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(54) Title: OVERMOLDED ROTOR INSULATION FOR A ROTOR BASE BODY OF A ROTOR OF AN ELECTRIC MACHINE

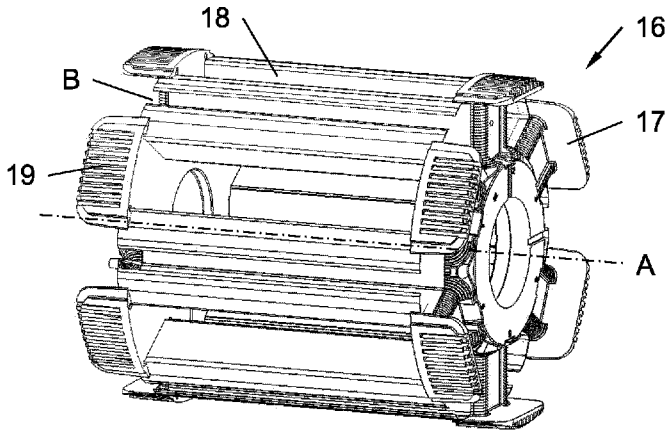

Fig. 2

(57) Abstract: A rotor base body (3, 3a, 3a', 3a") for a rotor (2, 2a) of an electric machine (1) is disclosed, which comprises a rotor lamination pack (5, 5a) with a first front face (C1) and a second front face (C2) as well as grooves (D) running in-between. Moreover, the rotor base body (3, 3a, 3a', 3a") comprises a rotor insulation (16) with a first star shaped front insulation (17) arranged on the first front face (C1), a second star shaped front insulation (19) arranged on the second front face (C2) and insulation profiles (18) arranged in the grooves (D), wherein each insulation profile (20) has a hollow cross section with a radial opening (B). The rotor insulation (16) is overmolded on the rotor lamination pack (5, 5a). Moreover, a rotor (2, 2a) with such a rotor base body (3, 3a, 3a', 3a"), an electric machine (1) with such a rotor (2, 2a) and an electric vehicle (27) with such an electric machine (1) is disclosed. Finally, a method of manufacturing a such rotor base body (3, 3a, 3a', 3a") is disclosed.

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Overmolded rotor insulation for a rotor base body of a rotor of an electric machine

TECHNICAL FIELD

The invention relates to a rotor base body for a rotor of an electric machine, which comprises a rotor lamination pack with a plurality of stacked rotor laminations and a rotor insulation. The rotor lamination pack comprises a first front face and a second front face as well as grooves running in axial direction from the first front face to the second front face. The rotor insulation comprises a first star shaped front insulation arranged on the first front face of the rotor lamination pack, a second star shaped front insulation arranged on the second front face of the rotor lamination pack, and insulation profiles arranged in the grooves of the rotor lamination pack, wherein the insulation profiles each have a hollow cross section with a radial opening. Moreover, the invention relates to a rotor for an electric machine, which comprises a rotor shaft, a rotor base body of the above kind, which is mounted on the rotor shaft, and rotor windings arranged in the hollow insulation profiles of the rotor insulation. In addition, the invention relates to an electric machine, comprising a stator, which has a stator lamination pack and stator windings arranged in the stator lamination pack, and a rotor of the aforementioned kind, which is rotatably arranged in the stator by means of the rotor shaft. Further on, the invention relates to an electric vehicle with a drivetrain, which comprises an electric machine of the above kind, which is provided to propel the electric vehicle. Finally, the invention relates to a method of manufacturing a rotor base body for a rotor of an electric machine.

BACKGROUND ART

A rotor base body, a rotor, an electric machine, an electric vehicle and a method for manufacturing a rotor base body of the above kinds are generally known in prior art. The rotor insulation avoids direct contact between the rotor windings and the rotor lamination pack as is known per se. For this reason, insulation profiles

are mounted in the grooves of the rotor lamination pack and then the first and second star shaped front insulations are mounted to the rotor lamination pack before the rotor windings are applied. According to prior art, separate insulation profiles are provided, each of which is pushed into the grooves of the rotor lamination pack. In a separate step, the star shaped front insulations are mounted. This process however is time consuming, prone to errors and expensive.

DISCLOSURE OF INVENTION

Accordingly, an object of the invention is to provide an improved rotor base body, an improved rotor, an improved electric machine, an improved electric vehicle and an improved method of manufacturing a rotor base body. In particular, a solution shall be proposed, which allows manufacturing of a rotor base body in a more efficient and more reliable way.

The object of the invention is solved by a rotor base body as defined in the opening paragraph, wherein the rotor insulation is overmolded on the rotor lamination pack. In other words, the rotor insulation is manufactured by overmolding the rotor lamination pack.

Moreover, the object of the invention is solved by a rotor for an electric machine, comprising a rotor shaft, a rotor base body of the above kind, which is mounted on the rotor shaft, and rotor windings arranged in the hollow insulation profiles of the rotor insulation.

In addition, the object of the invention is solved by an electric machine, comprising a stator, which has a stator lamination pack and stator windings arranged in the stator lamination pack, and a rotor of the kind disclosed before, which is rotatably arranged in the stator by means of the rotor shaft.

