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(54) **ROTARY VANE PUMP**

FLÜGELZELLENPUMPE

POMPE ROTATIVE À PALETTES

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Description

[0001] The invention relates to a rotary vane pump according to the preamble of claim 1 and to a power assisted power steering system of a motor vehicle comprising such a rotary vane pump.

[0002] A rotary vane pump is a positive-displacement pump that in a simple form consists of vanes or blades mounted to a rotor which rotates somewhat eccentrically inside of an annular cavity which is formed by a pump housing. The rotor is a metallic cylindrical body having substantially plane lateral faces which slide on corresponding inner faces of the pump housing. The vanes are arranged in radially extending slots in the rotor and are tensioned to maintain contact with the walls of the pumping house while the pump rotates. Vanes are allowed to slide into and out of the rotor and seal on all edges, creating variable volume vane chambers that do the pumping work. In the automotive industry, vane pumps are used for power assisted power steering, supercharging and automatic transmission, for example.

[0003] EP 1 614 900 A2 discloses a rotary vane pump having the features of the preamble of claim 1, wherein the recesses are L-shaped and extend over a medium third of that radial lengths of the slots which guide and support the vanes.

[0004] US 2014/0234150 A1 discloses a rotary vane pump having a cylindrical rotor and a plurality of vanes arranged in radially extending slots in the rotor, the rotor having recesses which extend at edges between a plane lateral face and the slots of the rotor, wherein the recesses have L-shaped cross sections in the circumferential direction of the rotor, wherein in a radial direction of the rotor, the recesses extend only over a small part of that radial lengths of the slots which guide and support the vanes and not at a relatively broad ridge at the radial outer periphery of the lateral face of the rotor.

[0005] EP 2 778 418 A1 discloses another rotary vane pump without tensioned vanes but having a cylindrical rotor and a plurality of vanes arranged in radially extending slots in the rotor, the rotor having recesses which extend at edges between a plane lateral face and the slots of the rotor, wherein the recesses form a circular channel on the lateral face of the rotor. In a radial direction of the rotor, the recesses extend over most of that radial lengths of the slots which guide and support the vanes, with the exception of a somewhat narrow ridge at the radial outer periphery of the lateral face of the rotor.

[0006] DE 3 441 076 A1 discloses a rotary vane pump having a cylindrical rotor and a plurality of vanes arranged in radially extending slots in the rotor, the rotor having recesses in the form of chamfers at edges between a lateral face and a slot of the rotor. The chamfers are provided in order to prevent break of the oil film which could cause seizing between rotor and the pump housing.

[0007] In the course of time rotary vane pumps may be damaged by small contamination particles inside of the system. Such damages limit the pump to create enough pressure.

[0008] The inventors of the present invention have found that one reason for additional particle contamination is at follows. A lateral face of the rotor can touch the pump housing. In case of a rotor which rotates around a vertically arranged axis, this face would be a bottom face. In particular under high pressure and with high velocity, the touching can be so intensive that scoring at the lateral faces of the rotor occurs. Such a scoring is associated with certain dislocation of abraded rotor material at the rotor surface in circumferential direction. At the trailing edges of the rotor lateral face and the slots, dislocated material gradually forms small spurs which can protrude into the slots and which can hinder the free movement of the vanes, or the moving vanes can break of the protruding spurs or parts of it, which results in additional contamination particles. Both effects limit the pump to create enough pressure.

[0009] The object of the invention is increase the pump life and to prevent unexpected pump damages without raised system cost.

[0010] This object is solved by a rotary vane pump according to claim 1.

[0011] The dependent claims state some preferred embodiments of the invention.

[0012] According to the invention, the recesses have either L-shaped cross sections in the circumferential direction of the rotor or form a circular channel on the lateral face of the rotor.

[0013] In contrast to the above mentioned state of the art, the invention does not try to prevent wear, but wear is accepted and protruding spurs are accommodated within the recesses. While such an effect may be occur partly also in said state of the art, any chamfers have limited capabilities to accommodate any spur material. In contrast to this, the L-shaped or continuous recesses according to the invention provide enough space for accommodation of any spurs independently of the intensity of scoring and the size of spurs.

[0014] That is, the invention makes the pump rotor much more resistant against contamination by designing the surface where the pump rotor and vanes come together to protect the vanes motion from damaged rotor surface.

