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(54) **Moineau pump**

(57) The invention refers to a Moineau Pump comprising a ring-shaped outer element (2) having a conical cavity (6) along its longitudinal axis (X) and a conical inner element (4) arranged in said cavity (6), wherein the longitudinal axis (Y) of the inner element intersects the longitudinal axis of the outer element in an intersection point (I), thereby a spherical cross section (C) of the cavity (6) having said intersection point I of said longitudinal axes (X, Y) as centre forms a hypocycloid (16) or an epicycloids or an offset thereof.

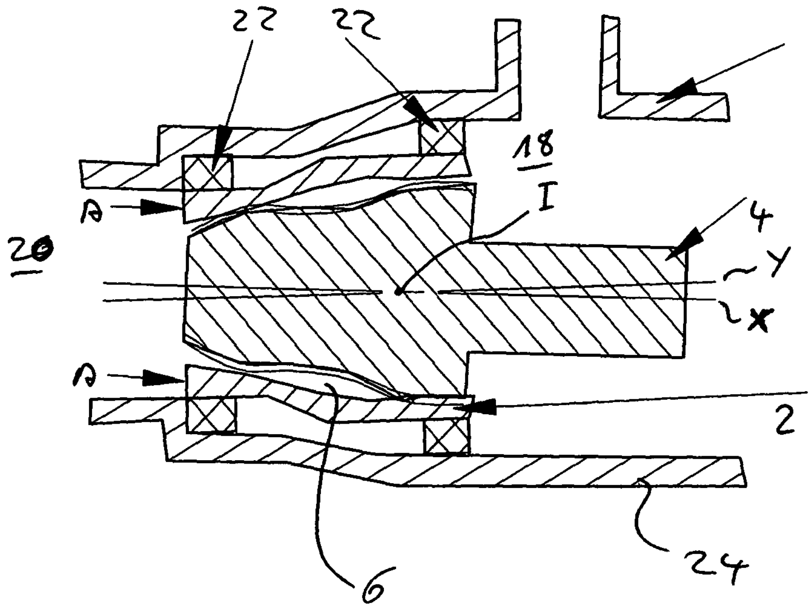

Fig 1

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Description

[0001] The invention relates to a conical Moineau Pump according to the introductory portion of claim 1.

[0002] A Moineau Pump is often referred to as a progressing cavity pump (PCP) and can be used for various purposes. These pumps comprise an outer and an inner element, whereas the inner element is arranged in a central cavity of the ring shaped outer element. The outside of the inner element and the inner side of the outer element both have a helical or screw-shaped contour forming a helical groove on the inside of the outer element and a helical groove on the outside of the inner element. The inner element is rotating along its longitudinal axis and along a circular path around the longitudinal axis of the outer element. Thereby, the outer surface of the inner element is in contact with the inner surface of the outer element.

[0003] A special form of such Moineau Pump is a conical Moineau Pump. Conical Moineau Pumps have a cavity in the outer element which widens from one end to the other, i.e. has a smaller diameter on its first end than on its opposed second end. The inner element has a corresponding conical shape, i.e. expanding from one to the other end. In such conical Moineau Pumps the longitudinal axes of the inner and outer element are inclined to one another, i.e. intersecting in one intersection point.

[0004] Up to now it is usual to manufacture at least the outer surface of the inner element or the inner surface of the outer element from an elastic material. This is required to ensure the tightness between the pressure zones in the pump which are separated by a contact line between the inner and the outer element. However, the use of an elastic material has the disadvantage that for higher pressures it is difficult to achieve the required tightness along the contact line between the inner and the outer element. In view of this it would be appreciated to use a less elastic or rigid material on both sides, i.e. the outer surface of the inner element and the inner surface of the outer element. However, because of the complex geometry of the inner and outer part and the complex motion between these elements in the pump it is impossible to produce both elements from a rigid material with the required precision to insure leak-tightness between the pressure zones inside the pump.

[0005] In view of this it is the object of the invention to improve a conical Moineau Pump in such way that it ensures leak-tightness even at high pressures.

[0006] This object is achieved by a Moineau Pump as defined in claim 1. Preferred embodiments are disclosed in the subclaims, the following description and the enclosed drawings.

[0007] The Moineau Pump according to the invention comprises a basically ring-shaped outer element having a conical cavity along its longitudinal axis. This ring-shaped outer element on its inner side has a helical path or contour as known from conventional Moineau Pumps. Further, the Moineau Pump comprises a conical inner element arranged in said cavity of the ring-shaped element. This inner element has a helical contour or path on its circumferential outer surface as known from conventional Moineau Pumps. As usual for Moineau Pumps it is preferred that the helical contour of the outer element has one more thread than the helical contour on the inner element.

