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(54) A PROTECTIVE SLEEVE FOR ELECTRICALLY AND THERMALLY PROTECTING AN ELECTRICALLY CONDUCTIVE BUSBAR AND A METHOD FOR OBTAINING THE PROTECTIVE SLEEVE

(57) The present invention relates to a protective sleeve (S) for electrically and thermally protecting an electrically conductive busbar, wherein the protective sleeve (S) is a textile sleeve made of closed-mesh circular warp knitbraided fibreglass yarns, which provides a high thermal and electric resistance and a high adaptability to curved geometries.

The present invention also concerns to a method for obtaining the protective sleeve (S) of the first aspect.

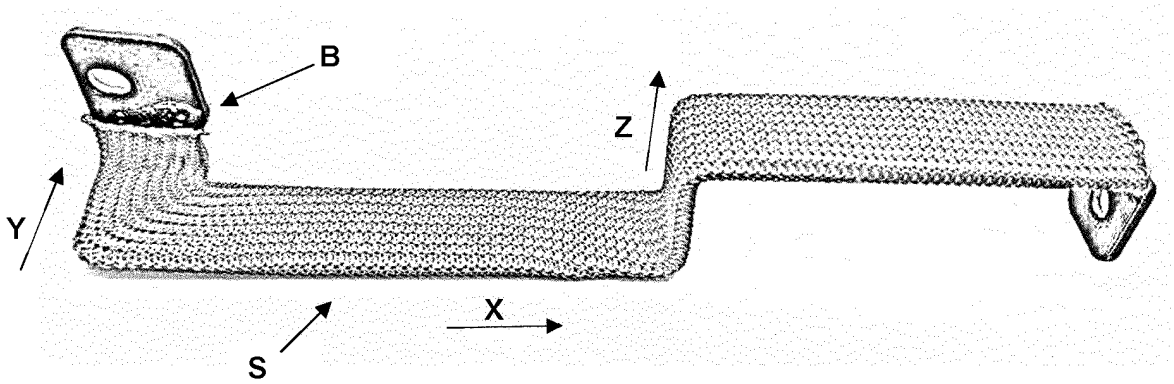

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates, in a first aspect, to a protective sleeve for electrically and thermally protecting an electrically conductive busbar, and particularly to a protective textile sleeve with a high thermal and electric resistance and a high adaptability to curved geometries.

[0002] A second aspect of the invention relates to a method for obtaining the protective sleeve of the first aspect.

BACKGROUND OF THE INVENTION

[0003] Manufacturers are looking for a product with which to cover/protect/isolate some electrically conductive pieces called busbars. These pieces are metallic elements that act as a system of electrical conductors in a generating or receiving station in which electrical energy is concentrated for distribution or feeding of large capacity equipment.

[0004] When this electrical energy is concentrated, high temperature peaks can be produced and it is for this reason that said metal parts must be protected/isolated from these temperature peaks.

[0005] The protective sleeves for electrically and thermally protecting an electrically conductive busbar known in the art are generally made of vinyl, such as that disclosed in KR100845950 B1, or, for a busbar having bent sections, with a heat-shrinkable insulating tubing, as disclosed in CN105957591B.

[0006] Those known in the art protective sleeves have several drawbacks, such as being heavy, providing clearly improvable thermal and electrical resistances, and having a low transversal elasticity. The latter drawback is clearly shown in CN105957591B, where a sleeve with a larger diameter is first sleeved over the different bent sections of the busbar, and then heat is applied to heat-shrink the sleeve.

[0007] It is therefore necessary to provide an alternative to the state of the art which covers the gaps found therein, by providing a protective sleeve for electrically and thermally protecting an electrically conductive busbar, which offers a higher thermal and electric protection, is lighter and is also made to have a greater adaptation to curved geometries, so that it can be used for a busbar having bent sections.

SUMMARY OF THE INVENTION

[0008] To that end, the present invention relates, in a first aspect, to a protective sleeve for electrically and thermally protecting an electrically conductive busbar.

[0009] In contrast to the protective sleeves for busbars known in the prior art, in the one of the present invention, in a characterizing manner, the protective sleeve is a textile sleeve, particularly a textile sleeve made of closed mesh circular warp knitbraided fibreglass yarns.

[0010] Therefore, in the textile sleeve meshes are formed vertically in a closed manner, and joined to each other between adjacent passes, so that diagonal and vertical connections are provided, providing a property to the so knitted sleeve that makes it difficult to unravel.