[0015] Realization of the invention is very inexpensive in comparison with known solutions for wear prevention like using expensive materials or any means for separation of contaminants.

[0016] In a radial direction of the rotor, the recesses extend at least over these radial lengths of the slots which guide and support the vanes, but with the exception of a narrow ridge of 1-2 mm width at the radial outer periphery of the lateral face of the rotor.

[0017] Each of the recesses has a depth, as seen in the direction of the rotational axis of the rotor, of preferably at least 1 mm.

[0018] If the recesses have L-shaped cross sections, each of the recesses preferably has a width, as seen in

a circumferential direction of the lateral face of the rotor, of at least 1 mm.

[0019] If the recesses have L-shaped cross sections, each recess extents circumferentially between each corresponding slot and a radially extending ridge which is located circumferentially between two each slots.

[0020] The rotary vane pump is particular suited as a hydraulic pump of a power assisted power steering system of a motor vehicle.

[0021] In the following an embodiment of the invention is described in detail with reference to the drawings, in which:

Fig. 1 is a sectional view of a rotary vane pump;
Fig. 2 shows a perspective view and a plan view of a new rotor design; and
Fig. 3 is a perspective view of another new rotor design.

[0022] As shown in Fig. 1, a rotary vane pump comprises a stator 1 which is an inner part of a pump body or housing 2, a cylindrical rotor 3 which can rotate around an axis which extends vertically along the plane of the figure, as indicated schematically by an elliptical arrow, an inlet 4 connecting to an inlet line, and an outlet 5 connecting to a pressure line.

[0023] The plane lateral faces of the rotor 3 and in particular a lateral face which is oriented downward as in Fig. 1, thus forming a bottom face, tends to be in a touch condition with the stator 1 and to be damaged when working under high pressure. In Fig. 1, this critical area is surrounded by a broken line and indicated by a broad arrow.

[0024] It has been found that such damages are particularly frequently and critical in an outer circumferential area of the rotor lateral face. On edges where the rotor lateral face meets the slots, in the course of operation a sort of burrs can occur which consist in small spurs which form trailing prolongations in the form of scores or striae at the rotor lateral face. Such spurs protrude into the slots of the rotor 3 and can impede the sliding of the vanes into and out of the rotor 3, thus the pump does not work efficiently.

[0025] Instead to try to reduce scoring, the rotor 2 is provided with recesses which are shaped and voluminous enough to accommodate any spurs.

[0026] As shown in Fig. 2, within a circular area of a lateral face 6 of the rotor 3 there are a plurality of recesses 7. Each recess 7 extents circumferentially between each edge of a slot 8 and a straight ridge 9 of material which has been left between two adjacent recesses 7.

[0027] Radially, each recess 7 extents between an exterior curved ridge 10 of material which has been left at the periphery of the lateral face 6 of the rotor 3 and an interior boundary 11 which lies on a circle around the rotational axis 12 of the rotor 3. The value of the radius of said circle is a fraction of the radius of the rotor 3, which fraction is in the shown rotor configuration about 4/5. However, said radius can vary according to requirements. One such requirement is that the interior boundary 11 of the recesses 7 should extent radially within a circle which has a smaller radius than the distance between the rotation axis 12 and the radially inner ends of the portions of the slots 6 which hold and guide the vanes.

[0028] Thus, each recess 7 has a L-shaped cross section in the circumferential direction of the rotor 3, which L-shape is open toward one of the slots 8 and the stator 1, respectively, and has a flat U-shaped cross section in the radial direction of the rotor 3, which opens toward the stator 1.

[0029] In Fig. 2, all recesses 7 are formed identically or mirror inverted, and all recesses 7 have the same depth of approximately 1or 2 mm, for example. However, the ridges 9 must not be located halfway between two each slots 8 as shown in Fig. 2, but they can be located anywhere between two each slots 8, and their depths can vary.

[0030] In the embodiment of Fig. 2, each slot 8 has two adjacent recesses 7, that is one leading recess 7 and one trailing recess 7 with respect to relative rotation between the rotor 3 and the stator 1. However, in case of a pump which rotates always in the same direction, recesses 7 at the trailing edge would suffer.

[0031] The circumferentially extending curved ridge 10 must be provided to avoid short-circuit between cells of the pump, and for this end a width of approximately 1 or 2 mm, for example, would suffer.

[0032] The width of the radially extending ridges 9 is not critical. In the shown embodiment, the width is approximately 1 or 2 mm, but the ridges 9 can be substantially wider.

