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(54) **SLIDING VANE PUMP**

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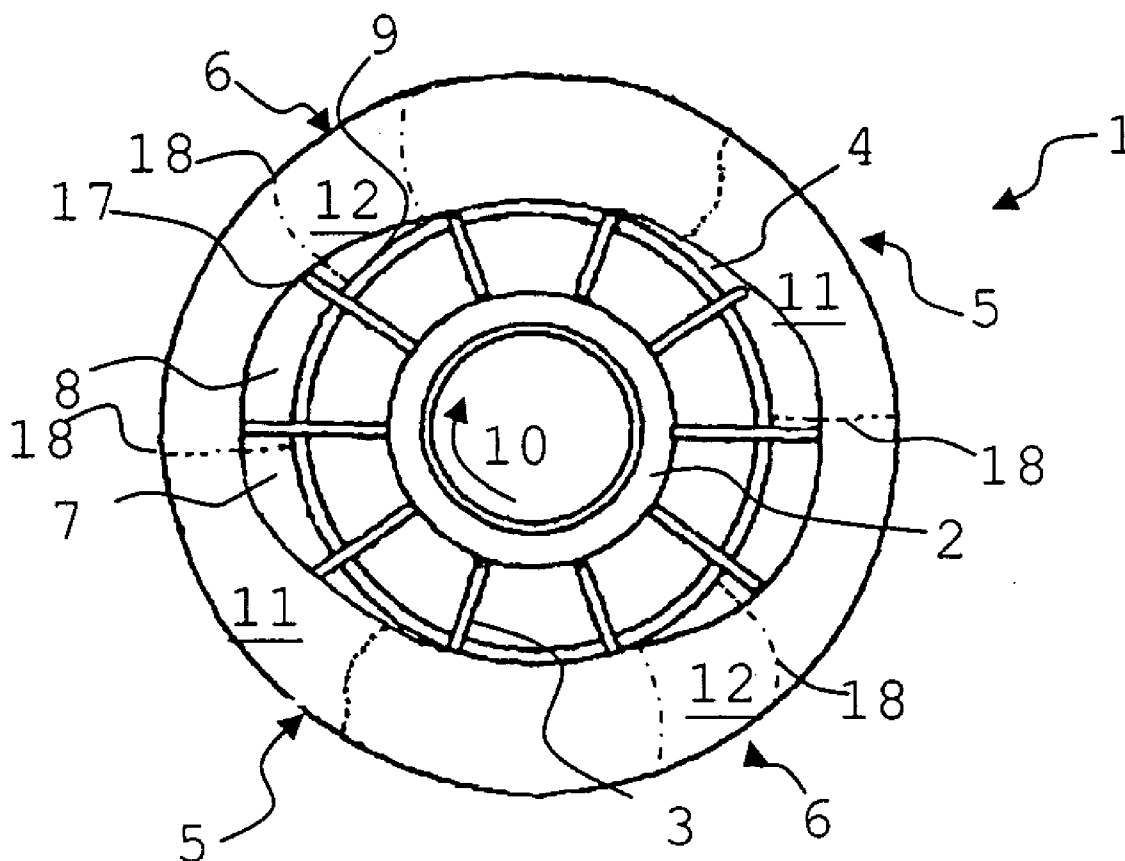
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(57) **ABSTRACT**

In a sliding vane pump comprising a rotor supported in a housing and having vanes supported radially movably in radially extending slots of the rotor so as to be in contact with the inner surface of a contour ring which is rotatably supported in the housing and forms with the vanes suction pumping and pressure chambers for pumping and pressurizing a fluid, a pressure control arrangement is provided for limiting the pressure in the pumping chamber to the pressure present in the pressure chamber thereby to prevent the generation of noise upon coupling of the pumping chamber with the pressure chamber.