[0011] For an embodiment, the protective sleeve is dimensioned and has a determined transversal elasticity (preferably providing an expansion ratio of at least 1:6) to allow the protective sleeve to sleeve over and tightly cover consecutive flat straight strip segments of the busbar longitudinally running along crossing directions and respective intermediate curved flat segments joining said flat straight strip segments, said determined transversal elasticity being provided by the closed mesh circular warp knitbraiding of the fibreglass yarns.

[0012] For a preferred embodiment, the textile sleeve is impregnated with an impregnant comprising silicone to improve its thermal stability, dielectric strength and achieve a better coupling when sleeved over the busbar.

[0013] Indeed, by means of that impregnation, the protective sleeve of the first aspect of the present invention has still a greater capability for adaptation to curved geometries, and a higher thermal and electrical resistance is achieved, protecting the busbar from thermal leaks generated, for example, in a battery connected thereto, and protecting that battery from short circuits.

[0014] For an embodiment, said impregnant is a water-based impregnant that comprises one or more emulsifying silicones and an acrylic resin.

[0015] For a variant of said embodiment, the water-based impregnant comprises between 45% and 70%, preferably between 55% and 60%, in weight of said one or more emulsifying silicones and between 15% and 40%, preferably between 22% and 27%, in weight of said acrylic resin.

[0016] According to an embodiment, the textile sleeve has been made in a knitting machine with a head with 18 needles and an E8 to E12 gauge. In this sense, it must be clarified that the diameter of the textile sleeve without impregnation is the product of the use of a head with 18 needles and an E8 to E12 gauge; this head/needle ratio comes from the formula:

$$\text{No. of needles} = ø.\pi.E$$

Where:

ø: Cylinder diameter in inches
π: 3.1416
E: Machine gauge

[0017] This head/needle ratio gives the textile sleeve a 1:6 expansion ratio.

[0018] According to an embodiment, the fibre glass yarns have a title ranging from 34/2 tex to 136/6 tex.

[0019] For an embodiment, the textile sleeve has a weight ranging from 20 g/m to 40g/m.

[0020] According to an embodiment, the textile sleeve ranges from 2 to 12 stitches/cm and from 2 to 8 wales/cm in a rest position, when not covering the busbar, and ranges from 8 to 24 stitches/cm in use, when sleeved over the busbar.

[0021] For an embodiment, the textile sleeve has a warp length ranging from 1 mm to 5 mm.

[0022] For an embodiment, the textile sleeve has an optical coverage factor ranging from 70% to 85%.

[0023] According to an embodiment, the textile sleeve has a wall thickness ranging 0.2 mm to 2 mm.

[0024] An embodiment combining the above described embodiments defining ranges for different properties of the textile sleeve is also embraced by the first aspect of the present invention.

[0025] Specifically, an embodiment combining at least the above mentioned wall thickness and weight ranges provides a protective sleeve which indeed has an even greater capability for adaptation to curved geometries and to small spaces where the busbars are installed, without the protective sleeve requiring to modify those installation spaces, as it occupies a minimum space in the compartment where the electric batteries are located.

[0026] The main advantages of the protective sleeve of the first aspect of the present invention compared to those of the prior art are: higher transversal elasticity, lighter, greater thermal stability and a higher production.

[0027] In a second aspect, the present invention relates to a method for obtaining a protective sleeve for electrically and thermally protecting an electrically conductive busbar which, in contrast to the methods known in the art, comprises closed-mesh circular warp knitbraiding fibreglass yarns to obtain the protective sleeve in the form of a textile sleeve.

[0028] For an embodiment, the method further comprises impregnating the textile sleeve with an impregnant comprising silicone.

[0029] For a variant of said embodiment, the method of the second aspect of the present invention further comprises curing said impregnant that impregnates the textile sleeve, at a temperature ranging from 150°C and 600°C during a period ranging from 15 seconds to 15 minutes.

[0030] The method of the second aspect of the present invention is applied, for some embodiments, to manufacture the protective sleeve of the first aspect of the present invention for any of its embodiments.

BRIEF DESCRIPTION OF THE FIGURES

[0031] In the following some preferred embodiments of the invention will be described with reference to the enclosed figures. They are provided only for illustration purposes without however limiting the scope of the invention.

