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Squirrel-cage rotor for an asynchronous machine

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ABSTRACT OF THE DISCLOSURE

In a squirrel-cage rotor for an asynchronous machine, having a laminated core (2) which is mounted on the shaft (1), held together at both ends by press rings and is intended for accommodating the cage bars (3), the latter are respectively permanently connected to a short-circuiting ring (4) outside the laminated core (2). Each short-circuiting ring (4) is supported in the radial direction by a support ring (6) fixed on the shaft.

In order to couple the cage head to the rotor body over the entire speed range of the machine for the purpose of suppressing natural vibrations, the two press rings are axially spaced from the laminated core (2) and simultaneously form the support ring (6) for the short-circuiting ring (4). In order to ensure the ventilation of the winding overhang, there are provided between the end face of the laminated core (2) and the support ring (6) spacer webs (7) which are preferably constructed in one piece with the support ring (6).

(Figure 1)

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ABB DAIMLER-BENZ TRANSPORTATION (SCHWEIZ) AG

ORIGINAL

COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:

Squirrel-cage rotor for an asynchronous machine

The following statement is a full description of this invention including the best method of performing it known to us:-

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to a squirrel-cage rotor for an asynchronous machine, having a laminated core which is mounted on the shaft, held together at both ends by press rings and is intended for accommodating the cage bars, which are respectively permanently connected to a short-circuiting ring outside the laminated core, and each short-circuiting ring is supported in the radial direction by a support ring fixed on the shaft.

The invention proceeds here from a prior art such as emerges from, for example, DE 27 21 211 A1.

Discussion of Background

In fast-running asynchronous motors, the ends, projecting from the laminated core at both ends, of the cage bars and the short-circuiting rings connected to them are particularly strongly stressed by high temperatures in conjunction with large centrifugal forces, and put at risk by uncontrolled unbalances. Moreover, in the region of the exposed winding (winding overhang), each barred cage structure has a capacity for vibration in the radial and in the circumferential directions, which, particularly in the case of traction motors, can lead to harmful resonant vibrations because it is virtually impossible to place the natural frequencies outside the exciter frequencies, e.g. from the gearing (pinion teeth).

In order to control the centrifugal forces in the region of the short-circuiting rings of an asynchronous machine, use has been made for many years of shrink rings, which are pushed over the short-circuiting ring. The shrink ring serves the purpose only of mechanical support against bending. The entire structure continues to be capable of vibration.

In the squirrel-cage rotor disclosed in DE 27 21 211 A1, each short-circuiting ring is secured by a centering ring fixed on the shaft. The centering ring bears, with its inside, under axial pressure against the neighboring end face of the cage bars, and the free portion of the inner end face of the centering ring has an annular cutout against whose lateral surface there bears, at a spacing from the annular groove end face, the outer annular surface of an axial projection of the short-circuiting ring, whose inner annular surface surrounds the shaft at a radial spacing.

The known structure has good damping characteristics against forced vibrations and resonant vibrations. However, it is basically suitable only for small motors with a small rotor diameter, because the comparatively solid centering ring impairs the cooling of the rotor, in particular optimum flow through the cage head.

Another way to increase the stiffness of the cage head of an asynchronous machine with respect to torsional vibration is shown in DE 42 33 474 C2. There, the cage bars, which project axially at the ends, are subdivided in the end region in such a way that separate bar ends situated radially one above another are formed, and the bar ends respectively belonging to one groove are offset tangentially in opposite senses. This structure is very complicated and is capable of influencing the radial stiffness of the winding overhang only to a comparatively slight extent.

Summary of the Invention

The present invention is a squirrel-cage rotor for an asynchronous machine, the rotor having a laminated core mounted on a shaft and held together at each end of the core by two press rings, the core being configured to hold cage bars which are permanently connected to a short-circuiting ring outside each end of the laminated core, wherein the two press rings are axially spaced from the laminated core and are also configured to function as support rings which support the short-circuiting ring in a radial direction, and wherein spacer webs are provided between respective end faces of the laminated core and the respective support rings.