[0008] Since the Moineau Pump according to the invention is a conical Moineau Pump the cross section or diameter of the cavity of the outer element increases from one end to the opposite other end. Preferably the inner element has a corresponding conical shape, i.e. a cross section or diameter increasing from one end to the opposite other end. The longitudinal axis of the inner element is inclined to the longitudinal axis of the outer element, both axes are intersecting in one intersection point. This intersection point is preferably the point at which the inner element or outer element is connected with a drive shaft.

[0009] The important feature of the present invention is that the cavity of the outer element has an optimized shape. The cavity is shaped so that it is a spherical cross section which has the intersection point of said longitudinal axes as a centre forms a hypocycloid or an epicycloid. Preferably any spherical cross section of the cavity having said intersection point of that longitudinal axes, i.e. the longitudinal axis of the inner element and the longitudinal axis of the outer element, as a centre forms a hypocycloid or an epicycloid.

[0010] The spherical cross-section of the cavity may have the form of a hypocycloid or an epicycloid itself or of an offset of such hypocycloid or epicycloid. Such offset contour is generated if a ball or circle with the radius R (offset) is moved along a hypocycloid or an epicycloids path, whereas the centre point of the ball or circle follows this path. The offset contour defines the line or surface on which the circle or ball would have to roll so that its centre is moved along the hypocycloid or epicycloid path.

[0011] An outer element having an inner contour designed so that a, preferably any spherical cross section forms a hypocycloid or an epicycloid enables a better or more precise fit of the inner element inside the cavity of the outer element. The means the outer contour of the inner element fits with the inner contour of the outer element in an optimized manner during operation of the pump. It is therefore achieved that the Moineau Pump according the invention has reduced diameter tolerance requirements of the inner and the outer element. Such a better fit of inner and outer element guarantees that the pressure zones between inner and outer element are leak-tight even at higher pressures. Therefore, with the Moineau Pump according to the invention higher pressures may be generated. Further, the better fitting results in a high efficiency, since friction between outer and inner element is reduced. Further, the wear of the pump is reduced so that the service life of the pump may be lengthened. Moreover, the reduced friction has the advantage of a lower starting torque required for starting the pump.

[0012] Furthermore, with the design according to the invention the need for providing the inner and/or outer element with a resilient surface material is at least partly eliminated. Further, the design according to the invention makes the pump being less sensitive to dry running.

[0013] Preferably, the spherical cross section forms a hypotrochoid or an epitrochoid. This means that the spherical cross section may have the form of a hypocycloid or a hypotrochoid or of an epicycloid or an epitrochoid. Depending on the form of the inner element the hypocycloid or epicycloid design of the cavity of the outer element may have a different number of lobes. For example the hypocycloid or epicycloid may be a three-lobe hypocycloid or epicycloid or for example a four-lobe hypocycloid or epicycloid, respectively. The exact design of the spherical cross section of the cavity mainly depends on the form of the rotor. Preferably the spherical cross section has a form of a hypocycloid with one or more lobe. In a preferred embodiment the spherical cross-section of the cavity in the outer element has the form of a two-lobe hypocycloid, further preferred with an offset corresponding to the radius of the inner element. However, geometries of the spherical cross-section of the outer element in form of a hypocycloid or epicycloid having a higher number of lobes may be beneficial due to the quantitative smaller but more frequent thrust or torque peaks, in particular thrusts in axial direction.

[0014] Furthermore, preferably the spherical cross section of the inner element having said intersection point of said longitudinal axes as a centre has a round form or the form of a hypocycloid or an epicycloid. The spherical cross section of the inner element corresponds to the spherical cross section of the cavity so that the inner element can make an eccentric movement inside the cavity, i.e. rotate around the longitudinal axis of the inner element, whereas the longitudinal axis of the inner element at the same time rotates around the longitudinal axis of the cavity. This means the inner element is rolling on the inner surface of the cavity.

[0015] According to a preferred embodiment at least the inner surface of the cavity or outer element and at least the outer surface of the inner element are made out of the same material. As explained above resulting from the special design of the invention and the resulting better fit of inner and outer element it is not required anymore to have a combination of two different materials for the outer surface of the inner element and inner surface of the outer element or the cavity, respectively.

[0016] Furthermore it is preferred that at least the inner surface of the outer element and/or at least the outer surface of the inner element are made out of a non-resilient material. In preferred embodiments both surfaces which come into contact with one another during operation of the pump are made of a hard material, i.e. a non-resilient material. By the term hard material is meant a material with low resilience such as for example metal and certain types of composite materials. It would be beneficial to apply wear-resistant materials in order to achieve a long service life of the pump.

