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(54) **Volumetric fluid machine**

(57) A volumetric fluid machine includes a stator (2) in which are placed, with rotatory motion, a first rotor (6) and a second rotor (7), mutually associated and with conjugated external profiles (10, 11). The first rotor (6) has a profile (10) presenting at least a lobed part (10a), associated to an inner surface (4) of the stator (2), which defines, together with the inner surface (4) of the stator (2) and with the profile (11) of the second rotor (7), at least a chamber (12) with cyclically variable volume from a maximum value to a minimum value when the first rotor (6) rotates around a corresponding axis (X), in order to exchange energy with a moving fluid. Moreover the lobed part (10a) delimits, together with the inner surface (4) of the stator (2), a first gap (14) capable to guarantee fluid tightness.

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Description

[0001] This invention concerns a volumetric fluid machine, whose application can be either for liquids and for gas, especially in hydraulic machines, both as power generating machine (such as pumps and compressors) and as operating machine (such as hydraulic and gas turbines).

[0002] In detail, this invention concerns the field of volumetric machines, in which a defined volume, filled by a fluid, is periodically and alternatively put in communication with two separated surroundings at different pressures by the relative motion of mechanical parts. The invention is related to the rotary volumetric machine class in which at least one has a rotatory motion.

[0003] It is known that volumetric machines, in particular of type having rotating chambers, comprise one or more variable volume chambers which are periodically and alternatively put in communication with an intake room and with an exhaust room. The volume variation of the chambers is obtained by means of the relative motion of same surfaces delimitating them. This relative motion is achieved by different movement mechanisms, but having in any case a continuous relative motion between a stator and a rotor.

[0004] In detail, the chambers are defined by a properly shaped external profile of the rotor, and by a corresponding internal profile of the stator. The chambers are generally enclosed at their sides by floating plates, to recover the play in order to avoid fluid leakage.

[0005] As known, the chamber fluid sealing is achieved by one or more sliding contacts, realised between bulges or protuberances of the rotor and the stator internal surface, which avoid undesired fluid leakage from or into the chamber itself. Unfortunately this system requires the presence of sliding elements subject to wear and deterioration over time, which contribute therefore to reduce the fluid tightness in the machine reducing the hydraulic efficiency.

[0006] Improved systems for fluid tightness are known able to recover the play caused by the wear, which consist in positioning on the rotor proper sealing elements (blades), sliding radially. Owing to wear these sealing elements anyway tend to preserve their contact position with the inner stator surface, by means of compressed radial springs or even by the effect of the centrifugal force generated on them by the rotor movement. Nevertheless, such a system is characterised by the disadvantage of requiring slots on the rotor for the blade housing and anyway includes sliding elements causing wearing effects also on the stator.

[0007] Various types of volumetric machines, with gears or conjugated profiles, are known, in which two rotors are associated and put in rotation inside a stator, generally by driving a first rotor which actuates the second one. The two rotors have an external profile shaped so as to delimit one or more chambers with constant section, and combine together, defining at least one contact point, always present during the machine operation. Disadvantageously, a certain quantity of the fluid can remain trapped in correspondence of the contact point, for example due to surface deformability of the two rotors or due to irregularities of rotor profiles. The quantity of fluid which is so trapped is restricted into a small volume and in case of a sudden reduction of available volume for example due to local deformabilities of rotors in contact, it could generate very high pressure leading to irregular functioning and even danger for the machine itself.

[0008] In this situation the technical object of this invention is therefore to realize a volumetric fluid machine capable to avoid the described disadvantages. With reference to this technical object, the principal aim of this invention is to realize a volumetric fluid machine which can limit fluid leakage without the use of sliding sealing parts. Further aim of this invention is to realize a volumetric fluid machine which can avoid dangerous overpressures near the contact points between the rotating parts. Finally, aim of this invention is to realize a volumetric fluid machine which does not require expensive mechanical processing in order to house the sealing parts.

[0009] The described technical aim and the specified aims are substantially achieved by a volumetric fluid machine characterised in that it comprises one or more of the technical solutions presented hereafter.

