



US 20020009362A1

(19) **United States**

(12) **Patent Application Publication**

Jakoby et al.

(10) **Pub. No.: US 2002/0009362 A1**

(43) **Pub. Date: Jan. 24, 2002**

(54) **ROTOR FOR A PRIME MOVER AND/OR
DRIVEN MACHINE AND THE USE OF THE
ROTOR**

Publication Classification

(51) **Int. Cl.⁷ F04D 31/00**

(52) **U.S. Cl. 415/116**

(76) **Inventors: Ralf Jakoby, Unterbozberg (CH);
Oliver Popp, Fislisbach (CH); Jens
von Wolfersdorf, Holzerlingen (DE)**

Correspondence Address:

**BURNS DOANE SWECKER & MATHIS L L P
POST OFFICE BOX 1404
ALEXANDRIA, VA 22313-1404 (US)**

(21) **Appl. No.: 09/902,652**

(22) **Filed: Jul. 12, 2001**

(30) **Foreign Application Priority Data**

Jul. 19, 2000 (EP)..... 00 810 639.5

(57) **ABSTRACT**

The present invention discloses a rotor (1) for a prime mover or driven machine having a multiplicity of intake passages (5) for rotor cooling air which discharge axially outward. In the region of the axial discharge of the intake passages (5), their inner walls each form funnel-shaped inlet regions (8) which widen outward and open into a common radially extending end face (9). The transitions from the inner walls of the intake passages (5) into the inlet regions (8) and from the inlet regions (8) into the common end face (9) are designed to be smooth in order to avoid sharp transition edges. In this way, the cooling of the rotor (1) can be markedly improved compared with rotors of a similar type of construction.