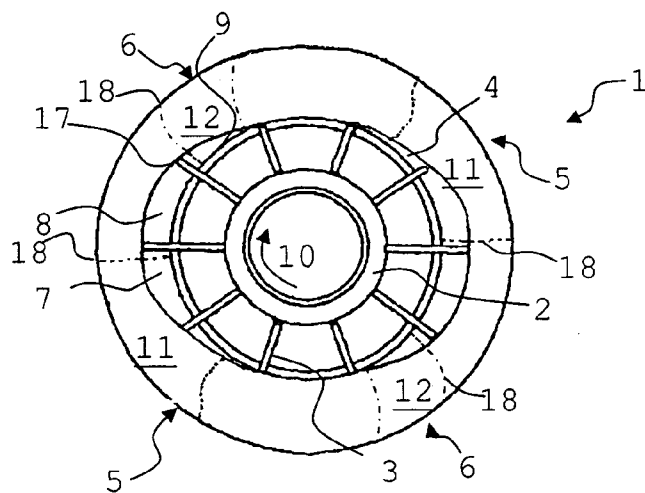


Fig. 1

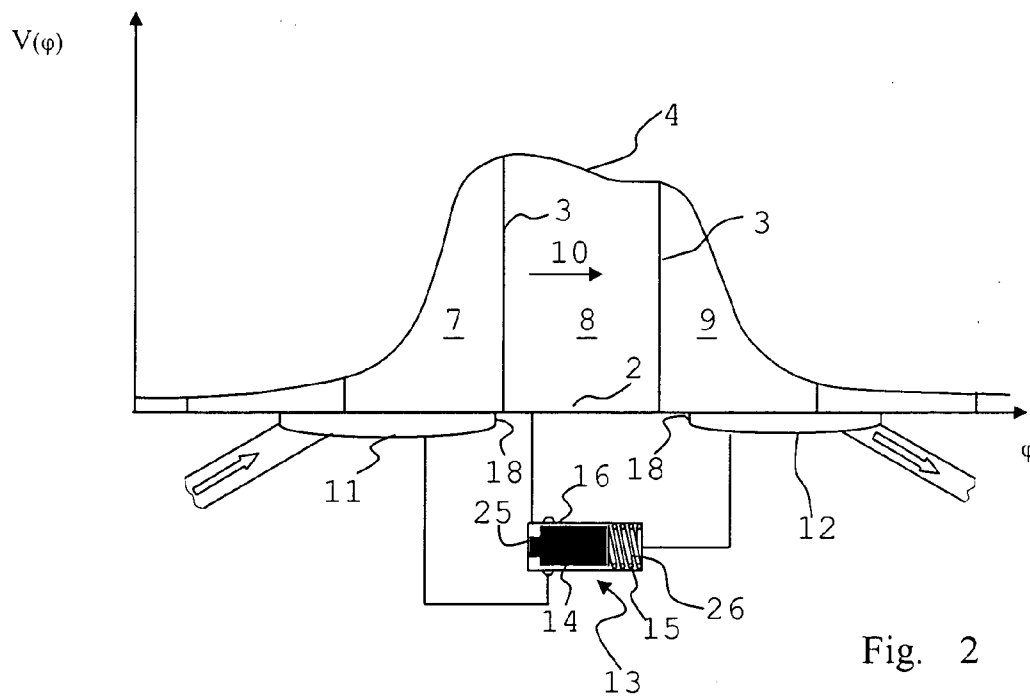


Fig. 2

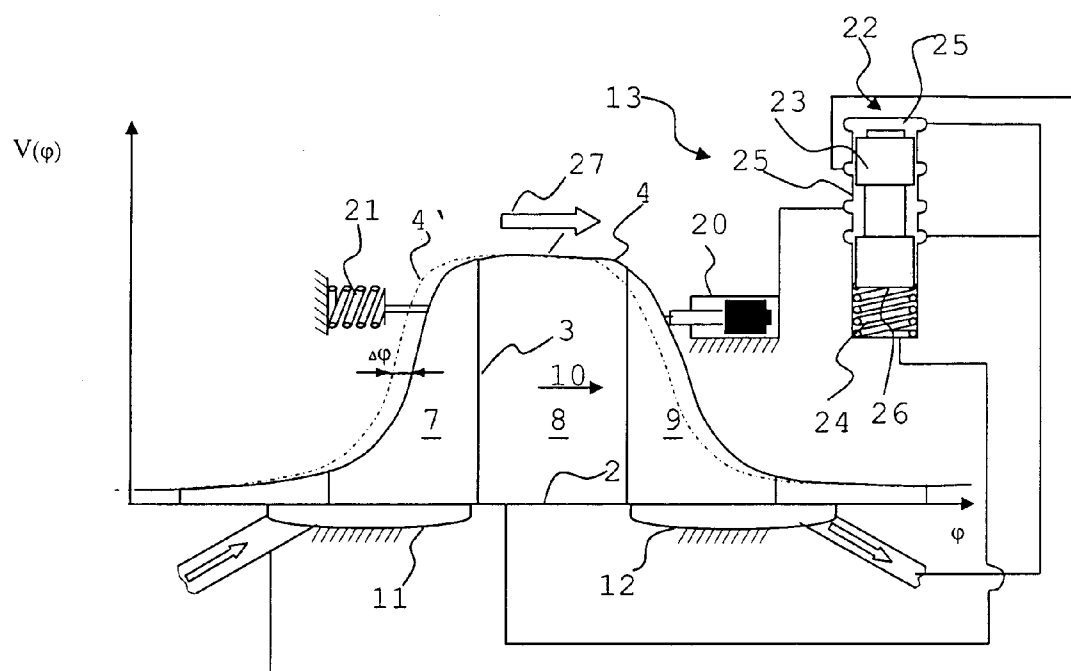


Fig. 3

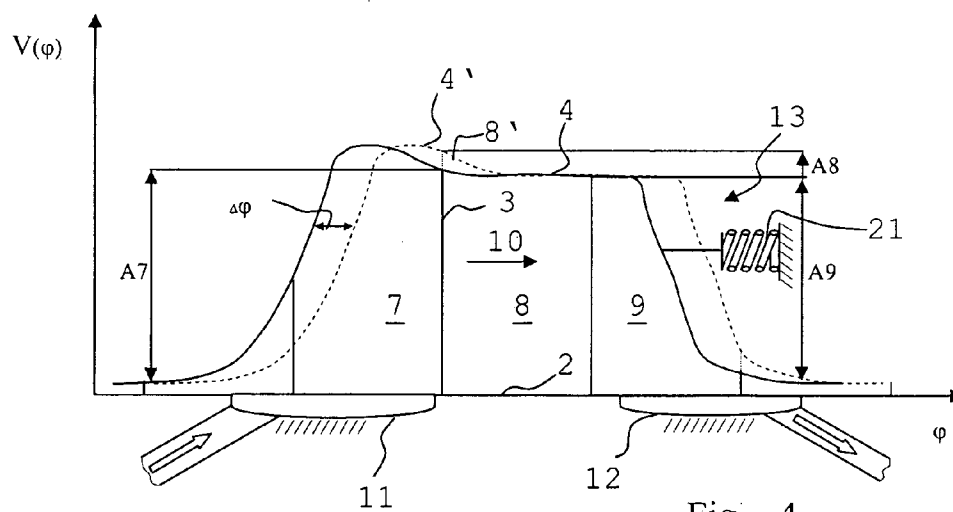


Fig. 4

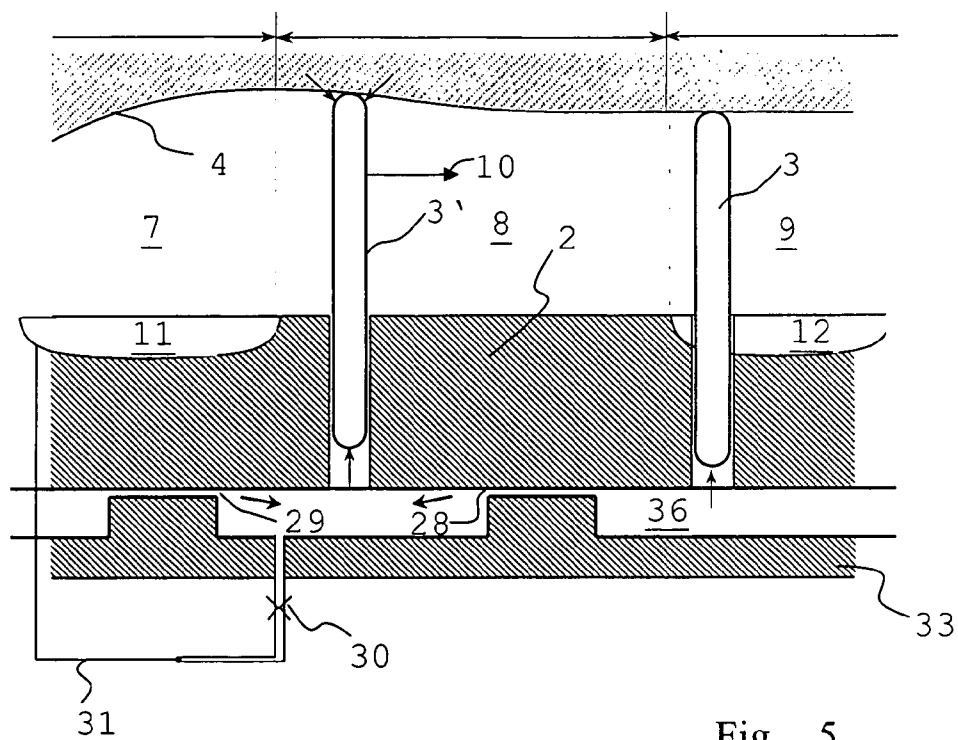


Fig. 5

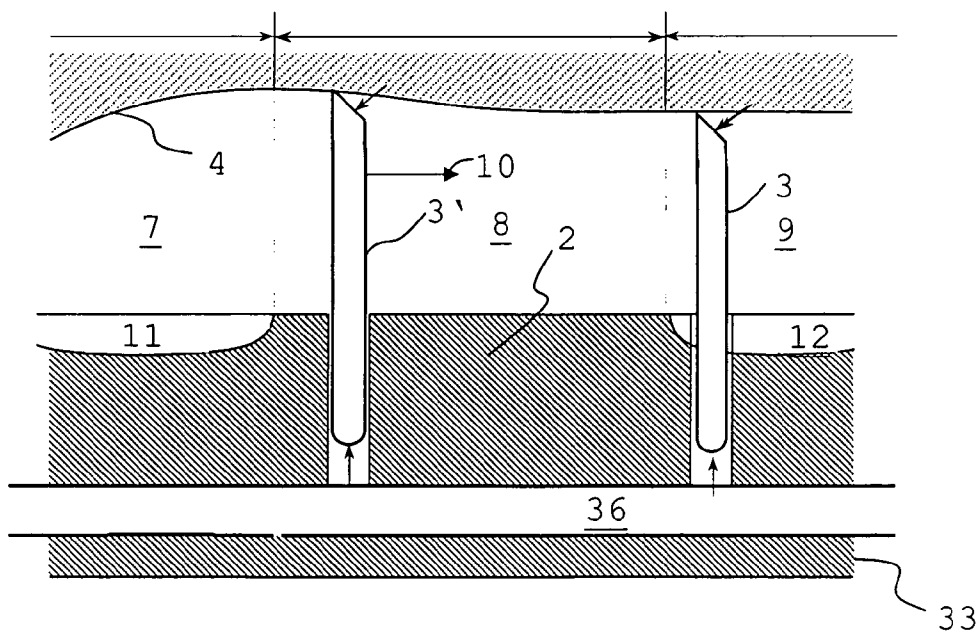


Fig. 6

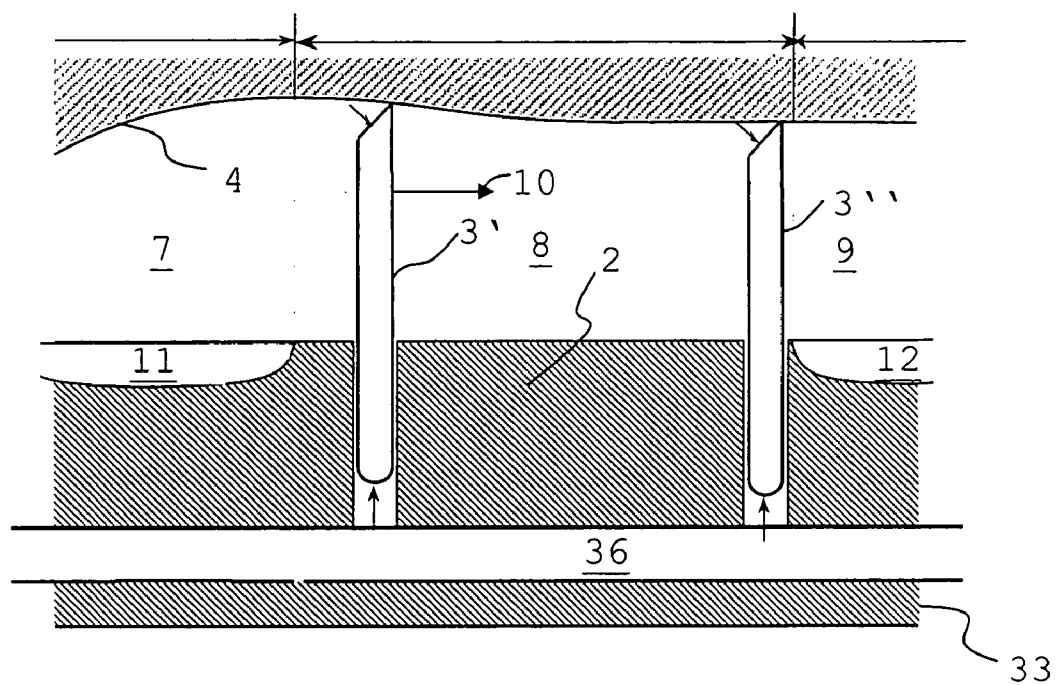


Fig. 7

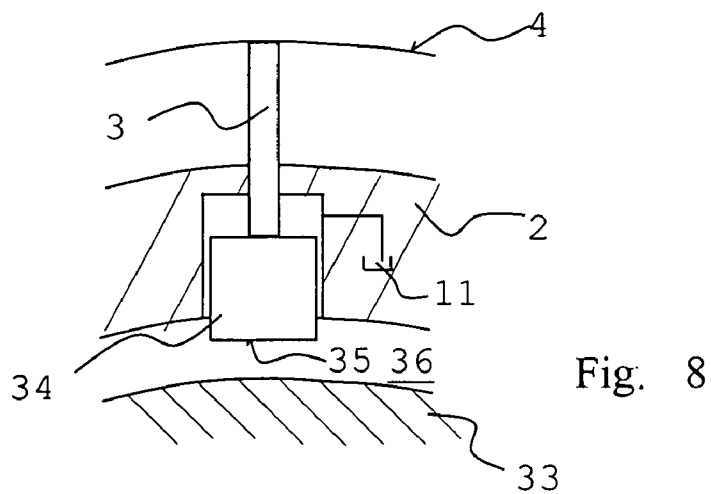


Fig. 8

SLIDING VANE PUMP

BACKGROUND OF THE INVENTION

[0001] The invention relates to a sliding vane pump including a rotor with vanes disposed in a pump housing including suction, pumping and pressure chambers formed between the vanes and the housing.

[0002] DOS 198 29 726 A1 discloses a sliding vane pump wherein the noise generated as a result of pressure pulses is reduced. In order to provide for a smooth pressure increase between the suction side and pressure side of the pump, transmission passages in the form of chambers are provided which permit a return flow of the hydraulic fluid from the pressure chamber to the pumping chamber. In this way, a pressure jump between the pumping chamber and the pressure side is reduced whereby the pressure pulsations are reduced, particularly with a high air content in the oil being pressurized.

[0003] The patent publication DE 196 26 211 C1 discloses a sliding vane pump with a contour ring formed in such a way that the hydraulic fluid can be pre-compressed as a result of a volume reduction of the pumping chamber. A pressure jump between the pumping chamber and the pressure side of the pump cannot be eliminated with such an arrangement, at least not for a particular operating point.

[0004] It is the object of the present invention to provide a sliding vane pump with a pre-compression in the pumping chamber which improves the noise behavior of the pump over a large operating range.

SUMMARY OF THE INVENTION

