

Description

Busbar arrangement for an electrical switchgear assembly

The invention relates to a busbar arrangement for an electrical switchgear assembly.

For some time, switchgear assemblies have been designed not only as single-front arrangements but also as double-front arrangements. A double-front arrangement is constructed such that the assembly has an operator control panel both on the front face (at the front) and on the rear face (at the rear). A double-front arrangement also has a common busbar system. The field rails are connected to the common busbar, which is situated in the middle, from the front and from the rear here.

Phase rails which are divided into a plurality of (usually two or four) conductor elements are often used in multiphase busbar arrangements. In the low-voltage range, division of this type is usually used to reduce eddy current losses. By way of example, German patent specification DE 199 53 561 C1 exhibits an arrangement with two conductor elements. In the busbar arrangements 100 with four conductor elements 101 arranged in a rectangle and a distance 102 between the conductor elements of approximately 10 mm which have been known to date, the different connection possibilities from the front and rear have always had to be taken into account in order to prevent the connection bolts 104 from colliding when field rails 103 were connected to the busbar, cf. fig. 5. A complex system was necessary for the simultaneous connection of devices to the busbar from the front and rear. Furthermore, busbar arrangements with four conductor elements arranged in a rectangle possess a current-carrying capacity which is insufficient in many cases.

One object of the present invention is therefore to find a solution with which a greater current-carrying capacity is achieved in the conductor elements.

This object is achieved by a busbar arrangement as claimed in claim 1. This claim makes provision for the busbar, which is held by at least one busbar holder, to have at least two first (front) conductor elements, at least two second (rear) conductor elements, and at least two third (central) conductor elements which are arranged between the first conductor elements and the second conductor elements, with the central conductor elements protruding beyond the front and rear conductor elements transverse to the longitudinal direction of the busbar. In this case, the front, central and rear conductor elements of the busbar are preferably each arranged transverse to the longitudinal direction of the busbar and aligned with one another, and have the same thickness (preferably 10 mm here).

A first basic idea of the invention initially involves increasing the distance between the front and rear conductor elements and arranging a number of central conductor elements in the resulting enlarged intermediate space between the front and rear conductor elements. Overall, this results in a greater current-carrying capacity. The cross sections for each phase can be designed for rated currents of above 3500 A. The distance between the front conductor elements and the rear conductor elements corresponds here to at least twice, but preferably at least three times, the thickness of one conductor element. Expressed in another way, the distance is preferably greater than or equal to twice or three times the thickness of one conductor element.

Furthermore, the implementation of this basic idea in a double-front arrangement means that the enlarged intermediate space between the front and rear conductor elements can be used for

connections to the front and to the rear, without leading to the connecting elements (preferably connection bolts) colliding. The simultaneous connection of devices to the busbar from the front and rear within the scope of a double-front arrangement can therefore be carried out in an extremely simple manner.

It has been found that current distribution to the individual conductor elements is very different on account of the skin effect. In particular, the central conductor elements carry scarcely any current. This leads to an unfavorable ratio of cross section for each phase to current which can be transmitted.

According to a further basic idea of the invention, provision is therefore made to form the central conductor elements in such a way that they protrude beyond the front and rear conductor elements transverse to the longitudinal direction of the busbar. In other words, the central conductor elements are offset toward the outside, are therefore higher than the outer conductor elements and project beyond these. On account of the fact that the central conductor elements are no longer at the same level as the outer conductor elements in the vertical direction, current is distributed to the individual conductor elements for each phase very uniformly, as demonstrated by measurements. This can be attributed to the skin effect. This produces a shift in current distribution in the direction of the central conductor elements. The shift of the central conductor elements in relation to the outer conductor elements produces a cross-sectional contour of the conductor elements involved which approximates a circle (compared to the square structure in the case of just four or six conductor elements which are not arranged offset in relation to one another). A particularly high current-carrying capacity can be achieved in the busbar with this cross-sectional contour. Furthermore, this arrangement of the central conductor elements means a greater

current-carrying capacity can be achieved with the same copper cross section.

Advantageous refinements of the invention are specified in the subclaims.

In all cases, it is necessary for the central busbar to be wider than the front and the rear busbars, so that it protrudes beyond these. However, in this case, the distance between the individual conductor elements of the central pair of conductor elements may be different.