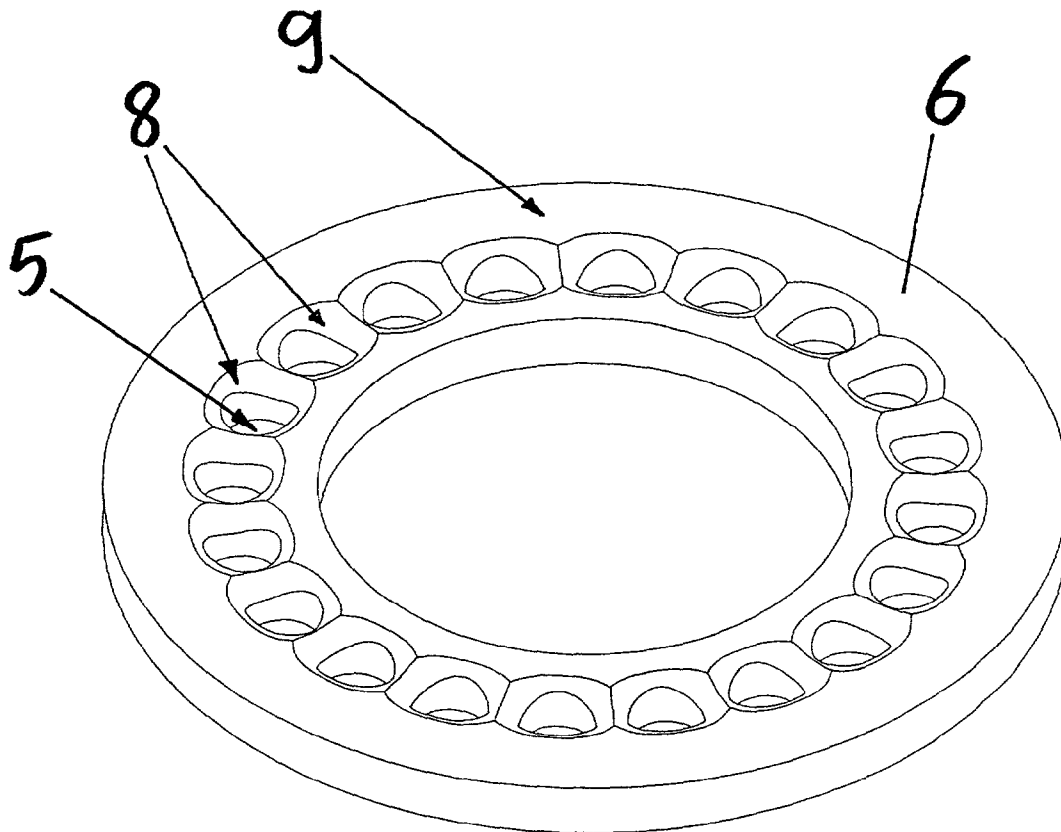


Fig. 1

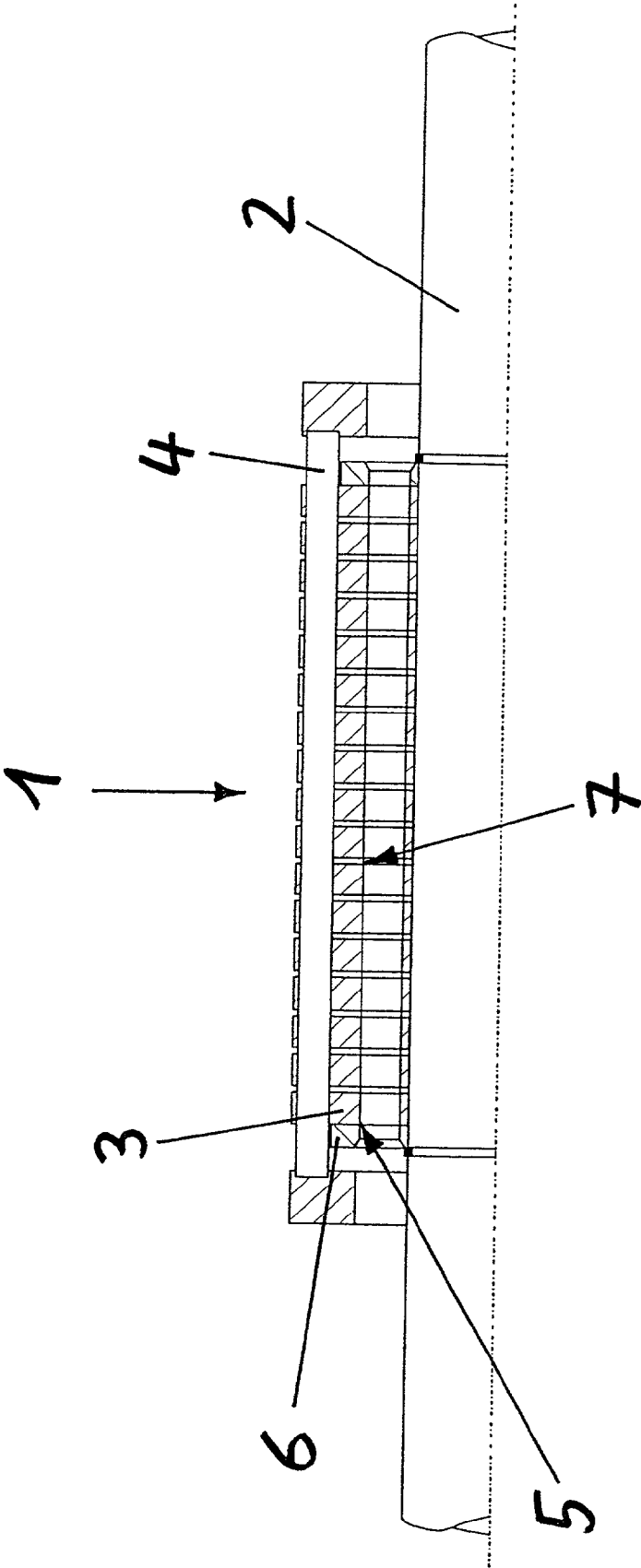