[0005] In a sliding vane pump comprising a rotor supported in a housing and having vanes supported radially movably in radially extending slots of the rotor so as to be in contact with the inner surface of a contour ring which is rotatably supported in the housing and forms with the vanes suction pumping and pressure chambers for pumping and pressurizing a fluid, a pressure control arrangement is provided for limiting the pressure in the pumping chamber to the pressure present in the pressure chamber thereby to prevent the generation of noise upon coupling of the pumping chamber with the pressure chamber.

[0006] If, for example, the pressure is higher in the pumping or pre-compression chamber than in the pressure chamber the arrangement provides for a pressure reduction in the pre-compression chamber to the pressure level in the pressure chamber. By the in-coupling of the volume of the pumping chamber into the pressure chamber, there are no pressure oscillations whereby noise development is prevented. The arrangement avoids the development of noise in the pressure range in an advantageous manner also with changing pressures which are determined by the operating pressure of a system to which the fluid is supplied.

[0007] The pre-compression pressure which can be achieved corresponds to a minimum operating pressure of a system to which the pressurized fluid is to be supplied. If the pumping chamber is so designed that the pressure achievable by the pre-compression corresponds to the maximum operating pressure of the system to which the fluid is supplied over the whole operating range of the system being supplied, there is the same pressure in the pumping chamber

at the time when the pumping chamber is placed into communication with the pressure chamber so that, at this point, little or no noise is generated.

[0008] In a particular embodiment of the invention, the arrangement includes a valve via which the pressure in the pumping chamber can be reduced by placing it in communication with the suction area. If the pressure in the pumping chamber is higher than the pressure in the pressure chamber hydraulic fluid is released, in a controlled manner, to the suction