[0010] The description of a preferred embodiment of the invention is presented hereafter as an indicative, but not limitative, example, with reference to the annexed drawings in which:

[0011] - Figure 1 shows a front sectional view of a machine in a first embodiment, according to the invention,

[0012] - Figure 2 shows a rear view of the machine of figure 1;

[0013] - Figure 3 shows a sectional view of a detail of the machine of figure 1

[0014] - Figure 4 shows a section view of another detail of the machine of figure 1

[0015] - Figure 5 shows a front sectional view of the machine, according to another embodiment.

[0016] With reference to the annexed drawings, the volumetric fluid machine according to the invention is referred to with number 1.

[0017] According to the embodiment shown in figure 1, the machine 1 comprises a stator 2 comprises the stationary part of the machine 1. The stator 2 includes an external stiff casing 3, divided in a first portion 3a and in a second portion 3b, associated each other by a movable connection,

[0018] In detail a screw connection 3c.

[0019] The external casing 3 presents an inner surface 4 which delimits, together with the machine sides (not depicted in the figures), an internal cavity 5 for housing a pair of rotors 6, 7. The first rotor 6 and the second one 7 can rotate respectively around a first X and around a second rotational axis Y. Preferably, according to the shown embodiments, the two rotational axis X and Y are parallel.

[0020] The inner surface 4 is defined in part by the first portion 3a of the casing 3, and in a remaining part by the second portion 3b of the casing 3. According to the sectional view of figure 1, the inner surface 4 has a shape defined substantially by a partial overlapping of a first circular profile having a larger diameter, associated to the first rotor 6, with a second circular profile having a smaller diameter than the first, associated to the second rotor 7. The cavity 5 communicates with the outside by an intake opening 8 and an exhaust opening 9, both of them located on the inner surface 4. In the illustrated embodiments, the two openings 8, 9 are placed near the intersections of the two above mentioned circular profiles which form the inner surface 4 of the casing 3.

[0021] The two openings 8, 9 communicate respectively with an intake pre-chamber 8a and with an exhaust pre-chamber 9a through two ducts 10 placed in the second portion 3b of the external casing 3. In an embodiment, not illustrated in the figures, the two openings 8, 9 are associated with unidirectional valves in order to avoid refluxes of fluid which could be very dangerous for the proper functioning of the machine 1.

[0022] The first rotor 6 has a substantially circular external profile 10 and presents a lobed part 10a that extends towards the inner surface 4 of the casing 3 and that is associated with the inner surface 4 itself. In the illustrated embodiments, such lobed part is cusped shaped with the vertex is associated with the inner surface 4 of the casing 3.

[0023] The second rotor 7 has an external profile 11 conjugated to the external profile 10 of the first rotor 6, so that the above mentioned external profiles 10, 11 are allowed to continuously associate each other during the rotation of the two rotors 6, 7.

[0024] The external profile 10 of the first rotor 6, with the mentioned lobed part 10a, has the function of delimiting together with the inner surface 4 and with the external profile 11 of the second rotor 7, at least one chamber 12 whose variable volume cyclically varies from a maximum to a minimum value when rotor 6 rotates around the first axis X, in order to exchange energy with a moving fluid. This chamber 12 is therefore intended to contain the fluid and, cyclically, to move it at least from the intake opening 8 to the exhaust opening 9. In particular, in the embodiment illustrated in figure 1, the external profile 10 of the first rotor 6, together with the inner surface 4 and with the external profile 11 of the second rotor 7, delimits two chambers: a first chamber 12 associated with the intake opening 8 and a second chamber 13 associated with the exhaust opening 9, each of them having a volume which can vary cyclically changing from a maximum to a minimum value during the rotation of the first rotor 6 around the first axis X.

[0025] Advantageously the lobed part 10a, together with the inner surface 4 of the casing 3, delimit a first gap 14 capable to guarantee fluid tightness between the first chamber 12 and the second chamber 13, as shown in figure 3. The fluid sealing between the lobed part 10a and the inner surface 4 therefore relies therefore on the manufacturing accuracy of these parts. With regard to this, the first gap 14 must have a width S1 as small as possible, measured in radial direction. Preferably such width S1 must be less than 1 mm. Moreover, in order to avoid accidental interferences, for example caused by any anomalous play or by superficial roughness, the value of width S1 could be restricted to be above a proper low limit. A suitable value for width S1 is therefore expected to be in the range between 0,02 to 0,05 mm.