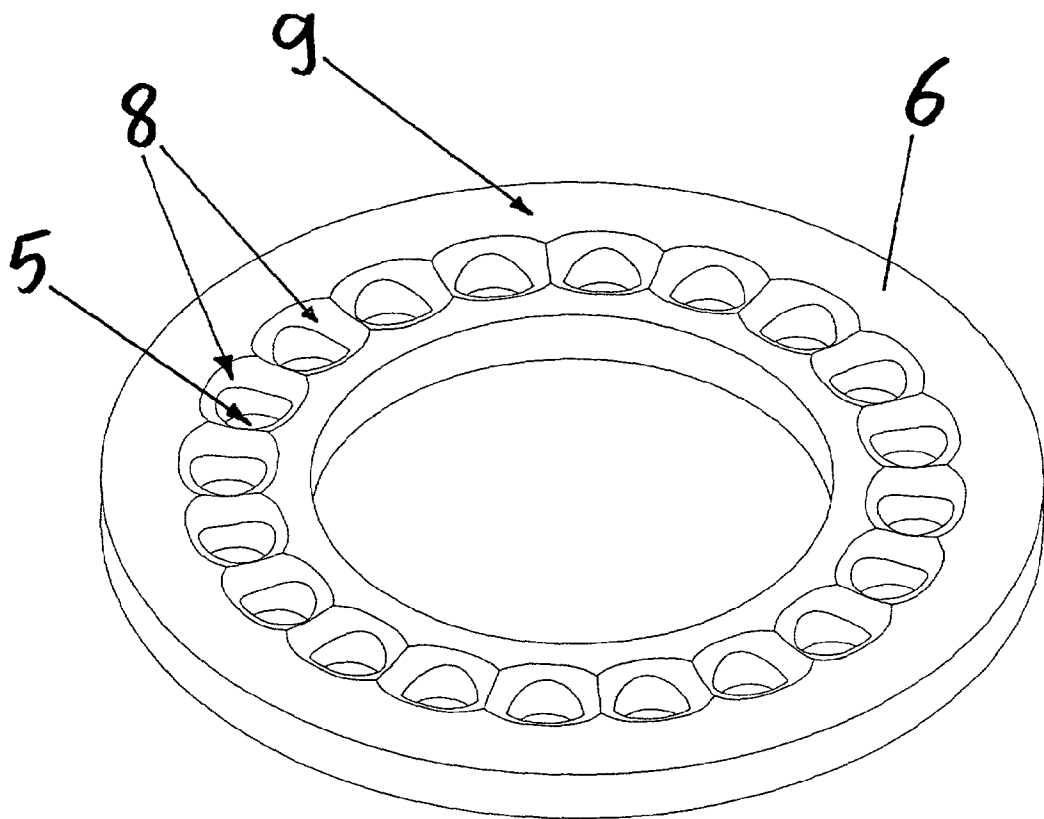
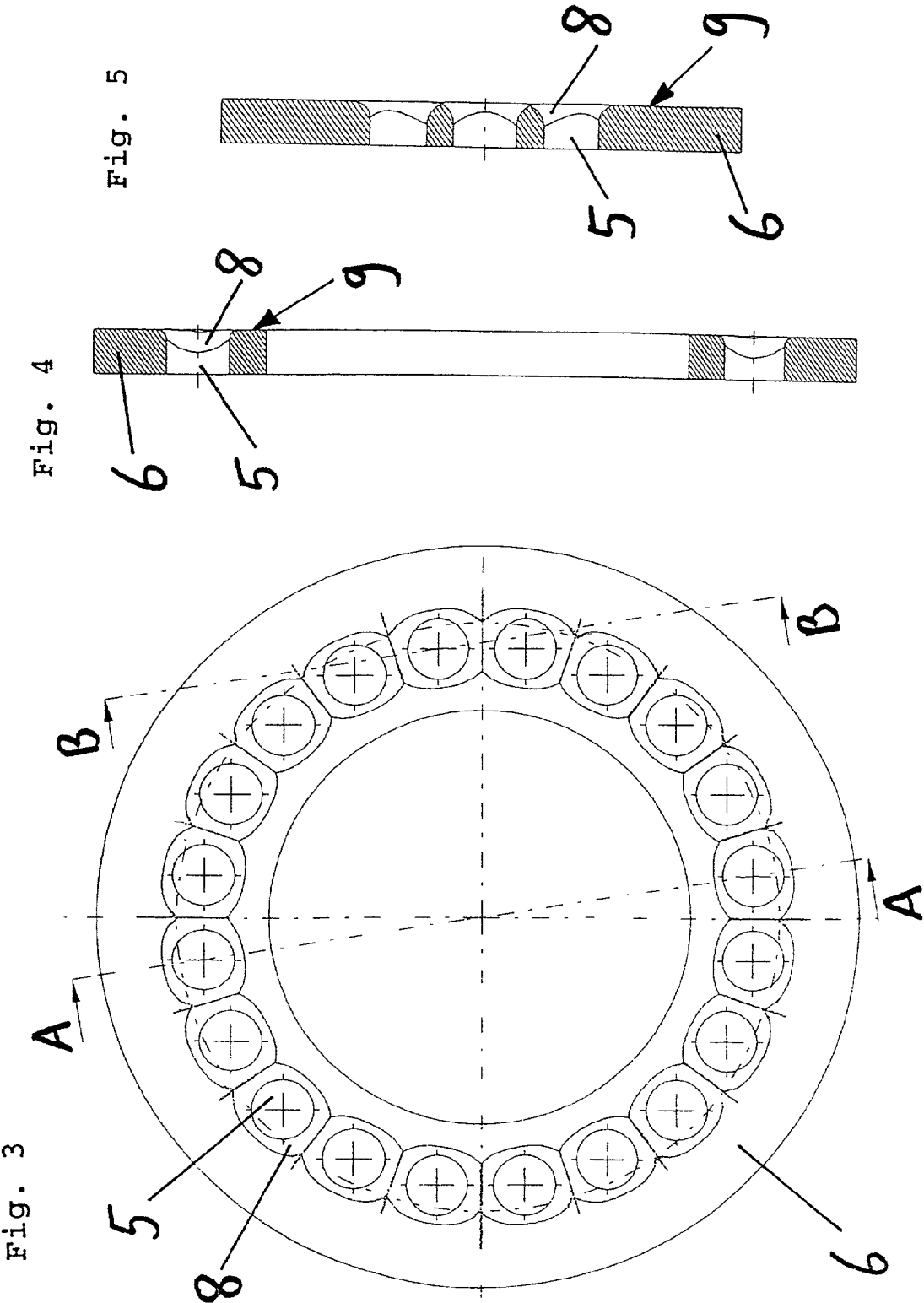