[0017] For example at least the inner surface of the outer element and/or at least the outer surface of the inner element may be made out of a plastic material, a ceramic material, metal or composite material. This may for example be instance polyamide, polyamide-imide (PAI), poly-etheretherketones (PEEK) or filled epoxy or phenolic resin. Such materials secure a long service life due to the materials wear-resisting properties. Moreover, the application of these materials makes it possible to use the pump in an aggressive environment (pumping acids, hot water or dry conditions with no fluid), which would not be possible with conventional pumps comprising a rubber coated stator. According to preferred embodiment both, the inner element and the outer element or at least their surfaces coming into contact with one another are made of the same material, for example a plastic material or ceramics. Nevertheless, it is also possible to combine several types of material so that for example the inner element is made out of one material and the outer element is made of another material. Composite materials may be beneficial due to their flexibility with regard to shape and design.

[0018] According to a further embodiment of the invention the inner and/or outer element may at least partially comprise more than one material layer. This means that for example only the surface of the element, in particular the outer surface of the inner element and the inner surface of the cavity of the outer element are made of special wear-resistant material, in particular a non-resilient material. Further it is possible to produce a Moineau Pump that is designed to have an optimal geometry when the pump has been subject to a certain wear. This means that the outer layer of the inner or outer element which comes into contact with the surface of the other element, for example the outer surface of the inner element may be produced from a material which should show a certain wear when the pump is operated for the first time or the first times, thereby a certain amount of material is removed due to friction between the inner and the outer element so that the cavity of the outer element and/or the outer surface of the inner element becomes the optimal shape, depending which surface is made from the respective material. This allows to produce the pump with reduced tolerance requirements, rotor and stator, i.e. inner and outer element, are automatically brought into the optimal shape during operation of the pump because of desired or allowed wear on the surface of the inner and/or outer element (cavity of the outer element).

[0019] Further it is possible to provide at least certain areas of the outer surface of the inner element or the inner surface of the outer element with special wear-resistant layers to reduce the wear inside the pump. It is possible to design the pump so that certain specific critical parts of the internal element and the external element can be provided with one or more extra layers of material. It is also possible to apply different kinds of material.

[0020] Further, it is an option, to arrange the internal element within the external element in a manner that permits that the internal element may be moved towards the external element and still fits in the channel or cavity inside the external element. This allows maintaining the optimal fit even after a certain amount of wear occurred. Because of the conical shape and the cross section according to the invention it is possible to just move or press the inner element more into the cavity of the outer element.

[0021] Furthermore, according to a preferred embodiment of the present invention the internal element and/or the external element are provided with at least one layer of a friction decreasing material. By way of this it possible to reduce the friction between the internal element and the external element and hereby improve initial dry running properties. This will lengthen the reliability and service time of the pump. It would be advantageous to provide the pump with a friction decreasing layer comprising polytetrafluoroethylene (Teflon), graphite or another lubricative.

[0022] According to a further special embodiment of the invention the outer and the inner element are movable relative to one another along the longitudinal axis of the outer element. This allows a design in which the pressure force between inner and outer element is variable, for example depending on the pressure of the fluid or substance to be pumped. The pump may be designed in a manner that the fluid pressure generated by the pump acts on the inner and/or outer element to press both elements together so that the contact force between both elements increases with increasing pump pressure of the pumped substance or fluid. The internal and external elements are pressed together by the pressure generated in the pump only a very small force is needed to press the elements together during the start of the pump. Therefore, only a small starting torque is required. With increasing pressure in the pressure zone of the pump also the force acting on an inner and outer element in axial direction may increase to ensure that the contact area between outer and inner element is leak-tight. Further, by axial movement of the inner and outer element relative to one another it is possible to compensate wear of the pump as disclosed above.

[0023] Further, it is preferred that a plane cross section of the flow path between inner and outer element normal to the longitudinal axis, in particular the longitudinal axis of the outer element has the same magnitude for all plane cross sections along said longitudinal axis or decreases along the longitudinal axis of the outer element. It is preferred that the flow path through the pump has a constant cross-sectional area which secures a constant flow and will avoid cavitation. It may be preferred that the plane flow path cross-section decreases along the longitudinal axis of the outer element. Hereby it is achieved that the fluid or substance pumped by the pump is forced through the channel or flow path and thus the substance of fluid is slightly compressed. The compression of the fluid or substance will avoid damaging because of cavitation. Thereby, it is preferred that the plane flow path cross-section decreases only slightly along the longitudinal axis of the outer element. The decrease should advantageously extend in the direction of the flow.

