METHOD AND ARRANGEMENT IN AN ELECTRICAL MACHINE EXCITED BY PERMANENT MAGNETS

Abstract: A method for installing a rotor (3) excited by permanent magnets into an electrical machine (13) using a support, the electrical machine including a stator (2) and a rotor (3). The support contains a shaft (4) supporting the rotor (3). The rotor (3) is rotated, or the shaft (4) supporting the rotor is rotated, whereupon the rotor (3) is moved to its operating position with the help of mutually corresponding threads (6, 8) arranged on the rotor (3) and the shaft (4) supporting the rotor.
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METHOD AND ARRANGEMENT IN AN ELECTRICAL MACHINE EXCITED BY PERMANENT MAGNETS

Field of technology

The object of the invention is a method according to the preamble of Claim 1 for installing a rotor that is excited by permanent magnets into an electrical machine and an arrangement according to Claim 11 in an electrical machine excited by permanent magnets.

Prior art

In electrical machines excited by permanent magnets, permanent magnets are fitted into the rotor. A great attractive force is always prevalent between the permanent magnet rotor and the stator. The force can be either radial or axial. This force substantially hinders the installation of the rotor in its place because it makes it difficult to position and align the rotor and the stator. If a sufficient air gap between the stator and the rotor cannot be maintained during installation, the rotor will stick to the stator. Sticking is intense and may lead to damage to the stator and the rotor. Repairs will be expensive and time-consuming.

Particularly demanding applications are those in which the electrical machine has no bearings of its own to maintain the air gap between the stator and the rotor. In such a case, the air gap of the electrical machine is maintained by means of the structure of the actuator. To the applicable extent, the electrical machine will only be assembled at the time of installation into the actuator. This causes problems with regard to the positioning and alignment of the rotor and the stator mutually and with regard to the actuator.

The publication JP 10-066312 presents a means of assembly for a permanent magnet synchronous machine. In the solution, the stator is moved axially while the rotor stays still. Assurance of an air gap being maintained between the stator and the rotor during installation is provided by means of guide pins or rails.

Disclosure of the invention
The purpose of the present invention is to create a method for installing a rotor excited by permanent magnets into an electrical machine, as well as an arrangement in an electrical machine excited by permanent magnets. In order to achieve this, the invention is characterised by the features specified in the characteristics sections of Claims 1 and 11. Some other preferred embodiments of the invention have the characteristics specified in the dependent claims.

In the method according to the invention, a rotor excited by permanent magnets is installed into an electrical machine by means of a support. An electrical machine comprises a stator and a rotor. The support contains a shaft supporting the rotor. The rotor is fitted onto the end of the shaft supporting the rotor. The rotor is rotated, or the shaft supporting the rotor is rotated, whereupon the rotor is moved to its operating position with the help of mutually corresponding threads arranged on the rotor and the shaft supporting the rotor.

An arrangement according to the invention comprises an electrical machine excited by permanent magnets. The arrangement comprises the stator of an electrical machine and the rotor of an electrical machine excited by permanent magnets, as well as a support. The support contains a shaft supporting the rotor. Mutually compatible threads are arranged on the rotor and, correspondingly, on the shaft supporting the rotor. The rotor is movable to its operating position by rotating the rotor or by rotating the shaft supporting the rotor.

In an embodiment of the invention, the stator is attached to the support in order to keep it stationary during the installation of the rotor. However, it is not always necessary to secure the stator, particularly in the case of a large electrical machine and a stator that is inherently heavy enough to prevent the magnetic attraction between the stator and the rotor from moving the stator during installation.

The threads on the rotor are arranged on the rotor shaft or the inner surface of the rotor, for example. In an embodiment of the arrangement according to the invention, the rotor comprises a sheet pack and a bushing fitted inside the sheet pack that has an inner thread. The bushing protrudes from the rotor sheet pack at the end facing the actuator.
When the rotor is installed directly on the shaft of the actuator, the rotor shaft and the shaft supporting the rotor are interlocked by means of a wedge and/or a locking flange. A wedge can be, for example, a slot wedge installed between the shafts of the rotor and the actuator. A locking flange is installed at the end of the rotor.

