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(71) Applicant: **ABB SCHWEIZ AG**
5400 Baden (CH)

(72) Inventors:
- **VIERTEL, Julia**
  Västerås (SE)
- **ZHAO, Su**
  Västerås (SE)
- **JOHANSSON, Erik**
  Västerås (SE)
- **PAULSSON, Göran**
  Västerås (SE)

(74) Representative: **Kransell & Wennborg KB**
P.O. Box 27834
115 93 Stockholm (SE)

(54) **SLIP RING UNIT**

(57) A slip ring unit (1-1) comprising: a slip ring (5-1), and a brush (3-1), wherein one of the slip ring (5-1) and the brush (3-1) comprises a composite material comprising graphene and metal, wherein the graphene content is in a range 0.1-5 wt.% and the metal content is at least 90 wt.% of the total weight of the composite material.

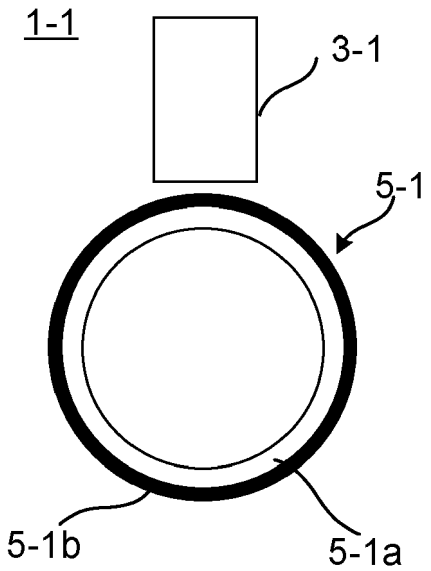

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present disclosure generally relates to slip ring units.

BACKGROUND

[0002] Slip ring units are used for conducting current to or from the rotating shaft of electrical machines. Slip ring units comprise a slip ring, typically made of copper, bronze or stainless steel and a carbon brush as the counterpart, typically made of graphite or a metal-graphite blend.

[0003] The slip ring is mounted to the rotor shaft while the carbon brush is stationary. The carbon brush is pressed to the slip ring surface by a spring to ensure good electrical contact.

[0004] The graphite has two functions. The first is to provide sufficient conductivity to transfer the needed current to the slip ring and the second is to act as a solid lubricant to provide low friction to keep the slip ring intact.

[0005] The main drawback of existing carbon brushes is that they wear out over time and need to be replaced to ensure proper functionality. Depending on the application carbon brushes usually need to be replaced every 6 to 12 months, generating high maintenance costs during the entire lifetime of electrical machines.

[0006] Moreover, due to the wear of the carbon brush, carbon dust is created, which can lead to clogging or electrical bridging for example.

[0007] CN109524866 aims to solve issues with abrasion and prolonging the service life of motors. This document discloses a graphene and nano-fibre reinforced copper-based graphite motor carbon brush. The carbon brush of CN109524866 contains graphite, which is thus subjected to wear.

SUMMARY

[0008] A general object of the present disclosure is to provide a slip ring unit that solves or at least mitigates the problems of the prior art.

[0009] There is hence provided a slip ring unit comprising: a slip ring, and a brush, wherein one of the slip ring and the brush comprises a composite material comprising graphene and metal, wherein the graphene content is in a range 0.1-5 wt.% and the metal content is at least 90 wt.% of the total weight of the composite material.

[0010] With an amount of graphene in the range 0.1-5 wt.% in the composite material contained in the slip ring or brush, low friction can be maintained while wear can be drastically reduced. Moreover, the electrical conductivity of the metal is not altered due to the outstanding electrical properties of graphene and is improved compared to carbon brushes containing graphite. The electric conductivity of graphene is higher than that of copper and on the same level as silver. Further, dust creation is reduced and thus the risk of clogging and/or short circuiting may be reduced or avoided.