Figure 1 schematically shows the protection sleeve of the first aspect of the present invention tightly sleeved over a busbar having different segments, including curved segments;

Figure 2 shows an enlarged portion of the textile sleeve of the first aspect of the present invention, showing its knitting structure, where the vertical arrow pointing upwards shows the direction of weaving process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] In the present section some working embodiments of the present invention will be described with reference to the Figures.

[0033] Specifically, Figure 1 shows the protection/textile sleeve S of the first aspect of the present invention tightly sleeved over and tightly covering an electrically conductive busbar B, particularly consecutive flat straight strip segments of the busbar B longitudinally running along crossing directions, indicated in the Figure by arrows X, Y, and Z, and also along intermediate curved flat segments joining the flat straight strip segments. The high transversal elasticity of the sleeve S provided by the circular warp knit braiding of the fibreglass yarns makes it suitable to be sleeved over busbars B with such varying geometry, i.e. including several and different curved segments.

[0034] Figure 2 shows the knitting structure used to knit the fiberglass yarns to manufacture the textile sleeve S, particularly a closed mesh circular warp knitbraided structure. As shown in that Figure, the textile sleeve meshes are

formed vertically in a closed manner, and joined to each other between adjacent passes, so that diagonal and vertical connections are provided, providing a property to the so knitted sleeve that makes it difficult to unravel.

[0035] The choice of this type of knitting structure is mainly due to the above mentioned transversal elasticity offered thereby, which makes the sleeve S able to elastically deform to expand and contract when being sleeved over the busbar B, even along busbar segments with complex radii of curvature, as shown in Figure 1.

[0036] The present inventors have manufactured a prototype of the protective sleeve S, impregnating the textile sleeve with a water-based impregnation that is composed of emulsifying silicones, acrylic resins and a portion of pigmentation that provides the final colour to the textile element, particularly with the following composition:

• Transparent emulsifying silicones (58.3%)

- ◦ Appearance: viscous liquid
- ◦ Colour: translucent white
- ◦ Odour: slight
- ◦ Initial boiling point and range:> 65 ° C @ 760 mm Hg
- ◦ Flash point:> 100 ° C Pensky-Martens Closed Cup
- ◦ Relative density: 1.10
- ◦ Viscosity: 44000 cSt @ 25°C

• Acrylic resin (25.3%)

- ◦ Appearance: White or whitish, opaque liquid
- ◦ pH: 5.50 - 7.50

• Pigment (16.4%)

◦ Appearance 20 / 25°C: Orange pigment dispersion

◦ Fastness. See table below:

Xenotest 100 h		**60°C Wash**	**Perchloroethylene Dry Wash**		**Rubbing**	
					Dry	**Wet**
30 g/kg	1/10	30 g/kg	30 g/kg	1/10	30 g/kg	
7	4-5	5	4	4	4	3-4
ZN* Reducer Stability		**Migration into PVC**				
30 g/kg		30 g/kg				
3-4		3-4				

[0037] The manufactured prototype has the following properties:

- Wall thickness: 0.82mm
- Weight: 28.32 g/m
- Sleeve diameter: 10mm
- N° of Stitches: 12

[0038] The prototype has been submitted to essays, obtaining the following values:

- ◦ Heat resistance test at 500°C for 5 min - Passed
- ◦ Heat resistance test at 600°C for 10min - Passed
- ◦ Dielectric strength test: Passed with values of 0.7 kV

[0039] The dielectric strength test has not been carried out on a gauge but directly on the busbar B to be sheathed. Once the busbar B is sheathed with the protective sleeve S, a part of this sheathed busbar B is wrapped in silver foil and the ends of the busbar B are placed in the vortices of the measuring device and then the test is started, providing the above identified results.

[0040] A person skilled in the art could introduce changes and modifications in the embodiments described without departing from the scope of the invention as it is defined in the attached claims.

Claims

1. A protective sleeve (S) for electrically and thermally protecting an electrically conductive busbar (B), **characterized in that** said protective sleeve (S) is a textile sleeve made of closed-mesh circular warp knitbraided fibreglass yarns.

2. The protective sleeve (S) according to claim 1, wherein said textile sleeve is impregnated with an impregnant comprising silicone.

3. The protective sleeve (S) according to claim 2, wherein said impregnant is a water-based impregnant that comprises one or more emulsifying silicones and an acrylic resin.

