the supply of electric power to the switch, and a cable for the supply
25 of electric power from the switch to a load side,

the method comprising the following steps: under a condition such that the circuit switch-over unit sets the circuit wherein the command provided from the protective relay is provided to the breaking command receiving means, issuing a breaking command
5 to the three-position type switch by the command issuing means, thereby moving the three-position type switch to a breaking position; thereafter, switching over to the circuit wherein the command provided from the protective relay is provided to the disconnecting command receiving means by the circuit
10 switch-over unit, and thereby issuing a disconnecting command to the three-position type switch by the protective relay, thereby moving the three-position type switch to a disconnecting position; and through the above-mentioned steps, testing interlocking between the protective relay and the
15 three-position type switch in the switchgear.