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(54) Peristaltic pump

(57) A pump (1) for circulating a medium comprises: an elastically deformable hose (4) which lies against a pressing surface (3), with a medium inlet (6) and a medium outlet (7); and
pressing elements (9,10) which move along the hose and press the hose part in contact with a pressing element against the pressing surface while locally compressing and closing the hose part; whereby medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

The pump has the special feature that a cavity (15) is defined in the pump housing (2), the pressing surface of which cavity forms a boundary and in which cavity the hose and the pressing means with the pressing elements are accommodated; and the cavity is hermetically sealed and filled with a filling medium.

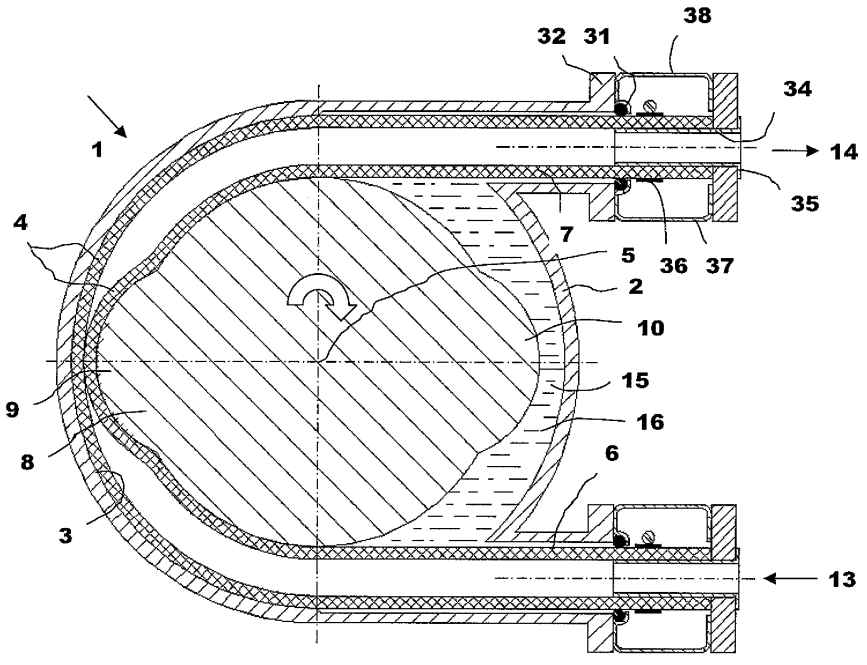

Fig. 1

EP 1 884 663 A1

Description

[0001] The invention relates to a peristaltic pump for circulating a medium such as a liquid, a gas, a slurry, a granulate or a combination of two or more thereof, which pump comprises:

- a pump housing;
- a pressing surface present in this pump housing;
- an elastically deformable hose, a part of which lies against the pressing surface, which hose has a medium inlet and a medium outlet; and
- pressing means with a number of equidistantly placed pressing elements such as rollers or cams;

which pressing means are drivable such that the pressing elements move along the hose; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing the hose part;
this such that during driving of the pressing means medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

[0002] Owing to the local compression, and thereby closing of the hose by the pressing elements, and the displacement of this local compression under the influence of the pressing means driven along the hose, the medium present in the hose will be pushed along. After a pressing element has passed, the form of the hose is restored due to its elastic properties. Owing to this mechanism medium is drawn into the hose on the suction side.

[0003] Because it is ensured that the hose is always pressed shut locally by at least one locally acting pressing element, the pump operates as closing valve such that the delivery side and the suction side are separated from each other.

[0004] The functions of the hose in a peristaltic pump or hose pump in fact display a mutual contradiction. During compression of the hose by a pressing element a hose with the smallest possible radial stiffness is desired, whereby the smallest possible compression force, drive torque, stresses in the hose, development of heat resulting from hysteresis and friction between a pressing element and the hose will occur. However, during the restoring phase after a pressing element has passed a certain degree of stiffness of the hose is desired with a view to restoring the initial, for instance round, form of the hose. This does after all define the suction capacity.

