

TITLE OF THE INVENTION

Multi Circuit Selecting Switchgear

BACKGROUND OF THE INVENTION

[Field of Technology]

5 The present invention relates to a multi circuit selecting switchgear using vacuum interrupters for switching among power source lines.

[Background of Art]

10 In an electric distribution system, generally speaking, switching among power source lines supplying electricity to loads is carried out by using a multi circuit selecting switchgear. A multi circuit selecting switchgear has been represented by what is known as a gas-insulated-type multi circuit selecting
15 switchgear. But this gas insulated type demands a lot of work in the maintenance against the degradation of insulating gas. Besides, since insulating gas is inferior in withstand voltage ability to solid insulators, it is demanded to enlarge the distance
20 between phases regarding three-phase conductors, particularly when a total number of circuits is three or more as in the case where there are two power source lines and one load line.

 For the reason above, a vacuum interrupter is used
25 to construct a multi circuit selecting switchgear.

This vacuum interrupter has a vacuum chamber constructed by sealing with a shield end plate either open end of an insulated cylinder. In the vacuum chamber, there are a fixed contact connected to a
5 fixed holder penetrating the shield end plate at one open end and a moving contact connected to a moving holder penetrating the shield end plate at the other open end. These electric contacts are placed facing each other, with arc shields placed like surrounding
10 them.

Outside the vacuum chamber a moving side bus bar is in contact with the moving holder, and the outside of the vacuum chamber is covered with a solid-insulator molding axially throughout from the fixed
15 side end (fixed holder side) to the moving side end (moving holder side). An earthed outer case capsulates the whole space through the moving side of the vacuum chamber including the moving side bus bar and is fastened and fixed on the solid insulator, and being
20 filled with insulating gas therein.

In the past, to mold and insulate a vacuum chamber with a solid insulator, the outside of the vacuum chamber has been given a solid-insulator molding that covers it axially throughout from the fixed side end
25 to the moving side end. This is, for instance,

described in Patent Document 1 below.

[Patent Document 1] Japanese Patent application
Laid-open publication No. 2002-15645

SUMMARY OF THE INVENTION

5 According to the prior art, the outside of the
vacuum chamber has been given a solid-insulator
molding that covers it axially throughout from the
fixed side end to the moving side end. When the moving
contact is put into the closed position, it turns out
10 that the solid insulator located between the vacuum
chamber and the earthed outer case has its end face
receiving in the surface directions the application of
a great electric field strength equivalent to power
source voltage. This leads to the problem of the
15 necessity for enlarging the thickness of the solid
insulator, which results in a rise in the size and the
manufacturing cost of the multi circuit selecting
switchgear.

 The object of the present invention is to provide
20 a multi circuit selecting switchgear capable of
reducing the electric field strength applied to the
solid insulator that puts a vacuum chamber to a molded
and insulated state due to its molding and thus of
size reduction.

25 To achieve the above-mentioned object, according

to the invention, a multi circuit selecting switchgear is provided characterized in that a vacuum chamber constructed by sealing with a shield end plate either open end of an insulated cylinder has a molded and insulated state due to a solid-insulator molding that covers a part of the insulated cylinder axially from the fixed side.

Put otherwise, according to the invention, a multi circuit selecting switchgear is provided characterized in that the solid insulator axially covers the insulated cylinder where an electric contact (fixed contact or moving contact) and an arc shield have a smaller capacitance in between than that between an arc shield and the earthed outer case.

Note that this specification has appellation such that the fixed contact (fixed holder) of the vacuum chamber (vacuum interrupter) lies on "the fixed side" and that the moving contact (moving holder) lies on "the moving side."

According to the invention, the capacitance between arc shields and an earthed outer case is made greater than that between electric contacts and arc shields by having a molded and insulated state due to a molding that covers a part of an insulated cylinder, thus it is possible to lessen the distributed voltages

of the arc shields and the earthed outer case. It is further possible to lessen the electric field strength applied to the solid insulator in its surface directions, and to lessen the thickness of the solid insulator, which makes a smaller-size multi circuit selecting switchgear possible.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal sectional view illustrating an embodiment of the present invention.

Figure 2 is a sectional view taken along the line A - A of Figure 1.

Figure 3 is top view of Figure 2.

