

Description

Device for conducting electrical direct current

The invention relates to a device for conducting electrical direct current, having at least one bus bar.

The term bus bar is here to be understood as an electrical conductor for the distribution of electrical energy. Bus bars are usually made of copper or aluminum, and are in an electrically uninsulated form.

The object underlying the invention is to specify an improved device for conducting electrical direct current, having at least one bus bar, and which is in particular suitable for limiting electrical short-circuit currents.

This object is achieved in accordance with the invention by the characteristics of claim 1.

Advantageous embodiments of the invention are the subject of the sub-claims.

A device in accordance with the invention for conducting electrical direct current incorporates at least one bus bar and at least one electrically conducting edge element, arranged on a lateral external surface of the bus bar and extending along the bus bar, which is bonded to the bus bar in an electrically conducting manner and has a lower electrical conductivity than the bus bar.

Here, the edge elements serve to suppress current components which change at a high frequency. For this purpose, the invention makes use of the skin effect in electrical conductors, by which electrical currents within a conductor which change at a high frequency are carried mainly close to the external surfaces of the conductor. By the inventive arrangement of edge elements on external surfaces of bus bars, electrical currents which change at a high frequency are thus fed to the edge elements, and there they are suppressed due to the lower electrical conductivity of the edge elements compared to the bus bar. This effect advantageously permits, in particular, the suppression of components of electrical short-circuit currents with current strengths which change at a high frequency, which typically arise in direct current circuit arrangements. The invention thereby permits a simple and cost-effective reduction in electrical short-circuit currents in direct current bus bars.

One embodiment of the invention provides at least two edge elements, which are arranged on lateral external surfaces on opposite sides of a bus bar.

In this way, the skin effect is even better used and electrical short-circuit currents can advantageously be yet further reduced.

One further embodiment of the invention provides several bus bars, arranged alongside each other in a stack-like manner.

This embodiment makes it possible to utilize not only the skin effect but also the proximity effect, in order to force out electrical currents which change at a high frequency into edge elements. Here, the term proximity effect is to be understood as

a current displacement between two neighboring electrical conductors under the influence of alternating currents.

In the case of the embodiment of the invention cited above, it is preferable if at least one edge element extends over several bus bars arranged alongside each other in a stack-like manner, wherein it is arranged on lateral external surfaces of these bus bars and is bonded to each of these bus bars in an electrically conducting manner.

This simplifies the construction of the inventive device, because one edge element can be used for several bus bars, and thus the individual bus bars do not need to be provided separately with edge elements.

A further embodiment of the invention provides at least one bus bar made of copper or aluminum.

Due to their high electrical conductivity, copper and aluminum are particularly suitable as materials for bus bars.

A further embodiment of the invention provides at least one edge element of iron or a steel, in particular a stainless steel.

Due to their low electrical conductivity, iron and steel, in particular stainless steel, are particularly suitable as materials for edge elements.

A further embodiment of the invention provides at least one bus bar constructed in strip or plate-shaped form.

Advantageously, bus bars constructed in strip or plate-shaped form permit good heat dissipation from the bus bars.

The invention provides in particular the use of an inventive device for limiting electrical short-circuit currents in an electrical circuit arrangement, wherein at least one bus bar of the device is electrically bonded to one pole of an electrical direct current source.

This usage exploits in an advantageous way of the reduction cited above in electrical short-circuit currents in a device in accordance with the invention.

The properties, characteristics and advantages of this invention described above, together with the way and manner in which these are achieved, will become more clearly and plainly comprehensible in conjunction with the following description of exemplary embodiments, which are explained in more detail in conjunction with the drawings. These show:

FIG 1 a typical graph of a short circuit current in a direct current circuit arrangement, and

FIG 2 a cross-sectional view of a device in accordance with the invention, for conducting electrical direct current.

Figure 1 shows a typical graph $I(t)$ of a short-circuit current I in a direct current circuit arrangement, as a function of time t . The current strength of the short-circuit current I changes with a high frequency about a mean value which decreases over time. The high-frequency changes in the short-circuit current I can here be caused and influenced by various electrical components in a direct current circuit arrangement, for example by rectifiers or capacitors.

Figure 2 shows a cross-sectional view of a device 1 in accordance with the invention for conducting an electrical direct current. The device 1 incorporates two bus bars 3 and two edge elements 5.