According to a first embodiment of the invention, the central conductor elements of the busbar are wider than the front and rear conductor elements, and the distance between the two central conductor elements is equal to the distance between the two front conductor elements and, respectively, between the two rear conductor elements. This is particularly advantageous from a manufacturing point of view since the elongate hole to be made in the busbars for producing the pairs of conductor elements can always be produced in the same way.

According to a second embodiment of the invention, the central conductor elements of the busbar are arranged in a manner displaced transverse to the longitudinal direction of the busbar in such a way that the distance between the two central conductor elements is greater than the distance between the two front conductor elements and, respectively, between the two rear conductor elements. In this case, it is particularly advantageous for uniform distribution of current for the third conductor elements of the busbar to have the same width as the first and second conductor elements.

In order to ensure a simple connection system, the bolt heads preferably bear against the mutually facing inner faces of the front and rear conductor elements. The bolt heads of the

connection bolts are therefore arranged between the front and the central conductor elements for the connections from the front, whereas the bolt heads of the connection bolts are arranged between the central and the rear conductor elements for the connections from the rear.

The busbar arrangement according to the invention is preferably formed in such a way that the first connection bolts for producing a connection between a field rail and the front conductor elements can be arranged, such that they can be mounted, in any desired manner in relation to the second connection bolts for producing a connection between a field rail and the rear conductor elements. For example, they can be arranged such that they are not aligned or else such that they are aligned with one another. In other words, the increased distance between the front and rear conductor elements enables the field rails to be mounted in such a way that the connection bolts can be mounted level and offset in relation to one another or else aligned. Since a single connection bolt - as known from the prior art - is no longer used in order to connect the field rails to the busbar, but instead two connection bolts which are independent of one another are used according to the invention, the front connection is decoupled from the rear connection.

However, it is likewise possible to use continuous connection bolts in place of the first and second connection bolts. In other words, these connection bolts run through the front, central and rear conductor elements and connect the latter to a field rail which is to be connected. Since simultaneous connection from the front and from the rear is no longer possible in this case, continuous connection bolts of this type are particularly advantageous when only one single field rail is to be connected to the busbar and/or in the case of a single-front arrangement.

The connection bolts used may be cup square bolts according to DIN 603. However, it has proven particularly advantageous for quick and reliable mounting for the connection bolts used to be T-head bolts with a square neck according to DIN 186. Compared to cup square bolts, said T-head bolts with a square neck provide the advantage that the bolt is inserted from the front or rear into the free space between the conductor elements of an arrangement which has already been fully mounted, and can be turned through 90° in the free space. In other words, the bolt does not rotate when the nut is tightened since the square neck is located between the conductor elements.

If the conductor elements of the busbar are connected to one another in the vicinity of the field rail connections by means of preferably screwed-in intermediate pieces, as is provided in a further preferred embodiment of the invention, current compensation can be produced between front or rear conductor elements and the central conductor elements in a simple manner, without resulting in a collision between the front and rear connections. In this case, the intermediate pieces are advantageously likewise produced from rail material (in particular copper).

The invention is described below with reference to exemplary embodiments which are explained in greater detail with the aid of drawings. In the drawings, in simplified, partly schematic illustrations:

fig. 1 shows a switchgear cabinet of double-front design,

fig. 2 shows (a perspective view of) a busbar with three pairs of conductor elements,

fig. 3 shows a busbar with three pairs of conductor elements (sectional illustration III-III in fig. 2),

fig. 4 shows a further busbar with three pairs of conductor elements (sectional illustration analogous to III-III in fig. 2), and

fig. 5 shows a busbar with two pairs of conductor elements according to the prior art (sectional illustration).

Fig. 1 shows a busbar arrangement 1 for a switchgear assembly, that is to say an assembly in which electrical energy is distributed. The switchgear assembly comprises a plurality of switchgear cabinets 2. It is designed as a double-front arrangement. This means that the assembly has an operator control panel 5, 6 both on the front face 3 (at the front) and on the rear face 4 (at the rear). The double-front arrangement also has a common busbar system (N, L1, L2, L3). In this case, the field rails 7 are connected to the common, centrally positioned busbar 8 (main busbar) from the front and from the rear. Switchgear devices 9, 10 are connected to the field rails, the operator control panels 5, 6 of said switchgear devices each protruding from the front face 3 or rear face 4 of the switchgear cabinet 2 for operator control purposes. Further connection rails 11 pass from the switchgear devices 9, 10 to further devices (not illustrated) in the switchgear cabinet 2.