[0024] Furthermore, it is preferred that the maximum distance between the longitudinal axis of the inner element and the longitudinal axis of the outer element is in the range of 0 to 50% of the length of the inner element along its longitudinal axis and preferably in the range of 1 to 10% of the length of the inner element along its longitudinal axis. This means the eccentricity of the motion between inner and outer element is in a range of 0 to 50% of the length of the inner element along its longitudinal axis. Thereby, the eccentricity varies linearly along the axis of the inner element. The eccentricity is zero at the intersection point of both longitudinal axes and has a maximum at the opposite end of the internal element. It is further preferred that the maximum of the eccentricity lies within the range of 0 to 20% of the length of the internal element, further preferred within the range of 1 to 10% of the length of the internal element.

[0025] As explained above inner and outer element will fulfil a relative movement to one another during operation of the pump. Thereby the inner element may act as a rotor whereas the outer element acts as a stator. It is also possible that the outer element acts as a rotor and the inner element acts as a stator. Further, also both elements may be in motion, i.e. rotate relatively to one another so that the inner element fulfils an eccentric motion inside the outer element.

[0026] The invention is hereinafter described by way of example and by way of the accompanying figures. In these are shown in:

Fig. 1	a schematic diagram of a spherical cross-section in a perspective view,
Fig. 2	a cross-section according Fig. 1 in a top view,
Figs. 3a-3c	three examples of hypocycloids,
Figs. 4a-4c	the spherical cross-sectioned profiles of outer elements of Moineau Pumps according to the invention generated from hypocycloid geometries,
Figs. 5a-5c	spherical cross-sectioned lobe profiles of inner elements at different positions on their paths within the cavity of an outer element corresponding to the spherical cross-section of the outer element as shown in Fig. 4a,
Figs. 6a-c	spherical cross-sectioned view of lobe profiles of inner elements at different positions on their paths within a cavity of outer element corresponding to the cavity of the outer element generated by a three-lobe geometry as shown in Fig. 4b and
Fig. 7	a schematic cross-section of a pump according to the invention.

[0027] As shown in Fig. 7 the Moineau Pump according to the invention has two main parts, an outer element 2 and inner element 4, wherein the outer element 2 may be a stator of the pump and the inner element 4 may be a rotor of the pump. The inner element 4 has a longitudinal axis Y and the outer element 2 has a longitudinal axis X. Since the Moineau Pump according to the invention is a conical Moineau Pump both axes are inclined relatively to each other and intersect in one intersection point I as can best seen in the schematic diagram of Fig. 1.

[0028] As with conventional Moineau Pumps the inner element 4 is arranged in a cavity 6 of the outer element 2. Both, the cavity 6 and the inner element 4 have a conical shape, this means their cross-sectional area or diameter normal to their longitudinal axes increases from one end to the other. In Fig. 7 on the left side which is the pressure side of the pump inner element 4 and cavity 6 have the smallest cross-sectional area and on the right side which is the suction side of the pump they have their biggest cross-sectional area.

[0029] During operation of the pump the inner element 4 fulfils an eccentric movement inside the cavity 6 and rolls on the inside of the outer element 2, i.e. on the inner circumferential surface of the outer element 2 defining cavity 6. Thereby, inner element 4 and outer element fulfil a relative movement to each other. In case that the outer element 2 is the stator and the inner element 4 is a rotor, the inner element 4 rotates along its longitudinal axis Y, whereas at the same time the inner element 4 and its longitudinal axis Y rotate around the longitudinal axis X of the outer element 2. Thus, the inner element 4 fulfils an eccentric movement inside the cavity 6, wherein the eccentricity increases starting from the intersection point I, where the eccentricity is 0, to the opposite end of the cavity 6.

[0030] The important characterizing feature of the invention is the special design of the outer element 4 and its cavity 6 along a spherical cross-section C which is shown in Fig. 1. The spherical cross-section C is a cross-section along a surface of a sphere, wherein the intersection point I of the longitudinal axis X, Y forms the centre of the sphere. In the example shown in figs. 1 and 2 the spherical cross-section of the cavity 6 has a geometry of a two-lobe hypocycloid. As can be seen in Fig 2 the inner element 4 has a circular cross section but the cross-section of the cavity 6 in the outer element 2 is not symmetric in a plane cross-section, however, the spherical cross-section as shown in fig. 1 is symmetric.

[0031] According to the invention preferably any spherical cross-section of the cavity 6 having said intersection point I as a centre forms a hypocycloid or an epicycloid. This means for any radius of the sphere along which the cross section is take the geometry of the cavity is a hypocycloid or epicycloid or an offset thereof.