4. The protective sleeve (S) according to claim 3, wherein the water-based impregnant comprises between 45% and 70%, preferably between 55% and 60%, in weight of said one or more emulsifying silicones and between 15% and 40%, preferably between 22% and 27%, in weight of said acrylic resin.

5. The protective sleeve (S) according to any of the previous claims, wherein the protective sleeve (S) is dimensioned and has a determined transversal elasticity to allow the protective sleeve (S) to sleeve over and tightly cover consecutive flat straight strip segments of the busbar (B) longitudinally running along crossing directions (X, Y; X, Z; Y, Z) and respective intermediate curved flat segments joining said flat straight strip segments, said determined transversal elasticity being provided by the circular warp knit braiding of the fibreglass yarns.

6. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve has been made in a knitting machine with a head with 18 needles and an E8 to E12 gauge.

7. The protective sleeve (S) according to any of the previous claims, wherein the fibre glass yarns have a title ranging from 34/2 tex to 136/6 tex.

8. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve has a weight ranging from 20 g/m to 40 g/m.

9. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve ranges from 2 to 12 stitches/cm and from 2 to 8 wales/cm in a rest position, when not covering the busbar, and ranges from 8 to 24 stitches/cm in use, when sleeved over the busbar.

10. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve has a warp length ranging from 1 mm to 5 mm.

11. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve has an optical coverage factor ranging from 70% to 85%.

12. The protective sleeve (S) according to any of the previous claims, wherein the textile sleeve has a wall thickness ranging 0.2 mm to 2 mm.

13. A method for obtaining a protective sleeve (S) for electrically and thermally protecting an electrically conductive busbar (B), **characterized in that** said method comprising closed-mesh circular warp knitbraiding fibreglass yarns to obtain the protective sleeve (S) in the form of a textile sleeve.

14. The method according to claim 13, further comprising impregnating said textile sleeve with an impregnant comprising silicone.

15. The method according to claim 14, further comprising curing said impregnant that impregnates the textile sleeve, at a temperature ranging from 150°C and 600°C during a period ranging from 15 seconds to 15 minutes.

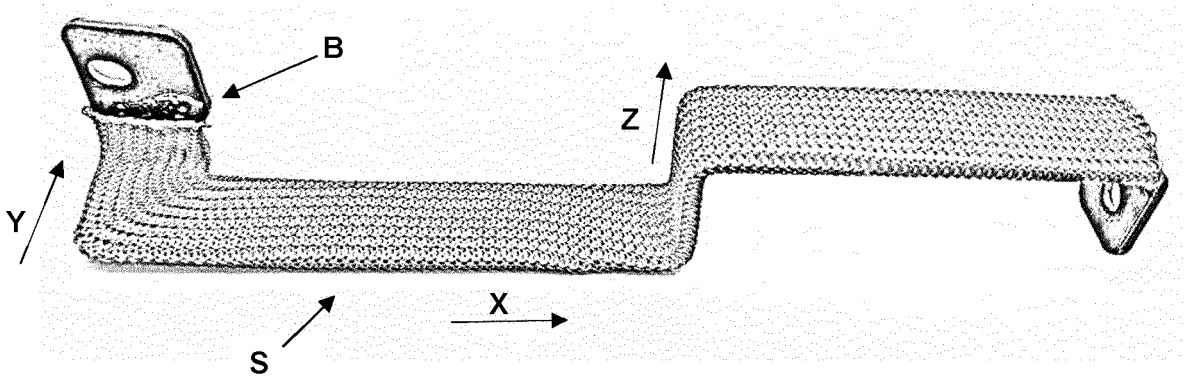

Fig. 1

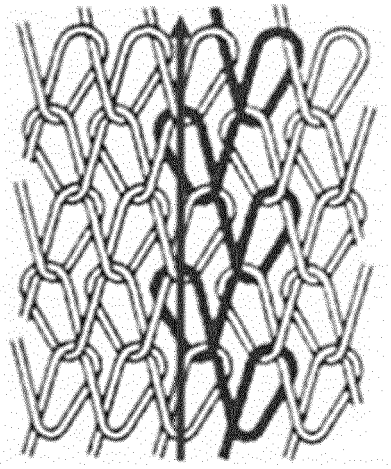

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 20 38 3044

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 May 2021	Sterle, Dieter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 38 3044

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- CN 105957591 B **[0005] [0006]**