Figure 4 is an enlarged sectional view of the principal part in the first embodiment.

Figure 5 is a single phase connecting diagram explaining a first embodiment of the present invention.

Figure 6 is an electric equipotential surface distribution chart for the description of the invention.

Figure 7 is another electric equipotential surface distribution chart for the description of the invention.

Figure 8 is other electric equipotential surface distribution chart for the description of the invention.

Figure 9 is a graph of characteristics for the description of the invention.

Figure 10 is a sketch view illustrating a second embodiment of the present invention.

5 Figure 11 is a longitudinal sectional view illustrating a third embodiment of the present invention.

Figure 12 is a sectional view taken along the line B - B of Figure 11.

10 Figure 13 is top view of Figure 12.

Figure 14 is a single phase connecting diagram explaining the third embodiment of the present invention.

15 Figure 15 is a longitudinal sectional view illustrating a fourth embodiment of the present invention.

Figure 16 is top view of Figure 15.

DETAILED DESCRIPTION OF THE INVENTION

20 A vacuum chamber is constructed by sealing with a shield end plate either open end of an insulated cylinder. A fixed contact is connected to a fixed holder penetrating the shield end plate at one open end, and a moving contact is connected to a moving holder penetrating the shield end plate at the other
25 open end. These electric contacts are placed facing

each other. In the vacuum chamber there are arc shields placed like surrounding the electric contacts (fixed and moving contacts). A moving side bus bar is in contact with the moving holder outside the vacuum chamber. A solid insulator gives a molded and insulated state due to its molding that covers axially from the fixed side end of the vacuum chamber a part of the insulated cylinder. An earthed outer case capsulates the vacuum chamber through the moving side end and is fastened and fixed on the solid insulator, and filled with insulating gas therein. A place of the solid insulator axially covers the insulated cylinder, where the electric contacts and the arc shields have a smaller capacitance in between than that between the arc shields and the earthed outer case.

[Embodiment 1]

Figures 1 to 4 illustrate a first embodiment of the invention. Figure 1 is a longitudinal sectional view. Figure 2 is a sectional view taken along the line A - A of Figure 1. Figure 3 is a top view of Figure 2. Figure 4 is an enlarged sectional view of the principal part. Note that Figures 1 to 4 illustrate an embodiment according to which three circuits are addressed, but an earthing switch oriented vacuum interrupter is provided additionally,

a frame to house a multi circuit selecting switchgear according to the invention omitted from illustration. Figure 4 shows a heavy dash and dotted line for a good understanding of the effects of the invention that
5 will be mentioned later.

With reference to Figures 1 to 4, there are three vacuum interrupters 1a, 1b and 1c all installed for each phase. A vacuum interrupter 1 is made up of a vacuum chamber 2 constructed by sealing with shield
10 end plates 4 and 5 the open ends of an insulated cylinder 3. The vacuum interrupter 1 is made up of a fixed contact 6 connected to the end of a fixed holder 7 penetrating the shield end plate 5 shown to be the lower one in the drawing. A moving holder 9 penetrates
15 the other shield end plate 4 and is positioned above and coaxial to the fixed holder 7. The fixed contact 6 faces the moving holder 9 whose end has a moving contact 8 connected and fixed to it. The moving contact 8 and fixed contact 6 are positioned facing
20 each other.

The fixed contact 6 and the moving contact 8 have their contact electrodes surrounded by arc shields 10. The moving holder 9 is exposed outside the vacuum chamber 2 and is connected through an operating rod 11
25 to an operating device 12. The operating device 12 is

provided with an operating mechanism (not shown in the drawing) for the opening and closing between the moving contact 8 and fixed contact 6.

5 The moving holder 9 has a vertical movement, against which the vacuum of the vacuum chamber 2 is secured by using a bellows 13 made of stainless steel. The moving holder 9 is in contact outside the vacuum chamber 2 with a moving side bus bar 14. The moving side bus bar 14 has a sliding contact shoe, through
10 which it is electrically connected to the moving holder 9. The moving side bus bar 14, as shown in Figure 1, is in contact with the moving holder 9 for each of the three vacuum interrupters 1a, 1b and 1c of the same phase.