[0032] Figs. 3a-3c show three examples of hypocycloids. A hypocycloid is formed by a point P on the circumference of a small circle 8 rolling along the inside of larger outer circle 10. Fig 3a shows a two-lobe hypocycloid which is formed when the small circle has half the diameter of the outer larger circle 10. Fig. 3b shows a three-lobe hypocycloid which is formed when the larger circle has three times the diameter of the small circle 8. Fig. 3c shows a four-lobe hypocycloid which is formed when the larger circle 10 has four times the diameter of the small circle 8. As can be seen in Fig. 3 point P for a two-lobe hypocycloid moves along a straight line. The three-lobe hypocycloid has the form of a triangle with concave sides on which point P moves when rolling circle 8 along the inner circumference of larger circle 10. For the four-lobe hypocycloid the path of point P has the form of a square with concave sides.

[0033] Figs. 4a-4c show profiles or spherical cross-sections of a cavity 6 formed on basis of the hypocycloids shown figs. 3a, 3b and 3c, i.e. the cavity according to fig. 4a is based on a two-lobe cycloid, the cavity 6 of fig. 4b on three-lobe cycloid and the cavity 6 according fig. 4c on a four-lobe cycloid. The cavities 6 are defined by an offset R added to the hypocycloid geometries as shown in fig. 3a to fig.3c. The offset R is a radius R of circle or ball moving along a line defined by the hypocycloid according to fig. 3a, 3b or 3c, respectively, wherein the centre point of the circle or ball follows the hypocycloid or epicycloids path.

[0034] Figs. 5a to 5c show a spherical cross-sectioned view of a rotor 2 inside cavity 6 according to fig. 4a in three different positions. This two-lobe geometry of the hypocycloid cross-section is a preferred embodiment. When moving the inner element 2 (rotor in this example) inside the cavity 6 by rotating the axis Y around axis X and rotating the inner element 2 around its longitudinal axis Y the rotor 2 according to the embodiment shown in fig 4a and 5a to 5c moves along a straight line 12 in the curved plane of the spherical cross section, i.e. oscillates on a circle line along the spherical cross-section with the intersection point I as a centre of this circle line.

[0035] Fig. 6a to 6c show the profile or geometry of cavity 6 and the inner element 2 along the spherical cross-section for a three-lobe hypocycloid according to fig. 3b and 4b. Fig. 6a, 6b and 6c show three different positions of the inner element 2 during the movement of the inner element 2 inside the outer element 4 when operating of the pump. In this example in spherical cross-section the rotor 2 has an oblong shape with opposed ends in form of half circles. The two centre points 14 of these half circles are moving on a hypocycloid path as shown in fig. 3b, wherein the half circles have a radius R as shown in fig. 4b so that the surface of the inner element 2 comes into contact with the inner surface 15 of the outer element 4, i.e. the wall defining cavity 6. Thus, the inner element 2 can roll on said wall defining cavity 6.

[0036] The important advantage of the design of cavity 6 and the corresponding design of the inner element 2 along any spherical cross-section so that the outer form of the cavity follows a hypocycloid curve or a hypocycloid curve with an offset (radius R) is that the inner element 2 can fulfil a more precise movement inside the outer element 4. This allows reducing the tolerance requirements and it is not required to use resilient materials for the surface of the inner element 2 and/or the inner surface 15 of the outer element 4. With the design according to the invention both surfaces may be made from a non-resilient material. This results in a greater stiffness of the surface and keeps the pressure zones between inner element 4 and outer element 2 leak-tight even at high pressures.

[0037] Fig. 7 shows a special embodiment of the invention in which the outer element 2 is movable relative to the inner element 4 along the longitudinal axis X. This allows that the pressure generated by the pump acts on the outer element 2 and forces the outer element 2 against or inside the inner element 4. By this force the pressure zones may be kept leak-tight even at higher pressures inside the pressure zones. At the same time the pressure force between outer element 2 and inner element 4 is reduced at lower fluid pressures, in particular when starting the pump, so that wear and torque can be reduced in such operating conditions. As indicated by arrows A in fig. 7 the pressure on the pressure side 20 of the pump acts on the outer element 2 in the axial direction along longitudinal axis X. The outer element 2 is mounted on bearing elements 22 which are slidable in longitudinal direction Y inside a housing 24. The inner element 4 or rotor 4, respectively, is supported in longitudinal directions via bearing elements which are not shown in fig. 7.

List of reference numerals

[0038]

2	outer element
4	inner element
6	cavity
8	small circle
10	larger circle
12	circle line
14	centre point
15	inner surface
16	hypocycloid
18	suction side
20	pressure side
22	bearing element
24	housing

X, Y	longitudinal axes
I	intersection point
C	spherical cross-section
A	direction of pressure
P	Point

Claims

1. Moineau Pump comprising a ring-shaped outer element (2) having a conical cavity (6) along its longitudinal axis (X) and a conical inner element (4) arranged in said cavity (6), wherein the longitudinal axis (Y) of the inner element intersects the longitudinal axis of the outer element in an intersection point (I),
characterized in that
a spherical cross section (C) of the cavity (6) having said intersection point I of said longitudinal axes (X, Y) as centre forms a hypocycloid (16) or an epicycloids or an offset thereof.