Fig. 2





ROTOR FOR A PRIME MOVER AND/OR DRIVEN MACHINE AND THE USE OF THE ROTOR

TECHNICAL FIELD

[0001] The present invention relates to a rotor for a prime mover and/or driven machine and to the use of the rotor according to the preambles of the independent patent claims.

DISCUSSION OF BACKGROUND

[0002] In many rotary prime movers and driven machines, it is necessary to dissipate heat continuously at certain locations during operation so that admissible component temperatures and tolerances can be maintained. In the rotors of these machines, this is preferably effected by a flow of cooling medium being produced through the rotor, this flow of cooling medium normally entering the rotor axially and discharging radially outward through cooling passages arranged in the rotor and in the process absorbing and dissipating heat from the rotor parts to be cooled. Since many of these machines do not have separate cooling-medium pumps, such as, for example, separate cooling-air blowers, but rather the cooling medium has to be drawn in by self-ventilation of the rotor, the cooling capacities which can be achieved and thus the performance or service life of such machines are unsatisfactory.

DESCRIPTION OF THE INVENTION

[0003] The object of the invention is therefore to provide a rotor for a prime mover or driven machine having improved cooling capacity.

[0004] This object is achieved by the rotor as claimed in claim 1.

[0005] Accordingly, the rotor for a prime mover (e.g. a gas turbine or an electric motor) or a driven machine (e.g. a compressor or a generator) or for a combination of both types of machine has one or more intake passages which discharge axially outward at one or both of its end faces and are intended for drawing in a cooling medium. The orifice openings are arranged at a distance from one another, so that they rotate about the axis of the rotor on one or more circular paths. The inner walls of the intake passages each form a funnel-shaped inlet region which opens outward into an end face extending essentially radially from the rotor center. The expression "funnel-shaped" means that the cross section of the intake passage in this region increases outward in the axial direction, which is the case, for example, when the inner walls of the inlet region enclose a cone, a pyramid or a type of trumpet whose largest cross section lies in the plane of the end face. The cross sections may be rotationally symmetrical, symmetrical or even asymmetrical. If the rotor has a plurality of intake passages, they preferably open into a common end face. However, it is likewise conceivable for the intake passages to open in groups in each case into a common end face or for each intake passage to open into a separate end face, in which case these end faces may lie in identical or different planes. The transition of the inner wall of the respective intake passage into the funnel-shaped inlet region of the same and/or from the funnel-shaped inlet region into the end face is designed to be smooth at some of the intake passages or at all of the intake passages, that is to say that the respective surfaces merge into one another without forming edges. Only in regions in which the inlet regions of two intake passages lying next to one another merge directly into one another are transition edges provided between these inlet regions, these transition edges splitting

the flow of the drawn-in medium into partial flows which enter the individual intake passages. It has been found that, in this way, the cooling of the rotor can be markedly improved compared with rotors of a similar type of construction, as a result of which longer service life can be achieved at the same machine output, owing to reduced component temperatures, or greater machine outputs can be achieved with the same service life.