15 The vacuum chamber 2 has a molded and insulated state due to a solid insulator 15 molding that covers a part of the insulated cylinder 3 axially (vertically) from the fixed side. The solid insulator 15 gives a molded and insulated state due to a molding
20 in a position (upper position) 15a that covers the insulated cylinder 3 axially so that the capacitance between the fixed contact 6 or the moving contact 8 and the arc shields 10 can be smaller than that between the arc shields 10 and the earthed outer case
25 16. Figures 1, 2 and 4 show cases where the upper

position 15a of the solid insulator 15 is positioned in the vertical vicinity of the lower ends of the arc shields 10.

The earthed outer case 16 capsules the vacuum
5 interrupters 1a, 1b and 1c through the moving side of the vacuum chamber 2 including the moving side bus bar 14 and its lower opening port was fastened and fixed on the solid insulator 15. The earthed outer case 16 is filled with insulating gas. The solid insulator 15
10 retains the three vacuum interrupters 1a, 1b and 1c, which are housed inside the earthed outer case 16 filled with insulating gas. The operating rods 11 for the vacuum interrupters 1a, 1b and 1c are connected inside the earthed outer case 16 to the moving holder
15 9, penetrate the earthed outer case 16 and are connected to the operating device 12.

Switch units 26 (26U, 26V and 26 W) are each made up of the vacuum interrupters 1a to 1c for their respective phases U, V and W, the earthed outer case
20 16 and other components. These units are, as shown in Figure 2, placed in a row for three phases. The solid insulator 15 has its lower portion formed tapering toward the lower end and is fastened to a cable head 17. The fixed holder 7 is in contact with a fixed side
25 bus bar 24 and is connected through the cable head 17

to a cable 18. The solid insulator 15 has an earthed layer 19 formed around it.

The vacuum interrupter 1 is provided, as shown in Figures 2 and 4, adjacent with an earthing-switch-oriented vacuum interrupter 20. The vacuum interrupter 20 is, like the vacuum interrupter 1, retained by the solid insulator 15. The vacuum interrupter 20 has its fixed side connected through a bus bar 21 to the fixed holder 7 of the vacuum interrupter 1 and its moving side connected through an operating rod 22 to an operating device 23.

A multi circuit selecting switchgear constructed in the manner so far described operates in conventional manners, thus there will only be necessity for outlined description. Single-line connection for one phase will be shown in Figure 5. It is assumed that the vacuum interrupter 1c has its fixed side connected to a load line L and that the vacuum interrupters 1a and 1b have their fixed side connected to power source lines A and B different from each other. The vacuum interrupters 1 (1a, 1b and 1c) are driven by the operating devices 12 (12a, 12b and 12c) in a pair of the same alphabet.

The load line L is supplied with electricity by closing for each phase the vacuum interrupter 1c and

then the vacuum interrupter 1a. The vacuum interrupter 1c has its fixed side connected to the load line L, which is supplied with electricity by the power source line A that the vacuum interrupter 1a has its fixed
5 side connected to. Supplying the load line L with electricity from the load line B is carried out by opening the vacuum interrupter 1a for each of the phases U, V and W and then closing the vacuum interrupter 1b. In this manner, multi circuit
10 selecting and switching is possible. The operation of the vacuum interrupter 20 is carried out by operating devices 23 (23a, 23b and 23c).

Now, according to the invention, the vacuum interrupter 1 is made up of the vacuum chamber 2, to
15 which the solid insulator 15 gives a molded and insulated state due to a molding that covers a part of the insulated cylinder 3 axially from the fixed side of the vacuum chamber 2. When the vacuum interrupter 1 is in the closed position with the fixed holder 7 and
20 the moving holder 9 having a power source voltage applied to them, simulation analysis has given the electric equipotential surface distribution shown in Figures 6 to 8.

This electric equipotential surface distribution
25 analysis has been carried out for the block bounded by

the heavy dash and dotted line in Figure 4. Where the solid insulator 15 is a molding covering the fixed side of the vacuum interrupter 1 (namely a height) is the parameter for this block. Calculations have been made by letting the potential of the electric contacts (the fixed contact 6 and the moving contact 8), namely of the fixed holder 7 (the moving holder 9), be 100 percent, that of the earthed outer case 16 be zero percent and that of the arc shield 10 be floating potential.