[0026] Advantageously as shown in figure 4, also the two rotors 6 and 7 do not operate with mutual contact. In more detail, the first rotor 6 and the second rotor 7 mutually define a second gap 15 in order to guarantee fluid tightness without causing scratching effects between the corresponding two conjugated profiles 10, 11. The second gap 15 must have a constant width S2 measured in radial direction, i.e. along a segment connecting the the first and the second rotation axis X and Y, therefore along a segment connecting rotation centres of the two rotor 6, 7. The second gap 15 allows the absence of contact between the two profiles 10, 11 of the two rotors 6, 7 thus avoiding every inconvenience that might arise and that have been already described referring to the affecting known devices.

[0027] The absence of contact between rotors 6, 7 is allowed by the fact that machine 1 comprises means for motion transmitting motion 16, in order to mutually connect rotors 6, 7 in rotatory motion. This allows to drive at the same time the two rotors 6, 7 without requiring the contact between the rotors and without the necessity of using two different actuators. Advantageously, means for transmitting motion 16 generate a constant transmission ratio, according to the peculiar geometry of the profiles 10, 11 related to rotors 6, 7, which are conjugated and therefore they need to associate each other in periodic cyclic configurations. Moreover, this transmission ratio is preferably unitary in order to simplify the aboe mentioned means for transmitting motion 16 and to guarantee a perfect association between the profiles 10, 11 of the two rotors 6, 7, which can rotate with the same angular velocity.

[0028] Advantageously, the two rotors 6, 7 rotate in the same direction. Consequently, the two corresponding profiles 10, 11, have peripheral speed with opposite direction in correspondence of the second gap 15. This generates a parallel dragging of two thin layers of fluid in opposite directions, each thin layer of fluid being associated with one of the profiles 10, 11 of the two rotors 6, 7. This causes a "scraping" effect of the thin layer of fluid associated with the profile 10 of the first rotor 6, therefore reducing the leakage of fluid through the second gap 15.

[0029] The fluid sealing between the two profiles 10, 11 of the two rotors 6, 7 relies, as for the first gap, on the manufacturing accuracy of the mentioned profiles 10, 11 and in any case assumes that also the second gap 15 has a width S2, measured in radial direction, as small as possible. Width S2 must be preferably not greater than 1 mm, for example in the range between 0,02 to 0,05 mm.

[0030] The rotation of the two rotors 6, 7 in the same direction is carried out by a mechanical setup similar to the one shown in figure 2, where a toothed belt driving transmission is illustrated, connecting in rotatory motion the two rotors 6, 7.

[0031] In detail, a toothed drive belt 18 is tied onto a pair of gear wheels 19, 19, each of which is associated with one of the two rotors 6, 7. Each gear wheel 19 is connected and permanently fixed to one of rotors 6, 7, and can rotate around one of the above mentioned rotational axis X, Y.

[0032] Moreover tensioning devices 20 are employed, implemented simply by a tensioning wheel which engages on the external non-toothed surface of the drive belt 18, in order to guarantee a constant transmission ratio between the two rotors 6, 7. Furthermore, to assure this constant transmission ratio, gear wheels 19, 19 are required to have the same diameter.

[0033] A chain or gear transmission can be used as substitute for drive belt transmission 17.

[0034] During operation, considering an initial configuration in which the lobed part 10a is placed near the intake opening 8, the first chamber 12 has a volume substantially close to its minimum value while the second chamber 13 has a volume substantially close to its maximum value. Starting from this configuration, due to a clockwise rotation of the first rotor 6, the first chamber 12 has a progressively increasing volume while the second chamber 13 has a progressively decreasing volume. This implies that the fluid is sucked up from the intake opening 8 into the first chamber 12, while the fluid contained in the second chamber 13 is pushed towards the exhaust opening 9, through which it moves out. A pumping action on the fluid is therefore produced from the intake pre-chamber 8a to the exhaust pre-chamber 9a. The described functioning is supported by the rotation of the second rotor 7, which is clockwise, that contributes to guarantee the fluid sealing of the two chambers 12, 13.

[0035] It must be specified that the profile 11 of the second rotor 7 comprises a matching surface 21 made on purpose to continuously associate itself with the lobed part 10a. Such a matching surface 21 defines on the second rotor 7 a truncated portion with reduced radial extension.