[0033] The ridges 9 can be so wide that the L-Form of the recesses 3 which is rather stretched in Fig. 2 approaches a L-Form having legs with equal lengths. However, the narrower the ridges 9, the more volume is available to adopt any spurs or other material which otherwise could restrict vane motion.

[0034] On the other side, the width of the ridges 9 can be made zero. In this case, the rotor design would be as shown in Fig. 3. Instead of a twenty-two separate recesses 7, this rotor 3 has eleven recesses 7' which extend circumferentially from each slot 8 to the neighboring slots 8. That is, the recesses 7' are contiguous from one slot 8 to the next slot 8.

[0035] The recesses 7' of the embodiment of Fig. 3 form a circular channel around the rotational axis 12 of the rotor 3. Width and depth of the channel can vary.

[0036] In this embodiment, because of the channel, the complete circular area of the lateral face 2 of the rotor 3 where the vanes are supported by the slots 8 is kept away from inner lateral faces of the stator 1, thus the touch condition and the friction there between has lessened. This prevents deformation of the lateral face 2 of the rotor 3 in its critical radial outer area.

Claims

1. A rotary vane pump, suitable for use in a power assisted power steering system of a motor vehicle, the pump having a cylindrical rotor (3, 3') and a plurality of vanes arranged in radially extending slots (8) in the rotor (3, 3') and tensioned to maintain contact with the walls of the pumping house while the pump rotates, the rotor (3, 3') having recesses (7, 7') which extend at edges between a plane lateral face (6) and the slots (8) of the rotor (3, 3'), wherein the recesses (7, 7') have either L-shaped cross sections in the circumferential direction of the rotor (3, 3') or form a circular channel on the lateral face (6) of the rotor (3, 3'),
characterized in that
in a radial direction of the rotor (3, 3), the recesses (7, 7') extend at least over that radial lengths of the slots (8) which guide and support the vanes, with the exception of a narrow ridge (10) of 1-2 mm width at the radial outer periphery of the lateral face (6) of the rotor (3, 3').

2. A rotary vane pump according to claim 1,
characterized in that
each recess (7) extents between the exterior curved ridge (10) of material which has been left at the periphery of the lateral face (6) of the rotor (3) and an interior boundary (11) which lies on a circle around the rotational axis (12) of the rotor (3), wherein the radius of said circle is a fraction of the radius of the rotor (3), which fraction is 4/5.

3. A rotary vane pump according to claim 1,
characterized in that
each of the recesses (7, 7') has a depth, as seen in the direction of the rotational axis of the rotor (3, 3'), of at least 1 mm.

4. A rotary vane pump according to one of the proceeding claims,
characterized in that
if the recesses (7) have L-shaped cross sections, each of the recesses (7, 7') has a width, as seen in a circumferential direction of the lateral face (6) of the rotor (3, 3'), of at least 1 mm.

5. A rotary vane pump according to one of the proceeding claims,
characterized in that
if the recesses (7) have L-shaped cross sections, each recess (7) extents circumferentially between each corresponding slot (8) and a radially extending ridge (9) which is located circumferentially between two each slots (8).

6. A power assisted power steering system of a motor vehicle, comprising a rotary vane pump according to one of the proceeding claims.

Patentansprüche

1. Flügelzellenpumpe, die zur Verwendung in einem elektrisch unterstützten Servolenkungssystem eines Kraftfahrzeugs geeignet ist, wobei die Pumpe einen zylindrischen Rotor (3, 3') und eine Vielzahl von Flügeln aufweist, die in sich radial erstreckenden Schlitzen (8) im Rotor (3, 3') dazu angeordnet und gespannt sind, Kontakt mit den Wänden des Pumpengehäuses aufrechtzuerhalten, während sich die Pumpe dreht, wobei der Rotor (3, 3') Ausnehmungen (7, 7') aufweist, die sich an Kanten zwischen einer ebenen Seitenfläche (6) und den Schlitzen (8) des Rotors (3, 3') erstrecken, wobei die Ausnehmungen (7, 7') entweder L-förmige Querschnitte in der Umfangsrichtung des Rotors (3, 3') aufweisen oder einen kreisförmigen Kanal auf der Seitenfläche (6) des Rotors (3, 3') bilden,

   dadurch gekennzeichnet, dass
   in einer radialen Richtung des Rotors (3, 3) die Ausnehmungen (7, 7') sich mindestens über die radialen Längen der Schlitze (8) erstrecken, die die Flügel führen und halten, mit der Ausnahme eines schmalen Grats (10) von 1-2 mm Breite am radialen Außenumfang der Seitenfläche (6) des Rotors (3, 3').