[0011] It has further been found that if a higher amount than about 5 wt.% of graphene is employed, the electrical conductivity starts to decrease, probably due to that the graphene start to form graphite.

[0012] Herein the term graphene is used collectively for carbon atoms in a 2D-lattice in the form of mono-layer sheets, bi-layer sheets, few (3-5 layers)-layer sheets, or nano-platelets having a thickness of at most 50 nm, e.g. within the range of 1 to 50 nm. Also, when graphene is discussed herein, it should be understood, that some of the graphene may be in the form of graphene oxide (GO) or reduced Graphene Oxide (rGO). Thus, the graphene may comprise only pure graphene or a mixture of pure graphene and GO/rGO.

[0013] According to one embodiment the graphene content is in the range 0.1-2 wt.%.

[0014] According to one embodiment the graphene content is in the range 0.1-0.5 wt.%.

[0015] According to one embodiment the metal content is at least 95 wt.%.

[0016] According to one embodiment the metal content is in a range of 99.9-95 wt.%.

[0017] According to one embodiment the slip ring or the brush which comprises the composite material comprises a metal carrier, wherein the composite material is provided as a coating on the metal carrier.

[0018] The coating may for example be performed by electroplating, cold spraying, or thermal spraying.

[0019] The metal carrier may for example be copper, silver, bronze, or stainless steel.

[0020] According to one embodiment the composite material is a bulk material.

[0021] The bulk material forms a rigid body.

[0022] The metal and the graphene may be mixed homogeneously in the bulk material.

[0023] The bulk material may be prepared via powder metallurgy, by mixing metal powder with graphene followed by consolidation into the bulk. By use of electroless deposition technique, the graphene flakes can be covered with metal prior to mixing. The consolidation can be achieved for instance by sintering, either in a conventional or a microwave oven, with spark plasma or by hot-pressing.

[0024] According to one embodiment the slip ring comprises the composite material and the brush consists of metal.

[0025] Low-friction and wear-limiting properties are thus provided by the slip ring, which do thus not have to be provided by the brush. The material of the brush can thus be free of graphite and/or carbon black. The metal of the brush may for example be copper or silver. This leads to a substantially extended lifetime of the brush.

[0026] According to one embodiment the brush comprises the composite material and the slip ring consists of metal.

[0027] According to one embodiment the metal is one of copper, silver, bronze, or stainless steel.

[0028] According to one embodiment the composite material is free of graphite.

[0029] According to one embodiment the composite material is free of carbon black.

[0030] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, etc. are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, etc., unless explicitly stated otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The specific embodiments of the inventive concept will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 schematically shows a cross-sectional view of a first example of a slip ring unit;

Fig. 2 schematically shows a cross-sectional view of a second example of a slip ring unit;

Fig. 3 schematically shows a cross-sectional view of a third example of a slip ring unit;

Fig. 4 schematically shows a cross-sectional view of a fourth example of a slip ring unit;

Fig. 5 schematically shows a cross-sectional view of a fifth example of a slip ring unit; and

Fig. 6 schematically shows a cross-sectional view of a sixth example of a slip ring unit.

DETAILED DESCRIPTION

[0032] The inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplifying embodiments are shown. The inventive concept may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those skilled in the art. Like numbers refer to like elements throughout the description.

[0033] Various examples of a slip ring unit will be described in the following. The slip ring unit comprises a brush and a slip ring. The slip ring is configured to be arranged on a rotating member such as a rotor shaft of an electrical machine. The brush is configured to be arranged stationary relative to the slip ring. The brush may for example be arranged fixed to a stationary part of an electrical machine. The brush is arranged in mechanical contact with the slip ring.

[0034] One of the brush and the slip ring, or both the brush and the slip ring, comprises a composite material comprising graphene and metal. The graphene content is in a range 0.1-5 wt.% of the total weight of the composite material and the metal content is at least 90 wt.% of the total weight of the composite material.