Further on, the object of the invention is solved by an electric vehicle with a drivetrain comprising an electric machine of the above kind, which is provided to propel the electric vehicle.

Finally, the object of the invention is solved by a method of manufacturing a rotor base body for a rotor of an electric machine, which comprises the steps of:

- arranging a rotor lamination pack with a plurality of stacked rotor laminations in a mold, wherein the rotor lamination pack comprises a first front face and a second front face as well as grooves running in axial direction from the first front face to the second front face and
- overmolding the rotor lamination pack with a rotor insulation by use of said mold, wherein the rotor insulation comprises a first star shaped front insulation arranged on the first front face of the rotor lamination pack, a second star shaped front insulation arranged on the second front face of the rotor lamination pack, and insulation profiles arranged in the grooves of the rotor lamination pack, each having a hollow cross section with a radial opening.

By the proposed measures, a rotor base body and thus a rotor and an electric machine can be produced in a more efficient and more reliable way. Instead of pushing separate insulation profiles into the grooves of the rotor lamination pack, the rotor lamination pack is overmolded with the rotor insulation. So, basically just a single process step is necessary to apply the rotor insulation to the rotor lamination pack. In particular, the rotor insulation can be one-part or formed in one piece for that reason.

Beneficially, the rotor insulation is made of plastics. Such a rotor insulation provides very good electrical insulation and can easily be produced for example by injection molding. As an alternative to the star-shaped design, the first front face and the second front face of the rotor insulation can also have a different design.

BRIEF DESCRIPTION OF DRAWINGS

The invention now is described in more detail hereinafter with reference to particular embodiments, which the invention however is not limited to.

Fig. 1 shows a sectional view of an exemplary and schematically drawn electric machine;

Fig. 2 shows an oblique view of an exemplary rotor insulation in detached state;

Fig. 3 shows an oblique view of a rotor lamination pack;

Fig. 4 shows the rotor lamination pack of Fig. 3 with the overmolded rotor insulation;

Fig. 5 shows the rotor base body with the rotor windings being mounted;

Fig. 6 shows the rotor base body of Fig. 5 with additional optional covers ready to be mounted;

Fig. 7 shows the rotor base body of Fig. 5 with the mounted additional covers;

Fig. 8 shows a rotor with the rotor base body of Fig. 7;

Fig. 9 shows a first process step of manufacturing a rotor base body where the rotor lamination pack is arranged in an open mold;

Fig. 10 shows a second process step when the mold has been closed;

Fig. 11 shows a third process step when material for the rotor insulation is injected into the mold;

Fig. 12 shows a fourth process step when the mold has been opened again;

Fig. 13 shows the rotor base body with the overmolded rotor insulation and

Fig. 14 shows a schematic view of an electric vehicle with an electric machine of the disclosed kind.

DETAILED DESCRIPTION

Generally, same parts or similar parts are denoted with the same/similar names and reference signs. The features disclosed in the description apply to parts with the same/similar names respectively the same/similar reference signs. Indicating the orientation and relative position is related to the associated figure.

Fig. 1 shows a cross sectional and schematic view of an exemplary electrical machine 1. The electrical machine 1 comprises a rotor 2 with a rotor base body 3 and a rotor shaft 4, which the rotor base body 3 is mounted to. The rotor base body 3 has a rotor axis A and comprises a rotor lamination pack 5 with a plurality of stacked rotor laminations 6 as well as rotor windings 7 arranged in the rotor lamination pack 5. Moreover, the electrical machine 1 comprises a stator 8 with a stator lamination pack 9 with a plurality of stacked stator laminations (which are not shown in detail in Fig. 1) as well as stator windings 10 arranged in the stator lamination pack 9. The rotor 2 is rotatably mounted with respect to the stator 8 with the aid of (rolling) bearings 11a, 11b about the rotor axis A. In detail, the first bearing 11a is seated in a first bearing shield 12 and the second bearing 11b is seated in a second bearing shield 13. Furthermore, the electrical machine 1 comprises a middle housing part 14, which connects the first bearing shield 12 and the second bearing shield 13 and accommodates the stator 8. In this example, the first bearing shield 12, the second bearing shield 13 and the middle housing part 14 form the housing 15 of the electric machine 1. However, the housing 15 may also have less or more parts than depicted as the case may be. For example, the second bearing shield 13 and the middle housing part 14 may be one-part.

Fig. 2 shows an oblique view of an exemplary rotor insulation 16 in the virtual detached state (note that the rotor insulation 16 is overmolded on the rotor lamination pack 5 and hence the state depicted in Fig. 2 in reality does not exist). The rotor insulation 16 comprises a first star shaped front insulation 17, a second star shaped front insulation 19 and insulation profiles 18 in-between. The insulation profiles 18 each have a hollow cross section with a radial opening B. In particular, rotor insulation 16 can be one-part like this is depicted in Fig. 2.

Generally, the rotor insulation 16 can be made of plastics. Such a rotor insulation 16 provides very good electrical insulation and can easily be produced for example by injection molding.

