FLEXIBLE CONDUCTOR AND SWITCHGEAR MADE WITH THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a flexible conductor used to connect a moving electrode as a moving conductor operated with an operation rod to a load conductor as a fixed conductor, for example, in a switch and in particular to a flexible conductor used in a vacuum vessel and relates to a switchgear comprising a main circuit switch section for bringing a generating line conductor connected to a power supply (power supply conductor) and a load conductor into and out of contact with each other.

2. Description of the Related Art

A switchgear (enclosed switchboard) used to distribute electric power received from a generating line to various load machines or a different electricity room comprises connection conductors such as a generating line conductor for connection to a generating line and a load conductor for connection to a power transmission cable to the load, and internal components such as a main circuit switch for bringing the generating line conductor and the load conductor into and out of contact with each other, a ground switch for grounding the load conductor, and a controller required for monitor and control, the internal components being disposed appropriately in an outer case made of ground metal.

Available as one type of switchgear is a switchgear comprising a main circuit switch housed in a vacuum vessel

maintained under high vacuum around 10^{-7} Torr for stably turning on and off a large electric current by using a large dielectric strength and good extinction action of arc in a high vacuum.

FIGS. 21 and 22 are sectional side views to show the configuration of the main part of a switchgear disclosed in JP-A-56-7317. The switchgear comprises a vacuum vessel 3 supported in an outer case 2 of an insulator.

In the vacuum vessel 3, a fixed electrode 5 fixedly supported on one side of the vacuum vessel 3 and a moving electrode 6 supported on an opposite side movably in an axial length direction via a bellows 8 are placed so that the tip contacts of the fixed electrodes 5 and the moving electrode 6 face each other. A generating line conductor 9 fixedly supported on the outer case 2 is connected to an extension end of the fixed electrode 5 to the outside of the vacuum vessel 3 and an extension part of the moving electrode 6 to the outside of the vacuum vessel 3 is connected to a load conductor 11 fixedly supported on the outer case 2 by a flexible conductor 10 connected at one end at an intermediate point of the extension and is coupled to a switching operation mechanism via an operation rod (not shown).

In the described switchgear, the operation of the switching operation mechanism is transmitted to the moving electrode 6 through the operation rod for bringing the moving electrode 6 into and out of contact with the fixed electrode 5, thereby turning on and off a main circuit current between the generating line conductor 9 connected to the fixed electrode

5 and the load conductor 11 connected to the moving electrode 6. FIG. 21 shows a make state in which the fixed electrode 5 and the moving electrode 6 are in contact with each other and FIG. 22 shows a break state in which the moving electrode 6 is out of contact with the fixed electrode 5. The flexible conductor 10 for connecting the moving electrode 6 and the load conductor 11 becomes deformed so as to allow displacement of the moving electrode 6 occurring relative to the load conductor 11 fixedly supported on the outer case 2 in response to the switching operation for maintaining the electric conduction state between the moving electrode 6 and the load conductor 11.

FIG. 23 is a sectional side view to show the configuration of the flexible conductor 10 in the related art. As shown here, the flexible conductor 10 has a thickness of about 100 μm and comprises a plurality of electric conductor layers 10a, 10a... each made of a material rich in electric conductivity (generally, copper foil is used), the electric conductor layers 10a, 10a... deposited in the thickness direction with both end parts of the electric conductor layers 10a, 10a... bundled up by fix brackets 21 and 21 made of electrically conductive metal. The flexible conductor 10 is tightened to the corresponding positions of the moving electrode 6 and the load conductor 11 by fix bolts (not shown) inserted into through bolt holes 22 and 22 made in the fix brackets 21.

In the described flexible conductor 10, each of the electric conductor layers 10a, 10a... is restrained only at both

end parts by the fix brackets 21 and 21 and the above-described displacement of the moving electrode 6 is allowed because the electric conductor layers 10a, 10a... become deformed in the thickness direction.

FIG. 30 is a schematic sectional side view to show the configuration of the main part of a switchgear in a related art. In the figure, numeral 20 denotes a vacuum vessel held in a high vacuum. One end part of a power supply (generating line) conductor 21 is introduced through a generating line bushing 22 into the vacuum vessel 20 from the top thereof and one end part of a load conductor 33 is introduced through a cable bushing 34 into the vacuum vessel 20 from one side thereof. The power supply conductor 21 is formed at the lower end part with a first fixed electrode 23, which is opposed to a first moving electrode 24 placed on the upper end part of a conductive rod 26 with an appropriate spacing below the first fixed electrode 23. The first fixed electrode 23 and the first moving electrode 24 make up a main circuit switch section 25.

The conductive rod 26 is installed on the same line as the power supply conductor 21 and is coupled at the lower end part to an insulating rod 29, which in turn is coupled through an operation rod 28 to a drive unit (not shown) provided outside the vacuum vessel 20 for bringing the first fixed electrode 23 of the power supply conductor 21 and the first moving electrode 24 of the conductive rod 26 into and out of contact with each other by the drive unit. A first bellows 31 is placed between

the operation rod 28 and the margin of a hole made in the vacuum vessel 20 to allow the operation rod 28 to pass through, thereby holding the vacuum vessel 20 hermetic.

On the other hand, a metal ring 27 is fixedly put on an intermediate part of the conductive rod 26 so that the peripheral surface of the metal ring 27 is opposed to the load conductor 33. The peripheral surface of the metal ring 27 and one end part of the load conductor 33 are connected by a flexible conductor 40 comprising metal foil films deposited on each other, specifically, by brazing the end parts of the flexible conductor 40. From the lower part of the vacuum vessel 20, the upper end part of a ground conductor 36 is projected to the position facing the load conductor 33 and is brought into and out of the load conductor 33 by the drive unit.

A second moving electrode 38 is attached to the upper end part of the ground conductor 36 and a second fixed electrode 37 is attached to the peripheral surface of the load conductor 33 facing the second moving electrode 38. The second moving electrode 38 and the second fixed electrode 37 make up a ground switch section 39.

A second bellows 32 is placed between the ground conductor 36 and the margin of a hole made in the vacuum vessel 20 to allow the ground conductor 36 to pass through, thereby holding the vacuum vessel 20 hermetic.

FIG. 31 is a schematic sectional side view to show the configuration of the main part of a switchgear in a related art,

too. In the figure in place of the metal ring 27, an annular slide contact 41 is put slidably on a conductive rod 26, and a load conductor 33 is coupled to the peripheral surface of the slide contact 41.

In the described switchgear, the inside of the outer case 2 in which the flexible conductor 10 is disposed is filled with an inert gas such as CFC gas for providing an insulating effect; however, in recent year, considering the effect on the environment, there has been a tendency to limit use of inert gases. Then, the development of a switchgear comprising the parts requiring insulation, such as the connection part of the moving electrode 6 and the load electrode 11 by the flexible conductor 10 and the coupling part of the moving electrode 6 and the operation rod, housed in the vacuum vessel 3 together with the main circuit switch is pursued.

However, if the flexible conductor 10 in the related art as described above is disposed in the vacuum vessel, the following problem arises: When the flexible conductor 10 in the related art becomes deformed so as to allow displacement of the moving electrode 6 as described above, the electric conductor layers 10a, 10a... deposited in the thickness direction come in sliding contact with each other on the interfaces and oxide films formed on the interfaces are removed.

If the electric conductor layers 10a, 10a... come in sliding contact with each other in an inert gas or in the

atmosphere, the removed oxide films are restored again by oxidation; whereas, if the electric conductor layers 10a, 10a... come in sliding contact with each other in a vacuum, oxidation does not again occur, thus the copper foil films making the electric conductor layers 10a, 10a... come in direct sliding contact with each other not via the oxide films as the flexible conductor 10 becomes deformed repeatedly, and as the copper foil films come in direct sliding contact with each other, the electric conductor layers 10a, 10a... are agglutinated to form one piece; essential flexibility is lost gradually. Thus, it is made impossible for the flexible conductor 10 to well allow displacement of the moving electrode 6 and the switching operation is hindered.