chamber. The valve includes a slide member and a spring. The pressure limiting valve must have high dynamics; therefore a slide member of the pressure limiting valve consist preferably of aluminum. Since the volume flows through the valve are very small, the slide member should also be of a relatively small design.

[0009] In a further embodiment of the invention, the arrangement comprises vanes which delimit the pumping chamber and which are subjected to a low vane pressure. If the pre-compression pressure of the pumping chamber is higher than the pressure in the pressure chamber, the hydraulic fluid flows through a gap between a contour ring and a vane from the pumping chamber to the suction and/or pressure chamber. To this end, a vane vacuum which determines the force with which the vane is engaged with the contour ring, is to be adjusted such that the pressure in the pumping chamber is lowered to the level of the pressure in the pressure chamber. As soon as the force resulting from the vane vacuum effective on the front side of the vane disposed between the pumping and the suction chamber is smaller than the force resulting from the pressure in the suction and pumping chamber on the opposite front side of the vane, the vane lifts off the contour ring and a reduction of the pumping chamber pressure is facilitated by a release flow of the hydraulic fluid from the pumping chamber to the suction chamber. By the same principle, the pressure is released from the pumping chamber by a flow of the hydraulic fluid from the pumping chamber to the pressure chamber. As soon as the force from below the vane on the front side of the vane disposed between the pumping chamber and the pressure chamber is smaller than the force resulting from the pressure in the pumping- and pressure chambers on the opposite front side of the vane, the vane lifts off the contour ring and a pressure equalization between the two chamber is facilitated. The arrangement according to the invention can therefore be provided very cost-effectively.