2. Flügelzellenpumpe nach Anspruch 1,

   dadurch gekennzeichnet, dass
   jede Ausnehmung (7) sich zwischen dem äußeren gekrümmten Grat (10) aus Material, das am Umfang der Seitenfläche (6) des Rotors (3) belassen wurde, und einer inneren Begrenzung (11) erstreckt, die auf einem Kreis um die Drehachse (12) des Rotors (3) liegt, wobei der Radius des Kreises ein Bruchteil des Radius des Rotors (3) ist, der 4/5 beträgt.

3. Flügelzellenpumpe nach Anspruch 1,

   dadurch gekennzeichnet, dass
   jede der Ausnehmungen (7, 7') in der Richtung der Drehachse des Rotors (3, 3') gesehen eine Tiefe von mindestens 1 mm aufweist.

4. Flügelzellenpumpe nach einem der vorhergehenden Ansprüche,

   dadurch gekennzeichnet, dass
   wenn die Ausnehmungen (7) einen L-förmigen Querschnitt aufweisen, jede der Ausnehmungen (7, 7') in einer Umfangsrichtung der Seitenfläche (6) des Rotors (3, 3') gesehen eine Breite

von mindestens 1 mm hat.

5. Flügelzellenpumpe nach einem der vorhergehenden Ansprüche,

dadurch gekennzeichnet, dass
wenn die Ausnehmungen (7) einen L-förmigen Querschnitt aufweisen, jede Ausnehmung (7) sich in Umfangsrichtung zwischen jedem entsprechenden Schlitz (8) und einem sich radial erstreckenden Grat (9) erstreckt, der in Umfangsrichtung zwischen jeweils zwei Schlitzen (8) angeordnet ist.

6. Elektrisch unterstütztes Servolenkungssystem eines Kraftfahrzeugs, umfassend eine Flügelzellenpumpe nach einem der vorhergehenden Ansprüche.

Revendications

1. Pompe rotative à palettes, appropriée pour l'utilisation dans un système de servo-direction assistée d'un véhicule à moteur, la pompe ayant un rotor cylindrique (3, 3') et une pluralité de palettes agencées dans des fentes s'étendant radialement (8) dans le rotor (3, 3') et tendues pour maintenir un contact avec les parois du logement de pompage alors que la pompe est en rotation, le rotor (3, 3') ayant des évidements (7, 7') qui s'étendent à des bords entre une face latérale plane (6) et les fentes (8) du rotor (3, 3'), dans laquelle les évidements (7, 7') ont des sections transversales en forme de L dans la direction circonférentielle du rotor (3, 3') ou forment un canal circulaire sur la face latérale (6) du rotor (3, 3'),

caractérisée en ce que
dans une direction radiale du rotor (3, 3), les évidements (7, 7') s'étendent au moins sur ces longueurs radiales des fentes (8) qui guident et supportent les palettes, à l'exception d'une saillie étroite (10) de 1 à 2 mm de largeur à la périphérie extérieure radiale de la face latérale (6) du rotor (3, 3').

2. Pompe rotative à palettes selon la revendication 1,

caractérisée en ce que
chaque évidement (7) s'étend entre la saillie incurvée extérieure (10) de matériau qui a été laissée à la périphérie de la face latérale (6) du rotor (3) et une limite intérieure (11) qui se trouve sur un cercle autour de l'axe de rotation (12) du rotor (3), dans laquelle le rayon dudit cercle est une fraction du rayon du rotor (3), laquelle fraction est 4/5.

3. Pompe rotative à palettes selon la revendication 1,

caractérisée en ce que
chacun des évidements (7, 7') a une profondeur, en vue dans la direction de l'axe de rotation du rotor (3, 3'), d'au moins 1 mm.