Figure 6 illustrates an electric equipotential surface distribution when the solid insulator 15 is a molding in a position (a height) covering the shield end plate 5 of the vacuum chamber 2 and also a part of the insulated cylinder 3. The electric equipotential surface distribution shows that the shorter the line interval is the greater the electric field strength is. Note that the structure and the analytical result can be easily compared by seeing the left half of Figure 6, which shows the structure bounded by the heavy dash and dotted line in Figure 4.

In this case, since the arc shields 10 and the earthed outer case 16 have the solid insulator 15 inserted partially between them, they have a rise of capacitance in between. The electric potential of the

arc shields 10 is inversely proportional to the capacitance between the electric contacts (the fixed contact 6 and the moving contact 8), namely the fixed holder 7 (the moving holder 9), and the arc shields 10 and that between the arc shields 10 and the earthed outer case 16. The greater the capacitance is, the smaller the distributed voltage is. In this case, the potential of the arc shields 10 is reduced to 56 percent, a value closer to that of the earthed outer case 16. The solid insulator 15 is joined to the insulated cylinder 3 at a junction 50 whose potential is 43 percent.

Figure 7 illustrates an electric equipotential surface distribution when the solid insulator 15 is a molding in a position as high as below the shield end plate 5 of the vacuum chamber 2. In this case, since the arc shields 10 and the earthed outer case 16 do not have the solid insulator 15 inserted between them, the electric potential of the arc shields 10 is 65 percent, a value a little greater than in the case shown in Figure 6. Since the center axis side of the solid insulator 15 is in contact with the fixed holder 7, the potential at the junction 50 is 100 percent.

Figure 8 illustrates an electric equipotential surface distribution when the solid insulator 15 is a

molding in a position as high as the upper end of the insulated cylinder 3 of the vacuum chamber 2. In this case, since the arc shields 10 and the earthed outer case 16 have the solid insulator 15 inserted totally
5 between them, the electric potential of the arc shields 10 is 35 percent, a value much smaller than in the case shown in Figure 6. Since the solid insulator 15 is in contact with the shield end plate 4, the potential at the junction 50 is 100 percent.

10 Figure 9 is a graph of characteristics showing the three cases in Figures 6 to 8 compared in which the path from the junction 50 where the solid insulator 15 is joined to the insulated cylinder 3 toward a junction 51 where the solid insulator 15 is joined to
15 the earthed outer case 16 has an electric equipotential surface distribution. The origin is designated for the junction 50, the horizontal axis is for the reach of the path toward the earthed outer case 16, and the vertical axis is for the logarithm-
20 indicated relative values of electric field strength distribution.

Characteristic a is an electrical field strength distribution in the case shown in Figure 6 where the solid insulator 15 is a molding in a position covering
25 a part of the insulated cylinder 3, Characteristic b

is an electrical field strength distribution in the case shown in Figure 7 where the solid insulator 15 is a molding in a position as high as below the fixed side shield end plate 5, and Characteristic c is an
5 electrical field strength distribution in the case shown in Figure 8 where the solid insulator 15 is a molding in a position as high as the upper end of the insulated cylinder 3, namely, covering the whole.

Comparison of these cases shows that the electric
10 field strength when the solid insulator 15 is a molding in a position covering a part of the insulated cylinder 3, as is apparent from Characteristic a, is much smaller than in the case for Characteristic b where the solid insulator 15 is a molding in a
15 position as high as below the shield end plate 5 or in the case for Characteristic c where the solid insulator 15 is a molding in a position covering the insulated cylinder 3 throughout. Therefore, it is possible to lessen the electric field strength applied
20 to the solid insulator 15 in its surface directions, and then to lessen the thickness of the solid insulator 15, which makes a smaller-size multi circuit selecting switchgear possible.

It is further possible to functionwise fasten the
25 vacuum interrupter 1 and also to effectwise raise the

electrical insulation reliability of its junction 50
with the solid insulator 15.

[Embodiment 2]

Figure 10 illustrates a second embodiment of the
5 invention. The difference from the first embodiment
lies in that a moving side bus bar 25 is made up of a
flexible conductor.