Fig. 3 shows an oblique view of an example of a rotor lamination pack 5a. The rotor lamination pack 5a comprises a first front face C1 and a second front face C2 as well as grooves D running in axial direction from the first front face C1 to the second front face C2. Moreover, Fig. 3 shows the shaft bore F in the rotor lamination pack 5a. Note that Fig. 3 does not show single rotor laminations 6 but instead the rotor lamination pack 5a is depicted as solid body for simplicity reasons.

Fig. 4 shows the rotor base body 3a' with the rotor lamination pack 5a of Fig. 3 and the overmolded rotor insulation 16 of Fig. 2.

In a next step, the rotor windings 7a are mounted. Fig. 5 shows the resulting rotor base body 3a" in oblique view. The rotor windings 7a are wound around the rotor lamination pack 5a by use of the grooves D or in more detail by use of the radial openings B of the rotor insulation 16. The rotor insulation 16 avoids direct contact between the rotor lamination pack 5a and the rotor windings 7a.

In addition, an optional first rotor cover 20, an optional second rotor cover 21, an optional first front cover 22 and an optional second front cover 23 may be mounted to the rotor base body 3a" for further protection of the rotor windings 7a. In this

context, Fig. 6 shows rotor base body 3a'' and the above parts ready to be mounted and Fig. 7 shows the arrangement or the base body 3a respectively in the mounted state.

Fig. 8 shows a rotor 2a, where the rotor base body 3a has been mounted on a rotor shaft 4a.

A method of manufacturing a rotor base body 3a', which is illustrated by use of Figs. 9 to 13, may comprise the steps of:

- arranging a rotor lamination pack 5, 5a with a plurality of stacked rotor laminations 6 in a mold 26, wherein the rotor lamination pack 5, 5a comprises a first front face C1 and a second front face C2 as well as grooves D running in axial direction from the first front face C1 to the second front face C2 and
- overmolding the rotor lamination pack 5, 5a with a rotor insulation 16 by use of said mold 26, wherein the rotor insulation 16 comprises a first star shaped front insulation 17 arranged on the first front face C1 of the rotor lamination pack 5, 5a, a second star shaped front insulation 19 arranged on the second front face C2 of the rotor lamination pack 5, 5a, and insulation profiles 18 arranged in the grooves D of the rotor lamination pack 5, 5a, each having a hollow cross section with a radial opening B.

In detail, Fig. 9 shows the rotor lamination pack 5 between a first mold part 24 and a second mold part 25. Arrows indicate how the mold 26, which comprises the first mold part 24 and the second mold part 25, can be closed. Fig. 10 shows the closed state of the mold 26. Fig. 11 shows the production process during injection of the material for the rotor insulation 16 as indicated by arrows. As is visible, the rotor insulation 16 has already been formed and injection in principle is finished. Fig 12 shows the arrangement after the mold 26 has been opened again as indicated by arrows. Finally, Fig. 13 shows the shows the rotor base body 3a' with the rotor lamination pack 5 and the overmolded rotor insulation 16. Hence, the state shown in Fig. 13 in principle corresponds to the state shown in Fig. 4.

Fig. 14 finally shows an electric vehicle 27, which comprises an electric machine 1 of the aforementioned kind coupled to a gearbox 28. The electric machine 1 is mechanically coupled to wheels 30 of the electric vehicle 27 by means of the gearbox 28 and side shafts or axles 29. The electric machine 1 can be provided for driving the electric vehicle 27 permanently in a pure electric car or intermittently, e.g. in combination with a combustion engine in a hybrid car.

It is noted that the invention is not limited to the embodiments disclosed hereinbefore, but combinations of the different variants are possible. In reality, the rotor base body 3, 3a, 3a', 3a'', the rotor 2, 2a, the electric machine 1 and the electric vehicle 27 may have more or less parts than shown in the figures. Moreover, the description may comprise subject matter of further independent inventions.

It should also be noted that the term "comprising" does not exclude other elements and the use of articles "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

LIST OF REFERENCES

1	electric machine
2, 2a	rotor
3, 3a, 3a', 3a''	rotor base body
4, 4a	rotor shaft
5, 5a	rotor lamination pack
6	rotor lamination
7, 7a	rotor winding
8	stator
9	stator lamination pack
10	stator winding
11a, 11b	(rolling) bearing
12	first bearing shield
13	second bearing shield
14	(middle) housing part
15	housing
16	rotor insulation
17	first star shaped front insulation
18	insulation profile
19	second star shaped front insulation
20	first rotor cover
21	second rotor cover
22	first front cover
23	second front cover

24	first mold part
25	second mold part
26	mold
27	vehicle
28	gear
29	side shaft
30	wheel
A	rotor axis
B	radial opening
C1	first front face
C2	second front face
D	groove
F	shaft bore

Claims

1. Rotor base body (3, 3a, 3a', 3a") for a rotor (2, 2a) of an electric machine (1), comprising

- a rotor lamination pack (5, 5a) with a plurality of stacked rotor laminations (6), wherein the rotor lamination pack (5, 5a) comprises a first front face (C1) and a second front face (C2) as well as grooves (D) running in axial direction from the first front face (C1) to the second front face (C2) and
- a rotor insulation (16), which comprises a first star shaped front insulation (17) arranged on the first front face (C1) of the rotor lamination pack (5, 5a), a second star shaped front insulation (19) arranged on the second front face (C2) of the rotor lamination pack (5, 5a), and insulation profiles (18) arranged in the grooves (D) of the rotor lamination pack (5, 5a), each having a hollow cross section with a radial opening (B),

characterized in that

- the rotor insulation (16) is overmolded on the rotor lamination pack (5, 5a).