In the switchgear as described above, after pretreatment of baking for removing gases is applied, the flexible conductor 40 is placed on the metal ring 27 and one end of the load conductor 33 and the end parts of the flexible conductor 40 are brazed for fixing the flexible conductor 40. At this time, the flexible conductor 40 undergoes the purifying action of scattering the impurities of the flexible conductor 40 and making the metal components homogeneous because of the annealing action of heating and heat release. However, in the purifying process and the process of rubbing the metal foil

films together, the oxide film is lost and when an electric current flows into the flexible conductor 40 and the flexible conductor 40 is heated, the surfaces of the metal foil films forming the flexible conductor 40 agglutinate each other.

If agglutination occurs in the metal foil films of the flexible conductor 40, the essential flexibility is load and in addition, each time the flexible conductor 40 warps as the conductive rod 26 is moved ahead or behind, a force is applied to the agglutination occurring portion from multiple directions, thereby causing shear deformation to occur in the metal foil films. If the portion in which the shear deformation occurs is broken, conductive agglutination wear powder scatters over the surroundings, thereby contaminating the inside of the vacuum vessel 20 holding insulating characteristics, lowering dielectric strength performance.

SUMMARY OF THE INVENTION

The present invention was made to solve the above problem and an object of the invention to provide a flexible conductor which has flexibility not lost if it is used in a vacuum, and can stably allow displacement of a moving conductor relative to a fixed conductor over a long term.

Additionally, it is an object of the invention to provide a switchgear wherein the inside of a cover member for covering a flexible conductor is placed in a hermetic state and is filled with an atmospheric or nitrogen gas, thereby preventing the flexible conductor from agglutinating and preventing the inside of a vacuum vessel from being contaminated with agglutination wear powder at the breaking time for stabilizing dielectric strength performance.

Further, it is another object of the invention to provide a switchgear wherein a flexible conductor is placed outside a vacuum vessel for preventing agglutination itself from occurring and preventing the inside of the vacuum vessel from being contaminated with conductive agglutination wear powder for stabilizing dielectric strength performance.

Further, it is still another object of the invention to provide a switchgear wherein a conductive member shaped like a pipe is placed on a conductive rod and a load conductor, thereby preventing agglutination from occurring and preventing the inside of the vacuum vessel from being contaminated with conductive agglutination wear powder for stabilizing dielectric strength performance.

Further, it is still another object of the invention to provide a switchgear wherein a cover member is formed of a bellows and a conductive member is formed of a conductive bellows shaped like a pipe, whereby the conductive member for

connecting a conductive rod and a load conductor can be smoothly followed as a power supply conductor and the conductive rod come in and out of contact with each other.

According to the first aspect of the present invention, there is provided a flexible conductor comprising a flexible part comprising a plurality of conductor metal layers deposited with agglutination prevention layers each placed between the conductor metal layers.

In the invention, when the conductor metal layers become deformed, they come in sliding contact with each other via the agglutination prevention layers each placed therebetween and do not come in direct contact with each other, so that loss of flexibility caused by their agglutination is suppressed.

As described above in detail, in the flexible conductor according to the first aspect of the present invention, the flexible part is formed by depositing a plurality of conductor metal layers with agglutination prevention layers each placed between the conductor metal layers. Thus, when deformation occurs following displacement of the moving conductor connected to one side, the conductor metal layers come in sliding contact with the agglutination prevention layers each placed therebetween and do not come in direct contact with each other. To use the flexible conductor in a vacuum, displacement of the moving conductor relative to the fixed conductor can be allowed stably over a long term without agglutinating the conductor metal layers and without losing flexibility.

According to the second-fourth aspect of the present invention, in the flexible conductor, each of the agglutination prevention layers is formed of a carbon sheet, inorganic powder, or metal foil placed between the conductor metal layers.

In the invention, the agglutination prevention layers each placed between the conductor metal layers generally formed of copper foil are formed of a material hard to cause a diffusion reaction with copper, such as carbon sheets, inorganic powder of silicon nitride, alumina, etc., or stainless foil, for preventing not only the conductor metal layers, but also the conductor metal layers and the agglutination prevention layers from being agglutinated, thereby suppressing loss of flexibility. To form the agglutination prevention layers of inorganic powder, an application agent provided by mixing the inorganic powder in a solvent of alcohol, etc., is applied onto one face or both faces of the copper foil forming the conductor metal layers.

According to the second-fourth aspect of the present invention, in the flexible conductor, each of the agglutination prevention layers is formed of a carbon sheet, inorganic powder, or metal foil placed between the conductor metal layers. Thus, agglutination of the conductor metal layers and the agglutination prevention layers is hard to occur and loss of flexibility can be suppressed more effectively.

According to the fifth aspect of the present invention, each of the agglutination prevention layers is formed of a plating film formed on one face or both faces of each conductor

metal layer.

In the invention, the conductor metal layer is plated on one face or both faces with metal producing a stabler oxide film as compared with copper used as the material of the conductor metal layers, such as nickel or chromium, and the resultant plating films are brought into sliding contact with each other for preventing agglutination from occurring as the conductor metal layers come in sliding contact, thereby suppressing loss of flexibility.

According to the fifth aspect of the present invention, each of the agglutination prevention layers is formed of a plating film formed on one face or both faces of each conductor metal layer. Thus, the plating film is formed of metal producing a stable oxide, thereby preventing agglutination from occurring as the conductor metal layers come in sliding contact, and suppressing loss of flexibility.

According to the sixth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by depositing the conductor metal layers on each other in the thickness direction.

In the invention, the fix parts on both sides of the flexible part are formed by bringing the conductor metal layers into contact with each other without placing the agglutination preventions layer each therebetween, and in the use state in which the fix parts are fixed to the fixed conductor or the moving conductor, the specific resistance of the whole flexible conductor is decreased and good electric conductivity is

provided.

According to the sixth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by depositing the conductor metal layers on each other in the thickness direction. Thus, contact resistance in the fix parts is decreased, so that good electric conductivity can be provided.

According to the seventh aspect of the present invention, there is provided a flexible conductor comprising a flexible part formed by depositing a plurality of conductor metal layers each formed with protrusions on one face or both faces thereof.

In the invention, the conductor metal layers are deposited with the gap equivalent to the height of each protrusion, thereby forming the flexible part. When the flexible part is deformed, each of the conductor metal layers comes in sliding contact with the conductor metal layers deposited on both sides of the conductor metal layer only at the limited parts of the tips of the protrusions for minimizing agglutination accompanying the sliding contact and suppressing loss of flexibility.

According to the seventh aspect of the present invention, the flexible part is formed by depositing a plurality of conductor metal layers each formed with protrusions on one face or both faces thereof. Thus, the conductor metal layers are deposited with the gap equivalent to the height of each protrusion. When the flexible part is deformed, the conductor

metal layers come in sliding contact with each other only at the limited parts of the tips of the protrusions for minimizing agglutination accompanying the sliding contact and suppressing loss of flexibility.

According to the eighth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by diffusing and joining the conductor metal layers.

In the invention, the fix parts on both sides of the flexible part are formed by bringing the conductor metal layers into contact with each other without placing the agglutination preventions layer or protrusions each therebetween and diffusing and joining them on their interfaces, and in the use state in which the fix parts are fixed to the fixed conductor or the moving conductor, the specific resistance of the whole flexible conductor is decreased and good electric conductivity is provided. They are diffused and joined by fastening fixing bolts for attaching the fix parts and heating in a compressed state.

According to the eighth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by diffusing and joining the conductor metal layers. Thus, contact resistance in the fix parts is decreased drastically, the specific resistance of the whole flexible conductor is decreased, and good electric conductivity can be provided.

According to the ninth aspect of the present invention, there is provided a flexible conductor comprising a flexible part formed by depositing a plurality of conductor metal layers

with spacer plates placed on both sides thereof for providing a gap therebetween.

In the invention, the conductor metal layers forming the flexible part are out of contact with each other. When the flexible part is deformed, the conductor metal layers do not come in sliding contact with each other, agglutination can be minimized, and loss of flexibility can be suppressed. In the use state, the specific resistance of the whole flexible conductor can be decreased and good electric conductivity can be provided by using conductor metal as the spacers.