The advantage of at least some embodiments of the invention is to be seen, in particular, in that, in this way, the cage head is also coupled to the rotor body over the entire speed range of the machine, starting already at low speeds, in such a way that no natural vibrations, or only damped natural vibrations, can occur. The solution takes account simultaneously in this case of changes in the size of the squirrel-cage winding which result from the centrifugal force and thermal expansion in the cage material with respect to the rotor body.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 shows a first embodiment of the invention in the form of a longitudinal section through the end part of a squirrel-cage rotor, the support essentially being produced by a shrink ring;

Figure 2 shows a cross section through the end part at the level of the press ring of the squirrel-cage rotor in accordance with Figure 1, along line AA therein;

Figure 3 shows a first modification of the embodiment of Figure 1, having an elastic member between the short-circuiting ring and the support ring;

Figure 4 shows a second embodiment of a squirrel-cage rotor, having a short-circuiting ring provided with material cutouts;

Figure 5 shows a plan view of the end face of the squirrel-cage rotor according to Figure 4; and

Figure 6 shows a third embodiment of the squirrel-cage rotor, having a support ring which engages in a groove in the short-circuiting ring and contains an elastic member.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, in Figure 1 a laminated core 2 is mounted in the usual way on a shaft 1. On the outer circumference, the laminated core has axially extending grooves into which cage bars 3 are inserted and secured radially there against the influence of centrifugal force. The cage bars 3 project beyond the laminated core 2 and are connected to a short-circuiting ring 4 which is clearly spaced from the end face of the laminated core 2. The projecting ends of the cage bars 3 and the short-circuiting ring 4 form a so-called winding overhang.

The ends of the cage bars 3 taper in the radial direction. A shrink ring 5 is pushed over the short-circuiting ring 4. Arranged in the annular space between the shaft 1 and the short-circuiting ring 4 is a support ring 6 which is permanently connected to the shaft 1, for example is shrunk onto the latter, and bears, over its entire outer circumference, against the inner circumference of the short-circuiting ring 4. This support ring 6 is spaced from the end face of the laminated core 2. On its side facing the laminated core 2, it has a plurality of radially extending webs or ribs 7. The latter serve both as spacing with respect to the laminated core 2 and as press fingers for the laminated core 2. The support ring simultaneously assumes the function of the press ring for the laminated core 2. The axial fixing of the support ring is performed in the same way as is described in DE 27 21 211 A1 mentioned at the beginning.

Upon cooling of the shrink ring 5, the shrinking force initially acts on the short-circuiting ring 4 and then on the support ring 6. The prestressing of the shrink ring 5 is dimensioned in this case such that at no operating point on the machine is there cancellation of the frictional locking between the inner lateral surface of the short-circuiting ring 4 and the outer lateral surface of the support ring 6.

As is very clear from Figure 1, the described support structure only insubstantially hinders the ventilation of the cage head, which is subjected to a high electrical stress. The cooling air can flow radially outward in a virtually unhindered manner from the axial cooling air bores 8 in the laminated core 2 through the spacings between the webs 7. If required, moreover, it is also possible to provide in the support ring 6 through-bores 9 which are respectively situated between two neighboring webs 7, but need not necessarily be aligned with the cooling air bores 8.

In that development which is of the squirrel-cage rotor according to Figures 1 and 2, represented in Figure 3, the coupling of the short-circuiting ring 4 to the support ring 6 is assisted by an elastic member, for example a coil spring 10. This coil spring 10 is situated partly in a circumferential groove in the outer lateral surface of the support ring 6 and partly in the inner lateral surface of the short-circuiting ring 4. In a fashion analogous to the embodiment according to Figure 1, the short-circuiting ring 4 and support ring 6 are supported directly on one another. The coil spring 10 in this case ensures the coupling for the case in which there is, after all, cancellation of the frictional locking.

In that embodiment of the invention which is represented in Figures 4 and 5, the frictional locking, and thus the coupling between the short-circuiting ring 4 and support ring 6, are ensured by a special configuration of the short-circuiting ring. Instead of a short-circuiting ring with a uniform cross section in the circumferential direction, the short-circuiting ring 4 used here has an intentional anisotrophy in the circumferential direction. This anisotrophy is achieved by providing material cutouts 11 on the sections, three sections in the case of the example, of the short-circuiting ring 4. Said cutouts are distributed uniformly over the inner circumference of the short-circuiting ring and extend approximately over an angle of 60° to 90° in each case. In the zone 12 between the material cutouts, virtually the entire width of the short-circuiting ring 4 is situated on the support ring 6, whereas, in the region of the material cutouts 11, it has only approximately half its (original) ring width. During operation of the machine, it is a consequence of this anisotrophy that both the short-circuiting ring 4 and the shrink ring 5 change shape under the effect of centrifugal force, this being illustrated in the plan view according to Figure 5 by dashes and in an exaggeratedly large fashion. This change in shape results in forces in the radial direction, which are symbolized by arrows in Figure 5 and tend to strengthen the coupling via the frictional locking in the zones 12.