4. Pompe rotative à palettes selon l'une des revendications précédentes,

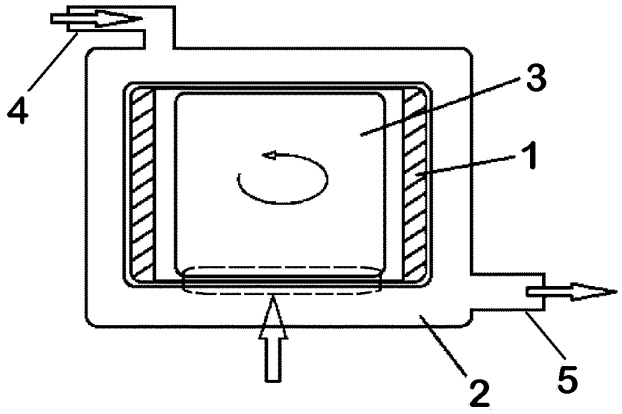
caractérisée en ce que
si les évidements (7) ont des sections transversales en forme de L, chacun des évidements (7, 7') a une largeur, en vue dans une direction circonférentielle de la face latérale (6) du rotor (3, 3'), d'au moins 1 mm.

5. Pompe rotative à palettes selon l'une des revendications précédentes,

caractérisée en ce que
si les évidements (7) ont des sections transversales en forme de L, chaque évidement (7) s'étend circonférentiellement entre chaque fente correspondante (8) et une saillie s'étendant radialement (9) qui est située circonférentiellement entre chaque paire de fentes (8).

6. Système de servo-direction assistée d'un véhicule à moteur, comprenant une pompe rotative à palettes selon l'une des revendications précédentes.

Fig. 1



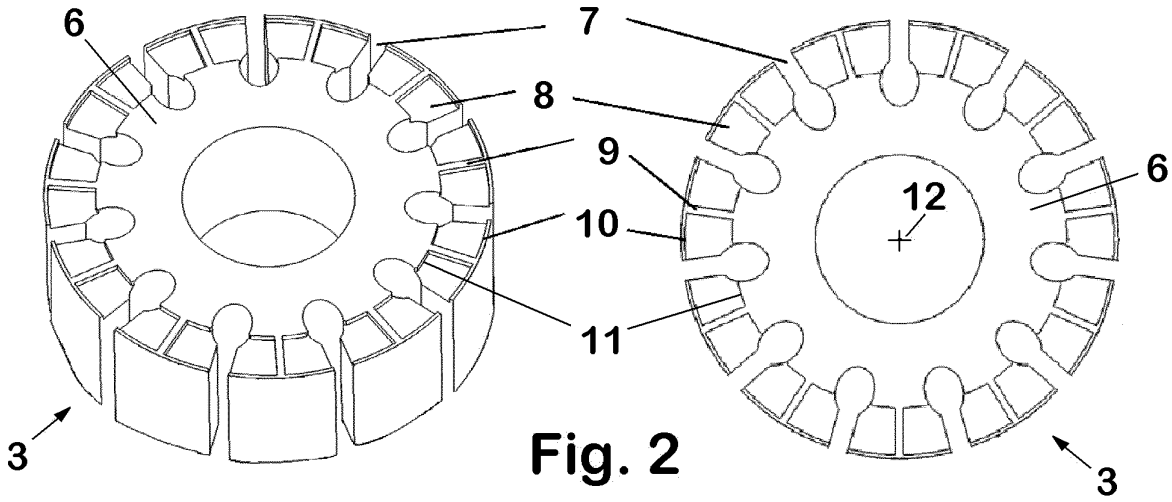
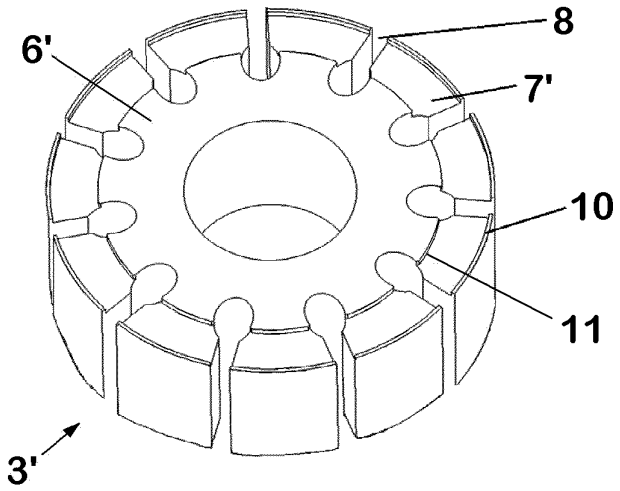


Fig. 2

Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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