According to the ninth aspect of the present invention, the flexible part is formed by depositing a plurality of conductor metal layers with spacer plates placed on both sides thereof for providing a gap therebetween. Thus, the conductor metal layers forming the flexible part are out of contact with each other. When deformation occurs following displacement of the moving conductor connected to one side, the conductor metal layers do not come in sliding contact with each other. To use the flexible conductor under vacuum, displacement of the moving conductor relative to the fixed conductor can be allowed stably over a long term without agglutinating the conductor metal layers and without losing flexibility.

According to the tenth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by diffusing and joining the conductor metal layers and the spacer plates.

In the invention, the fix parts on both sides of the

flexible part are formed by diffusing and joining the conductor metal layers and the spacer plates each placed therebetween on their interfaces, and in the use state in which the fix parts are fixed to the fixed conductor or the moving conductor, the specific resistance of the whole flexible conductor containing the fix parts is decreased and good electric conductivity is provided. They are diffused and joined by fastening fixing bolts for attaching the fix parts and heating in a state in which the conductor metal layers and the spacer plates are pressed against each other.

According to the tenth aspect of the present invention, in the configuration as claimed in claim 9, the fix parts placed on both sides of the flexible part are formed by diffusing and joining the conductor metal layers and the spacer plates each placed therebetween. Thus, contact resistance in the fix parts is decreased drastically, the specific resistance of the whole flexible conductor is decreased, and good electric conductivity can be provided.

According to the eleventh aspect of the present invention, there is provided a flexible conductor comprising a flexible part formed by forming wire rods of conductor metal like meshes and sandwiching both sides in a thickness direction between regulation plates.

In the invention, thin wires made of conductor metal are made meshes and loosening of the meshes is regulated by the regulation plates for forming the flexible part. When the flexible part is deformed, the thin wires come in sliding

contact with each other, so that the agglutination range is minimized and loss of flexibility is minimized.

According to the eleventh aspect of the present invention, the flexible part is formed by forming wire rods of conductor metal like meshes and sandwiching both sides in a thickness direction between regulation plates. Thus, when deformation occurs following displacement of the moving conductor connected to one side, sliding contact in the conductor metal layer and agglutination caused by the sliding contact occur only in the contact parts of the wire rods; loss of flexibility is prevented effectively and displacement of the moving conductor relative to the fixed conductor can be allowed stably over a long term.

According to the twelfth aspect of the present invention, the fix parts placed on both sides of the flexible part are formed by diffusing and joining the wire rods forming the meshes in both side portions of the flexible part projected from the regulation plates.

In the invention, the fix parts on both sides of the flexible part are formed by projecting a part of the flexible part to both sides of the regulation plates and diffusing and joining the wire rods of conductor metal forming the meshes making up the flexible part in their contact parts, and in the use state in which the fix parts are fixed to the fixed conductor or the moving conductor, the specific resistance of the whole

flexible conductor containing the fix parts is decreased and good electric conductivity is provided. They are diffused and joined by fastening fixing bolts for attaching the fix parts and heating in a state in which the wire rods are brought into intimate contact with each other.

According to the twelfth aspect of the present invention, in the configuration as claimed in claim 11, the fix parts are formed by projecting the flexible part comprising the wire rods of conductor metal formed like meshes to both sides of the regulation plates and diffusing and joining the wire rods in their contact parts. Thus, the fix parts with contact resistance decreased can be formed easily, the specific resistance of the whole flexible conductor is decreased, and good electric conductivity can be provided.

According to the thirteenth aspect of the present invention, there is provided a switchgear comprising in a vacuum vessel, a power supply conductor, a conductive rod for coming in and out of contact with the power supply conductor, a load conductor, a flexible conductor which comprises conductive metal foil films deposited on each other and is connected to the load conductor and the conductive rod, and a cover member having flexibility for covering the flexible conductor, the cover member being fixed to the conductive rod and the load conductor in a hermetic state, wherein the inside of the cover member is filled with a gas containing oxygen or nitrogen.

In the invention, the cover member is placed on the

conductive rod for coming in and out of contact with the power supply conductor and the load conductor and is fixed thereto in a hermetic state and the inside of the cover member is filled with a gas containing oxygen or nitrogen, whereby an oxide or nitride film is formed on the surface of the flexible conductor and agglutination to the flexible conductor can be suppressed. Since the flexibility of the flexible conductor is not impaired, motion of the conductive rod can also be followed smoothly. If agglutination wear powder occurs, the inside of the vacuum vessel is not contaminated with the agglutination wear powder since the flexible conductor is covered with the cover member; reliability of the dielectric strength performance can be enhanced.

According to the thirteenth aspect of the present invention, the flexible conductor is covered with the cover member, so that depositing of an arc product can be blocked. The inside of the cover member is filled with a gas containing air or nitrogen and an oxide or nitride film can be formed on the surface of the flexible conductor, so that agglutination to the flexible conductor can be prevented. Thus, it is made possible to hold good flexibility and elasticity in the flexible conductor, agglutination wear powder can be prevented from occurring, the inside of the vacuum vessel is not contaminated with agglutination wear powder, and the dielectric strength performance can be maintained stable.

According to the fourteenth aspect of the present invention, there is provided a switchgear comprising in a vacuum

vessel formed with an opening, a power supply conductor, a conductive rod for coming in and out of contact with the power supply conductor, a connection conductor being connected to the conductive rod, and a cover member having flexibility and being placed on and fixed to the opening of the vacuum vessel and the connection conductor to place the vacuum vessel in a hermetic state, wherein the connection conductor and a load conductor placed outside the vacuum vessel are connected by a flexible conductor comprising conductive metal foil films deposited on each other through the cover member.

In the invention, to place the vacuum vessel in a hermetic state, the cover member having flexibility is fixed to the connection conductor connected to the power supply conductor and the opening in the side of the vacuum vessel and the flexible conductor is connected to the load conductor placed outside the vacuum vessel through the cover member, so that the flexible conductor itself can be placed outside the vacuum vessel, agglutination can be prevented from occurring on the flexible conductor, and the dielectric strength performance can be stabilized.

According to the fourteenth aspect of the present invention, the flexible conductor is placed outside the vacuum vessel, so that agglutination can be prevented from occurring in the flexible conductor and the operation can be stabilized. Since agglutination wear powder can also be prevented from occurring, the inside of the vacuum vessel is not contaminated with agglutination wear powder, and the dielectric strength

performance can be made stable.

According to the fifteenth aspect of the present invention, there is provided a switchgear comprising in a vacuum vessel, a power supply conductor, a conductive rod for coming in and out of contact with the power supply conductor, a load conductor, and a conductive member which has flexibility and is shaped like a pipe and is placed on and fixed to the load conductor and the conductive rod.

In the invention, the conductive member which has flexibility and elasticity and is shaped like a pipe is placed on the conductive rod and the load conductor, whereby agglutination itself and agglutination wear powder from occurring and the inside of the vacuum vessel is not contaminated with agglutination wear powder; the dielectric strength performance becomes stable.

According to the fifteenth aspect of the present invention, using the flexible conductive member, the operation of the conductive rod for making and breaking the main circuit can also be followed smoothly. Further, the members do not come in contact with each other, thus agglutination does not occur and the fear of contaminating the inside of the vacuum vessel with agglutination wear powder is eliminated, thus the dielectric strength performance can be made stable.

According to the sixteenth aspect of the present invention, the cover member is a bellows.

According to the seventeenth aspect of the present of the present invention, the conductive member is a bellows formed

of a conductive material.

In the invention, using the bellows, motion of the conductive rod coming in and out of contact with the power supply conductor can be followed smoothly while internal hermeticity is held.

