ORIGINAL

ABSTRACT

COMMUTATOR FOR POWER TRANSMISSION IN AN ELECTRIC MACHINE

Described herein is a commutator (1) for power transmission in an electric machine. The commutator (1) includes an armature-side collector (2) and at least one brush (3) contacting the collector (2). Further, at least one current carrying component (2, 3) of the commutator (1) is configured as a porous ceramic body having infiltrated metal (P-MMC).

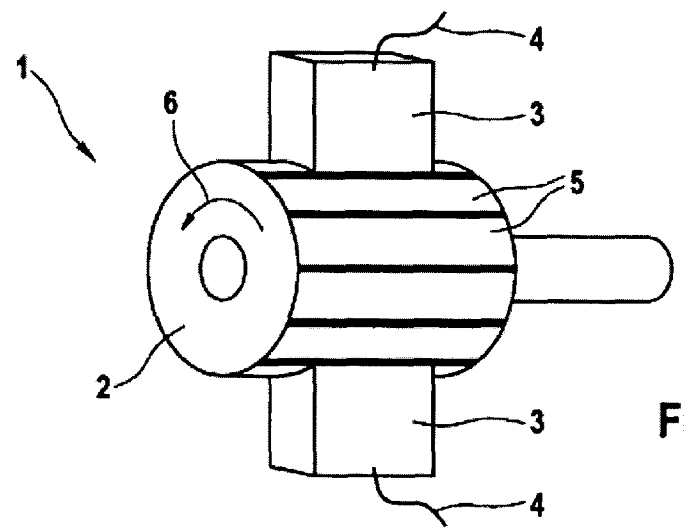

FIG. 1

I/We claim:

1. A commutator (1) for power transmission in an electric machine; comprising:

    an armature-side collector (2); and

    at least one brush (3) contacting the collector (2);

    characterized in that,

    at least one current carrying component (2, 3) of the commutator (1) is configured as a porous ceramic body having infiltrated metal (P-MMC).

2. The commutator (1) as claimed in claim 1, wherein the at least one brush (3) is made from the ceramic body having infiltrated metal.

3. The commutator (1) as claimed in claim 2, wherein a brush plate (7) of the brush (3) is formed by a surrounding cast, and wherein the surrounding cast is present during moulding process of metal in the ceramic body.

4. The commutator (1) as claimed in one of the preceding claims 1 to 3, wherein the collector (2) is formed at least partially as a ceramic body having infiltrated metal.

5. The commutator (1) as claimed in claim 4, wherein a core (11) of the collector (2) is formed as a ceramic insulator, and wherein the core (11) is a carrier of segments (5) that are formed as ceramic body with infiltrated metal.

6. The commutator (1) as claimed in one of the preceding claims 1 to 5, wherein the current carrying component (2, 3) of the commutator (1) comprises at least two layers (8, 9) having a differing metal-/ceramic part in the metal-ceramic composite material.

7. The commutator (1) as claimed in one of the claim 2 and 6, wherein the at least one brush (3) comprises two layers (8, 9) having different metal content, and the forward layer, based on the relative movement between the collector (2) and the brush (3), as a power

layer (8) comprises a higher metal part than the rear mounted layer that forms a commutator layer (9).

8. The commutator (1) as claimed in claim 7, wherein the power layer (8) comprises a greater contact cross-section than the commutator layer (9), and wherein the at least one brush (3) is provided in contact with the collector (2) using the contact cross-section.

9. The commutator (1) as claimed in one of the claim 2, 4 and 7, wherein the metal part, in the collector (2), comprises at least approximately same metal part as the power layer (8) in the at least one brush (3).

10. The commutator (1) as claimed in one of the claim 2, 4 and 7, wherein the metal part in the collector (2) is greater than the proproportion of metal in the commutator layer (9) in the brush (3).

11. The commutator (1) as claimed in one of preceding claims 1 to 10, wherein the ceramic component comprises oxides, nitrides or carbides.

12. The commutator (1) as claimed in one of preceding claims 1 to 11, wherein the metal component comprises copper or a copper alloy.