2. Moineau Pump according to claim 1, **characterized in that** any spherical cross section (C) of the cavity (6) having said intersection point (I) of said longitudinal axes (X, Y) as centre forms a hypocycloid (16) or an epicycloids or an offset thereof.

3. Moineau pump according to claim 1 or 2, **characterized in that** the spherical cross section (C) forms a hypotrochoid or an epitrochoid.

4. Moineau Pump according to one of the preceding claims, **characterized in that** a spherical cross section (C) of the inner element (4) having said intersection point (I) of said longitudinal axes (X, Y) as centre has a round or oval form or the form of a hypocycloid or an epicycloid.

5. Moineau Pump according to one of the preceding claims, **characterized in that** at least the inner surface of the outer element (2) and at least the outer surface of the inner element (4) are made out of the same material.

6. Moineau Pump according to one of the preceding claims, **characterized in that** at least the inner surface of the outer element (2) and/or at least the outer surface of the inner element (4) are made out of a non resilient material.

7. Moineau Pump according to one of the preceding claims, **characterized in that** at least the inner surface of the outer element (2) and/or at least the outer surface of the inner element (4) are made out of a plastic material, a ceramic material, metal or a composite material.

8. Moineau Pump according to one of the preceding claims, **characterized in that** the inner (4) and/or outer (2) element are at least partially comprising more than one material layer.

9. Moineau Pump according to one of the preceding claims, **characterized in that** the outer (2) and the inner (4) element are movable relatively to one another along the longitudinal axis (X) of the outer element (2).

10. Moineau Pump according to one of the preceding claims, **characterized in that** a plane cross section of the flow path between inner (4) and outer (2) element normal to the longitudinal axis (X) has the same magnitude for all plane cross sections along said longitudinal axis (X) or decreases along the longitudinal axis (X) of the outer element (2).

11. Moineau Pump according to one of the preceding claims, **characterized in that** the maximum distance between the longitudinal axis (Y) of the inner element (4) and the longitudinal axis (X) of the outer element (2) is in the range of 0 to 50 % of the length of the inner element (4) along its longitudinal axis (Y) and preferably in the range of 1 to 10 % of the length of the inner element (4) along its longitudinal axis (Y).