[0035] The composite material may according to one example consist of graphene and metal. Thus, when the graphene content is in the range of 0.1-5 wt.%, such as 0.1-2 wt.%, such as 0.1-0.5 wt.%, metal may make up the rest of the composite material.

[0036] The composite material may optionally for example comprise a binder, but it is not necessary.

[0037] The composite material is preferably free of carbon black and graphite.

[0038] If the brush comprises the composite material, the composite material of the brush is in mechanical contact with the slip ring. The composite material forms the contact interface of the brush against the slip ring.

[0039] If the slip ring comprises the composite material, the composite material of the slip ring is in mechanical contact with the brush. The composite material forms the contact interface of the slip ring against the brush.

[0040] The composite material may be in the form of a bulk material comprising the graphene and metal. The metal may for example be copper, silver, bronze, or stainless steel. The bulk material may form the entire or only part of the brush.

[0041] Alternatively, the brush or slip ring may comprise a metal carrier provided with a coating of the composite material. The metal carrier may for example be copper, silver, bronze, or stainless steel.

[0042] Examples of slip ring units will now be described with reference to Figs 1-6.

[0043] Fig. 1 shows a slip ring unit 1-1 comprising a brush 3-1 and a slip ring 5-1. The brush 3-1 consists of metal such as copper, silver, bronze, or stainless steel. The slip ring 5-1 comprises a metal carrier 5-1a made of for example copper, silver, bronze, or stainless steel. The slip ring 5-1 comprises the composite material in the form of a coating 5-1b provided on the outer surface of the metal carrier 5-1a. The coating is provided along the entire circumference of the metal carrier 5-1a. The brush 3-1 is in mechanical contact with the coating 5-1b.

[0044] Fig. 2 shows a slip ring unit 1-2 comprising a brush 3-2 and the slip ring 5-1. The brush 3-2 comprises a metal carrier 3-2a made of for example copper, silver, bronze, or stainless steel. The brush 3-2 comprises the composite material in the form of a coating 3-2b provided on the outer surface of the metal carrier 3-1a facing the slip ring 5-1. The coating 3-2b is thus in mechanical contact with the slip ring 5-1. In this example the two coatings 5-1b and 3-2b are in mechanical contact with each other.

[0045] Fig. 3 shows a slip ring unit 1-3 comprising a brush 3-3 and the slip ring 5-1. The brush 3-3 comprises bulk material 3-3a made of the composite material.

[0046] Fig. 4 shows a slip ring unit 1-4 comprising the brush 3-2 and a slip ring 5-2. The slip ring 5-2 consists of metal such as copper, silver, bronze, or stainless steel. Thus, in this example, the slip ring 5-2 has an outer surface consisting of metal. The coating 3-2b of the brush 3-2 is in mechanical contact with the outer surface of the slip ring 5-2.

[0047] Fig. 5 shows a slip ring unit 1-5 comprising the brush 3-3 and the slip ring 5-2.

[0048] Fig. 6 shows a slip ring unit 1-6 comprising a brush 3-4 and the slip ring 5-2. The brush 3-4 comprises a metal carrier 3-4a made of for example copper, silver, bronze, or stainless steel. The brush 3-4 comprises a tip of bulk material 3-4b made of the composite material. The tip of bulk material 3-4b is mechanically integrated with the metal carrier 3-4a. The tip of bulk material 3-4b is in mechanical contact with the slip ring 5-2.

[0049] According to some variations, the slip ring may be made of a bulk material consisting of the composite material. The brush may in this case be any of the brushes 3-1 to 3-4.

[0050] The inventive concept has mainly been described above with reference to a few examples. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the inventive concept, as defined by the appended claims.