According to the sixteenth aspect and the seventeenth aspect of the present invention, using the bellows, internal hermeticity is held and the operation of the conductive rod coming in and out of contact with the generating line and load electrodes can also be followed smoothly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view to show the configuration of a flexible conductor of a first embodiment according to the invention;

FIG. 2 is a plane view of the flexible conductor shown in FIG. 1;

FIG. 3 is a side view to show the configuration of a flexible conductor of a second embodiment according to the invention;

FIG. 4 is a side view to show the configuration of a flexible conductor of a third embodiment according to the invention;

FIG. 5 is a plane view of the flexible conductor shown in FIG. 4;

FIG. 6 is a side view to show the configuration of a

flexible conductor of a fourth embodiment according to the invention;

FIG. 7 is a side view to show the configuration of a flexible conductor of a fifth embodiment according to the invention;

FIG. 8 is a plane view of the flexible conductor shown in FIG. 7;

FIG. 9 is a side view to show the configuration of a flexible conductor of a sixth embodiment according to the invention;

FIG. 10 is a side view to show the configuration of a flexible conductor of a seventh embodiment according to the invention;

FIG. 11 is a side view to show the configuration of a flexible conductor of an eighth embodiment according to the invention;

FIG. 12 is a side view to show the configuration of a flexible conductor of a ninth embodiment according to the invention;

FIG. 13 is a side view to show the configuration of a flexible conductor of a tenth embodiment according to the invention;

FIG. 14 is a side view to show the configuration of a flexible conductor of an eleventh embodiment according to the invention;

FIG. 15 is a plane view of the flexible conductor shown in FIG. 14;

FIG. 16 is a side view to show the configuration of a flexible conductor of a twelfth embodiment according to the invention;

FIG. 17 is a side view to show the configuration of a flexible conductor of a thirteenth embodiment according to the invention;

FIG. 18 is a plane view of the flexible conductor shown in FIG. 17;

FIG. 19 is a side view to show the configuration of a flexible conductor of a fourteenth embodiment according to the invention;

FIG. 20 is a plane view of the flexible conductor shown in FIG. 19

FIG. 21 is a sectional side view to show the configuration of the main part of a switchgear;

FIG. 22 is a sectional side view to show the configuration of the main part of the switchgear;

FIG. 23 is a side view of a flexible conductor in a related art.

FIG. 24 is a schematic sectional side view to show the main configuration of a switchgear according to a fifteenth embodiment of the invention;

FIG. 25 is a schematic sectional side view to show the main configuration of a switchgear according to a sixteenth embodiment of the invention;

FIG. 26 is a schematic sectional side view to show the main configuration of a switchgear according to a seventeenth

embodiment of the invention;

FIG. 27 is a schematic sectional side view to show the main configuration of a switchgear according to a eighteenth embodiment of the invention;

FIG. 28 is a schematic sectional side view to show the main configuration of a switchgear according to a nineteenth embodiment of the invention;

FIG. 29 is a schematic sectional side view to show the main configuration of a switchgear according to a twentieth embodiment of the invention;

FIG. 30 is a schematic sectional side view to show the main configuration of a switchgear in another related art; and

FIG. 31 is a schematic sectional side view to show the main configuration of a switchgear in another related art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTSB

Referring now to the accompanying drawings, there are shown preferred embodiments of the invention.

First embodiment:

FIGS. 1 and 2 are a side view and a plane view to show the configuration of a flexible conductor of a first embodiment according to the invention respectively. In the figures, a flexible conductor 1 comprises a flexible part 1a comprising an alternating pattern of a plurality of conductor metal layers 10a, 10a... and a plurality of agglutination prevention layers 10b, 10b... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The

fix parts 1b and 1b are tightened to a fixed conductor 24 and a moving conductor 25 each by two fixing bolts 27 and 27 via a press plate 26 covering the full length.

For example, copper foil having a thickness of about 100 μm is used as the conductor metal layers 10a, 10a... and foil made of material hard to cause agglutination accompanying sliding contact relative to copper of general material of the conductor metal layers 10a, 10a..., such as carbon sheets or stainless foil having a thickness of about 50-100 μm, is used as the agglutination prevention layers 10b, 10b... The flexible part 1a comprises a predetermined number of copper foil films deposited in the thickness direction with a carbon sheet or stainless foil placed therebetween. FIG. 1 shows the conductor metal layers 10a, 10a... and the agglutination prevention layers 10b, 10b... in such a manner that they are deposited as if a gap were placed therebetween; in fact, however, they are deposited in a state in which they are placed in intimate contact with each other.

The deposition range of the agglutination prevention layers 10b, 10b... covers roughly the full length of the conductor metal layers 10a, 10a... as hatched in FIG. 2 with a margin of a predetermined length on both sides in a length direction. The fix parts 1b are formed by depositing the conductor metal layers 10a, 10a... directly on each other in non-deposition portions of the agglutination prevention layers 10b, 10b... The press plate 26 is a flat plate of a size capable of covering all area of the fix part 1b. The press plate 26,

which is tightened by the fixing bolts 27 and 27, uniformly presses the corresponding fix part 1b sandwiched between the press part 26 and the fixed conductor 24 or the moving conductor 25. It also prevents the carbon sheets or stainless foil forming the agglutination prevention layers 10b, 10b... from shifting in the flexible part 1a.

FIG. 1 shows the conductor metal layers 10a, 10a... in such a manner that they are deposited in the fix part 1b as if a gap were placed therebetween, but the conductor metal layers 10a, 10a... are brought strongly into intimate contact with each other as they are sandwiched between the press part 26 and the fixed conductor 24 or the moving conductor 25, decreasing contact resistance. The fix parts 1b and 1b are heated at about 500°C in a tightened state by the fixing bolts 27 and 27, whereby the conductor metal layers 10a, 10a... are diffused and joined on the contact face and contact resistance can be decreased furthermore.

When the moving conductor 25 is displaced up and down in the figure with respect to the fixed conductor 24, the flexible conductor 1 as described above can allow the displacement of the moving conductor 25 because of deformation of the flexible part 1a while maintaining the conduction state between the fixed conductor 24 and the moving conductor 25. When such deformation occurs, the deposited layers making up the flexible part 1a come in sliding contact with each other. However, the flexible part 1a comprises an alternating pattern of the conductor metal layers 10a, 10a... and the agglutination

prevention layers 10b, 10b... deposited on each other as described above, and the sliding contact occurs on the interface between the conductor metal layer 10a and the agglutination prevention layer 10b; the fear of the conductor metal layers 10a, 10a... coming in sliding contact with each other and being agglutinated is avoided, thus loss of flexibility is suppressed.

Since the carbon sheet or stainless foil forming each agglutination prevention layer 10b is a material hard to cause a diffusion reaction with the copper foil forming each conductor metal layer 10a, there is not a fear of occurrence of agglutination between the conductor metal layer 10a, 10a... and the agglutination prevention layer 10b, 10b... Therefore, when the flexible conductor 1 shown in the description of the first embodiment is used in a vacuum, it can also hold essential flexibility over a long term and can reliably allow displacement of the moving conductor 25 relative to the fixed conductor 24.

The fix parts 1b and 1b on both sides of the flexible part 1a are formed by bringing the conductor metal layers 10a, 10a... into intimate contact with each other without placing the agglutination prevention layers 10b, 10b... each therebetween for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced.

This can be accomplished more effectively by diffusing and joining the conductor metal layers 10a, 10a... as described above.

The configuration of the flexible conductor 1 for linearly connecting the fixed conductor 24 and the moving conductor 25 has been described with reference to FIGS. 1 and 2. However, the conductor metal layers 10a, 10a... and the agglutination prevention layer 10b, 10b... can be deposited in a state in which they are previously bent for forming the flexible part 1a for use to connect the load conductor 11 as the fixed conductor 24 and the moving electrode 6 as the moving conductor 25 in the switchgear shown in FIGS. 21 and 22. This also applies to the following embodiments.

Second embodiment:

FIG. 3 is a side view to show the configuration of a flexible conductor of a second embodiment according to the invention. A flexible conductor 1, like that shown in FIG. 1, comprises a flexible part 1a comprising an alternating pattern of conductor metal layers 10a, 10a... and agglutination prevention layers 10b, 10b... deposited and fix parts 1b and 1b placed on both sides of the flexible part 1a where only the conductor metal layers 10a, 10a... are deposited.