When the method according to the invention is used in connection with the manufacture of a motor at a factory, an installation support with a shaft supporting the rotor is used. The stator is attached to the installation support and the permanent magnet rotor is fitted onto the end of the shaft on the installation support that supports the rotor. The rotor is moved into its operating position by means of the threads. The stator and the rotor are locked in relation to each other using a locking plate, for example, while the rotor is in its operating position. The installation support is then removed.

In an embodiment of the invention, the support is the body part of the actuator operated by the electrical machine. The stator is aligned and attached to the body part of the actuator, and the actuator's shaft supports the rotor. The rotor is fitted onto the end of the actuator's shaft. The rotor is rotated by electromagnetic force between the rotor and stator or by some other external force, or the actuator's shaft is rotated by some other external force, and the rotor is moved to its operating position using the threads.

According to another embodiment of the invention, the rotor is fitted onto the end of the actuator's shaft and initially rotated by an external force, after which it is moved using the threads to a position in which a static attractive force prevails between the stator and the rotor.

When the electrical machine is being connected to the actuator, it is possible that in connection with rotor installation, the rotor is moved to its operating position in relation to the actuator while the stator and the rotor are interlocked. In this case, the stator and the rotor are interlocked when the rotor shaft is fitted to the end of the actuator shaft. The stator and rotor will thus turn as a single entity on the actuator shaft. The interlock between the stator and the rotor will be eliminated once the stator and the rotor are supported by the actuator.

In an embodiment of the invention, the shaft supporting the rotor is bearing-mounted onto the support. An actuator with its own bearings typically has a body part containing
the bearing housing for the actuator. The bearing housing contains a bearing through which the actuator's shaft extends. Typically the shaft extends outside the actuator to some degree. The rotor is attached directly to this end of the shaft. The stator of the electrical machine is attached to the body part of the actuator so that the actuator's shaft is in the middle of the stator. The air gap of the electrical machine is maintained by means of the actuator's bearings; the electrical machine as such has no bearings.

In an embodiment of the invention, the actuator has an end shield containing the actuator's bearing housing. The bearing housing contains a bearing through which the actuator's shaft extends. The rotor is attached directly to this end of the actuator's shaft. The end shield also typically has a guide for aligning the motor's stator and threaded screw holes for attaching the stator. In a preferred embodiment of the invention, the actuator's shaft is bearing-mounted onto the actuator's end shield, and the stator of the electrical machine is attached to the actuator's end shield.

The method and arrangement according to the invention make it possible to install a rotor excited by permanent magnets into its operating position in a controlled manner. The method and arrangement make it possible to install the rotor without any support; the rotor can be placed into the stator, and the rotor can be mounted. The rotor can be mounted onto the stator in a manner that makes the rotor and stator compatible and in relation to the rotor and stator can be controlled and even utilised. The positioning and alignment of the rotor and stator are important, and the method and arrangement can be utilised in the assembly of the electrical machine as well as in the application. The method and arrangement are particularly preferred in applications in which a bearingless electrical machine is installed into an actuator.

The method for installing a rotor excited by permanent magnets into an electrical machine and the arrangement in an electrical machine excited by permanent magnets are applicable for use in several solutions utilising permanent-magnet technology. The most common electrical machines fitted with permanent-magnet rotors are axial flux
and radial flux machines. There are numerous applications, including lift motors, wind power generators, rubbish crushers, extruders, separators and mixers.

Description of the figures in the drawings

In the following the invention will be described in more detail with the help of certain embodiments by referring to the enclosed drawings, where

- Fig. 1 illustrates an installation arrangement according to the invention at the initial phase of installation,

- Fig. 2 illustrates an installation arrangement according to the invention at the middle phase of installation,

- Fig. 3 illustrates an installation arrangement according to the invention at the final phase of installation,

- Fig. 4 illustrates an installation arrangement according to the invention at the initial phase of installation in an axial flux machine.