[0006] The inlet region is advantageously designed as a trumpet-shaped funnel in such a way that its inner wall, in radial sections with regard to its central axis, describes arcs having a constant radius or a radius decreasing outward, that is arcs of a circle or elliptical arcs, the dimensions of which, in the case of a rotationally symmetrical inlet region, as viewed over its entire periphery, remain the same, or else, in the case of non-rotationally symmetrical or asymmetrical inlet regions, as viewed over the periphery, may vary. Furthermore, it is conceivable for the basic shape of these wall contours to vary as viewed over the periphery, e.g. from the shape of an arc of a circle to an elliptical shape. In addition, provision is made for the inlet region to be designed in such a way that this inlet region, at different positions of its periphery, extends axially into the intake passage to a varying degree, as viewed from the plane formed by the radially extending end face, and/or extends radially into this end face to a varying degree, as viewed from the center of said inlet region. In this way, even in existing arrangements and restricted space conditions, an advantageous inlet contour with harmonic transitions between the surfaces can be realized, as a result of which only a small resistance is offered to a flow of cooling medium flowing into the intake passages.

[0007] In a preferred embodiment, the inlet region extends radially from the center of the inlet region into the end face to a smaller degree at those positions on its periphery which lie on a radial line which leads from the rotor center through its center, that is to say at the positions which are closest to and furthest away from the rotor center, than at positions on its periphery which lie on a perpendicular to this radial line, this perpendicular leading through its center. At the same time, or alternatively, the inlet region in the first-mentioned regions extends axially into the intake passage to a smaller degree than in the last-mentioned region.

[0008] It is especially preferred if the inlet regions of the intake passages of rotors cooled by self-ventilation are designed in the aforesaid manner, these intake passages being connected to radial cooling passages in the rotor and advantageously extending through the entire rotor. This design is especially advantageous in rotors of electrical prime movers and driven machines having rotor windings, since the cooling capacity can be markedly increased in this way. Such a rotor is especially suitable for use in a gas-cooled machine, in which case the cooling gas may be drawn in from a closed circuit with heat exchangers (e.g. a closed hydrogen circuit) or from the surroundings (air).

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Further refinements, advantages and uses of the invention follow from the dependent claims and the description below with reference to the figures. In the drawing,

[0010] **FIG. 1** shows one half of an electric motor rotor, partly in section;

[0011] **FIG. 2** shows a perspective oblique plan view of an inlet element of the rotor of **FIG. 1**;

[0012] FIG. 3 shows a plan view of the inlet element from FIG. 2;

[0013] FIG. 4 shows a section along line A-A in FIG. 3; and

[0014] FIG. 5 shows a section along line B-B in FIG. 3.

WAYS OF IMPLEMENTING THE INVENTION

[0015] A preferred embodiment of the invention is shown in FIG. 1. The drawing shows one half of an air-cooled electric motor rotor 1, partly in section. As can be seen, the rotor 1 comprises the rotor shaft 2 (not shown sectioned), the laminated stacks 3 and the rotor winding bars 4. The rotor is a self-ventilating type of construction and has intake passages 5 which open axially outward through the end inlet elements 6. The intake passages 5, which serve to draw in cooling air, extend in the axial direction through the laminated stacks 3 and are connected to radial cooling passages 7 arranged in the rotor 1. If the rotor 1 is set in rotation, cooling air, as a result of centrifugal force, is delivered radially outward in the radial cooling passages 7 arranged axially between the laminated stacks 3, as a result of which a vacuum develops in the intake passages 5 and a cooling-air flow is thus produced, this cooling-air flow entering the intake passages 5 axially and discharging from the cooling passages 7 radially.

[0016] As can be seen from FIG. 2, which shows a perspective plan view of an inlet element 6 of the rotor 1, the intake passages 5 in the inlet elements 6 are designed in such a way that their inner walls open outward via a funnel-shaped inlet region 8 into the common end face 9, extending radially with regard to the axis of rotation of the rotor, of the inlet element 6.