[0005] In order to go a considerable way toward enabling both the stated contradictory functionalies during operation of the pump, the invention proposes a peristaltic pump of the type stated in the preamble which has the feature that a cavity is defined in the pump housing, the pressing surface of which cavity forms a boundary and in which cavity the hose and the pressing means with the pressing elements are accommodated; and the cavity is hermetically sealed and filled with a filling medium.

[0006] In a specific embodiment the pump has the special feature that the pump is of the linear type. "Linear" is understood to mean a pump wherein the pressing elements follow an at least more or less linear path along the pressing surface, which pressing surface likewise has an at least more or less linear form.

[0007] A peristaltic pump is further known for circulating a medium, which pump is of the rotating type and comprises:

- a pump housing;
- a curved pressing surface which is present in this pump housing and at least a part of which takes the general form of a circular arc with a central axis;
- an elastically deformable hose, of which a part lies against the pressing surface, which hose has a medium inlet and a medium outlet;
- a rotor which has a number of pressing elements, such as rollers or cams, placed at equal angular and radial positions and which serves as pressing means;

which rotor is rotatingly drivable around a central axis; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing said hose part;
this such that during the rotation of the rotor medium is drawn in via the medium inlet and discharged under pressure via the medium outlet.

[0008] This pump is particularly important in the context of the invention because such a pump, generally referred to as "hose pump", is very common and is highly suitable for adaptation in terms of the teaching of the present invention.

[0009] According to the invention this said rotating peristaltic pump has the feature that a cavity is defined in the pump housing, the pressing surface of which cavity forms a boundary and in which cavity the hose and the rotor are accommodated; and
the cavity is hermetically sealed and filled with a filling medium.

[0010] It is noted that while this rotating pump has a construction other than for instance a linear pump according to the invention, the principles implemented therein are nevertheless the same. The results of the teaching according to the invention can hereby also be easily realized in the rotating pump.

[0011] The starting point for the above described invention, for both the linear and the rotating pump, is that the hose has its initial, for instance round form along a significant part of its active length except at the position where a pressing element compresses and thus locally closes the hose. The cavity in the pump housing is completely filled with a filling medium, some further aspects and possible options of which will be discussed herein-

below. When the pressing means are displaced, the positions of the pressing elements will be displaced along the hose. As a result of the constant volume in the case a liquid is used as filling medium, the hose will be restored to its original form as a consequence of the incompressibility of this filling medium and the constant volume thereof. A change in volume at the one location must be compensated by an equal change in volume at another location. This could be otherwise expressed with the formulation that the hose is as it were hydraulically energized in this way.

[0012] In the case of an incompressible filling medium the bringing of the hose into a round form could for instance be realized during assemby, wherein the pump has not yet been filled with liquid. Via the inlet or outlet the hose could be temporarily brought to pressure by means of a gas or liquid. After filling of the cavity in the pump housing with liquid, such as a hydraulic oil, and subsequent venting, the medium pressure can be removed from the hose. As a result of the presence of the in this case incompressible filling medium the hose retains its round form.

[0013] As already discussed above, the pump according to the invention can have the special feature that the filling medium is a liquid.

[0014] Very simple and inexpensive is an embodiment in which the liquid is water. A hydraulic oil can also be applied.

[0015] There is also the possibility of embodying the pump such that the liquid is a coolant and lubricant.

[0016] According to yet another aspect of the invention, the pump has the special feature that the filling medium is a gas.

[0017] Inexpensive and simple is an embodiment of this latter principle in which the gas is air.

[0018] There is the further possibility of the filling medium being a combination of a liquid and a gas.

[0019] According to a final aspect of the invention, the pump has the special feature that a chosen pressure prevails in the gas.

[0020] These latter options, wherein use is made of a gas, provide a certain damping of the local changes in volume which occur and which compensate each other. The mechanical load on the components of the pump, such as the hose, the connections therefor and on the medium for circulating will hereby be reduced.

[0021] According to a determined aspect of the invention, the pump comprises adjusting means for adjusting the pressure in the filling medium present in the cavity.

[0022] In a practical embodiment this latter variant can have the special feature that the adjusting means comprise a cylinder in which a piston is sealingly displaceable and fixable at a position to be selected, wherein a space bounded by the cylinder and the piston connects to the cavity in the pump housing.