The two bus bars 3 are of the same type, and each is made in a strip-shaped form with a rectangular cross-sectional area, and is made, for example out of copper or aluminum. The two bus bars 3 are arranged alongside and parallel to each other in a stacked manner, with a space between them.

The two edge elements 5 are of the same type and each is made in a plate-like form with a rectangular cross-sectional area and is made, for example, of iron or steel, in particular a stainless steel.

Each edge element 5 lies against both bus bars 3, with the edge elements being arranged against opposite sides of the bus bars 3. In this way, a surface of each edge element 5 lies against a lateral external surface 7 of each bus bar 3, and has an electrically conducting bond to both bus bars 3 via these lateral external surfaces 7. Each of the two edge elements 5 extends, orthogonally to the plane of the drawing in Figure 2, over the entire length of the bus bars 3.

The edge elements 5 are, for example, spaced apart by the bus bars 3 by about ten times the spacing between the bus bars 3. The thicknesses of the bus bars 3 and the edge elements 5 correspond, for example, in each case to about the spacing of the bus bars 3 from each other. For example, the thicknesses of the bus bars 3 and the edge elements 5, and the spacing of two bus bars 3 from each other, is in each case about 10 mm, and the spacing of the edge elements 5 from each other amounts to about

100 mm. Here, the thickness of a bus bar 3 or of an edge element 5, as applicable, is in each case to be understood as the length of one of the shorter sides of the rectangular contour of the cross-sectional area respectively of the bus bar 3 or the edge element 5.

In direct current circuit arrangements use is made, for example, of two of the devices 1 shown in Figure 2, wherein the bus bars 3 of one of these devices 1 are electrically connected to one pole of an electrical direct current source and the bus bars 3 of the other device 1 are electrically connected to the other pole of the electrical direct current source.

Electrical currents which are changing at a high frequency are diverted by the skin effect and the proximity effect out of the bus bars 3 and into the edge elements 5, and are suppressed by the high electrical resistance of the edge elements 5.

Simulations have shown that by this means the electrical resistance of a device 1 as shown in Figure 2 is increased, for electrical currents which are changing at a high frequency, several times over compared to the electrical resistance of the bus bars 3, for example by a factor of 39 for current change frequencies of 1000 Hz when use is made of copper bus bars 3 with a cross-sectional area of 2000 mm^2 and edge elements 5 made of iron. In the case of a short-circuit current I with a pulse height of 220 kA, this leads to a voltage drop of some 75 V/m across a device 1. If stainless steel is used instead of iron for the material of the edge elements 5, the electrical resistance of a device 1 for currents changing with a high frequency, and the voltage drop across the device 1, can be further increased.

Although the invention has been illustrated and described in more detail by preferred exemplary embodiments, the invention is not restricted by the examples disclosed, and the person skilled in the art can deduce other variations from it without going outside the scope of the protection for the invention.

Claims

1. A device (1) for conducting electrical direct current, incorporating at least one bus bar (3) and, arranged on a lateral external surface (7) of the bus bar (3) and extending along the bus bar (3), at least one electrically conducting edge element (5) which has an electrically conducting bond to the bus bar (3) and has a lower electrical conductivity than the bus bar (3).
2. The device (1) as claimed in claim 1, characterized by at least two edge elements (5) which are arranged on a bus bar (3) on lateral external surfaces (7) of it which lie opposite each other.
3. The device (1) as claimed in one of the preceding claims, characterized by several bus bars (3) which are arranged alongside each other in a stack-like manner.
4. The device (1) as claimed in claim 3, characterized by at least one edge element (5) which extends across several bus bars (3), arranged alongside each other in a stack-like manner, wherein it is arranged on lateral external surfaces (7) of these bus bars (3) and is bonded to each of these bus bars (3) in an electrically conducting manner.
5. The device (1) as claimed in one of the preceding claims, characterized by at least one bus bar (3) made of copper or aluminum.
6. The device (1) as claimed in one of the preceding claims, characterized by at least one edge element (5) made of iron or a steel.

7. The device (1) as claimed in one of the preceding claims, characterized by at least one edge element (5) made of a stainless steel.

8. The device (1) as claimed in one of the preceding claims, characterized by at least one bus bar (3) with a strip or plate-shaped construction.

9. A use of a device (1) in accordance with one of the preceding claims, for the limitation of electrical short-circuit currents (I) in an electrical circuit arrangement, wherein at least one bus bar (3) of the device (1) is electrically bonded to one pole of an electrical direct current source.