In this case, a busbar system is understood to be a number of rail-like current conductors which are present in a number and arrangement in which they are required to transport power in single-phase or multiphase networks. In other words, the present invention is not restricted only to busbars in the actual sense of the word. In fact, the invention can be used in any type of conductor bar.

Fig. 2 shows a single busbar 8 of the busbar arrangement. For reasons of clarity, the busbar holder has not been illustrated. Said busbar holder is preferably positioned on at least one of the free ends of the busbar 8. The busbar L1 is illustrated in

the example. This busbar 8 has three copper conductor bars 14, 15, 28 which each, in the center, have an elongate hole 16 for mounting the field rails 7, 7' by means of connection bolts 17, 17'. This produces a total of three pairs of conductor elements, as illustrated in fig. 3. In this case, the first pair of conductor elements comprises the conductor elements 18, 19 which are formed above and below the elongate hole 16 in the first conductor bar 14. The second pair of conductor elements comprises the conductor elements 20, 21 which are formed above and below the elongate hole 16 in the second conductor bar 15. The third pair of conductor elements comprises the conductor elements 29, 30 which are formed above and below the elongate hole 16 in the third conductor bar 28. In this case, the front conductor elements 18, 19, the rear conductor elements 20, 21 and the central conductor elements 29, 30 of the busbar 8 each run transverse to the longitudinal direction 22 of the busbar and in a manner aligned with one another.

The distance 23 between the front conductor elements 18, 19 and the rear conductor elements 20, 21 corresponds to three times the thickness of one conductor element 18, 19, 20, 21 here. In the present case, the thickness 31 of one conductor element is 10 mm (cf. fig. 3) and the distance 23 between the front conductor elements 18, 19 and the rear conductor elements 20, 21 is 30 mm.

In the embodiment illustrated in fig. 3, the central conductor elements 29, 30 of the busbar 8 have a greater width 37 than the front and rear conductor elements 18, 19, 20, 21 which each have a smaller width 36. The central conductor elements 29, 30 therefore protrude beyond the front and rear conductor elements 18, 19, 20, 21 by a length 32. In this case, the distance 33 between the two central conductor elements 29, 30 is equal to the distance 34 between the two front conductor elements 18, 19 and, respectively, the two rear conductor elements 20, 21. In other words, the elongate holes 16 in all three busbars 8 are

of equal width. The central busbar 28 is arranged precisely in the center between the outer busbars 14, 15.

The field rails 7, 7' are connected to the front and rear conductor elements 18, 19, 20, 21 by connection bolts 17, 17'. The connection bolts 17, 17' used are cup square bolts according to DIN 603. In this case, the connection bolts 17, 17' are situated between the two front conductor elements 18, 19 and, respectively, the two rear conductor elements 20, 21 in the corresponding elongate holes 16 and, with their bolt heads 24, bear against the mutually facing inner faces 25 of the front and rear conductor elements 18, 19, 20, 21. The front connection bolts 17 can be mounted in a manner offset in relation to the rear connection bolts 17' in this case.

In the embodiment illustrated in fig. 4, the central conductor elements 29, 30 of the busbar 8 are arranged in a manner displaced transverse to the longitudinal direction 22 of the busbar in such a way that the distance 35 between the two central conductor elements 29, 30 is greater than the distance 34 between the two front conductor elements 18, 19 and, respectively, the two rear conductor elements 20, 21. In other words, the elongate holes 16 in the two outer busbars are narrower than the elongate hole in the central busbar. In this case, the conductor elements 29, 30 of the central busbar have the same width 36 as the first and second conductor elements 18, 19, 20, 21.

In this embodiment too, the field rails 7, 7' are connected to the front and rear conductor elements 18, 19, 20, 21 by connection bolts. However, the connection bolts 38, 38' used here are T-head bolts with a square neck according to DIN 186, on account of the larger intermediate space available between the central conductor elements 29, 30. In this case, as before, the connection bolts 38, 38' are situated between the two front conductor elements 18, 19 and, respectively, between the two

rear conductor elements 20, 21 in the corresponding elongate holes 16 and, with their bolt heads 39, bear against the mutually facing inner faces 25 of the front and rear conductor elements 18, 19, 20, 21. The front connection bolts 38 can again be mounted in a manner offset in relation to the rear connection bolts 38' here.