13. An electric machine comprising a commutator (1) as claimed in one of preceding claims 1 to 12.

Dated this 16th day of March 2012

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To
The Controller of Patents
The Patent Office at New Delhi

Applicant(s) Name: **ROBERT BOSCH GmbH**

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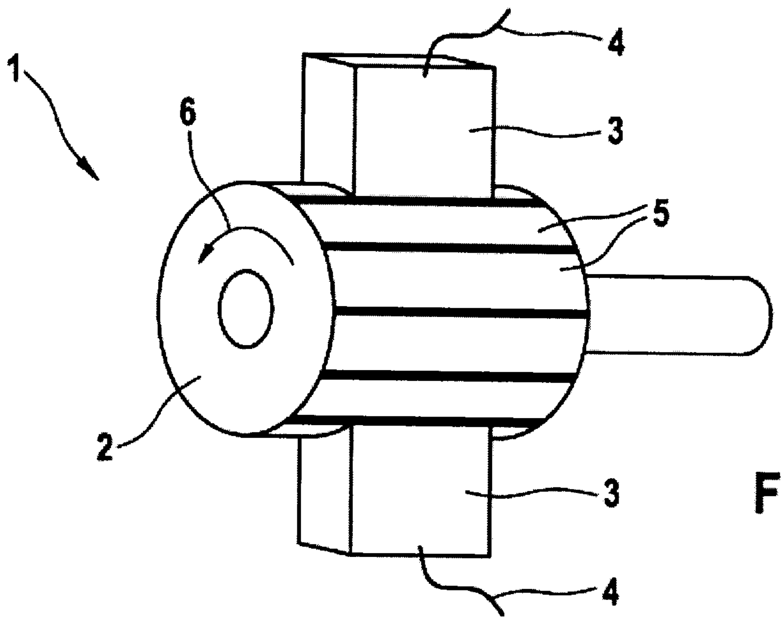

FIG. 1

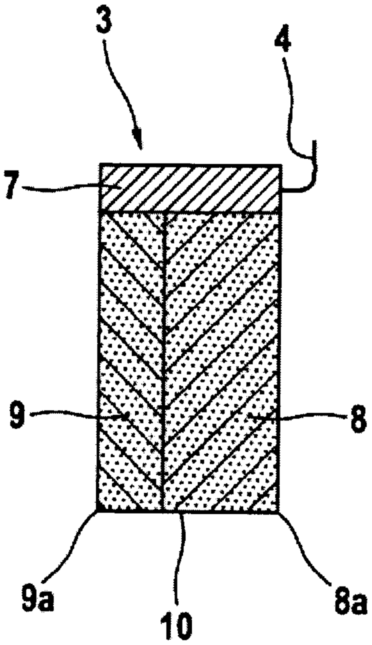

FIG. 2

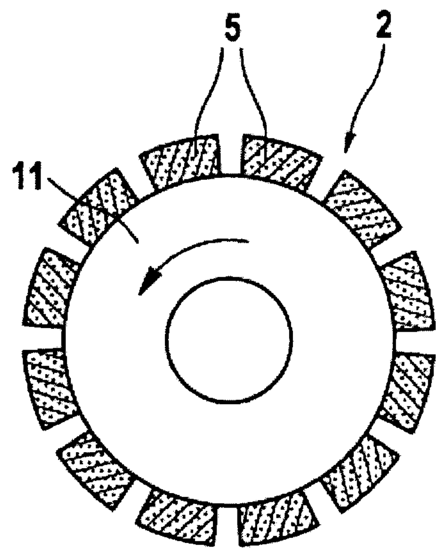

FIG. 3

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TECHNICAL FIELD

The present subject matter relates to a commutator for power transmission in an electric machine.

BACKGROUND

Commutators are used for power transmission to an armature rotatably mounted in a stator and for commutation in short-circuited armature coils. The commutators consist of an armature-side collector and carbon brushes provided at the collector. The housing-fixed carbon brushes are provided on a lateral surface of the rotating collector. The material composition of the commutator component has a substantial influence on the power transmission rate from the carbon brush to the collector and on the wear, in particular of the carbon brush.

A metal-filled carbon brush for a small motor is known from document DE 40 25 367 C2, where the metal-filled carbon brush is designed as a sintered component and includes a purified graphite powder. The purified graphite powder is mixed, compressed, moulded and sintered subsequently with the metal powders.

SUMMARY

This summary is provided to introduce concepts related to a commutator for power transmission in an electric machine and the concepts are further described below in the detailed description. This summary is neither intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one embodiment, the subject matter describes a commutator for power transmission in an electric machine. The commutator includes an armature-side collector and at least one brush contacting the collector. Further, at least one current carrying component of the commutator is configured as a porous ceramic body having infiltrated metal.

BRIEF DESCRIPTION OF THE FIGURES

Further advantages and embodiments of the present subject matter are evident from further claims, the description and the figures. The figures show:

Fig. 1 shows a perspective view of a commutator in an electric machine, including an armature-sided collector and two diametrically opposite brushes contacting the collector lateral surface.