[0017] FIG. 3 shows an end plan view of the inlet element 6, and FIGS. 4 and 5 show a section along lines A-A and B-B, respectively, in FIG. 3. As can be seen from these figures, the intake passages 5 have a circular cross section in the region of their transition into the inlet region 8. The inner walls of the intake passages 5 merge smoothly and without transition edges into their funnel-shaped inlet regions 8 and smoothly from there into the end face 9, as a result of which any edges impairing the flow are avoided. In the case shown, the inner walls of the inlet regions 8 are shaped like a trumpet and in fact in such a way that, as viewed in radial section, with regard to their center, they are formed at each of their peripheral positions by an arc having a constant radius, that is to say by an arc of a circle, the radius varying as viewed over the periphery of the respective inlet region 8. In this way, the inlet regions 8, at different positions at their periphery, extend, at one point to a greater degree and at another point to a smaller degree, axially into the intake passages 5 and radially into the end face 9. In the regions in which the inlet regions 8 of intake passages 5 arranged next to one another adjoin one another, there is no end face 9 in the case shown. Here, the inlet regions 8 merge directly into one another.

[0018] As can also be seen, the inlet regions 8 of the intake passages 5 extend radially from their center into the end face 9 to a smaller degree at those peripheral positions which lie on a radial line which passes from the rotor center through their center (e.g. section line A-A) than at those peripheral positions which lie on a perpendicular (e.g. section line B-B) to the above-described radial line, this perpendicular passing through their center.

[0019] Even if, in the present example, the inner contours of the inlet regions 8, as viewed in radial section with regard

to the center of the respective inlet region 8, are designed in the shape of an arc of a circle, provision is likewise made to design these inlet regions 8 entirely or partly in the shape of an ellipse as viewed over the periphery. It is also conceivable to design the inlet region 8 as a cone having smooth transitions to the adjoining surfaces, to select a rotationally symmetrical form of the inlet region 8 instead of the form shown, or to configure the inlet regions 8 of intake passages 5 arranged next to one another in such a way that the latter do not touch one another, but rather the region between the same is formed by the end face 9, and the inlet regions 8 also merge smoothly into the end face 9 in this region.

1. A rotor of a prime mover and/or driven machine, having one or more intake passages (5) which open axially outward and are intended for drawing in a cooling medium, and the orifice openings of which are arranged at a distance from the axis of rotation of the rotor (1), and the inner walls of which, in the region of the orifice, open outward via a funnel-shaped inlet region (8) into an essentially radially extending end face (9), characterized in that, at some of the intake passages (5) or at all of the intake passages (5), the transition from the inner wall into the inlet region (8) and/or from the inlet region (8) into the end face (9) is designed to be smooth in order to avoid transition edges.

2. The rotor as claimed in claim 1, characterized in that the intake passages (5), in the region of their transition into the inlet region (8), have an essentially round, in particular circular, cross section.

3. The rotor as claimed in one of the preceding claims, characterized in that the inlet region (8) is shaped like a trumpet in such a way that its inner wall, as viewed in radial section with regard to its center, at various positions on the periphery of the same, describes identical or different arcs having in each case a constant radius and/or a radius decreasing axially outward.

4. The rotor as claimed in one of the preceding claims, characterized in that the inlet region (8), at different positions on its periphery, extends axially into the intake passage (5) to a varying degree and/or extends radially from its center into the end face (9) to a varying degree.

5. The rotor as claimed in claim 4, characterized in that the inlet region (8) extends radially from its center into the end face (9) to a smaller degree and/or extends axially into the intake passage (5) to a smaller degree at those positions on its periphery which lie on a radial line (A-A) which leads from the rotor center through its center than at positions on its periphery which lie on a perpendicular (B-B) to this radial line (A-A), this perpendicular (B-B) leading through its center.

6. The rotor as claimed in one of the preceding claims, characterized in that this rotor (1) is a rotor (1) which is cooled by self-ventilation and is designed in such a way that the intake passages (5) are connected to radial cooling passages (7) in the rotor (1) and, in particular, that the intake passages (5) extend axially through the rotor (1).

7. The rotor as claimed in claim 6, characterized in that this rotor is a rotor (1) for an electrical prime mover and/or driven machine which has rotor windings (4).

8. The use of the rotor (1) as claimed in one of the preceding claims in a gas-cooled, in particular air-cooled, prime mover and/or driven machine, in particular in an electric generator and/or motor.

* * * * *