[0010] In a further embodiment of the invention, the arrangement includes a contour ring which is rotatable relative to the suction and pressure chamber whereby the pressure in the pumping chamber can be adjusted to the same pressure present in the pressure chamber. By rotating the contour ring relative to the suction and pressure chambers, the level of the pre-compression of the hydraulic fluid in the pumping chamber can be determined. The vanes of the sliding vane pump slide along the radially inner surface of the contour ring. A pumping chamber transports the hydraulic fluid from the suction to the pressure areas, the pumping chamber being separated from the suction chamber and the pressure chamber over an angular range predetermined by the design of the pump. If in the range determined by the angular range, the radius of the contour ring becomes smaller, the hydraulic fluid is pre-compressed by a volume reduction of the pumping chamber; if the radius remains constant the volume and the pressure level remain constant.

In accordance with the invention, the contour ring is rotated during operation of the pump such that the same pressure level is established in the pumping chamber and in the pressure chamber. In this way, no pressure changes occur with the in-coupling of the pumping chamber into the pressure chamber.

[0011] Preferably, the contour ring is rotatable by a cylinder piston unit. The cylinder-piston unit rotates the contour ring with respect to the suction and pressure chambers. The cylinder-piston unit is supported on the pump housing and is connected to the contour ring. By applying pressure to the cylinder-piston unit the contour ring can be rapidly rotated.

[0012] In a further embodiment, the contour ring is rotated by the pressure difference in the suction and pressure chambers. The contour ring is rotatably supported. In the suction and the pressure areas different pressure levels are present. The pressures in the suction and pressure areas and the pressure in the pumping chamber are effective on the surfaces of the contour ring which delimit these areas. If for example, the surface areas, on which the pressure is effective in the circumferential direction, are equal and the pressure in the pressure chamber is noticeably higher than in the suction chamber, a force is effective on the contour ring which can be used for rotating the contour ring relative to the suction and pressure chambers. Since the surface areas of the pumping chamber on which the pressure is effective in the circumferential direction is very small in comparison with the effective surface areas in the suction and the pressure area, this force component can be essentially neglected. With this arrangement, the contour ring can be rotated in an advantageous manner without an additional operating element.

[0013] Preferably, the contour ring is held in a predetermined position by a spring, which may be a coil spring, a leaf spring, a plate spring or an air spring. The spring is disposed between the contour ring and the housing of the suction and the pressure chamber. The spring force is directed opposite to a force which rotates the contour ring, for example a force of a cylinder piston unit. By way of the spring characteristic the angle of rotation of the contour ring is controllable.

[0014] The cylinder piston unit however may also be provided with a control unit. The control unit comprises a slide member disposed in a housing and a spring. The control unit controls the cylinder-piston unit in such a way that the pressure level present in the pumping chamber is adjusted to the same pressure level as is present in the pressure chamber. The control unit derives from the pressure in the pressure chamber the pressure for the cylinder piston unit. The level of the pressure is controlled depending on the difference of the pressure in the pumping and the pressure chambers. Under the control of the slide hydraulic fluid is supplied to the suction chamber for avoiding hydraulic fluid losses and cavitations.

[0015] In a particular embodiment of the invention, the vane pump includes two suction, two pumping and two pressure chambers. With the arrangement, a compact sliding vane pump with high pumping volume can be provided in an advantageous manner.

[0016] Further features and feature combinations will become apparent for the following description of the inven-

tion on the basis of the accompanying drawings. The drawings show the various embodiments in a simplified manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 shows schematically a sliding vane pump,

[0018] FIG. 2 shows a partial area of a development of the contour ring of the sliding vane pump of FIG. 1 in a first embodiment,

[0019] FIG. 3 shows a partial area of a development of the contour ring of the sliding vane pump of FIG. 1 in second embodiment of the invention,

[0020] FIG. 4 shows a partial area of development of the contour ring of the sliding vane pump of FIG. 1 in a third embodiment of the invention,

[0021] FIG. 5 shows a partial area of a development of the contour ring of the sliding vane pump of FIG. 1 in a fourth embodiment of the invention,

[0022] FIG. 6 shows a variation of the arrangement shown in FIG. 5,

[0023] FIG. 7 shows a variation of the arrangement shown in FIGS. 6, and

[0024] FIG. 8 shows an arrangement for the amplification of the vane engagement pressure.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

[0025] Identical component of the FIGS. 1 to 8 are designated below by the same reference numerals.

[0026] Sliding vane pumps are used in connection with various systems such as steering systems, brake systems, active wheel suspension systems or transmissions because they are compact and relatively inexpensive. FIG. 1 shows schematically a design of a double action sliding vane pump 1. A rotor 2 with radially movable vanes 3 is arranged within a contour ring 4. The sliding vane pump 1 includes two suction areas 5 and two pressure areas 6, which comprise each suction and pressure passages which are not shown, suction and pressure areas 11, 12 and suction and pressure chambers 7, 8. Two side plates which are not shown delimit the chambers 7, 8, 9 formed by the vanes 3 and the contour ring 4 in axial direction. Into these side plates, the suction pockets 11 and the pressure pockets 12 are formed which are in communication with the fluid suction and pressure passages. A shaft rotates the rotor 2 with the vanes 3 in the direction of rotation 10. The operation of the sliding vane pump 1 will be described below for one of the double action sides.

[0027] As the volume of the suction chamber 7 increases with the rotation of the rotor in the direction of the arrow 10 hydraulic fluid is sucked into the chamber 7. A pumping chamber 8 at the same time moves the previously sucked in hydraulic fluid to the pumping area 6 while the pumping chamber 8 is in communication with neither of the suction and the pressure pockets 11, 12. As soon as the, in the direction of rotation 10, rear edge 17 of the vane 3 of the pumping chamber 8 reaches the pressure pocket 12, the hydraulic fluid volume is coupled into the pressure area 6. The volume of the pressure chamber 9 then becomes smaller

whereby the hydraulic fluid is pumped by way of the pressure pockets 12 into a pressure channel.