The embodiment is characterized by the connection form of the fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25. As shown in FIG. 3, they are connected by butting the fix parts 1b and 1b against the end faces of the fixed conductor 24 and the moving conductor 25 and beam-welding the

butt parts. According to the configuration, a strong joint state is provided between the fixed conductor 24 and the moving conductor 25 and the fix parts 1b and 1b and contact resistance at the joint parts can be decreased. Because of heating at the beam welding time, the conductor metal layers 10a, 10a... forming the fix parts 1b and 1b are diffused and joined and their contact resistance can also be decreased; the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced.

Third embodiment:

FIGS. 4 and 5 are a side view and a plane view to show the configuration of a flexible conductor of a third embodiment according to the invention respectively. A flexible conductor 1 in the figures, like the flexible conductor 1 shown in FIGS. 1 and 2, comprises a flexible part 1a comprising an alternating pattern of a plurality of conductor metal layers 10a, 10a... and a plurality of agglutination prevention layers 10b, 10b... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The fix parts 1b and 1b are strongly tightened to a fixed conductor 24 and a moving conductor 25 each by two fixing bolts 27 and 27 via a press plate 26 covering the full length.

For example, copper foil having a thickness of about 100 μm is used as the conductor metal layers 10a, 10a... like those shown in FIGS. 1 and 2. However, as the agglutination prevention layers 10b, 10b... each placed between the conductor

metal layers 10a and 10a, unlike those shown in FIGS. 1 and 2, for example, an application agent provided by mixing inorganic powder of silicon nitride, alumina, etc., having a particle diameter of about 1-10 μm in a solvent of alcohol, etc., is applied onto one face or both faces of copper foil forming the conductor metal layers 10a, 10a... and the conductor metal layers 10a, 10a... to which the application agent is applied are deposited in the thickness direction, whereby the inorganic powder is placed between the conductor metal layers 10a and 10a.

The deposition range of the agglutination prevention layers 10b, 10b... covers roughly the full length of the conductor metal layers 10a, 10a... as hatched in FIG. 5 with a margin of a predetermined length on both sides in a length direction. This is easily accomplished by uniformly setting the application range of the application agent to each of the conductor metal layers 10a, 10a... The fix parts 1b and 1b are fixed to the fixed conductor 24 and the moving conductor 25 in a similar manner to that in the first embodiment and a detailed description is not given.

The flexible conductor 1 as described above allows displacement of the moving conductor 25 relative to the fixed conductor 24 because of deformation of the flexible part 1a. At this time, each of the conductor metal layers 10a, 10a... comes in sliding contact with the agglutination prevention layers 10b, 10b... deposited on both sides of the conductor metal layer 10a and there is little fear of the conductor metal layers 10a, 10a... coming in sliding contact with each other

and being agglutinated accordingly, thus loss of flexibility is suppressed and displacement of the moving conductor 25 relative to the fixed conductor 24 can be allowed reliably.

The fix parts 1b and 1b on both sides of the flexible part 1a are formed by bringing the conductor metal layers 10a, 10a... into intimate contact with each other without placing the agglutination prevention layers 10b, 10b... each therebetween for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts 1b and 1b and diffusing and joining the conductor metal layers 10a, 10a...

Fourth embodiment:

FIG. 6 is a side view to show the configuration of a flexible conductor of a fourth embodiment according to the invention. A flexible conductor 1 in the figure has a similar configuration to that of the flexible conductor of the third embodiment, and fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25 are connected by beam-welding their butt parts as in the second embodiment.

Fifth embodiment:

FIGS. 7 and 8 are a side view and a plane view to show the configuration of a flexible conductor of a fifth embodiment

according to the invention respectively. A flexible conductor 1 in the figures, like the flexible conductor 1 shown in FIGS. 1 and 2, comprises a flexible part 1a comprising an alternating pattern of a plurality of conductor metal layers 10a, 10a... and a plurality of agglutination prevention layers 10b, 10b... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The fix parts 1b and 1b are strongly tightened to a fixed conductor 24 and a moving conductor 25 each by two fixing bolts 27 and 27 via a press plate 26 covering the full length.

Copper foil having a thickness of about 100 μm is used as the conductor metal layers 10a, 10a... like those shown in FIGS. 1 and 2. However, as the agglutination prevention layers 10b, 10b... each placed between the conductor metal layers 10a and 10a, unlike those shown in FIGS. 1 and 2 and unlike those shown in FIGS. 4 and 5, a plating film made of metal for producing a stabler oxide as compared with copper used as material of the conductor metal layers 10a, 10a..., such as nickel (Ni) or chromium (Cr), is formed on one face of each of the conductor metal layers 10a, 10a... in a thickness of about 1-10 μm and the conductor metal layers 10a, 10a... each on which the film is formed are deposited in the thickness direction, whereby the plating film is placed between the conductor metal layers 10a and 10a. FIG. 7 shows the agglutination prevention layers 10b, 10b... each made of the plating film and the conductor metal layers 10a, 10a... in such a manner that they are deposited as if a gap were placed therebetween; in fact, however, they are

deposited in a state in which they are placed in contact with each other.

The deposition range of the agglutination prevention layers 10b, 10b... covers roughly the full length of the conductor metal layers 10a, 10a... as hatched in FIG. 8 with a margin of a predetermined length on both sides in a length direction. This is easily accomplished by uniformly setting the forming range of the plating film on each of the conductor metal layers 10a, 10a... The fix parts 1b and 1b are fixed to the fixed conductor 24 and the moving conductor 25 in a similar manner to that in the first and third embodiments and a detailed description is not given.

The flexible conductor 1 as described above allows displacement of the moving conductor 25 relative to the fixed conductor 24 because of deformation of the flexible part 1a. At this time, each of the conductor metal layers 10a, 10a... comes in sliding contact with the agglutination prevention layer 10b, 10b... facing one side of the conductor metal layer 10a and there is little fear of the conductor metal layers 10a, 10a... coming in sliding contact with each other and being agglutinated accordingly; if the flexible conductor 1 is used under vacuum, loss of flexibility caused by the agglutination is suppressed and displacement of the moving conductor 25 relative to the fixed conductor 24 can be allowed reliably.

Since the agglutination prevention layers 10b, 10b... are plating films formed of metal for producing a stable oxide, such as nickel (Ni) or chromium (Cr), as described above, the

degree to which the oxide films formed on the surfaces are removed as the agglutination prevention layers 10b, 10b... come in sliding contact with the conductor metal layers 10a, 10a... is small. Therefore, there is little fear of agglutination occurring between the conductor metal layers 10a, 10a... and the agglutination prevention layers 10b, 10b... as they come in sliding contact with each other, and to use the flexible conductor 1 under vacuum, essential flexibility is not impaired and is maintained over a long term.

The fix parts 1b and 1b on both sides of the flexible part 1a are formed by bringing the conductor metal layers 10a, 10a... into intimate contact with each other without placing the agglutination prevention layers 10b, 10b... each therebetween for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts 1b and 1b and diffusing and joining the conductor metal layers 10a, 10a...

Sixth embodiment:

FIG. 9 is a side view to show the configuration of a flexible conductor of a sixth embodiment according to the invention. A flexible conductor 1 in the figure has a similar configuration to that of the flexible conductor of the fifth

embodiment, and fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25 are connected by beam-welding their butt parts as in the second and fourth embodiments.

Seventh embodiment:

FIG. 10 is a side view to show the configuration of a flexible conductor of a seventh embodiment according to the invention. A flexible conductor 1 in the figure comprises a flexible part 1a comprising a plurality of conductor metal layers 10a, 10a... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The fix parts 1b and 1b are tightened to a fixed conductor 24 and a moving conductor 25 each by a fixing bolt 27 via a press plate 26 covering the full length.