[0023] In order to make clear the possible advantage of the latter two aspects, the reader can imagine that, in the design of prior art peristaltic pumps, the buckling behaviour of the hose has been a significant factor in determining the internal dimensions of the cavity in the pump housing of a peristaltic pump of the rotating type. When the radius of curvature is too small, the hose will begin to buckle. The reader is now invited to imagine that this situation does indeed occur. The cavity is then filled with a liquid, thus an incompressible medium. If liquid is now extracted from the cavity by means of said adjusting means, the hose will as it were be inflated to more or less its initial, round form due to the pressure difference between the interior and the exterior of this hose. The principle of the peristaltic pump is wholly retained, the operation of the pump merely taking place with a certain difference in pressure between the interior and the exterior of the hose. The relative underpressure in said cavity is favourable for drawing in medium.

[0024] Since said pressure difference inside and outside the hose is a decisive factor, the same effect can be achieved by mounting the hose under internal pressure of gas or liquid.

[0025] In relation to the foregoing, the pump according to the invention can comprise: pressure difference means for creating a chosen positive pressure difference between the interior of the hose and the medium present in the cavity such that the hose has a tendency to expand. These pressure difference means can be implemented as said adjusting means, but alternatively by mounting the hose under internal pressure. The positive pressure difference is after all the decisive factor.

[0026] The invention will now be elucidated on the basis of the accompanying drawings. In the drawings:

Figure 1 shows a cross-section through a peristaltic pump of the rotating type according to the invention;
Figure 2 shows a cross-section through a variant.

[0027] Figure 1 shows a cross-section through a peristaltic pump 1 of the rotating type according to the invention. Pump 1 comprises: a pump housing 2; a pressing surface 3 present in this pump housing 2 and having the general form of a half-cylinder extending through 180° and having a central axis 5; and an elastically deformable hose 4 which has a medium inlet 6 and a medium outlet 7; a rotor 8 with two pressing cams 9, 10 which are placed diametrically to each other, i.e. at mutual angles of 180° and equal radial positions relative to central axis 5, also the central axis of rotor 8, and which in this embodiment are embodied as partly cylindrical cams, which rotor 8 is rotatingly drivable around central axis 5 by means of drive means (not shown); which pressing cams 9, 10 press during operation the part of hose 4 in contact with the relevant pressing cam 9, 10 against pressing surface 3 while locally compressing and closing the hose part; this such that during the rotation of rotor 8 medium is drawn in via medium inlet 6 and discharged under pressure via medium outlet 7.

[0028] The indrawn medium is indicated with an arrow 13. The medium discharged under pressure is indicated

with an arrow 14.

[0029] Pump housing 2 comprises a cavity 15 wholly filled with filling medium 16, in this case a hydraulic oil. Cavity 15 is hermetically sealed for this purpose by means of provisions to be described hereinbelow.

[0030] Figure 2 shows a pump 21 which differs in one respect from pump 1 according to figure 1, i.e. pump housing 22 has a connection 24 to which connects a conduit 25 which connects in turn to a cavity 28 which is bounded by a cylinder 26 and a piston 27 which is reciprocally displaceable as according to an arrow 30 in sealing manner by means of a sealing ring 29. Since the hydraulic oil 26 is incompressible, a displacement of the piston to the left, so with a reduction in the volume of space 28, will exert a pressure on hose 4 such that this will tend to contract and begin to decrease in volume. A displacement of piston 27 to the right will increase the volume of space 28, whereby hose 4 will tend to expand. In the description introduction has been set forth that this can result in advantages.

[0031] It is noted that the same components in figures 1 and 2 are designated with the same reference numerals.

[0032] In both pump 1 and pump 21 the cavity 15 in pump housing 1 and 21 respectively is hermetically sealed such that filling medium 16 is wholly enclosed therein. Hose 4 is mounted in hermetically sealing manner relative to the pump housing on the side of both medium inlet 6 and medium outlet 7 of this hose. For purposes of elucidation the drawn components are stated below. The reference numerals have the following significance:

31: An O-ring, using which hose 4 seals against an end flange 32 of the pump housing.

33: A connecting flange for connecting the pump to external provisions.