According to this second embodiment, it is
possible to lessen the electric field strength applied
10 to the solid insulator 15 in its surface directions,
and at the same time to do without providing the
moving side bus bar 25 with a sliding contact and thus
to lessen the number of parts.

[Embodiment 3]

15 Figures 11 to 13 illustrate a third embodiment of
the invention. Figure 11 is a longitudinal sectional
view, and Figure 12 is a sectional view taken along
the line B - B of Figure 11. Figure 13 is a top view
of Figure 12.

20 According to the third embodiment, the vacuum
interrupters 1a, 1b and 1c for each of the phases are
used as a circuit breaker, an earthing switch and a
disconnecter respectively. The vacuum interrupters 1a
to 1c for each of the phases U, V and W and earthed
25 outer cases 16 and other components make up switch

units 26 (26U, 26V and 26W), which are, as shown in Figure 12, positioned in a row for the three phases. And as shown in Figure 13, the vacuum interrupter 1a as circuit breakers, the vacuum interrupter 1b as
5 earthing switches and the vacuum interrupter 1c as disconnectors are opened or closed in a bundle for the three phases by operating devices 12a, 23b and 23c respectively. The single phase connecting diagram for one phase according to the third embodiment is,
10 regarding the vacuum interrupters 1a to 1c, one as shown in Figure 14.

According to this third embodiment, it is possible to lessen the electric field strength applied to the solid insulator 15 in its surface directions, which
15 makes a smaller-size multi circuit selecting switchgear possible.

[Embodiment 4]

Figures 15 and 16 illustrate a fourth embodiment of the invention. According to the fourth embodiment,
20 the earthed outer case 16 in the third embodiment is constructed into a 3-phase circuit bundled type.

Inside the earthed outer case 16, vacuum interrupters 1a to 1c for each of the phases U, V and W are placed.

According to this fourth embodiment, it is
25 possible to lessen the electric field strength applied

to the solid insulator 15 for two phases, and at the same time to integrate the insulating gas areas into one and thus effectwise simplify the structure.

WHAT IS CLAIMED IS

1. A multi circuit selecting switchgear having a vacuum interrupter (1) comprising an insulated cylinder (3) sealed at either open end with a shield end plate (4, 5) to form a vacuum chamber (2), a fixed contact (6) placed inside the vacuum chamber (2) and connected to a fixed holder (7) penetrating the shield end plate (5) at one open end, a movable contact (8) placed inside the vacuum chamber (2) and connected to a movable holder (9) penetrating the shield end plate (4) at the other open end and facing the fixed contact (6), arc shields (10) surrounding the fixed and movable contacts (6, 8) inside the vacuum chamber (2), and an earthed outer case (16) sealed to capsule the vacuum interrupter (1) at the movable contact side and filled with insulating gas, characterized in that a part of the outside of the vacuum chamber (2) is covered with a solid insulator (15) molded from the fixed contact side toward the movable contact side, and the earthed outer case (16) is fixed on the solid insulator (15).

2. A switchgear according to claim 1, characterized in that the solid insulator (15) is molded from the fixed contact side toward the movable contact side to cover the outside of the vacuum chamber (2) up to such a position (15a), that the capacitance between the fixed contact (6) or the movable contact (8) and the arc shields (10) is smaller than that between the arc shields (10) and the earthed outer case (16).

3. A switchgear according to claim 1 or 2, characterized in that a vacuum interrupter (1a, 1b, 1c) is provided for each phase and is insulated by the molded solid insulator (15), and the earthed outer case (16) is fixed on the solid insulator (15).

4. A switchgear according to claim 1 or 2, characterized in that three vacuum interrupters (1a, 1b, 1c) are provided for each phase, the three vacuum interrupters for each phase being in a bundle insulated by one molded solid insulator (15), and an earthed outer case (16) provided for each phase is fixed on the solid insulator (15) of the respective phase.

5. A switchgear according to claim 4, characterized in that the three vacuum interrupters (1a, 1b, 1c) of each phase are used as a circuit breaker, an earthing switch and a disconnecter.

6. A switchgear according to claim 1 or 2, characterized in that the movable holder (9) is connected to a movable contact side bus bar (14) provided outside the vacuum chamber (2).

7. A switchgear according to claim 6, characterized in that the movable contact side bus bar (14) is made up of a flexible conductor.