Claims

1. A slip ring unit (1-1; 1-2; 1-3; 1-4; 1-5; 1-6) comprising:

   a slip ring (5-1, 5-2), and
   a brush (3-1, 3-2, 3-3, 3-4),
   wherein one of the slip ring and the brush comprises a composite material comprising graphene and metal, wherein the graphene content is in a range 0.1-5 wt.% and the metal content is at least 90 wt.% of the total weight of the composite material.

2. The slip ring unit (1-1; 1-2; 1-3; 1-4; 1-5; 1-6) as claimed in claim 1, wherein the graphene content is in the range 0.1-2 wt.%.

3. The slip ring unit (1-1; 1-2; 1-3; 1-4; 1-5; 1-6) as claimed in claim 1 or 2, wherein the graphene content is in the range 0.1-0.5 wt.%

4. The slip ring unit (1-1; 1-2; 1-3; 1-4; 1-5; 1-6) as claimed in any of the preceding claims, wherein the metal content is at least 95 wt.%.

5. The slip ring unit (1-1; 1-2; 1-3; 1-4; 1-5; 1-6) as claimed in any of the preceding claims, wherein the metal content is in a range of 99.9-95 wt.%.

6. The slip ring unit (1-1; 1-2; 1-3; 1-4) as claimed in any of the preceding claims, wherein the slip ring (5-1) or the brush (3-2) which comprises the composite material comprises a metal carrier (5-1a, 3-2a), wherein the composite material is provided as a coating (5-1b, 3-2b) on the metal carrier (5-ia, 3-2a).

7. The slip ring unit (1-3; 1-5; 1-6) as claimed in any of claims 1-5, wherein the composite material is a bulk material (3-3a; 3-4b).

8. The slip ring unit (1-3) as claimed in any of the preceding claims, wherein the slip ring (5-1) comprises the composite material and the brush consists of metal.

9. The slip ring unit (1-4; 1-5; 1-6) as claimed in any of claims 1-7, wherein the brush (3-2; 3-3; 3-4) comprises the composite material and the slip ring (5-2) consists of metal.

10. The slip ring unit as claimed in any of the preceding claims, wherein the metal is one of copper, silver, bronze, or stainless steel.

11. The slip ring unit (1-1; 1-2; 1-3; 1-4) as claimed in any of the preceding claims, wherein the composite material is free of graphite.

12. The slip ring unit (1-1; 1-2; 1-3; 1-4) as claimed in any of the preceding claims, wherein the composite material is free of carbon black.