The anisotrophy outlined can, of course, also be achieved by providing material additions distributed over the inner circumference of the short-circuiting ring 4 instead of material cutouts 11, this not being expressly represented in Figures 4 and 5.

Without going beyond the scope set out by the invention, in the case of soldered squirrel-cage windings made from alloyed conductor material of relatively high strength, the coupling of the short-circuiting ring to the support ring can also be performed in such a way that the support ring 6′ has, on the outer circumference, an axially outwardly directed projection 13 which dips into an annular groove 14 on that end face of the short-circuiting ring 4′ which faces the laminated core 2 (Figure 6). In accordance with a first variant, here the axial projection 13 on the support ring 6′ bears, with its shaft-side lateral surface, against the shaft-side groove wall. In the limiting case, it can even dip in a positively locking fashion into the groove 14 on the short-circuiting ring 4′. This produces a coupling which becomes stronger progressively with heating and speed. In order to keep the stressing of the projection 13 on the support ring 6′ within bounds, it is advantageous to insert an elastic member, preferably a coil spring 15, between the inner lateral surface of the projection 13 and the groove wall near the axis.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A squirrel-cage rotor for an asynchronous machine, the rotor having a laminated core mounted on a shaft and held together at each end of the core by two press rings, the core being configured to hold cage bars which are permanently connected to a short-circuiting ring outside each end of the laminated core, wherein the two press rings are axially spaced from the laminated core and are also configured to function as support rings which support the short-circuiting ring in a radial direction, and wherein spacer webs are provided between respective end faces of the laminated core and the respective support rings.

2. The squirrel-cage rotor as claimed in claim 1, wherein the short-circuiting ring rests with an inner circumference directly or partly, with the interposition of a first elastic member, on an outer circumference of the support ring and is pressed onto the support ring by a shrink ring which surrounds the short-circuiting ring.

3. The squirrel-cage rotor as claimed in claim 2, wherein the short-circuiting ring rests with its entire inner circumference on the support ring .

4. The squirrel-cage rotor as claimed in claim 2, wherein there is provided on the outer circumference of the support ring and/or on the inner circumference of the short-circuiting ring a groove in which the first elastic member is inserted.

5. The squirrel-cage rotor as claimed in claim 4, wherein the first elastic member is a coil spring.

6. The squirrel-cage rotor as claimed in claim 2, wherein the short-circuiting ring has material cutouts on its inner circumference, at three or more zones which are distributed uniformly over the inner circumference.

7. The squirrel-cage rotor as claimed in claim 2, wherein the short-circuiting ring has material accumulations on its inner circumference, at three or more points which are distributed uniformly over the inner circumference.

8. The squirrel-cage rotor as claimed in claim 1, wherein the support ring has, on an outer circumference, an axially-outwardly-directed projection which is received in an annular groove on an end face of the short-circuiting ring which faces the laminated core.

9 The squirrel-cage rotor as claimed in claim 8, wherein the said axial projection on the support ring bears with a shaft-side lateral surface against a shaft-side groove wall.

10. The squirrel-cage rotor as claimed in claim 9, wherein the axial projection is received in the groove on the short circuiting ring such that it locks itself into the groove.

11. The squirrel-cage rotor as claimed in either claim 9 or 10, wherein an elastic member is inserted between the shaft-side lateral surface of the projection and the groove wall near the axis.

12. The squirrel-cage rotor as claimed in claim 11, wherein the elastic member is a coil spring.

13. The squirrel-cage rotor as claimed in any one of the preceding claims, wherein the spacer webs are constructed as one piece with the support ring.

14. A squirrel-cage rotor substantially as hereinbefore described with reference to the accompanying drawings.

Dated this twenty eighth day of June 1999

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55924/96.