[0036] In order to smooth the functioning of the machine 1, in a second embodiment illustrated in figure 5 it is envisaged that two lobed parts 10a are made on the profile 10 of the first rotor 6. For symmetry reasons and to get an even functioning of the machine, the two lobed parts 10a, 10b are preferably placed in diametrically opposite positions. Such configuration envisages a third chamber 22 delimited by two lobed portions in cooperation with the profile 10 of the first rotor 10 and with the inner surface 4 of the casing 3. Such chamber 22, due to its positioning, maintains constant its volume for a part of the revolution of the first rotor 6 during the functioning of the machine 1.

[0037] Each lobed part 10a is associated with the inner surface 4 of the casing 3 and, together with the inner surface 4, delimits a first gap 14 in accordance with the previously described first embodiment.

[0038] Moreover, where the transmission ratio between the two rotors 6, 7 is kept unitary, it is required that the second rotor 7 must be properly shaped in order to get a correspondent profile 11 conjugated to the profile 10 of the first rotor 6. In detail, the second rotor 7 presents two matching surfaces placed in diametrically opposite positions, each of which associate always and only with one of the lobed parts.

[0039] Alternatively, according to another embodiment (not illustrated), by changing the transmission ratio between the two rotors 6, 7, the second rotor 7 presents one matching surface 21 only, that in turn can be associated with each lobed parts 10a, 10b. In this situation the means for transmitting motion 16 must be modified, for example modifying the diameter size of one or both gear wheels 19.

[0040] A volumetric fluid machine, as above described, can work either as an operating machine or as a mechanical power generator. In the first case the operating power machine, in particular a pump or a volumetric compressor, is intended to give a fluid a change in its pressure by using mechanical energy. In the second case the mechanical power generator, in particular a turbine, acts to transform at least a part of the energy of a fluid into mechanical energy. For example, a functioning as a volumetric compressor is envisaged in internal combustion engines, while a functioning as a pump, in particular a vacuum pump, is used in aircraft pressurization equipments.

[0041] In the reversal from operating machine to power generator, ad vice versa, the intake opening 8 and the exhaust opening 9 change their role, respectively becoming the exhaust opening and the intake opening. The same inversion occurs for the intake pre-chamber 8a and for the exhaust pre-chamber 9a.

[0042] Moreover it must be noted that the described machine can operate on any fluid, namely water or gas, due to their wide use in fluid machines.

[0043] This invention yields to important advantages.

[0044] With regard to the two gaps, the invention avoids any sliding contact actually present in known devices, ensuring a lasting functioning and reducing considerably the wear of the parts. Moreover this allows to eliminate possible overpressure effects that arise in known rotary devices near the contact points between the two rotors.

[0045] Among the advantages of the invention, it must be counted that the same direction of the rotation of the two rotors entails the second gap to operate under fluidodinamic conditions that ensure good fluid sealing, despite the lack of contacts between the two rotors.

[0046] Finally a fluid machine according to the invention considerably facilitates its manufacturing operations; in particular it does not require the realisation of radial slots to house the blades and the realisation of complex conjugated profiles, also with concave parts, as it happens in gearing volumetric machines whose manufacturing is difficult and very expensive.

Claims

1. Volumetric fluid machine that includes a stator (2) in which are placed, with rotatory motion, a first rotor (6) and a second rotor (7) mutually associated and with conjugated external profiles (10, 11), said first rotor (6) having a profile (10) presenting at least one lobed part (10a) associated on an inner surface (4) of the stator (2), said profile (10) of the first rotor (6) defining, together with the inner surface (4) of the stator (2) and with the profile (11) of the second rotor (7), at least a chamber (12) with cyclically variable volume from a maximum value to a minimum value when the first rotor (6) rotates around a corresponding axis (X), in order to exchange energy with a moving fluid, **characterised in that** said al least one lobed part (10a), delimits, together with the inner surface (4) of the stator (2), a first gap (14) capable to guarantee fluid tightness.

2. Machine according to claim 1, **characterised in that** the first rotor (6) and the second rotor (7) rotate in the same direction.

3. Machine according to claim 1 or 2, **characterised in that** the first rotor (6) together with the second rotor (7) delimit a second gap (15) capable to guarantee fluid tightness.

4. Machine according to any one of the preceding claims, **characterised in that** said at least one lobed part (10a) is cusp shaped.