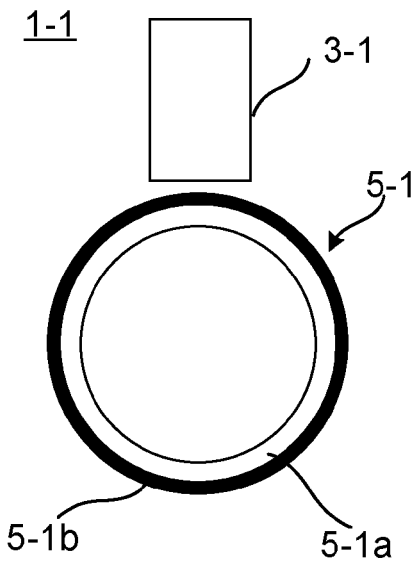

Fig. 1

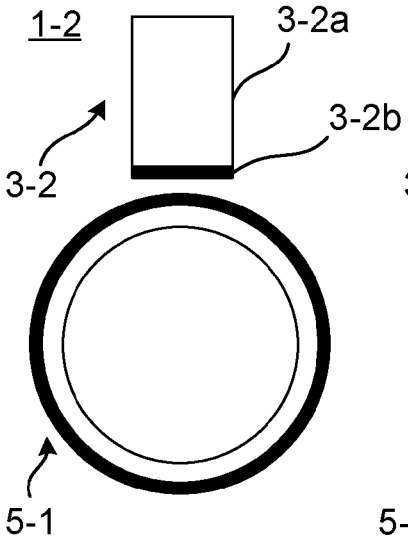

Fig. 2

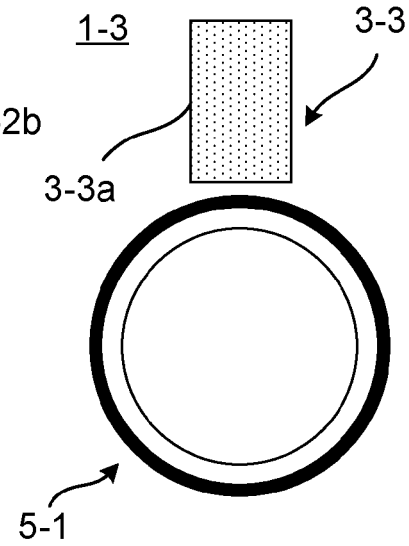

Fig. 3

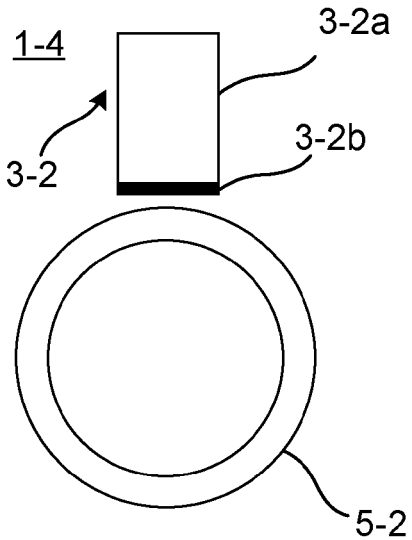

Fig. 4

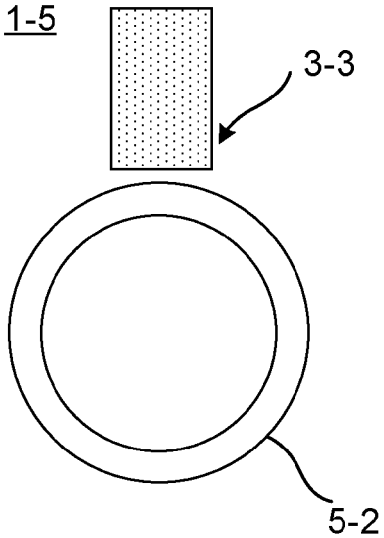

Fig. 5

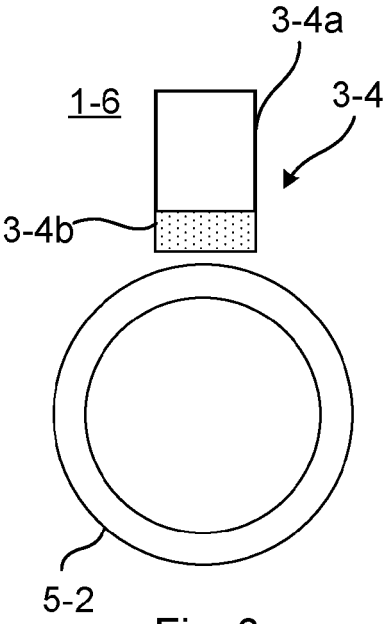

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 6420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 838 166 A1 (SCHLEIFRING UND APPBAU GMBH [DE]) 18 February 2015 (2015-02-18) * paragraphs [0014] - [0024], [0027] - [0030]; figures 1-4 *	1-6,8-12	INV. H01R39/08 H01R39/22 H01R39/56
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A	CN 103 952 588 A (UNIV JIANGXI SCI & TECHNOLOGY) 30 July 2014 (2014-07-30) * the whole document *	1-12	

TECHNICAL FIELDS SEARCHED (IPC)

H01R
H01B
C22C
H01H
B22F

2 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 December 2021	López García, Raquel

CATEGORY OF CITED DOCUMENTS

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

REFERENCES CITED IN THE DESCRIPTION

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