[0028] If the pressure in the pressure area 6 is noticeably higher than in the pumping chamber 8, pressure oscillation occur in the in-coupling phase which results in an increased noise generation of the sliding vane pump 1. Particularly if the pumping chamber 8 is not fully filled by hydraulic fluid but includes also air, a spontaneous compression of the pumping volume 8 occurs during in-coupling with a high pressure difference between the pumping and the pressure chambers 8, 9. This results in disturbing pumping pressure changes. Such a spontaneous compression is avoided by ensuring that the pressures in the pressure area 6 or, respectively, in the pressure chamber 9 and in the pumping chamber 8 are essentially the same.

[0029] FIG. 2 shows schematically a sliding vane pump 1 in a first embodiment 13. The circumference of the contour ring 4 the vanes 3 and the suction and pressure pockets 11, 12 are shown in the diagram in a development so that the volume of the chambers 7, 8, 9 is indicated over the angle or rotation ϕ . The pockets 11, 12, which are arranged in the actual pump housing in the side walls thereof are shown schematically in the following figures adjacent the chambers 7, 8, 9. The radii changes of the contour ring 4 are exaggerated to show the clearly the volume changes of the chambers. Analogous to FIG. 1, the volume of the chamber 7 and of the chamber 7a which is in the direction of rotation ahead of the chamber 7 increases whereby hydraulic fluid is sucked into those chambers. The suction step is completed as soon as, with the continued rotation of the rotor 2, the chamber 7 is no longer in communication with the suction pocket 11. In the pumping chamber 8, the hydraulic fluid is pre-pressurized. The pressure generated thereby is to be adjusted to the maximum operating pressure of the system to which the hydraulic fluid is to be supplied. The contour ring is therefore so shaped that the volume of the pumping chamber 8 is reduced upon rotation of the rotor. This arrangement makes it possible that, upon in-coupling of the pumping chamber 8 into the pressure area 6, no pressure pulsations occur. If the sliding vane pump 1 supplies a system with a variable operating pressure a device 13 lowers the pressure in the pumping chamber 8 to the level of that in the pressure chamber 9. The arrangement 13 in the form of an over pressure valve comprises, disposed in a housing 16, a piston 14 and a spring 15. A first front end face 23 of the piston 14 is subjected to the pressure of the pumping chamber 9 and the force of the spring 15. As a result of the pressure in the pumping chamber 8, a first force component acts on the piston 14; because of the pressure in the pressure chamber 9 a second force component is provided. If the first force component is greater than the second force component and the spring force, then the piston 14 moves to the right toward the spring 15. As a result, then the pumping chamber 8 is placed into communication with the suction pocket 11, whereby the pressure in the pumping chamber is released until the second force component combined with the spring force is larger than the first force component and the piston 14 is again moved toward the left.

[0030] The spring 15 has the purpose of holding the piston in a defined position. The spring force is very low so that the pressures in the chambers 8, 9 are controlled to be essentially the same. The apparatus 13 reduces the pressure in the chamber 8 to the pressure level effective in the chamber 9.

Noises generated by pressure pulsation can be effectively avoided even with changing pressures in the pressure pocket 12 and, respectively, in the pressure channel 6.

[0031] In an embodiment which is simplified with regard to FIG. 2, but which is not shown, the pressure pocket 12 is in communication with the pumping chamber 8 only via a connecting line without the apparatus 13 disposed therein. In this case also, the connection between the apparatus 13 and the suction pocket 11 is omitted.

[0032] If for example the pressure in the pressure pocket 12 is higher than in the pumping chamber 8, hydraulic fluid can flow from the pressure pocket 12, via the connecting line, to the pumping chamber 8 and, as a result, reduce the pressure difference and the resulting oscillations. The length and the cross-section of the connecting line and the transfer flow volume determined by the position of the control edges 18 should be optimized for an efficient oscillation reduction.

[0033] FIG. 3 shows a second embodiment of an apparatus 13, which provides for equal pressures in the pumping or pre-compression chamber 8 and in the pressure chamber 9. The apparatus 13 comprises a cylinder-piston unit 20, a spring 21, a control unit 22 and a rotatable contour ring 4. The cylinder piston unit 20 is connected to the contour ring 4. By applying pressure to the cylinder-piston unit 20, the contour ring 4 is rotated relative to the suction and pressure pockets 11, 12. By rotation of the contour ring in the same or the opposite direction indicated by the arrow 27, the level of the pre-compression of the hydraulic fluid is adjustable. For example, the pre-compression is increased as the contour ring 4 in FIG. 3 is rotated in a direction opposite to the arrow 27. A spring 21 provides for a well-defined position setting of the contour ring 4 and generates a return force. The spring 21 may be arranged between the housing of the suction and the pressure pockets 11, 12 or, alternatively it may be arranged in the cylinder piston unit 20. In order to compensate for temperature changes, the spring 21 may also be temperature sensitive that is it may be a bi-metal spring or a memory shape metal spring. Also, several springs may be provided in a parallel or in a serial arrangement. A control unit 22 determines the operating pressure for the cylinder piston unit 20. The control unit 22 includes a slide valve 23 with a spring 24 which are arranged in a housing 25. As master control pressure, the pressure of the pressure pocket 12 is applied to the front surface 25 of the slide member, while the pressure of the pumping chamber 8 and the force of the spring 24 are applied to the opposite front face 26.