Fig. 2 shows a section through a brush including a metal brush plate and two layers, where each layer includes a metal-ceramic composite material and are configured as a porous ceramic body with infiltrated metal.

Fig. 3 shows a section through the collector, where segments of the collector are also configured as a porous ceramic body with infiltrated metal.

DETAILED DESCRIPTION

An object of the present subject matter is to configure a commutator in an electric machine in such a way that the electric machine ensures a high power transmission and a long life.

The object of the present subject matter is achieved with the features of claim 1. The dependent claims describe advantageous embodiments of the present subject matter.

The commutator of the present subject matter is used for power transmission (also referred as current transmission) and commutation in electrical machines, especially in electric motors. Both, an application in direct current motor (DC motor) and in alternating current motor (AC motor) are considered. For example, such commutators are used in DC starter motors for internal combustion engines. The DC starter motors are used either as electrical or permanently excited motors and are used both for gasoline engines and for diesel engines. For example, start-stop systems for internal combustion engines or an application as electric machine in hybrid vehicles are also considered. Other possible uses include electrical drives, in particular as a servomotor in vehicles, for example, for engine cooling, air conditioning, or as windshield wiper motor of the vehicle. In addition, an application in electric motors for power tools is possible. A use in slip ring asynchronous motors and alternators with high robustness and long life is also possible.

The commutator includes an armature-side collector that is coupled to the armature of the electric machine, and at least one brush fixed on the housing is applied to the collector. The current is transmitted to the collector for energization of armature coils via the brush. At least one current carrying component of the commutator is configured as a porous ceramic body having infiltrated metal. The porous ceramic body is a preform (preform) that is infiltrated with molten metal, for example, using a gas pressure infiltration or using a squeeze cast technology during the manufacturing process. The current carrying component of the commutator configured in this manner thus includes a metal-ceramic composite material that is configured as perform based material (P-MMC) or is produced in this manner.

The ceramic proportion in the composite material ensures high wear and corrosion resistance, in addition, a high temperature resistance is also achieved (up to 800 °C using copper (Cu) as a metal component). The ceramic component reduces friction during the relative movement between the brush and surface of the commutator, so that the wear resistance is increased.

Another advantage of the embodiment of the present subject matter is that relatively large parts with complex geometries and completely free of cracks are infiltrated with the metal. Thus, both the brushes and the collector are manufactured with the desired geometry.

According to an embodiment, in the commutator of the present subject matter at least one commutator component - one or more brushes and / or the collector – are manufactured from the metal-ceramic composite material having the porous ceramic body with infiltrated metal. Variants of the embodiment where only brushes, or only the collector or both the brushes and the collector manufactured from the metal-ceramic composite material are also considered. In case where both the brushes and the collector are made of composite material, same composite materials and different composite materials are used for the brushes and the collector or same or different mixing ratios of ceramic to metal proportions are used.

Oxides, nitrides or carbides, such as Al_20_3, AlN, TiN, Si_3N_4, SiC or silicon infiltrated SiC are considered as a ceramic component. Particularly, highly conductive materials, such as copper or copper alloys, but also silver, gold, aluminum, iron, tin and their alloys are also used as metal components. In addition, if required, lubricants and abrasives can be added.

The composite material configured as a porous ceramic body with infiltrated metal, due to three-dimensional network structure of the structural components, in addition to wear, temperature and corrosion resistance that slumps to the ceramic component also includes a high electrical and thermal conductivity. Specific electrical resistances are generated between approximately 0.05 μΩm and 10^{15} Ωm by variation of ceramic proportion.

It may be evident to manufacture the brush having a plurality of functional layers that are manufactured as a metal-ceramic composite material includes different metal or ceramic proportions. The transition between the functional layers can either be discrete or continuous. The brush is configured, for example, with two layers with different metal proportion. The layer, provided in front in relative movement direction, configured as a power layer has a higher metal proportion and a higher power transmission rate than the layer provided in rear, in relative movement direction, configured as commutator layer. The comparatively higher ceramic proportion in the commutator layer allows the commutation through a high tangential resistance and reduces the spark formation present at the continuous edge of the brush.

For a high power transmission rate, it is suitable that the power layer having a higher metal proportion in relation to commutator layer includes a greater contact cross-section, in particular a greater thickness provided in the movement direction, and possibly also a greater width transversely to the movement direction. The greater contact area of the power layer allows higher power transmission rates.

Further, the collector manufactured from a composite material having a relatively high proportion of metal is suitable as the collector having relatively high proportion of metal allows a high power transmission rate. The composite material from which the collector is manufactured, may be at least configured similar to the composite material of the power layer in the brush, but having a higher metal proportion than the commutator layer.