2. Rotor base body (3, 3a, 3a', 3a") as claimed in claim 1, characterized in that the rotor insulation (16) is one-part.

3. Rotor base body (3, 3a, 3a', 3a") as claimed in claim 1 or 2, characterized in that the rotor insulation (16) is made of plastics.

4. Rotor (2, 2a) for an electric machine (1), characterized in a rotor shaft (4, 4a), a rotor base body (3, 3a, 3a', 3a") as claimed in any one of the claims 1 to 3 mounted on the rotor shaft (4, 4a) and rotor windings (7, 7a) arranged in the hollow insulation profiles (18) of the rotor insulation (16).

5. Electric machine (1), comprising

- a stator (8), which has a stator lamination pack (9) and stator windings (10) arranged in the stator lamination pack (9) and

- a rotor (2, 2a) according to claim 4, which is rotatably arranged in the stator (8) by means of the rotor shaft (4, 4a).

6. Electric vehicle (27) with a drivetrain comprising an electric machine (1) as claimed in claim 5, which is provided to propel the electric vehicle (27).

7. Method of manufacturing a rotor base body (3, 3a, 3a', 3a'') for a rotor (2, 2a) of an electric machine (1), comprising the steps of

- arranging a rotor lamination pack (5, 5a) with a plurality of stacked rotor laminations (6) in a mold (26), wherein the rotor lamination pack (5, 5a) comprises a first front face (C1) and a second front face (C2) as well as grooves (D) running in axial direction from the first front face (C1) to the second front face (C2) and
- overmolding the rotor lamination pack (5, 5a) with a rotor insulation (16) by use of said mold (26), wherein the rotor insulation (16) comprises a first star shaped front insulation (17) arranged on the first front face (C1) of the rotor lamination pack (5, 5a), a second star shaped front insulation (19) arranged on the second front face (C2) of the rotor lamination pack (5, 5a), and insulation profiles (18) arranged in the grooves (D) of the rotor lamination pack (5, 5a), each having a hollow cross section with a radial opening (B).