5. Machine according to any one of the preceding claims, **characterised in that** it comprises two lobed parts (10a).

6. Machine according to claim 5, **characterised in that** the two lobed parts (10a) are placed in diametrically opposite position on the profile (10) of the first rotor (6).

7. Machine according to any one of the claims 1 to 4, **characterised in that** it comprises a plurality of lobed parts (10a) .

8. Machine according to any one of the preceding claims, **characterised in that** the first gap (14) has a width, measured in radial direction, not higher than 1 mm.

9. Machine according to any one of the claims 1 to 7, **characterised in that** the first gap (14) has a width, measured in radial direction, between 0,02 mm and 0,05 mm.

10. Machine according to any one of the claims 3 to 9, **characterised in that** the second gap (15) has a width, measured in radial direction, not higher than 1 mm.

11. Machine according to any one of the claims 3 to 9, **characterised in that** the second gap (15) has a width, measured in radial direction, between 0,02 mm and 0,05 mm.

12. Machine according to any one of the preceding claims, **characterised in that** the first rotor (6) and the second rotor (7) rotate at the same angular velocity.

13. Machine according to any one of the preceding claims, **characterised in that** the first rotor (6) and the second rotor (7) are connected by means for transmitting motion (16).

14. Machine according to claim 13, **characterised in that** said means for transmitting motion (16) generate a unitary transmission ratio.

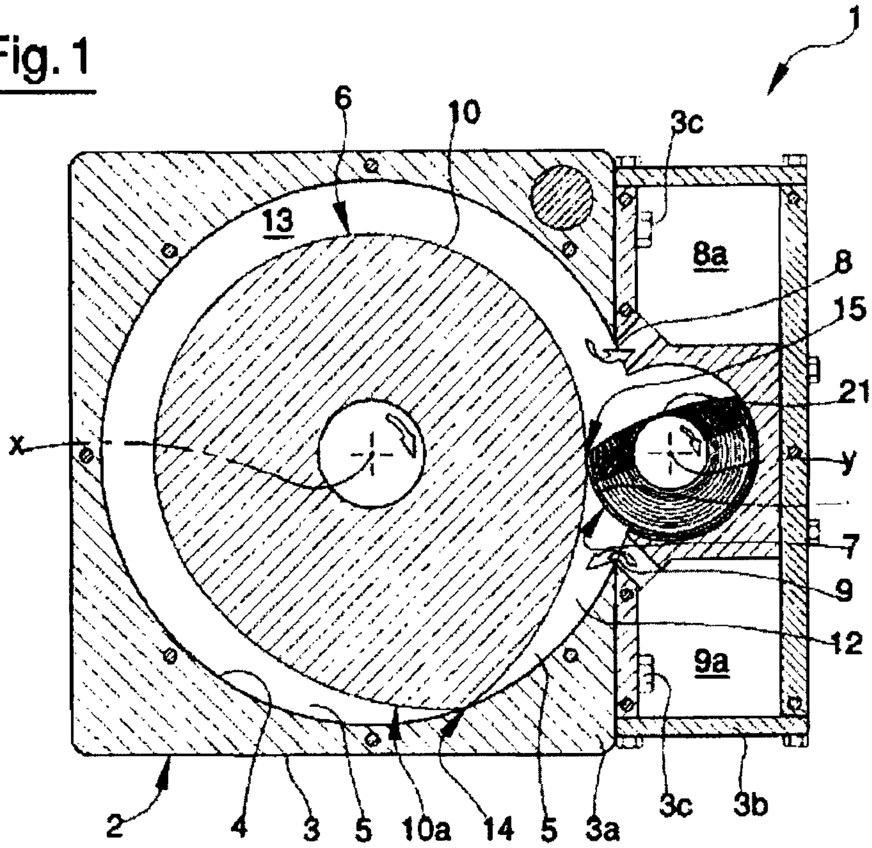
15. Machine according to claim 13 or 14, **characterised in that** said means for transmitting motion (16) are implemented by a toothed belt transmission (17).

16. Mechanical power generator, preferably of turbine type, **characterised in that** it includes one or more features according to any one of the preceding claims.

17. Volumetric compressor **characterised in that** it includes one or more features according to any one of the claims 1 to 15.