According to another embodiment of the present subject matter, the core of the collector is sealed ceramic insulator. For this purpose, the ceramic preform is configured such that the later continuous surfaces of the collector are composed from an arbitrary composition of metal and ceramic. Different mixing ratios of ceramic to metal proportion are used axially along the segments of the collector to produce the electrical contact for the armature winding.

Further, it may be suitable to use a manufacture related surrounding cast on the brush as brush plate. The electrical contacting is carried out using a rigid or flexible electrical conductor (for example wire) via the brush plate. The surrounding cast provides a layer at least partially covering the surface of the ceramic body. The covering layer may be used as a base plate for holding and contacting of the layers in the brush.

A commutator 1 shown in Fig. 1 is used for power transmission and commutation in electrical machines such as electric motors or generators. The commutator 1 includes a cylindrical collector 2 connected to the armature of the electric machine in a torque proof manner, where the armature is mounted rotatably in a stator, and brushes 3 that are provided radially outside on lateral surface of the cylindrical collector 2 or on the layer bearing surface to contact and transfer current to the collector 2. The current is conducted via a wire 4 into the brushes 3. The collector 2 may optionally also be designed disc-shaped. Other contacts, such as for example metal bands or pressure springs are also possible. In Fig. 1, the commutator 1 includes two diametrically opposite brushes 3. The commutators having larger brush number, for example commutators having four or six brushes are also considered.

The collector 2 has a plurality of single segments 5 separated in the circumferential direction. The segments 5 are electrically connected to armature coils. During a rotational movement of the armature or of the collector 2 in the rotational direction 6, the current is transmitted from the brushes 3 to the segments 5 of the collector 2 along the lateral surface of the collector 2 to the facing end face of the brush 3 simultaneously.

Fig. 2 shows a section through a brush 3. The current supply via the wire 4 or a similar contact is carried out if appropriate in a brush plate 7, where the brush plate 7 is a base plate and the brush plate 7 is connected to two layers 8 and 9 of the brush 3. The two layers 8 and 9 are configured as power layer 8 and commutator layer 9. Based on the relative movement between the collector 2 and the brush 3, the power layer is 8 provided in front and the commutator layer 9 is provided in rear. Further, the tapered edge (front edge) of the brush 3 is designated with 8a and the trailing edge (rear edge) designates with the 9a. During the relative movement between the brush 3 and the collector 2, the power layer 8 is provided in front of the commutator layer 9 in contact with the next segment 5 on the collector 2. The end face contact surface of the brush 3 is provided with reference numeral 10. The brush 3 is in contact with the lateral surface of the collector 2.

Both layers 8 and 9 of the brush 3 include a metal-ceramic composite material and are configured as a porous ceramic body having infiltrated metal (preform-based metal matrix composites - P-MMC). Porous ceramic preform (preform) is infiltrated preferably using pressure assisted gas pressure infiltration or using squeeze cast technology with molten metal. Conveniently, the front power layer 8 has a larger contact area than the rear mounted commutator layer 9, so that in region of the end face contact surface 10, the power layer 8 contacts the lateral surface of the collector 2 over a greater area than the commutator layer 9. The larger contact cross-section is achieved, particularly by increasing the width or thickness of the power layer 8, measured during the relative movement. In the embodiment of the present subject matter, the thickness of the power layer 8 is about twice as large as the thickness of the commutator layer 9.

The brush plate 7 is configured as surrounding cast, wherein the electrical contact is carried out using the brush plate 7 using the wire 4 or other contacting. The surrounding cast is obtained during the casting process during the introduction of the molten metal into the porous ceramic preform. The surrounding cast is a metal layer on the ceramic body towards outside and includes the same material as that of the metal introduced into the ceramic body. Oxides, nitrides or carbides are used as a ceramic component, copper or a copper alloy is used preferably as metal. Other highly conductive metals such as silver, gold, aluminum, iron, tin and alloys are suitable as a metal component.

The power layer 8 and commutator layer 9 differ in terms of ceramic or metal proportions. The power layer 8 has a higher metal proportion than the commutator layer 9 that improves the electrical conductivity of the power layer 8. Simultaneously, the commutator layer 9 due to the higher proportion of ceramics is highly wear-resistant and heat resistant. In addition, the sparks in the area of trailing edge 9a is reduced due to the higher ceramic proportion.

Fig. 3 shows the sectional view of the collector 2. The segments 5 on the outer side of the collector 2 are also made from a metal-ceramic composite material in form of a porous ceramic body having infiltrated metal (P-MMC). The segments 5 on the outer side of the collector 5 are separated from each other in the circumferential direction.