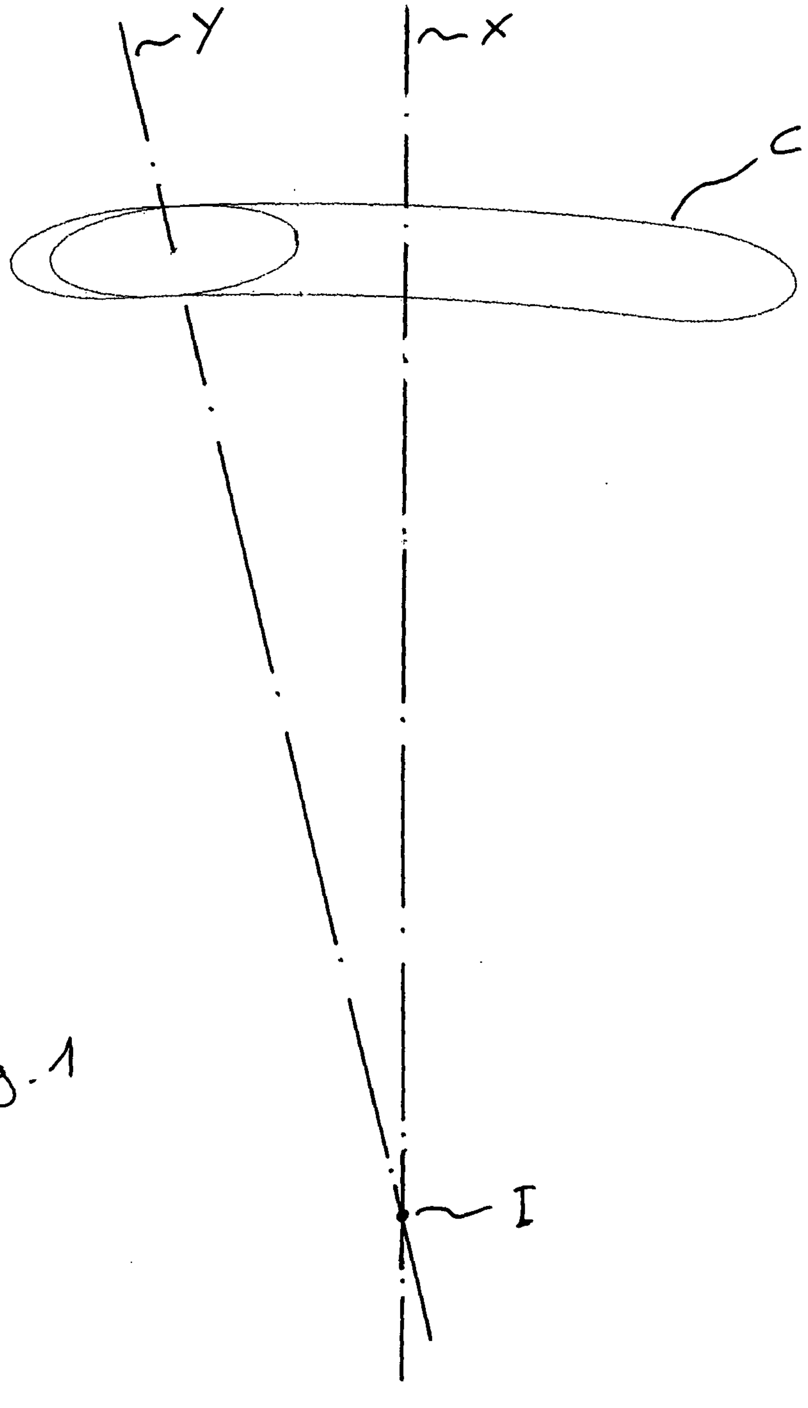


Fig. 1

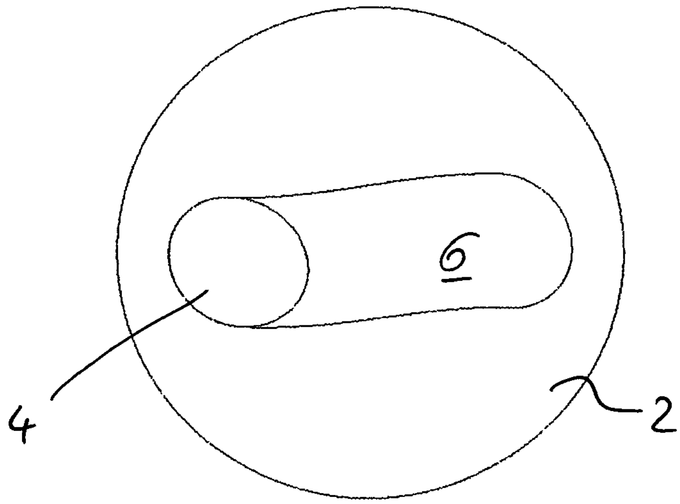


Fig. 2

Fig 3a

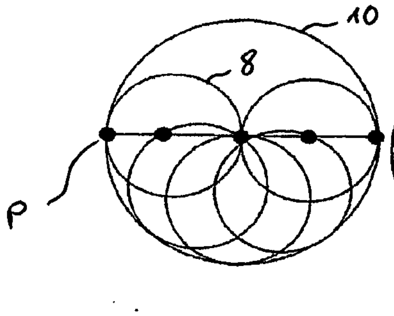


Fig. 3b

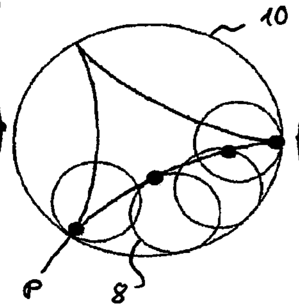


Fig. 3c

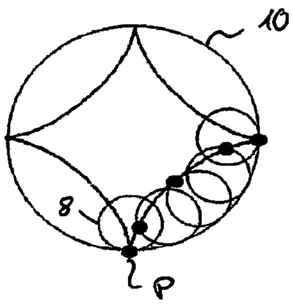


Fig. 4a

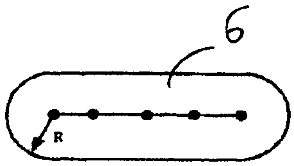


Fig. 4b

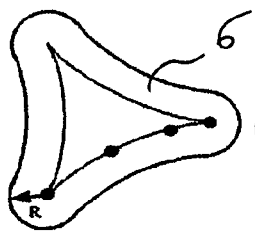


Fig. 4c

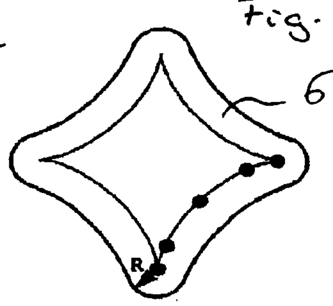


Fig 5a

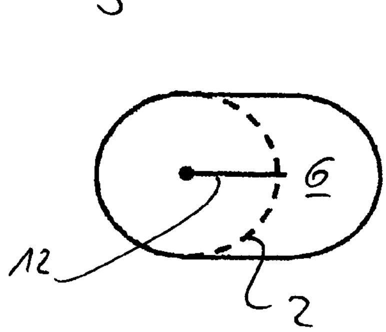


Fig 5b

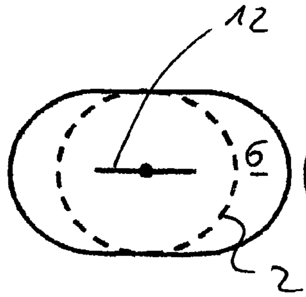
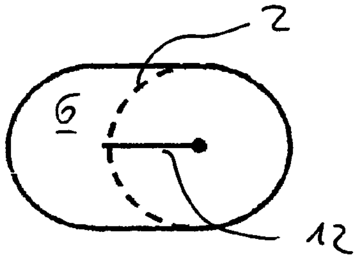


Fig 5c



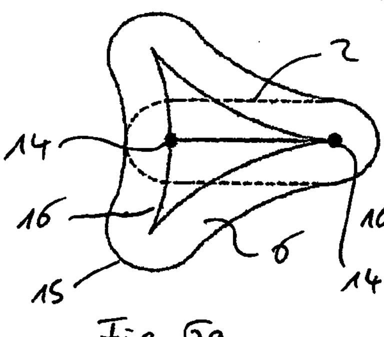


Fig 6a

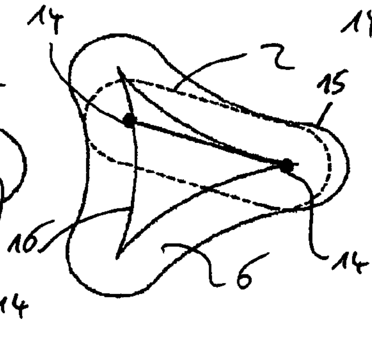