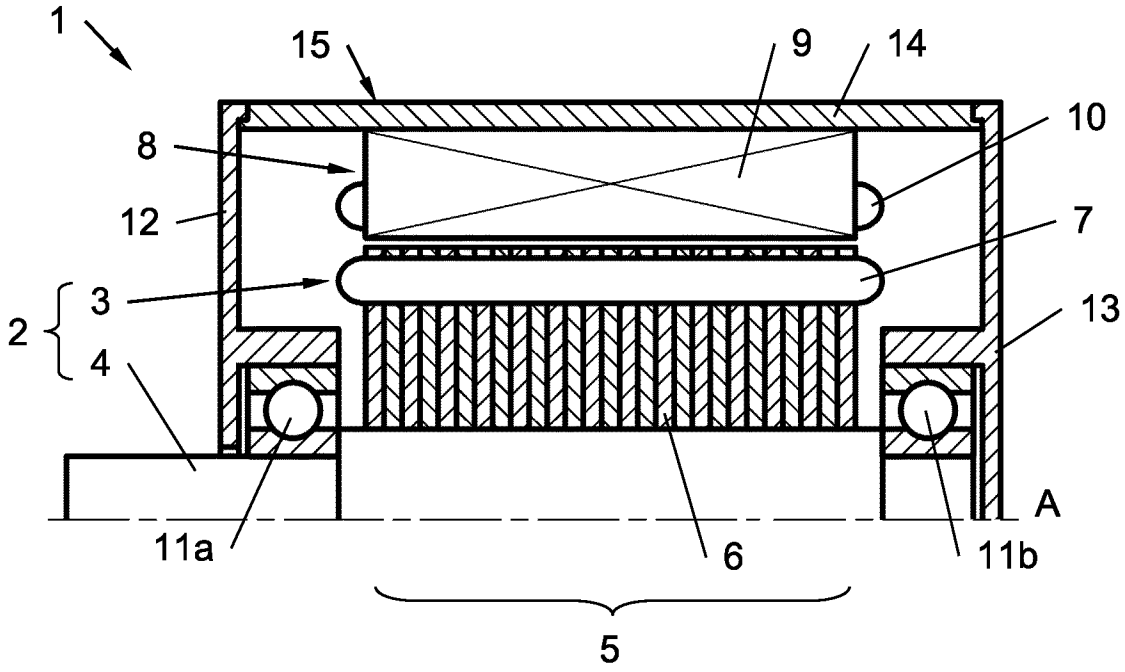

Fig. 1

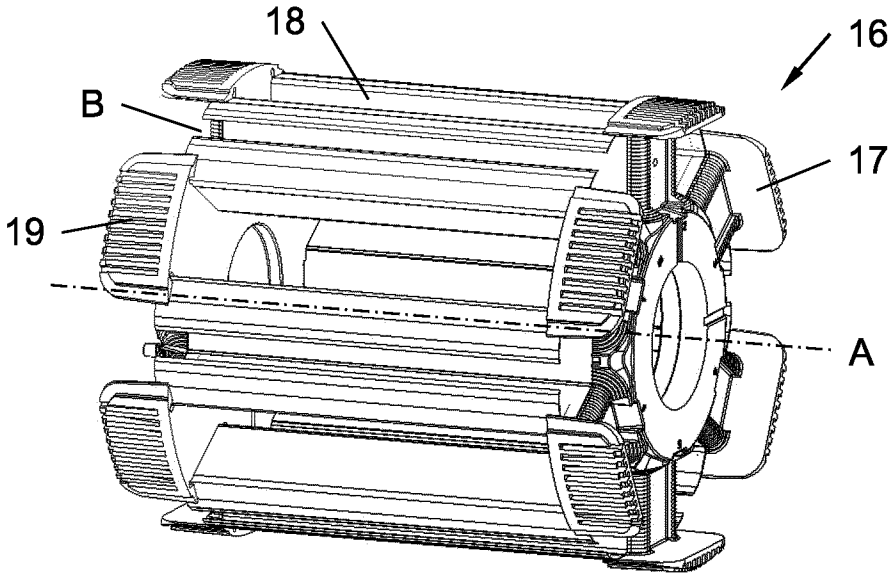

Fig. 2

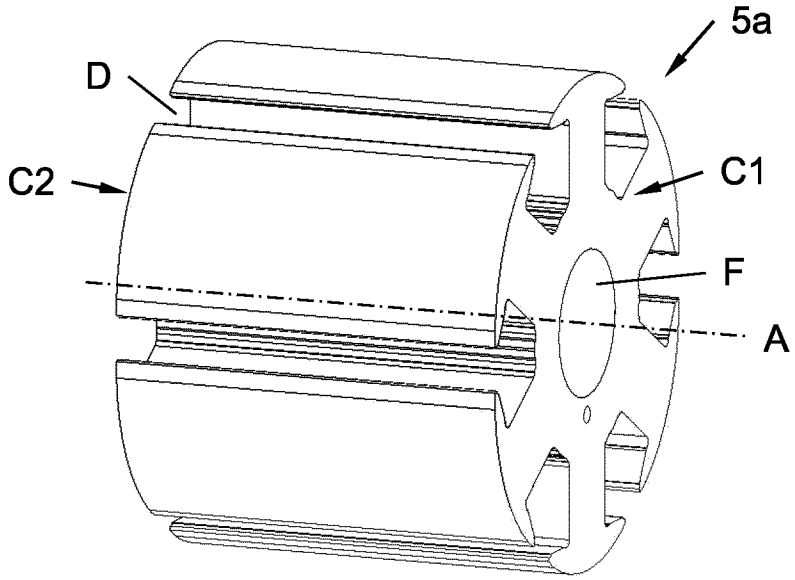

Fig. 3

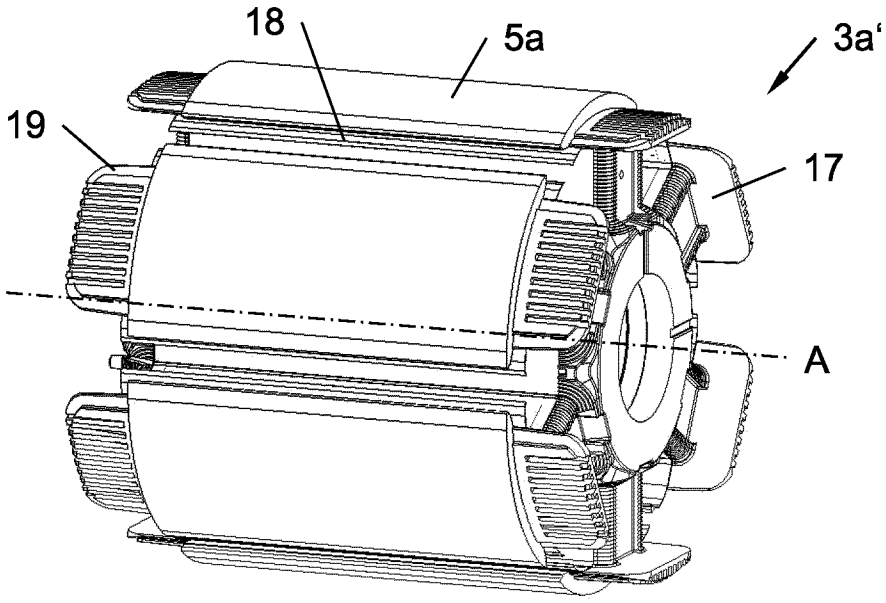

Fig. 4

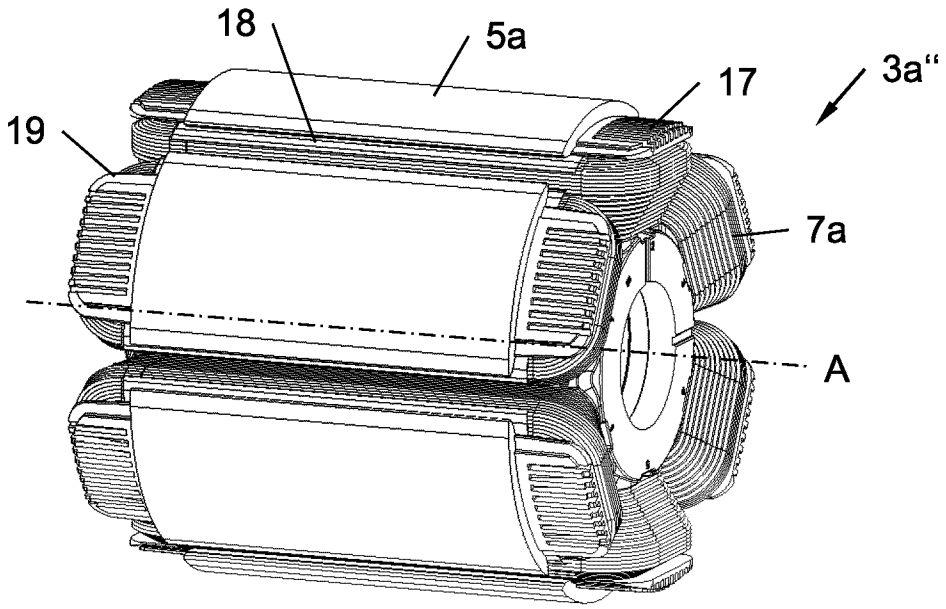

Fig. 5

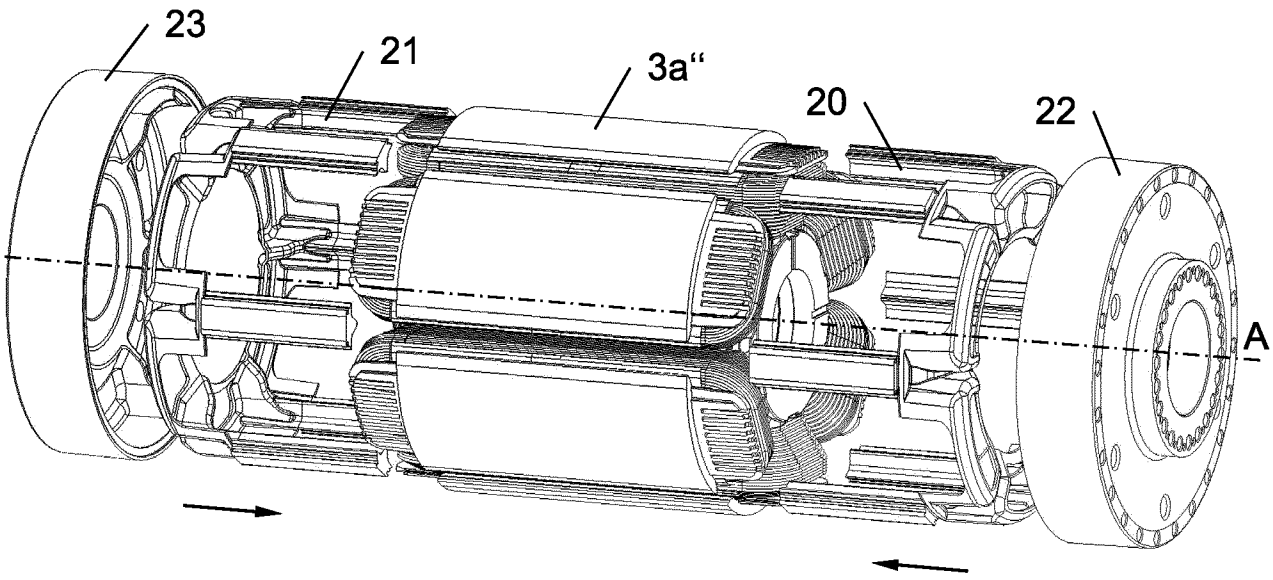

Fig. 6

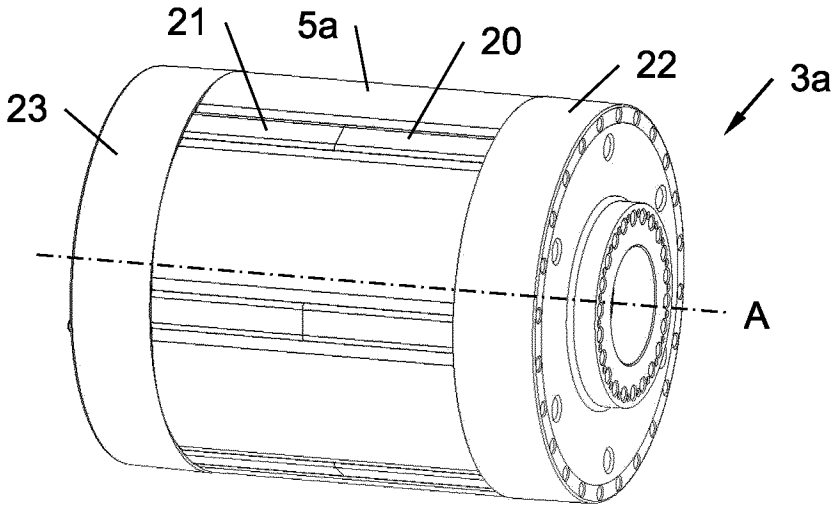

Fig. 7

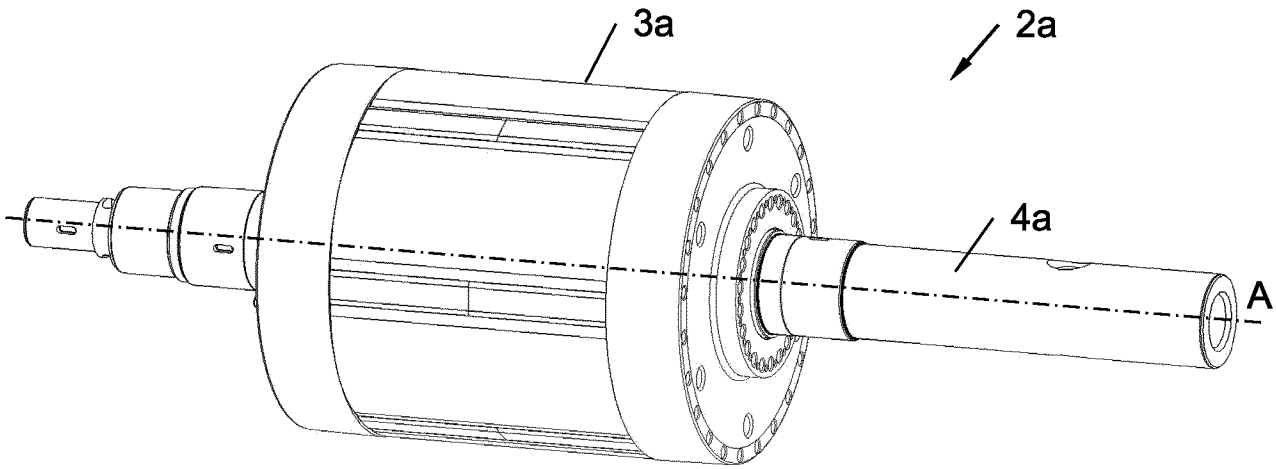