[0034] Below, the operation of the apparatus 13 according to the invention is described. If, for example, the operating pressure of the system to be operated is low, no pre-compression should take place in the pumping chamber 8. The spring 24 moves the slide member 23 into a position in which the line to the cylinder piston unit is connected to the suction pocket 11 so that the spring 21 can rotate the contour ring 4 in the direction of the arrow 27. The contour ring 4 is so designed that, in this position, the volume of the pumping chamber 8 does not change. As soon as, by an increase of the operating pressure, the force on the first front area 25 becomes larger than the spring force 20 and the pressure force on the second front face 26, the slide 23 moves and blocks the connection to the suction side.

[0035] At the same time, communication is established between the pressure in the pressure pocket 12 and the cylinder-piston unit 20.

[0036] As a result of the pressure application to the cylinder piston unit 20, the contour ring 4 is rotated by an angle $\Delta\phi$ in a sense opposite to the direction of the arrow 27 to the position 4', so that pre-compression of the pumping volume is increased. The contour ring 4 is rotated, that is the pressure in the pumping chamber is increased, until the pressure and spring force on the second front face 26 move the slide 23 back so that the communication with the cylinder piston unit 20 is again interrupted. The slide 23 maintains an equilibrium between the forces effective on the first and the second front sides 25, 26, with a very small spring force is therefore approximately the same pressure provided at both front faces. As a result, also the same pressure is established in the pumping chamber 8 and the pressure chamber 9 whereby pressure pulses or pressure oscillation and the generation of noise associated therewith is effectively avoided even with varying operating pressures.

[0037] FIG. 4 shows a third embodiment of an apparatus 13 according to the invention. The apparatus 13 comprises a spring 21 and a contour-ring 4 which is rotatable by an angle $\Delta\phi$. The contour ring 4 is engaged by the spring 21, which is connected to the housing of the suction and pressure pockets 11, 12. The contour ring 4 is rotatably relative to the suction and pressure pockets 11, 12 against the force of the spring 21. Contrary to the embodiment shown in FIG. 3, no cylinder piston unit is provided. The force for rotating the contour ring 4 is obtained directly from the pressures in the suction, the pumping and the pressure chambers 7, 8, 9. The force acting on the contour ring 4 can be determined by the following equation:

$$F_k = -A_7 \times p_7 + p_8 \times A_8 + p_9 \times A_9$$

[0038] wherein:

[0039] p_7 is the pressure in the suction chamber 7

[0040] A_7 is the surface area of the contour ring 4 when exposed to the suction pressure p_7 in the circumferential direction,

[0041] p_8 is the pressure in the pumping chamber 8,

[0042] A_8 is surface area of the contour ring 4 on which the pumping pressure is effective in the circumferential direction,

[0043] p_9 is the pressure in the pressure chamber 9, and

[0044] A_9 is the surface area of the contour ring 4 on which the pressure in the chamber 9 is effective in the circumferential direction.

[0045] The surface areas A_7 and A_9 can be calculated from the effective chamber height multiplied by the chamber depth which is not shown in the drawings. If the operating pressure of a system to be supplied with hydraulic fluid is small, the spring 21 moves the contour ring into a position which does not provide for a pre-compression in the pumping chamber 8. In this position, the area A_8 has the value zero, and the areas A_7 and A_9 have the same size. The force F_k provided by the difference of the pressures p_7 and p_9 is accommodated by the spring 21.

[0046] As the system operating pressure increases, also the force F_k becomes larger as a result of the increasing pressure p_9 and the contour ring 4 rotates by an angle $\Delta\phi$. In this position, the contour ring is designated by the reference

numeral 4'. As a result of the rotation, the pumping chamber is increased by a volume 8'. In the pumping chamber 8, the hydraulic fluid is subjected to a pre-compression since the volume of the pumping chamber is decreased up to the coupling to the pressure pockets 12 by the volume 8'. Because of the small compressibility of the hydraulic fluid such as oil of 3×10^{-5} /bar, the required compression volume 8' is small. This is, with a loss-free calculation for a coupling pressure of 135 bar below 1% of the volume of the pumping chamber 8. With a rotation of the contour ring 4 by an angle $\Delta\phi$ therefore the areas A_7 and A_8 change only slightly so that this change is insignificant with respect to the force F_k .

[0047] The system can be so adjusted that the pressure in the pumping chamber 8 corresponds at the point of coupling exactly to the system operating pressure and undesirable noises generated by pressure pulsations are avoided even if the system operating pressure changes, that is, if the pressures in the pressure area 6 change. The system is adjusted essentially by selecting the shape of the contour ring 4 and the spring 21. For providing a suitable spring characteristic several springs may be used in a parallel or in a serial arrangement.

[0048] In a modified embodiment which is not shown in the figures, for the adjustment of the pre-compression pressure in the pumping chamber 8, the suction pocket and/or the pressure pocket 12 are rotatable relative to the contour ring 4. For example, the side plates are rotatable by a suitable device in such a way that the same pressure level is obtained in the pumping chamber and in the pressure chamber. Also a movable element may be provided in the suction pocket 11 and/or the pressure pocket 12 by which the control edges 18 shown in FIGS. 1, 2 can be displaced. By an adjustment of the location of the control edges 18, the level of the pre-compression can be adjusted so that upon coupling of the pumping chamber 8 into the pressure chamber 9 no pressure pulses occur.

[0049] FIG. 5 shows a sliding vane pump with a vane 3 and a throttling device for controlling the pressure below the vane 3. A vane 3 is, in the shown position, designated by the reference numeral 3'. The adjustment of the pressure in the pumping chamber 8 to the level of the pressure in the pressure chamber is obtained by a flow of the hydraulic fluid between the vane 3' and the contour ring 4. The vanes 3 are exposed to a pressure below the vanes corresponding to the pressure in the pressure chamber 9. To this end a pressure pocket 12 disposed in a side plate is placed into communication with the area 36 below the vane 3 by a passage which is not shown. The pressure is present between the rotating rotor 2 and a stationary stator ring 33, which is connected to the side plate. The vane designated by the reference numeral 3' separates the suction chamber 7 from the pumping chamber 8. Because of the shape of the vane half of the face area in contact with the contour ring 4 is exposed to the pressure in the suction chamber 7, while the other half is subjected to the pressure in the pumping chamber 8. Since the suction pressure is relatively small, the force component resulting therefrom is negligible. By a throttling device including throttles 28, 29, 30, the vane face at the bottom of the vane 3' is exposed to a pressure which is half the pressure in the pressure chamber 9. As a result, the vane 9' is lifted off the contour ring 4 when the pre-compression pressure in the pumping chamber 8 exceeds the pressure in the pressure

chamber 9. The hydraulic fluid flowing through the throttle 3 is returned to the suction pocket 11 by way of a return line 31.