34: A stiff gauze, i.e. a tube which is provided with a flange 35 and which fits into hose 4, the hose 4 being connected clampingly and sealingly by means of a hose clip 36 to the gauze 34 which is manufactured from metal or a hard plastic. Hose clip 36 is arranged before gauze 34 and flange 33 are mounted. Reference numeral 37 refers to a flange support which on the left-hand side of the drawing positions O-ring 31 and which on its right-hand side is in contact with connecting flange 33. Flange support 37 consists of two connecting strips (not shown in the drawings) such that hose clip 36 can be tensioned by rotating the screw 38.

[0033] It is noted that said components are drawn only on the outlet side in figure 1. The elements in question are identical thereto on the inlet side in figure 1. The relevant connections in the embodiment according to figure 2 are identical to those of figure 1.

[0034] It is noted that the described hermetic seal relates only to a practical example and that many other structures can be applied.

Claims

1. Peristaltic pump for circulating a medium such as a liquid, a gas, a slurry, a granulate or a combination of two or more thereof, which pump comprises:

a pump housing;
a pressing surface present in this pump housing;
an elastically deformable hose, a part of which lies against the pressing surface, which hose has a medium inlet and a medium outlet; and
pressing means with a number of equidistantly placed pressing elements such as rollers or cams;

which pressing means are drivable such that the pressing elements move along the hose; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing the hose part;
this such that during driving of the pressing means medium is drawn in via the medium inlet and discharged under pressure via the medium outlet;
characterized in that

a cavity is defined in the pump housing, the pressing surface of which cavity forms a boundary and in which cavity the hose and the pressing means with the pressing elements are accommodated; and
the cavity is hermetically sealed and filled with a filling medium.

2. Peristaltic pump as claimed in claim 1,
characterized in that
the pump is of the linear type.

3. Peristaltic pump as claimed in either of the foregoing claims for circulating a medium, which pump is of the rotating type and comprises:

a pump housing;
a curved pressing surface which is present in this pump housing and at least a part of which takes the general form of a circular arc with a central axis;
an elastically deformable hose, of which a part lies against the pressing surface, which hose has a medium inlet and a medium outlet;
a rotor which has a number of pressing elements, such as rollers or cams, placed at equal angular and radial positions and which serves

as pressing means;

which rotor is rotatingly drivable around a central axis; and
which pressing elements during operation press the hose part in contact with the relevant pressing element against said pressing surface part while locally compressing and closing said hose part;
this such that during the rotation of the rotor medium is drawn in via the medium inlet and discharged under pressure via the medium outlet;
characterized in that

a cavity is defined in the pump housing, the pressing surface of which cavity forms a boundary and in which cavity the hose and the rotor are accommodated; and
the cavity is hermetically sealed and filled with a filling medium.

4. Peristaltic pump as claimed in any of the foregoing claims, comprising pressing means for feeding additional filling medium under pressure to the cavity such that the hose is subjected to a certain compression while maintaining a passage such that the quantity of medium circulated per unit of displacement of the pressing elements is reduced.

5. Peristaltic pump as claimed in claim 4, wherein the pressing means are adapted to feed to the cavity under pressure a quantity of additional filling medium which is adjustable as desired such that the quantity of medium circulated per unit of displacement of the pressing elements is adjustable.

6. Peristaltic pump as claimed in any of the foregoing claims, wherein the filling medium is a liquid.

7. Peristaltic pump as claimed in claim 6, wherein the liquid is water.

8. Peristaltic pump as claimed in claim 6, wherein the liquid is a coolant and lubricant.

9. Peristaltic pump as claimed in any of the claims 1-5, wherein the filling medium is a gas.

10. Peristaltic pump as claimed in claim 9, wherein the gas is air.

11. Peristaltic pump as claimed in any of the claims 1-5, wherein the filling medium is a combination of a liquid and a gas.

12. Peristaltic pump as claimed in any of the claims 9-11, wherein a chosen pressure prevails in the gas.

13. Peristaltic pump as claimed in any of the foregoing claims, comprising adjusting means for adjusting the pressure in the filling medium present in the cavity.

14. Peristaltic pump as claimed in claim 13, wherein the adjusting means comprise a cylinder in which a piston is sealingly displaceable and fixable at a position to be selected, wherein a space bounded by the cylinder and the piston connects to the cavity in the pump housing.