Each of the conductor metal layers 10a, 10a... comprises a plurality of protrusions 10c, 10c... made on one face. As shown in the figure, the face of the protrusions 10c, 10c is placed toward the same side and the tips of the protrusions 10c, 10c... are abutted against the opposite face of the adjacent conductor metal layer 10a so that the conductor metal layers 10a, 10a... are deposited with the gap equivalent to the height of each protrusion 10c, thereby forming the flexible part 1a. The protrusions 10c, 10c... can be formed like appropriate shapes, such as V-shaped protrusions over the full length or dimples arranged at proper intervals, by press molding of copper foil having a thickness of about 100 μm used as the conductor metal layers 10a, 10a... The fix parts 1b and 1b are fixed to the fixed conductor 24 and the moving conductor 25 in a similar

manner to that in the first, third, and fifth embodiments and a detailed description is not given.

The flexible conductor 1 as described above allows displacement of the moving conductor 25 relative to the fixed conductor 24 because of deformation of the flexible part 1a. At this time, each of the conductor metal layers 10a, 10a... comes in sliding contact with the conductor metal layers 10a and 10a deposited on both sides of the conductor metal layer 10a only at the limited parts of the tips of the protrusions 10c, 10c... formed as described above on each conductor metal layer 10a. Therefore, to use the flexible conductor 1 under vacuum, the range of agglutination occurring as the conductor metal layers 10a, 10a... come in sliding contact with each other is limited to the tip parts of the protrusions 10c, 10c...; loss of flexibility can be suppressed effectively and displacement of the moving conductor 25 relative to the fixed conductor 24 can be allowed reliably.

In the fix parts 1b and 1b on both sides of the flexible part 1a, the conductor metal layers 10a, 10a... are brought into intimate contact with each other by fastening the fixing bolts 27 via the press plate 26 for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by

heating the neighborhoods of the fix parts 1b and 1b and diffusing and joining the conductor metal layers 10a, 10a...

Eighth embodiment:

FIG. 11 is a side view to show the configuration of a flexible conductor of an eighth embodiment according to the invention. A flexible conductor 1 in the figure has a similar configuration to that of the flexible conductor of the seventh embodiment, and fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25 are connected by beam-welding their butt parts as in the second, fourth, and sixth embodiments.

Ninth embodiment:

FIG. 12 is a side view to show the configuration of a flexible conductor of a ninth embodiment according to the invention. A flexible conductor 1 in the figure comprises a flexible part 1a comprising a plurality of conductor metal layers 10a, 10a... deposited in a thickness direction and fix parts 1b and 1b formed with spacer plates 10d, 10d... each placed between the conductor metal layers 10a, 10a... on both sides of the flexible part 1a. The fix parts 1b and 1b are tightened to a fixed conductor 24 and a moving conductor 25 each by a fixing bolt 27 together with the spacer plates 10d, 10d... via a p plate 26 covering the full length.

In this state, the conductor metal layers 10a, 10a... making up the flexible part 1a are spaced from each other with a predetermined gap and are deposited without coming in direct contact with each other because the spacer plates 10d, 10d... are each placed between the conductor metal layers 10a, 10a...

in the fix parts 1b and 1b. The fix parts 1b and 1b are fixed to the fixed conductor 24 and the moving conductor 25 in a similar manner to that in the first, third, fifth, and seventh embodiments. The spacer plates 10d, 10d... tightened together with the conductor metal layers 10a, 10a... when the fix parts 1b and 1b are fixed are made of conductor metal having high electric conductivity, such as copper, like the conductor metal layers 10a, 10a... for decreasing contact resistance.

The flexible conductor 1 as described above allows displacement of the moving conductor 25 relative to the fixed conductor 24 because of deformation of the flexible part 1a. At this time, the conductor metal layers 10a, 10a... making up the flexible part 1a are deposited with the predetermined gap therebetween and scarcely come in sliding contact with each other. Therefore, to use the flexible conductor 1 under vacuum, it is not feared that the conductor metal layers 10a, 10a... may be agglutinated; essential flexibility can be maintained over a long term and displacement of the moving conductor 25 relative to the fixed conductor 24 can be allowed reliably.

In the fix parts 1b and 1b on both sides of the flexible part 1a, the conductor metal layers 10a, 10a... are brought into intimate contact with each other through the spacer plates 10d, 10d... made of conductor metal each placed therebetween by fastening the fixing bolts 27 via the press plate 26 for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole

flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts 1b and 1b to about 500°C and diffusing and joining the conductor metal layers 10a, 10a... together with the spacer plates 10d, 10d... each placed therebetween.

Tenth embodiment:

FIG. 13 is a side view to show the configuration of a flexible conductor of an tenth embodiment according to the invention. A flexible conductor 1 in the figure has a similar configuration to that of the flexible conductor of the ninth embodiment, and fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25 are connected by beam-welding their butt parts as in the second, fourth, sixth, and eighth embodiments.

Eleventh embodiment:

FIGS. 14 and 15 are a side view and a plane view to show the configuration of a flexible conductor of an eleventh embodiment according to the invention respectively. A flexible conductor 1 shown in the figures comprises a flexible part comprising a conductor metal layer 10a formed like meshes made of small-diameter wires made of conductor metal such as copper, the conductor metal layer 10a being sandwiched between thin regulation plates 10e and 10e made of metal with a small possibility of agglutination to copper, such as stainless material, from both sides in the thickness direction of the

conductor metal layer 10a and fix parts formed by projecting the conductor metal layer 10a on both sides of the regulation plates 10e and 10e. The fix parts are tightened to a fixed conductor 24 and a moving conductor 25 by fixing bolts 27 via a press plate 26 covering the full length and the flexible part is fixed at both ends to the fixed conductor 24 and the moving conductor 25 together with the regulation plates 10e and 10e by fixing bolts 29 via a press plate 28 covering the full length.

The flexible conductor 1 as described above allows displacement of the moving conductor 25 relative to the fixed conductor 24 because of deformation of the conductor metal layer 10a like meshes forming the flexible part. At this time, small-diameter wires shaped like meshes come in sliding contact with each other in the conductor metal layer 10a and it is feared that agglutination may occur in the sliding contact parts. However, the agglutination range is limited to the point contact parts between the wires and the flexibility in the flexible part is not impaired. Therefore, to use the flexible conductor 1 under vacuum, essential flexibility can be maintained over a long term and displacement of the moving conductor 25 relative to the fixed conductor 24 can be allowed reliably.

The regulation plates 10e and 10e sandwiching the conductor metal layer 10a on both sides regulate change in the shape of the conductor metal layer 10a because the meshes forming the conductor metal layer 10a get loose with the above-described deformation of the moving conductor 25. If the wire forming a part of the conductor metal layer 10a is cut and

projects to the outside, the regulation plates 10e and 10e also ease an electric field produced in the surroundings of the cut wire and maintain pressure resistance in a vacuum vessel. For the regulation plates 10e and 10e to function effectively, as shown in FIG. 15, each regulation plate 10e has a wider width than the conductor metal layer 10a has, and is extended to the outside as much as the length twice or three times that of the mesh spacing of the conductor metal layer 10a. The regulation plates 10e and 10e, which are thin plates made of stainless material, do not hinder the above-described deformation of the moving conductor 25 and agglutination does not occur either between the regulation plates 10e and 10e and the conductor metal layer 10a.

In the fix parts on both sides of the flexible conductor 1, the meshes forming the conductor metal layer 10a are crushed and the wires are brought into intimate contact with each other by fastening the fixing bolts 27 via the press plate 26 for decreasing contact resistance. Thus, as shown in the figure, in the use state in which the fixed conductor 24 and the moving conductor 25 are connected, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts to about 500°C and diffusing and joining the wires forming the conductor metal layer 10a.

Twelfth embodiment:

FIG. 16 is a side view to show the configuration of a flexible conductor of a twelfth embodiment according to the invention. A flexible conductor 1 in the figure has a similar configuration to that of the flexible conductor of the eleventh embodiment, and fix parts 1b and 1b and a fixed conductor 24 and a moving conductor 25 are connected by beam-welding their butt parts as in the second, fourth, sixth, eighth, and tenth embodiments. The beam welding is executed in the end margins of regulation plates 10e and 10e, whereby the functions of the regulation plates 10e and 10e as described in the twelfth embodiment can be provided.