Fig 6b

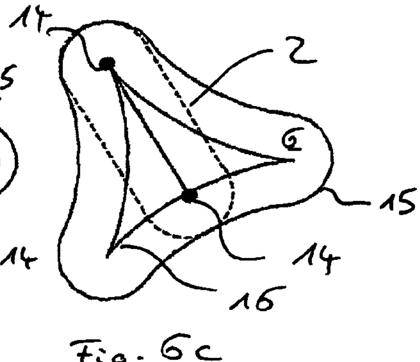


Fig. 6c

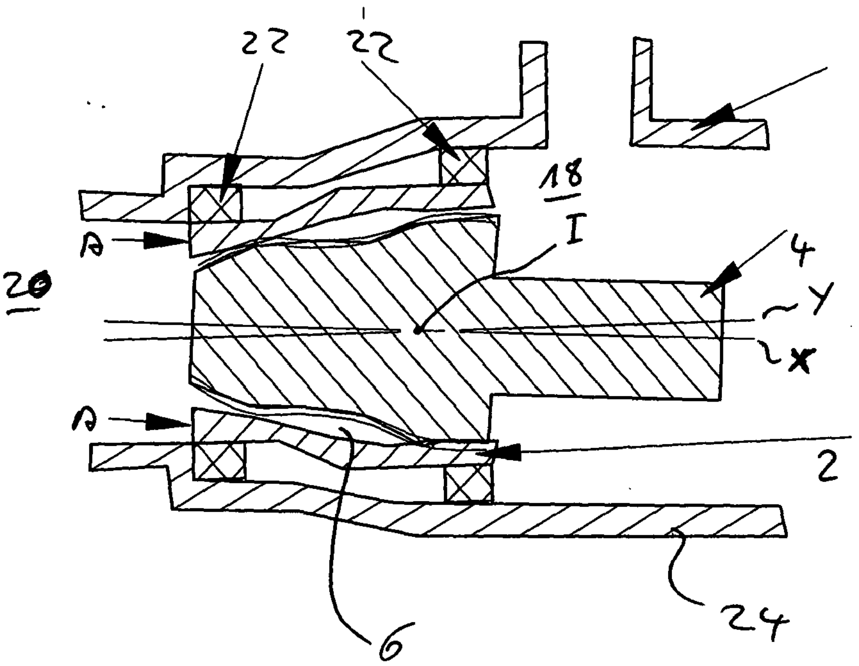


Fig 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 9009

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 27 36 590 A1 (KOWALZIK HARTMUT) 22 February 1979 (1979-02-22) * page 4; figure 1 * -----	1-11	INV. F04C2/107
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TECHNICAL FIELDS SEARCHED (IPC)
F04C
F01C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	26 October 2007	Descoubes, Pierre

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26-10-2007

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