15. Peristaltic pump as claimed in any of foregoing claims, comprising pressure difference means for creating a chosen positive pressure difference between the interior of the hose and the medium present in the cavity such that the hose has a tendency to expand.

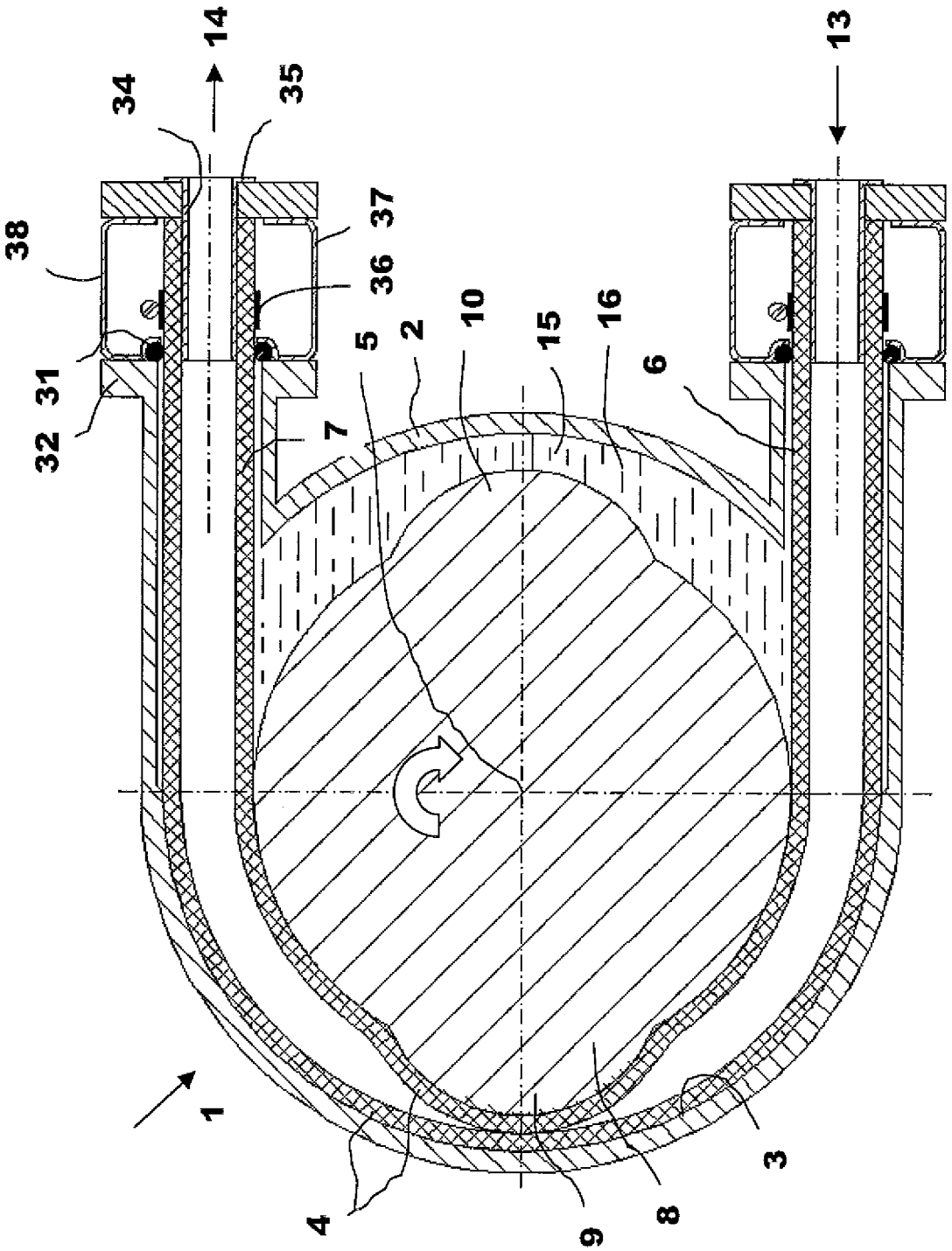

Fig. 1

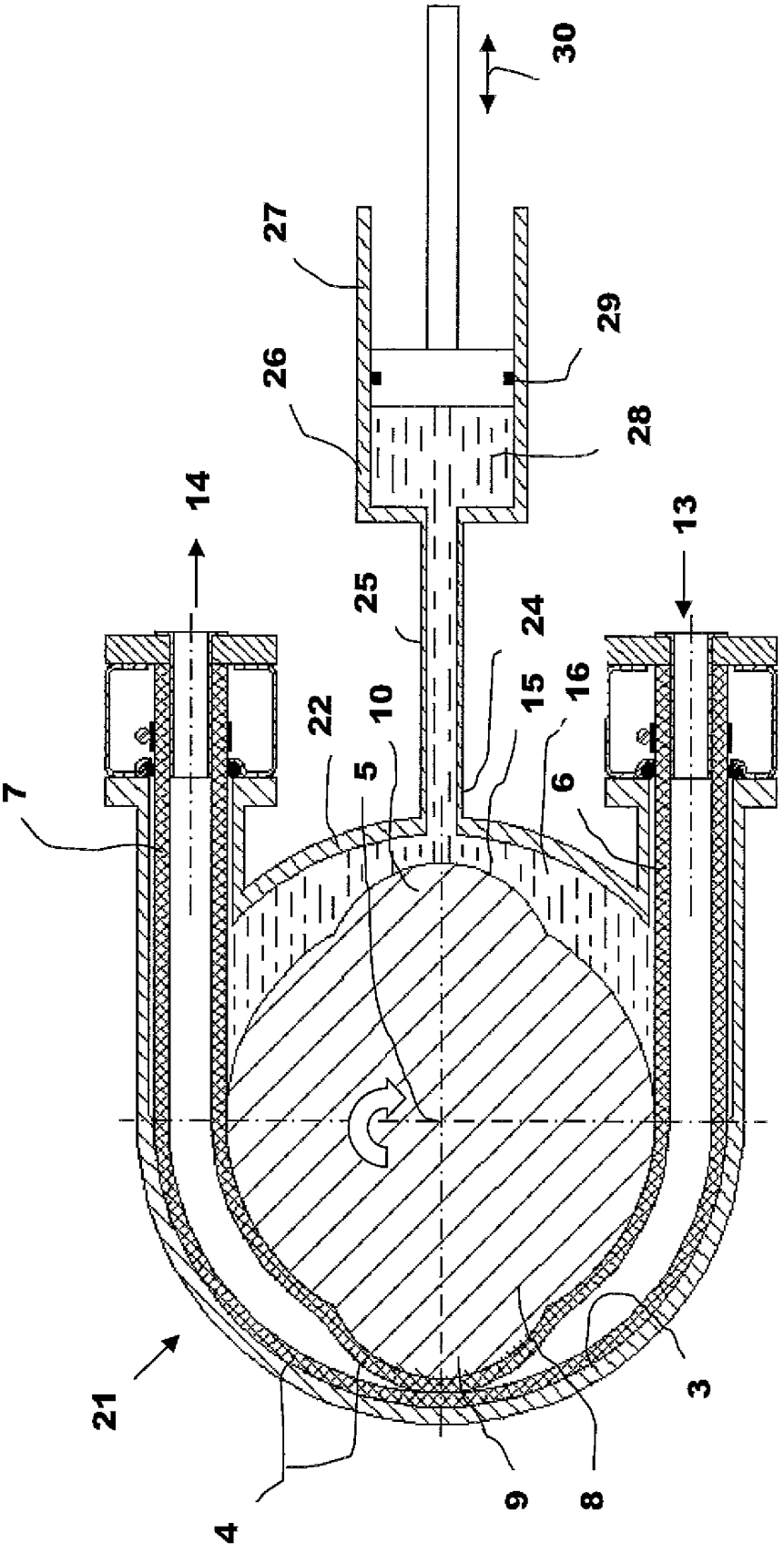

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 11 2809

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 37 03 124 A1 (STREICHER MANFRED [DE]) 11 August 1988 (1988-08-11) * column 7, lines 28,29; figure 11 * * column 10, line 55 - column 11, line 31 * -----	1-15	INV. F04B43/12
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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
Munich	6 November 2007	OLONA LAGLERA, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 11 2809

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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