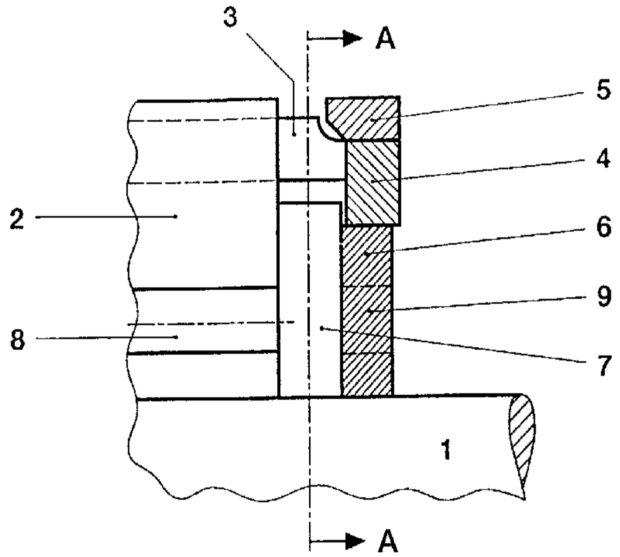

FIG. 1

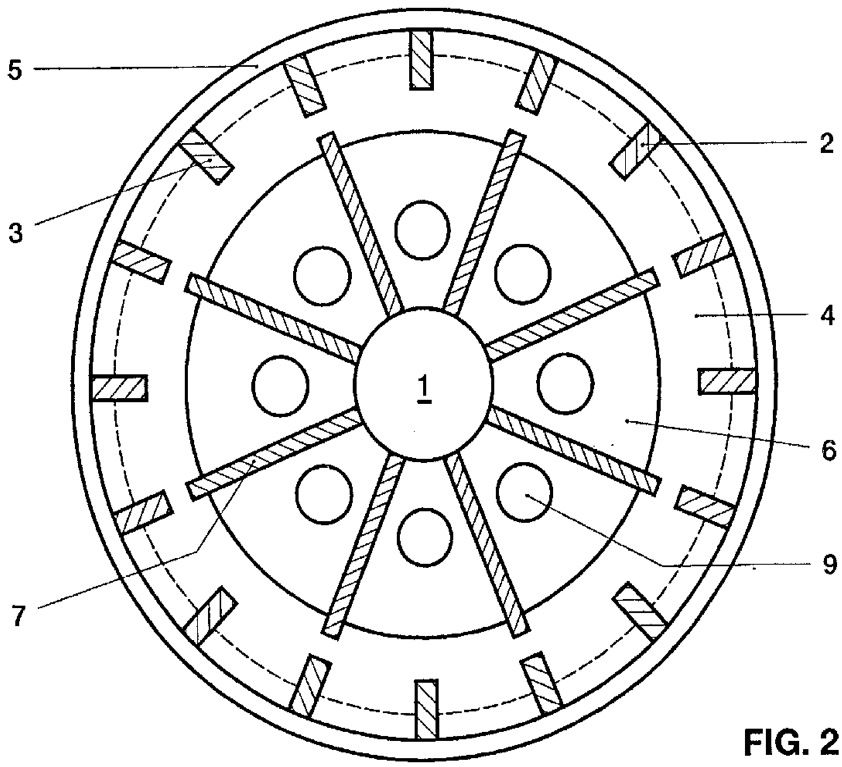

FIG. 2

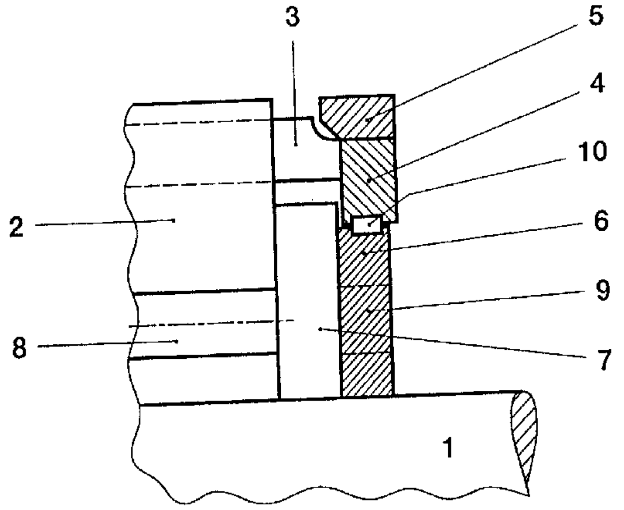

FIG. 3