Fig. 8

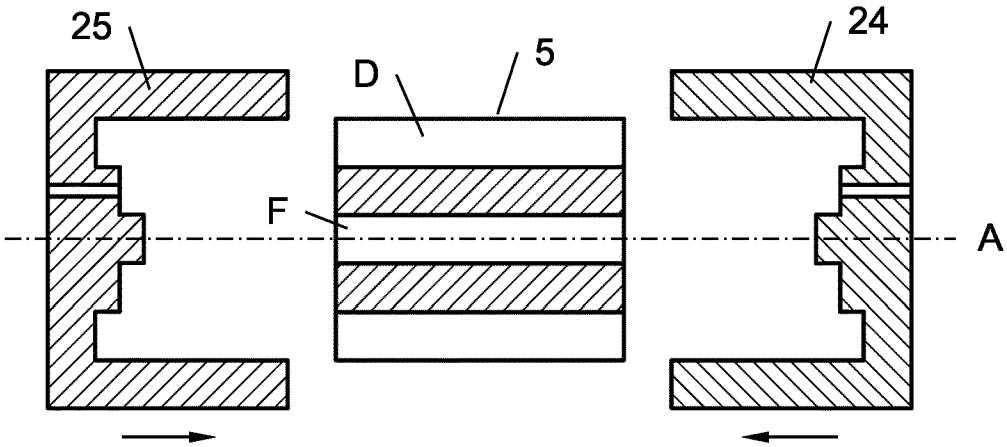

Fig. 9

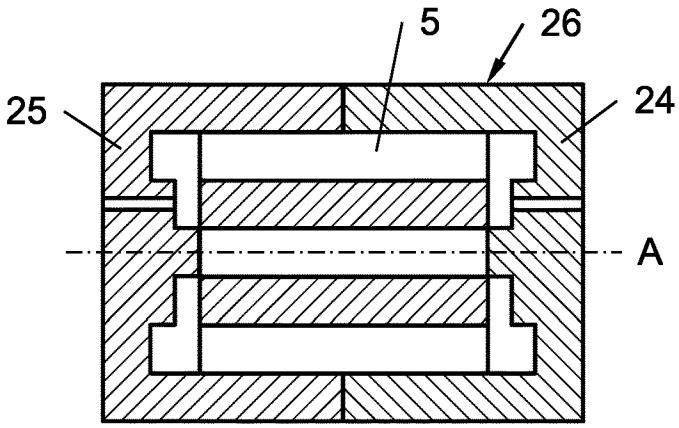

Fig. 10

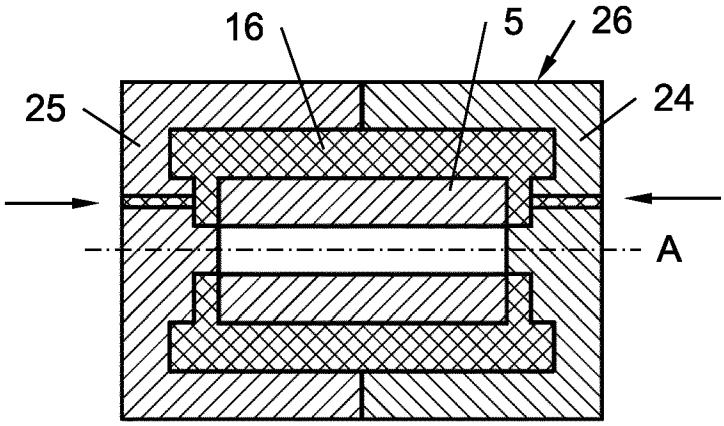

Fig. 11

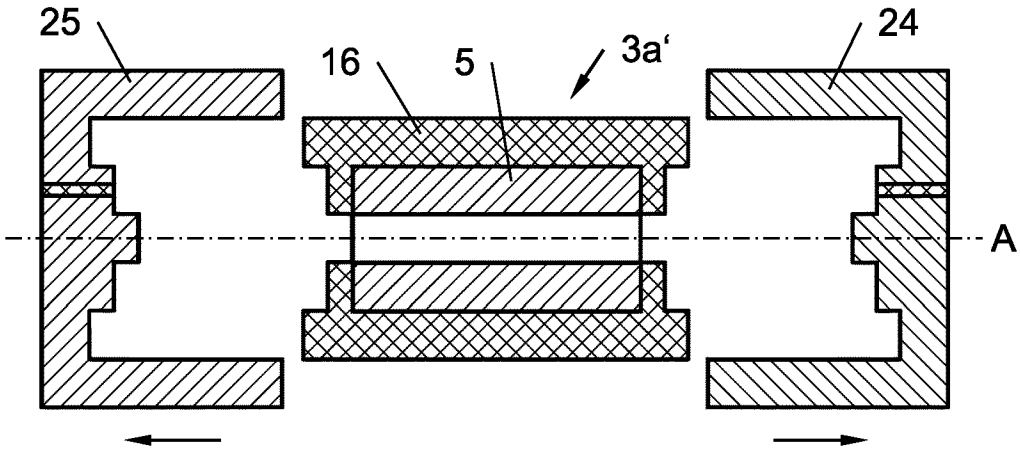

Fig. 12

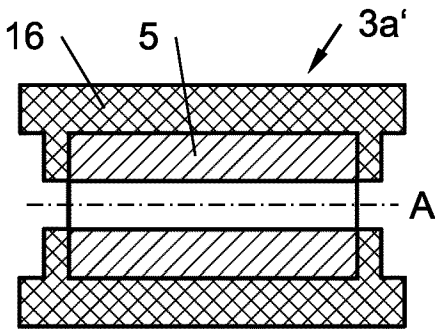

Fig. 13

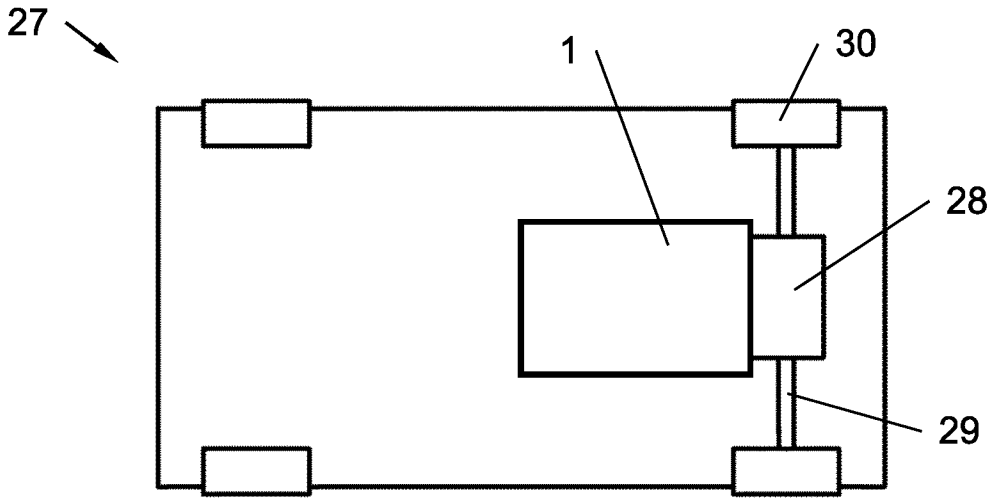

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/073180

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02K3/52
ADD. H02K15/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2020/128888 A1 (ELDOR CORP SPA [IT]) 25 June 2020 (2020-06-25) figures 1, 2 page 1 - page 1 page 5 - page 16 page 6 - page 29 page 7 - pages 1-4 page 8 - pages 7-10	1-7
X	JP H01 162745 U (KOBAL CO.) 13 November 1989 (1989-11-13) pages 2-3; figure 4	1-7
X	EP 0 343 125 A1 (SPAL SRL [IT]) 23 November 1989 (1989-11-23) column 1, line 1 - line 7; figures 1-3 column 3, line 21 - line 62	1-7

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
1 November 2023	13/11/2023

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International application No
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