The front conductor elements and the rear conductor elements (in the case of two pairs of conductor elements) and, respectively, the front conductor elements and the central conductor elements, and the central conductor elements and the rear conductor elements (in the case of three pairs of conductor elements) are preferably connected to one another in the vicinity of the field rail connections by means of screwed-in copper intermediate pieces (not depicted).

In this connection, it should be pointed out that the distances 23 between the individual pairs of conductor elements in fig. 2 and 3 have not been drawn to scale, but instead are illustrated on a greatly enlarged scale for reasons of clarity.

List of reference symbols

- 1 Busbar arrangement
- 2 Switchgear cabinet
- 3 Front face
- 4 Rear face
- 5 Operator control panel at the front
- 6 Operator control panel at the rear
- 7 Field rail
- 8 Busbar
- 9 Switchgear device at the front
- 10 Switchgear device at the rear
- 11 Connection bar
- 12 (free)
- 13 (free)
- 14 Conductor bar
- 15 Conductor bar
- 16 Elongate hole
- 17 Connection bolt
- 18 Front conductor element
- 19 Front conductor element
- 20 Rear conductor element
- 21 Rear conductor element
- 22 Longitudinal direction of the busbar
- 23 Distance
- 24 Bolt head
- 25 Inner face
- 26 (free)
- 27 (free)
- 28 Conductor bar
- 29 Central conductor element
- 30 Central conductor element
- 31 Conductor element thickness
- 32 Protruding length
- 33 Distance between central conductor elements
- 34 Distance between outer conductor elements

- 35 Distance between central conductor elements
- 36 Conductor element width
- 37 Conductor element width
- 38 Connection bolt
- 39 Bolt head

- 100 Busbar arrangement
- 101 Conductor element
- 102 Distance
- 103 Field rail
- 104 Connection bolt

Patent claims

1. A busbar arrangement (1) for an electrical switchgear assembly, having at least one busbar (8) which is held by at least one busbar holder, characterized

in that the busbar (8) has at least two first conductor elements (18, 19), at least two second conductor elements (20, 21) and at least two third conductor elements (29, 30) which are arranged between the first conductor elements (18, 19) and the second conductor elements (20, 21), with the third conductor elements (29, 30) protruding beyond the first and second conductor elements (18, 19, 20, 21) transverse to the longitudinal direction (22) of the busbar.

2. The busbar arrangement (1) as claimed in claim 1, characterized

in that the third conductor elements (29, 30) of the busbar (8) are wider than the first and second conductor elements (18, 19, 20, 21), and the distance (33) between the two third conductor elements (29, 30) is equal to the distance (34) between the two first conductor elements (18, 19) and, respectively, between the two second conductor elements (20, 21).

3. The busbar arrangement (1) as claimed in claim 1 or 2, characterized

in that the third conductor elements (29, 30) of the busbar (8) are arranged in a manner displaced transverse to the longitudinal direction (22) of the busbar in such a way that the distance (35) between the two third conductor elements (29, 30) is greater than the distance (34) between the two first conductor elements (18, 19) and, respectively, between the two second conductor elements (20, 21).

4. The busbar arrangement (1) as claimed in claim 3, characterized

in that the third conductor elements (29, 30) of the busbar (8) have the same width (36) as the first and second conductor elements (18, 19, 20, 21).

5. The busbar arrangement (1) as claimed in one of claims 1 to 4,

characterized

in that a field rail (7) is fitted to the first and/or second conductor elements (18, 19, 20, 21) of the busbar (8) using a number of connection bolts (17, 38), with the bolt heads (24, 39) being arranged on the mutually facing inner faces (25) of these conductor elements (18, 19, 20, 21).

6. The busbar arrangement (1) as claimed in one of claims 1 to 5,

characterized

in that the connection between a field rail (7) and the first conductor elements (18, 19) is produced by a number of first connection bolts (17), and the connection between a field rail (7') and the second conductor elements (20, 21) is produced by a number of second connection bolts (17').

7. The busbar arrangement (1) as claimed in claim 5 or 6, characterized

in that the connection bolts (38, 38') are T-head bolts with a square neck.

8. The busbar arrangement (1) as claimed in one of claims 1 to 7,

characterized

in that the conductor elements (18, 19, 20, 21, 29, 30) of the busbar (8) can be connected to one another by means of intermediate pieces in the vicinity of the field rail connections for current compensation between the conductor elements (18, 19, 20, 21).