Ways to implement the invention

Figures 1-3 illustrate the installation of a rotor excited by permanent magnets into an electrical machine that is connected to an actuator operated by the electrical machine. The stator 2 of the electrical machine 1, with its body, is aligned and attached to the end shield 9. The stator body is open at the end of the actuator 13. The stator body may also be closed with a flange shield that has an opening in the middle, fitted with a seal to accommodate a shaft. The end shield 9 contains the actuator's bearing housing that contains a bearing 10; the actuator's shaft 4 goes through the bearing. The rotor sheet pack 3 is fitted with permanent magnets. The outer diameter of the bushing 5 is equal to the inner diameter of the rotor sheet pack 3 referred to above. The inner surface of the bushing 5 has threads 6 and a keyway 11 with a flange 7 at the end of the latter. Lengthwise the bushing 5 extends further than the end of the sheet pack 3 closer to the actuator 13. Threads 8 are machined onto the actuator shaft 4; the shape and pitch of the threads correspond to the threads 6 made on the inner surface of the bushing 5. A threaded extension part can also be attached to the shaft 4.
When installing the rotor 3 into the electrical machine 1 and the actuator 13 at the initial phase (Fig. 1), the stator 2 is aligned to the actuator's end shield 9 by means of the guide and attached in place with threaded bolts. The bushing 5 with inner threads, on which the rotor sheet pack 3 has been installed in advance, is fitted onto threads 8 on the actuator shaft 4. The combination of the bushing 5 and rotor sheet pack 3 can freely rotate in relation to the stator 2. The combination of the bushing 5 and the rotor sheet pack 3 is rotated, which makes it screw along the shaft 4 into the stator 2. When the edge of the rotor sheet pack 3 approaches the stator 2, the flux of the permanent magnets starts to close through the stator 2 and the magnetic attractive force begins to have its effect.

Fig. 2. The threading 6, 8 now obstructs the movement of the rotor 3 into the stator 2, which means that the movement is easily controlled by braking the rotation of the rotor 3. The friction of the threads also reduces the movement. Thus the threads serve as limiters of movement in the axial direction, and the actuator shaft 4 centres the rotor 3 axially in relation to the stator 2.

Fig. 3. Once the rotor 3 has turned into its operating position within the stator, it is locked in its position using a slot wedge 12 going into a keyway 11 between the bushing 5 and the actuator shaft 4 and/or using flange mounting 7, 15. The air gap 14 of the electrical machine is maintained by means of the actuator bearings 10. Any removal of the rotor 3 is carried out in reverse order.

The installation of the rotor of an electrical machine illustrated in Fig. 1 can be carried out correspondingly on the shaft of an installation support, for example. The rotor threads can also be implemented on the inner surface of the rotor, as is the case with the keyway.

Fig. 3 illustrates the installation of a rotor excited by permanent magnets into an electrical machine with an actuator attached. When the method is used in connection with moving a permanent magnet rotor into a stator in connection with motor manufacturing, the stator and rotor are interlocked once the rotor has rotated to the correct position.
Fig. 4 illustrates the first phase of installation of the rotor 3 into an electrical machine 1 and the attached actuator 13. The method and arrangement are similar to those in Fig. 1 but the type of electrical machine is an axial flux machine. The rotor 3 can freely rotate in relation to the stator 2. The rotor 3 is rotated and therefore starts to screw towards the stator 2 along the shaft 4. In an axial flux machine, the rotor 3 is not installed into the stator 2; the rotor 3 is turned to the distance of the air gap in relation to the stator 2, which places it in its operating position. The rotor 3 is rotated until the bushing 5 meets the nut 16 prearranged on the shaft, which serves as a stop support. The stop support can also be a collar machined onto the shaft, in which case the shaft does not need to have a long threaded part.

The invention has been described above with the help of certain embodiments. However, the description should not be considered as limiting the scope of patent protection; the embodiments of the invention may vary within the scope of the following claims.

Part list: 1 electrical machine; 2 stator; 3 rotor sheet pack; 4 actuator shaft; 5 bushing; 6 threaded inner surface of bushing; 7 locking flange; 8 shaft threads; 9 end shield; 10 bearing; 11 keyway; 12 slot wedge, 13 actuator; 14 air gap; 15 flange; 16 nut.
CLAIMS

1. A method for installing a rotor (3) excited by permanent magnets into an electrical machine (1), said electrical machine having a stator (2) and a rotor (3) by means of a support (13), characterised in that the support (13) has a shaft (4) supporting the rotor (3), the rotor (3) is fitted onto the end of the shaft (4) supporting the rotor, and the rotor (3) or the shaft (4) supporting the rotor is rotated, which results in the rotor (3) being moved to its operating position by means of mutually corresponding threads (6, 8) arranged on the shaft (4) supporting the rotor and the rotor (3).