18. Vacuum pump **characterised in that** it includes one or more features according to any one of the claims 1 to 15.

Fig. 1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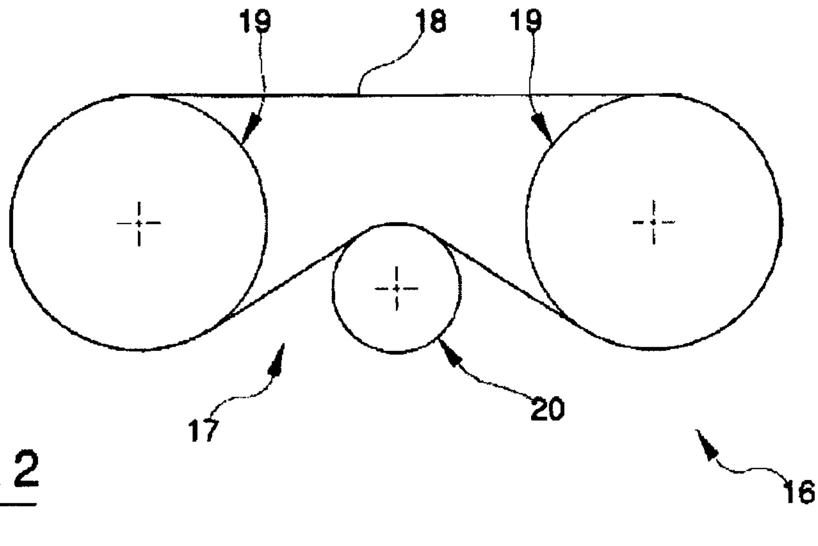
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Fig. 2

Fig. 3

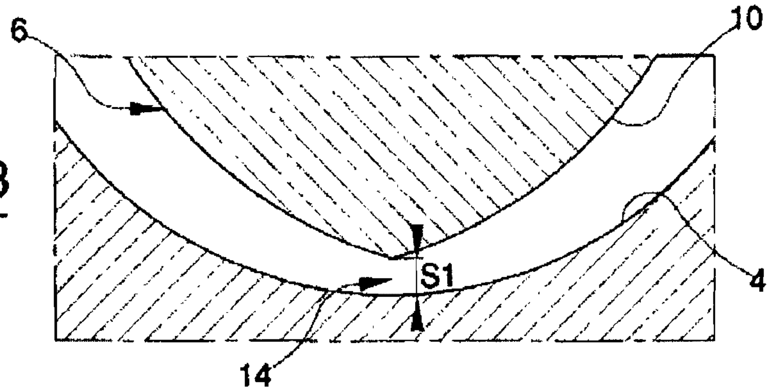


Fig. 4

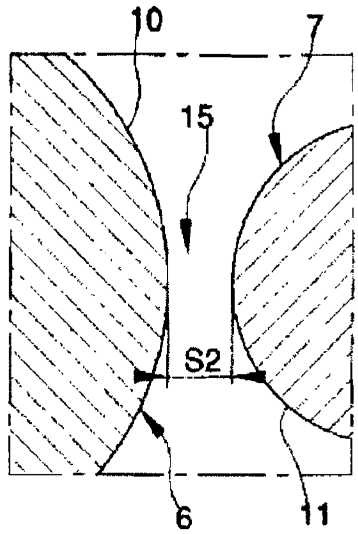
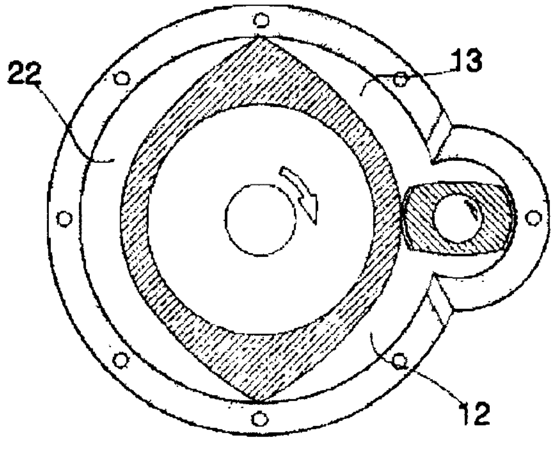


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 April 2007	Lequeux, Frédéric

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EUROPEAN SEARCH REPORT

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