Thirteenth embodiment:

FIGS. 17 and 18 are a side view and a plane view to show the configuration of a flexible conductor of a thirteenth embodiment according to the invention respectively. A flexible conductor 1 in the figures shows a modified example of the first embodiment. It comprises a flexible part 1a comprising an alternating pattern of a plurality of conductor metal layers 10a, 10a... and a plurality of agglutination prevention layers 10b, 10b... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The fix parts 1b and 1b are tightened to a fixed conductor 24 and a moving conductor 25 each by two fixing bolts 27 and 27 via a press plate 26 covering the full length.

As the agglutination prevention layers 10b, 10b..., as shown in FIG. 17, stainless foil shaped like waves is placed between the conductor metal layers 10a, 10a... and they are

fixed to the ends of the fixed conductor 24 and the moving conductor 25 via a press plate 28 by fixing bolts piercing both ends for preventing a shift. As shown in FIG. 18, the agglutination prevention layers 10b, 10b... are placed with a margin on both sides in the width direction of the conductor metal layers 10a, 10a... for saving the material. In the portions where the agglutination prevention layers 10b, 10b... are not placed, the conductor metal layers 10a, 10a... face each other with a gap equivalent to the height of each of the agglutination prevention layers 10b, 10b... shaped like waves and it is not feared that the conductor metal layers 10a, 10a... may come in sliding contact with each other and be agglutinated. As in the first embodiment, carbon sheets can also be used in place of the stainless foil.

In the fix parts 1b and 1b on both sides of the flexible part 1a, the conductor metal layers 10a, 10a... are brought into intimate contact with each other by fastening the fixing bolts 27 via the press plate 26 for decreasing contact resistance. Thus, in the use state shown in the figure, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts 1a and 1a to about 500°C and diffusing and joining the conductor metal layers 10a, 10a...

Fourteenth embodiment:

FIGS. 19 and 20 are a side view and a plane view to show

the configuration of a flexible conductor of a fourteenth embodiment according to the invention respectively. Like the flexible conductor 1 of the thirteenth embodiment, a flexible conductor 1 in the figures shows a modified example of the first embodiment. It comprises a flexible part 1a comprising an alternating pattern of a plurality of conductor metal layers 10a, 10a... and a plurality of agglutination prevention layers 10b, 10b... deposited in a thickness direction and fix parts 1b and 1b placed on both sides of the flexible part 1a. The fix parts 1b and 1b are tightened to a fixed conductor 24 and a moving conductor 25 each by two fixing bolts 27 and 27 via a press plate 26 covering the full length.

Foil material hard to cause agglutination to copper foil forming the conductor metal layers 10a, 10a..., such as carbon sheets or stainless foil, is used as the agglutination prevention layers 10b, 10b... like those in the first embodiment. The agglutination prevention layers 10b, 10b... have each the length reaching the piercing positions of the fixing bolts 27 and 27 in the fix parts 1b and 1b and circular notches made in the end margins on the same side are engaged with the fixing bolts 27 and 27 for preventing a shift. As shown in FIG. 20, the agglutination prevention layers 10b, 10b... are placed with a margin on both sides in the width direction of the conductor metal layers 10a, 10a... for saving the material as in the thirteenth embodiment.

In the fix parts 1b and 1b on both sides of the flexible part 1a, the conductor metal layers 10a, 10a... are brought into

intimate contact with each other in the half part on both end sides where the agglutination prevention layers 10b, 10b... are not placed by fastening the fixing bolts 27 via the press plate 26 for decreasing contact resistance. Thus, in the use state shown in the figure, the specific resistance of the whole flexible conductor 1 is decreased, good electric conductivity can be provided, and the heating value accompanying the passage of an electric current can be reduced. This can be accomplished more effectively by heating the neighborhoods of the fix parts 1b and 1b to about 500°C and diffusing and joining the conductor metal layers 10a, 10a...

Fifteenth embodiment:

FIG. 24 is a schematic sectional side view to show the main configuration of a switchgear according to the invention. In the figure, numeral 20 denotes a vacuum vessel held in a high vacuum of 10^{-3} Torr or less. A generating line bushing 22 provided by shaping ceramics like a truncated cone is attached to the vacuum vessel 20 and a generating line conductor 21 to which an external generating line is connected is made to pierce the generating line bushing 22.

A first fixed electrode 23 of a main circuit switch section 25 is fixed at the tip of the generating line conductor 21 and a first moving electrode 24 is placed facing the first fixed electrode 23. The first moving electrode 24 is fixed to the tip of a first conductive rod 26, which is coupled at the base end to an operation rod 28 moved ahead and behind by a drive unit (not shown) placed outside the vacuum vessel 20. The

operation rod 28 is made to pierce the vacuum vessel 20 and the vacuum vessel 20 is held in a hermetic state by a first bellows 31 placed between the operation rod 28 and the vacuum vessel 20.

A metal ring 27 is put on an intermediate part of the first conductive rod 26. A cable bushing 34 for supporting a load conductor 33 for coupling a power transmission cable is attached to the portion of the vacuum vessel 20 facing the peripheral surface of the metal ring 27. A second fixed electrode 37 of a ground switch section 39 is provided in the proximity of the tip of the load conductor 33 and a second moving electrode 38 is placed facing the second fixed electrode 37. The second moving electrode 38 is attached to the tip of a second conductive rod 36 piercing the vacuum vessel 20 and the second conductive rod 36 is moved ahead and behind by the drive unit (not shown). The second conductive rod 36 is installed. A second bellows 32 is placed between the second conductive rod 36 and the vacuum vessel 20 and the vacuum vessel 20 is held in a hermetic state by the second bellows 32.

A first cover member 51 shaped like a closed-end pipe is attached to the portion of the metal ring 27 opposed to the load conductor 33 in a state in which the first cover member 51 is abutted on the bottom against the peripheral surface of the metal ring 27. The dimension of the first cover member 51 in the axial length direction thereof is made a little shorter than the dimension between the metal ring 27 and the load conductor 33 and the margins of the first cover member 51 are

bent inside.

A second cover member 52 which has a similar shape to that of the first cover member 51 and is smaller than the first cover member 51 is attached to the load conductor 33 in a state in which it is abutted on the bottom against the tip of the load conductor 33 and has the tip entered in the first cover member 51. A hole is made in each of the inner bottoms of the first and second cover members 51 and 52 and a flexible conductor 40 shaped like a double arch is placed on the parts of the metal ring 27 and the load conductor 33 facing the holes.

With such a switchgear, the operation rode 28 is moved ahead and behind for moving ahead and behind the operation rod, the first conductive rod 26, and the first moving electrode 24 for bringing the first moving electrode 24 and the first fixed electrode 23 into and out of contact with each other, thereby operating the main circuit switch section 25. With the main circuit switch section 25 opened, the second conductive rod 36 is moved ahead and behind for bringing the second moving electrode 38 and the second fixed electrode 37 into and out of contact with each other, thereby operating the ground switch section 39.

To operate the main circuit switch section 25, as the first conductive rod 26 is moved ahead and behind, the flexible conductor 40 is warped and the warped flexible conductor 40 is restored to the former state, thereby maintaining conduction between the first conductive rod 26 and the load conductor 33. On the other hand, the surroundings of the flexible conductor

40 are covered with the first and second cover members 51 and 52, so that an arc product produced as the main circuit switch section 25 is operated is prevented from being deposited on the flexible conductor 40.

In the embodiment, the flexible conductor 40 is covered with the first and second cover members 51 and 52 placed facing each other, but the invention is not limited to it. Either the first cover member 51 or the second cover member 52 may be provided. In this case, the dimension of the cover member in the axial length direction thereof is made longer than the dimension of the flexible conductor 40.