[0050] Hydraulic fluid flows from the pumping chamber 6 to the suction chamber 7 until the pressure in the pumping chambers 8 equals that in the pressure chamber 9.

[0051] The throttling arrangement is such that from the area below the vane 3 a hydraulic volume flow is diverted and flows via the first and the second throttle 28, 29 to the area below the vane 3'. From this area, the hydraulic fluid volume flows via a third throttle 30 into a passage 31 which extends to the suction pocket 11. If the flow resistance of the throttles 28, 29 is twice that of the flow resistance of the throttle 30, a pressure is established below the vane 3' which is half as large as the pressure in the pressure chamber 9.

[0052] By changing the flow resistances of the throttles 28, 29, 30 of course also the pressure below other vanes is adjustable. In this way, for example, also the pre-compression pressure in the pumping chamber 8 is adjustable which is below or above the pressure level in the pressure chamber 9. Furthermore, also pressure losses which occur as a result of leakages can be compensated for by changing the pressure below the vane 3'.

[0053] FIG. 6 shows an arrangement wherein the throttling devices are omitted. The front surface of the vane 3' for example which is in contact with the contour ring 4 is so formed that the pressure of the pumping chamber 8 is effective on the whole front surface. The whole area 36 below the vane is subjected to the pressure in the pressure chamber 9. As a result, the vane 3' is lifted off the contour ring 4 as soon as the pre-compression pressure in the pumping chamber 8 exceeds the pressure in the pressure chamber 9 whereby the pressure in the pumping chamber 8 is adjusted to the level of the pressure in the pressure chamber 9.

[0054] The vane of the variant shown in FIG. 7 is so formed that the front side of the vane 3" which is in contact with the contour ring 4 is subjected to a force resulting from the pressure in the pumping chamber 8. The vane designated by the reference numeral 3" separates the pumping and the pressure chambers 8, 9. The area 36 below the vane is exposed to the pressure of the pressure chamber 9. If the pressure in the pumping chamber 8 exceeds the pressure in the pressure chamber 9, the vane 9" is lifted off the contour ring 4 so that the pressures in the pumping and pressure chambers are equalized.

[0055] FIG. 8 shows an arrangement for amplifying the vane engagement pressure. The area 35, which is subjected to the pressure in the pressure chamber 9, is increased by the provision of an amplifier piston 34. As a result, the force by which the vane 3 is biased toward the contour ring 4 is increased. The space at the opposite side of the piston is in communication with the suction pocket 11 so that no counter pressure can build up.

[0056] The arrangement may be used for example if only an insufficient contact pressure can be achieved because of leakages in the pumping chamber 8 and/or the pressure chamber 9.

[0057] The various arrangements 13 described above for the adjustment of a pressure of the same level in the pumping and in the pressure chamber 8, 9 can of course be combined. All arrangements can be used in connection with single stroke and/or controlled sliding vane pumps.

What is claimed is:

1. A sliding vane pump, comprising a rotor (2) with vanes (3) radially movably supported on the rotor (2) in circumferentially spaced relationship, a contour ring (4) extending around the rotor (2), the vanes being in contact with the contour ring (4) so as to form between the rotor, the contour ring (4) and the vanes (3) suction chambers (7), pumping chambers (8) and pressure chambers (9) for pumping and pressurizing a fluid, the fluid being pre-compressed in the pumping chamber (8), and an arrangement for providing in the pumping chamber (8) and in the pressure chamber (9) essentially the same maximum pump pressure level.

2. A sliding vane pump according to claim 1, wherein the maximum pressure level corresponds to the maximum operating pressure of a system to which the pressurized fluid is to be supplied.

3. A sliding vane pump according to claim 1, wherein the pump includes a fluid suction pocket (11) and a pressure pocket (12) and an arrangement (13) is provided including a valve disposed in a communication path between the fluid pressure chamber (8) and the fluid suction pocket (11) for discharging pressurized fluid from the fluid pumping chamber (8) when the fluid pressure in the fluid pumping chamber (8) exceeds the pressure of the fluid in the fluid pressure chamber (9).

4. A sliding vane pump according to claim 1, wherein means are provided for supplying fluid under pressure to an area in the rotor below the vanes for biasing the vanes outwardly into contact with the contour ring (4).

5. A sliding vane pump according to claim 3, wherein the contour ring (4) is rotatably supported for changing the angular position thereof relative to the fluid suction, pumping and pressure chambers (7, 8, 9) for controlling the pressure in the pumping chamber (8) relative to the pressure in the pressure chamber (9).

6. A sliding vane pump according to claim 5, wherein means are provided for rotating the contour ring (4) based on pressure differences in the suction, pumping and pressure chambers (7, 8, 9).

7. A sliding vane pump according to claim 6, wherein a cylinder piston unit (20) is connected to the contour ring (4) for rotating the contour ring (4).

8. A sliding vane pump according to claim 5, wherein a spring is connected to the contour ring (4) for biasing the contour ring (4) into a predetermined angular position.

9. A sliding vane pump according to claim 7, wherein the cylinder piston unit (20) is connected to a control unit (22) for controlling the angular position of the contour ring (4).

10. A sliding vane pump according to claim 1, wherein the sliding vane pump includes two suction, two pumping, and two pressure chambers (7, 8, 9).

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