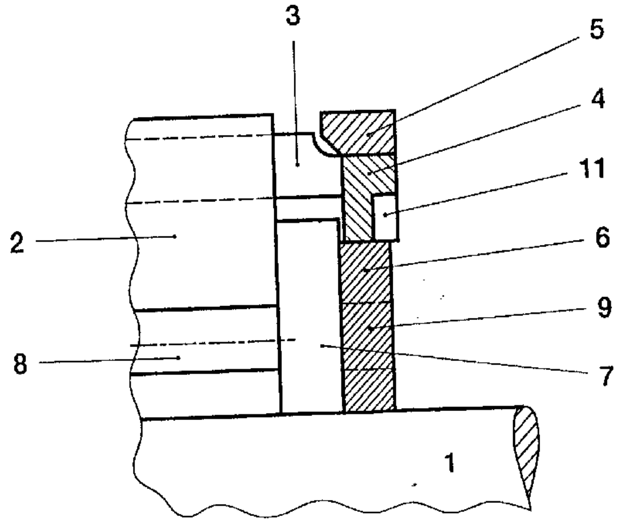

FIG. 4

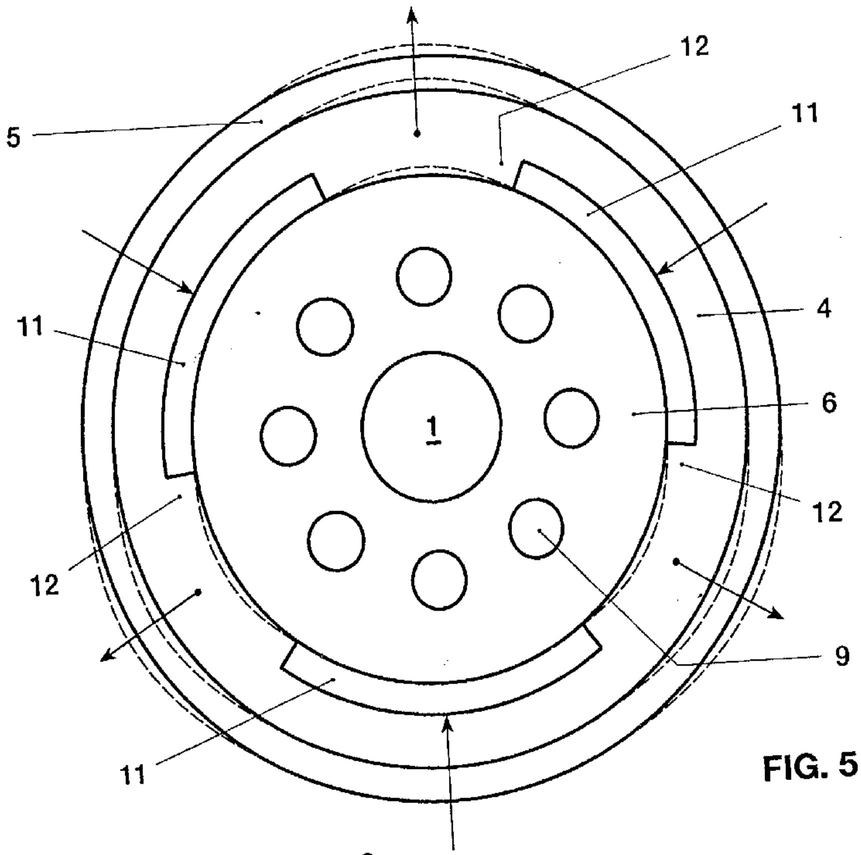

FIG. 5

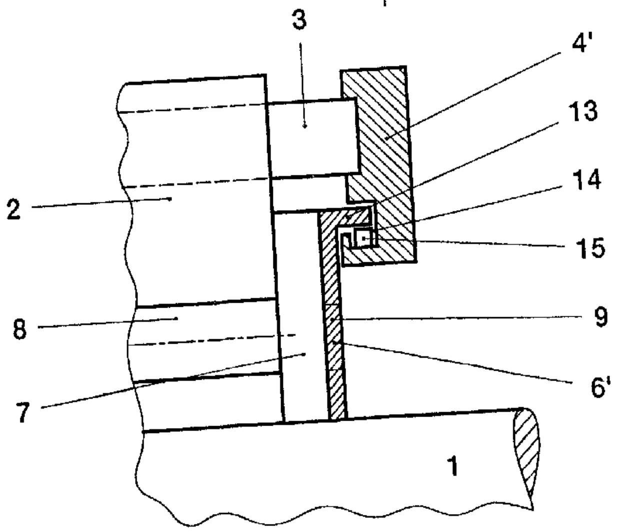

FIG. 6