Sixteenth embodiment:

FIG. 25 is a schematic sectional side view to show the main configuration of a switchgear according to a second embodiment of the invention, wherein a bellows 61 is used. Parts identical with or similar to those previously described with reference to FIG. 24 are denoted by the same reference numerals in FIG. 25 and will not be discussed again. As shown in FIG. 25, a flexible conductor 40 is placed between a metal ring 27 and a load conductor 33 and is housed in a third bellows 61 like a tube. The third bellows 61 is fixed at one end to the peripheral surface of the metal ring 27 and is put at an opposite end on the load conductor 33, whereby depositing of an arc product on the flexible conductor 40 can be prevented furthermore.

Seventeenth embodiment:

FIG. 26 is a schematic sectional side view to show the

main configuration of a switchgear according to a seventeenth embodiment of the invention, wherein a slide contact 41 is used. Parts identical with or similar to those previously described with reference to FIG. 24 are denoted by the same reference numerals in FIG. 26 and will not be discussed again. As shown in FIG. 26, in place of the metal ring 27 shown in FIG. 24, an annular slide contact 41 is put slidably on a first conductive rod 26, and a load conductor 33 is coupled to the peripheral surface of the slide contact 41.

A third cover member 53 and a fourth cover member 54 each like a box covering the slide contact 41 are put and fixed at positions at predetermined distances away from the top and bottom ends of the slide contact 41 on the first conductive rod 26, and a notch is made in each of the portions of the third cover member 53 and the fourth cover member 54 corresponding to the load conductor 33.

With such a switchgear, if the first conductive rod 26 is moved ahead and behind, it is slid in the slide contact 41 while maintaining the electric conduction state with the slide contact 41 put on the first conductive rod 26. At this time, the fourth cover member 54 is moved ahead and behind together with the first conductive rod 26. It is fixed to the first conductive rod 26 so as to produce an appropriate gap between the slide contact 41 and the bottom of the fourth cover member 54 when a first moving electrode 24 is brought into contact with a first fixed electrode 23, and the dimension of the fourth cover member 54 in the axial length direction thereof is set so that

the upper margin part of the first moving electrode 24 is positioned in the third cover member 53 if the first moving electrode 24 is brought out of contact with the first fixed electrode 23, whereby an arc product produced as a main circuit switch section 25 is operated is prevented from being deposited on the portion of the first conductive rod 26 coming in contact with the slide contact 41.

In the embodiment, the slide contact 41 is covered with the third and fourth cover members 53 and 54 placed facing each other, but the invention is not limited to it. Only the third cover member 53 may be provided. In this case, the dimension of the third cover member 53 in the axial length direction thereof is made long appropriately.

Eighteenth embodiment:

FIG. 27 is a schematic sectional side view to show the main configuration of a switchgear according to a eighteenth embodiment of the invention, wherein bellows are used. Parts identical with or similar to those previously described with reference to FIG. 26 are denoted by the same reference numerals in FIG. 27 and will not be discussed again. As shown in FIG. 27, a slide contact 41 is put slidably on a first conductive rod 26, and annular plates 45 and 46 each with a hole made in the center of a disk of a larger diameter than that of the slide contact 41 are put on a position at a predetermined distance away from the top end of the slide contact 41 on the first conductive rod 26 and on the bottom end of the slide contact 41. A fourth bellows 62 like a tube is placed between the upper

margin part of the slide contact 41 and the annular plate 45 opposed thereto, and a fifth bellows 63 like a tube is placed between the annular plate 46 disposed at the bottom end of the slide contact 41 and an operation rode 28.

With such a switchgear, if the first conductive rod 26 is moved ahead and behind, it is slid in the slide contact 41 while maintaining the electric conduction state with the slide contact 41 put on the first conductive rod 26. At this time, the fifth bellows 63 expands and contracts as the first conductive rod 26 is moved ahead and behind, whereby an arc product produced as a main circuit switch section 25 is operated is furthermore prevented from being deposited on the portion of the first conductive rod 26 coming in contact with the slide contact 41.

Nineteenth embodiment:

FIG. 28 is a schematic sectional side view to show the main configuration of a switchgear according to a nineteenth embodiment of the invention. In the nineteenth embodiment, a side wall of a vacuum vessel is formed with an opening facing the peripheral surface of a metal ring 27 fixedly put on a conductive rod 26.

A connection conductor 42 extended to one side is attached to the metal ring 27 and the opening has a diameter to allow a flexible conductor 40 to pass through with a considerable clearance. The flexible conductor 40 is brazed at one end part to one end part of the connection conductor 42 in the vacuum vessel 20 and is brazed at an opposite end part

passing through the opening to a load conductor 33 placed outside the vacuum vessel 20 for allowing an electric current to flow into the load side from a power supply. In the lower part of the vacuum vessel 20, the upper end part of a ground conductor 36 is made to pass through at a position facing the connection conductor 42, and the ground conductor 36 is coupled at the lower end part to a drive unit (not shown).

A bellows 41b made of metal of a stainless family is placed between one end part of the connection conductor 42 and the opening of the vacuum vessel 20 and is fixedly brazed at both ends to one end part of the connection conductor 42 and the margin of the opening of the vacuum vessel 20, so that the vacuum vessel 20 is held hermetic.

The flexible conductor 40 is thus placed outside the vacuum vessel 20, whereby agglutination to the flexible conductor 40 is suppressed and loss of flexibility is prevented. The inside of the vacuum vessel 20 is not contaminated with conductive agglutination wear powder scattering in the vacuum vessel 20 and the dielectric strength performance can be made stable.

Parts identical with or similar to those previously described with reference to FIG. 24 are denoted by the same reference numerals in FIG. 25 and will not be discussed again.

Twentieth embodiment:

FIG. 29 is a schematic sectional side view to show the main configuration of a switchgear according to a twentieth embodiment of the invention.

A conductive bellows 43 made of metal of a copper family is placed on the outer peripheral surface of a metal ring 27 fixedly put on a conductive rod 26 and one end part of a load conductor 33 and is brazed at both ends to them for connection. The conductive bellows 43 has flexibility and elasticity that can smoothly follow a position shift between the metal ring 27 and the load conductor 33 accompanying operating of a main circuit switch section 25.

In such a configuration, the members do not come in contact with each other, thus agglutination does not occur on the outer or inner peripheral surface of the conductive bellows 43 and agglutination wear powder is not produced, so that the dielectric strength performance can be made stable.

The conductive bellows 43 may be placed to the side of the load conductor 33 from the position of a ground switch section 39.

Further, the diametric cross-sectional shapes of the bellows 41a and 41b in the first and second embodiments and the conductive bellows 43 in the third embodiment are not limited to circles and may be ellipses, quadrangles, etc.

Parts identical with or similar to those previously described with reference to FIG. 24 are denoted by the same reference numerals in FIG. 26 and will not be discussed again.

1. A switchgear comprising in a vacuum vessel:

a power supply conductor,

a conductive rod for coming in and out of contact with said power supply conductor,

a load conductor, a flexible conductor which comprises conductive metal foil films deposited on each other and is connected to said load conductor and said conductive rod, and

a cover member having flexibility for covering said flexible conductor, said cover member being fixed to said conductive rod and said load conductor in a hermetic state, wherein;

the inside of said cover member is filled with a gas containing oxygen or nitrogen.

2. A switchgear comprising in a vacuum vessel formed with an opening:

a power supply conductor,

a conductive rod for coming in and out of contact with said power supply conductor,

a connection conductor being connected to said conductive rod, and

a cover member having flexibility and being placed on and fixed to the opening of the vacuum vessel and said connection conductor to place the vacuum vessel in a hermetic state, wherein;

said connection conductor and a load conductor placed

outside the vacuum vessel are connected by a flexible conductor comprising conductive metal foil films deposited on each other through said cover member.

3. A switchgear comprising in a vacuum vessel:

a power supply conductor,

a conductive rod for coming in and out of contact with said power supply conductor,

a load conductor, and

a conductive member which has flexibility and is shaped like a pipe and is placed on and fixed to said load conductor and said conductive rod.

4. The switchgear as claimed in claim 1 or 2 wherein said cover member is a bellows.

5. The switchgear as claimed in claim 3 wherein said conductive member is a bellows formed of a conductive material.