2. A method according to Claim 1, characterised in that the stator (2) is attached to the support (13).

3. A method according to any of the Claims from 1 to 2, characterised in that the threads (6) arranged on the rotor (3) are arranged on the shaft of the rotor.

4. A method according to Claim 3, characterised in that the shaft of the rotor (3) and the shaft (4) supporting the rotor are interlocked using a wedge (12).

5. A method according to Claim 3, characterised in that the shaft of the rotor (3) and the shaft (4) supporting the rotor are interlocked using a flange (7, 15) fitted onto the end of the rotor.

6. A method according to Claim 1, characterised in that the support (13) is a body part of the actuator operated by an electrical machine.

7. A method according to Claim 6, characterised in that the stator (2) is aligned and attached to the body part of the actuator (13), the rotor (3) is fitted onto the end of the actuator shaft (4), and the rotor (3) is rotated using electromagnetic or some other external force between the rotor (3) and the stator (2) or the actuator shaft (4) is rotated using some other external force, and the rotor (3) is moved into the operating position using the threads (6, 8).
8. A method according to Claim 6, **characterised** in that the stator (2) is aligned and attached to the body part of the actuator (13), the rotor (3) is fitted onto the end of the actuator shaft (4) and the rotor (3) is first rotated by means of an external force and moved using the threads (6, 8) to a position in which a static force of attraction prevails between the stator (2) and the rotor (3).

9. A method according to Claim 6, **characterised** in that the stator (2) and the rotor (3) are interlocked when the rotor (3) is fitted onto the end of the actuator shaft (4), and the interlock between the stator (2) and the rotor (3) is removed once the stator (2) and the rotor (3) are supported on the actuator (13).

10. A method according to any of the claims from 1 to 2, **characterised** in that the support (13) is an installation support.

11. An arrangement in an electrical machine excited by permanent magnets, the arrangement comprising the stator (2) of the electrical machine and the rotor (3) of the electrical machine, excited by permanent magnets, as well as a support (13), **characterised** in that the support (13) has a shaft (4) supporting the rotor; mutually corresponding threads (6, 8) are arranged on the shaft (4) supporting the rotor and on the rotor (3) correspondingly, and the rotor (3) is movable to its operating position by rotating the rotor (3) or by rotating the shaft (4) supporting the rotor.

12. An arrangement according to Claim 11, **characterised** in that the stator (2) is attached to the support (13).

13. An arrangement according to any of the Claims from 11 to 12, **characterised** in that the threads (6) arranged on the rotor (3) are arranged on the rotor shaft.

14. An arrangement according to Claim 13, **characterised** in that the shaft of the rotor (3) and the shaft (4) supporting the rotor are interlocked using a wedge (12).

15. An arrangement according to Claim 13, **characterised** in that the shaft of the rotor (3) and the shaft (4) supporting the rotor are interlocked using a flange (7, 15) fitted onto the end of the rotor.
16. An arrangement according to Claim 11, characterised in that the shaft (4) supporting the rotor is bearing-mounted on the support (13).

17. An arrangement according to Claim 11, characterised in that the support (13) is a body part of the actuator operated by the electrical machine.

18. An arrangement according to Claim 17, characterised in that the stator (2) is fitted onto the body part of the actuator (13) and the rotor (3) is movable to the operating position by rotating the rotor (3) by electromagnetic force.

19. An arrangement according to Claim 11, characterised in that the support (13) is an installation support.

20. An arrangement according to Claim 11, characterised in that the rotor (3) comprises a sheet pack and a bushing (5) fitted into it that has an inner thread (6).

21. An arrangement according to Claim 20, characterised in that the bushing (5) protrudes from the rotor sheet pack (3) at the end facing the actuator (13).

22. An arrangement according to Claim 17, characterised in that the actuator shaft (4) is bearing-mounted onto the actuator's end shield (9) and that the stator (2) of the electrical machine is attached to the actuator's end shield (9).

23. An arrangement according to Claim 17, characterised in that the air gap (14) of the electrical machine is maintained by means of the actuator's bearings (10).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

H02K1/30, H02K15/03, H02K15/16

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 practical, search terms used):

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C See patent family annex

* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search: 29 January 2007

Date of mailing of the international search report: 08/02/2007

Name and mailing address of the ISA

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