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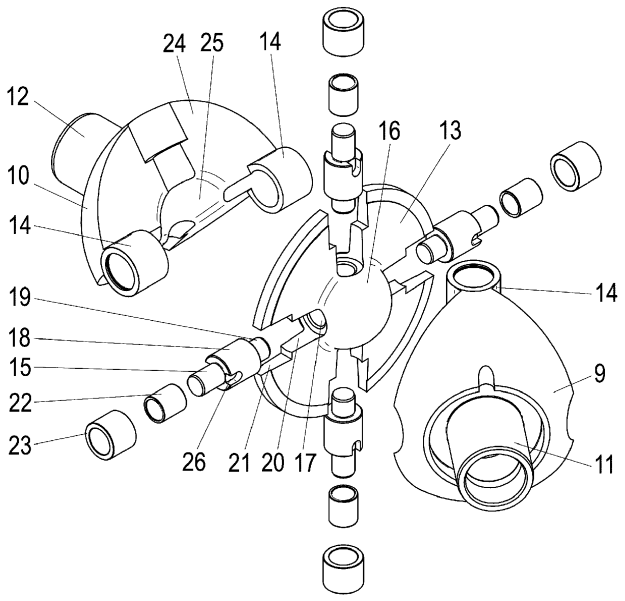
(54) A ROTARY PISTON PUMP

(57) Invention relates to a rotary piston pump comprising a housing (1, 2) with inlet and outlet orifices for the pumped fluid, inside the spherical piston chamber the two rotor halves (9, 10) of the rotary piston are connected together by a universal-joint spider, where rotation axes of said rotor halves are at an angle in relation to each other and where the universal-joint spider is included in the disk element (13) between the rotor halves (9, 10). The spider arms (15) of the universal-joint are formed by semi-axles (18), which are connected to the spherical part in the centre of the disk element (13).

Fig. 2



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Description

Technical Field

[0001] Present invention relates to a positive displacement pump, more precisely to a rotary piston pump, where the rotary piston i.e. rotor is formed on the principle of a universal-joint or Hooke's joint.

Background Art

[0002] The state of the art includes many known rotary piston pumps and rotary piston internal combustion engines with a similar design.

[0003] In order to fully understand the following specification it should be mentioned right at the beginning that the universal-joint or the Hooke's joint or the cross-joint comprises two opposing universal-joint forks (yokes) having intersecting axes of rotation, where said forks are connected by a universal-joint spider (also called trunnion cross), where on spider arms (i.e. on the ends of two crosswise shafts forming said cross) there are four bearings, two for each fork. In the present invention forks of the universal-joint are formed by two opposing rotor halves of the rotary piston and the universal-joint spider is included in the disk element between said rotor halves.

[0004] From patents US2204760 (published on 18.06.1940) US2727465 (published on 20.12.1955) and US5171142 (published on 15.12.1992) rotary piston pumps are known comprising in the spherical piston chamber of the pump housing two rotor halves, which are connected by the universal-joint spider included in the disk element between said rotor halves.

[0005] The closest known solution from the prior art having the design of the rotary piston pump similar to the present invention is known from the international patent application WO2009/053764A1 (published on 30.04.2009). This solution comprises housing, in the spherical piston chamber of the housing two rotor halves of the rotary piston connected by a universal-joint spider, where said universal-joint spider is included in the disk element between the rotor halves and where the rotation axes of said rotor halves are at an angle to each other and where the spherical piston chamber is divided by said disk element between the corresponding opposite faces of the rotor halves, the spherical wall of the piston chamber and the sides of the disk element into four mutually separated spatial compartments having changing volume due to the rotation of the rotor.

[0006] In those designs the main source of the problems are the bearings at the ends of the spider arms of the universal-joint spider, whose operating resource ends or which fail usually before other components of the pump. Dependent on the type of the bearings used, the arm of the spider could be also damaged due to the failure of the bearing so that a new bearing cannot be used on that arm.

[0007] Usually this leads to the replacement of the pump as a whole. But in fact other components of the pump are fit to go on operating. In addition the rotary piston of the pump is usually made from stainless steel and processing of stainless steel is refractory, especially if the spherical outer surface of the piston is considered. The rotary piston is located in the pump housing in the spherical piston chamber, whereas manufacturing of said chamber in such a way that it has a fit that the rotary piston can rotate in the chamber freely but sits in the chamber sufficiently snugly to pump fluid medium, is also problematic, time consuming and relatively expensive.

[0008] Therefore there is a need for a construction, where in the universal-joint spider included in the disk element of the pump, bearings of the spider arms and the spider arms themselves can be easily reparable and/or replaceable when needed. This would enable to fully use the whole operating recourse of other components of the pump and essentially reduce the costs relating to the pumping of fuels, oils, water and sewage.

[0009] Present invention is directed at solving the above described problems.

Summary of invention

[0010] Present invention provides a rotary piston pump comprising pump housing with inlet and outlet orifices and in the spherical piston chamber of the pump housing two rotor halves connected by a universal-joint spider. The rotation axes of the rotor halves are at an angle in relation to each other.

[0011] The universal-joint spider is located in the disk element between the rotor halves, where the spherical pump chamber (i.e. piston chamber) is divided by said disk element between the corresponding opposite end faces of the rotor halves, the spherical wall of the pump chamber and the sides of the disk element into four mutually separated spatial compartments having changing volume due to the rotation of the rotor.

[0012] The distinctive feature of the invention is that the spider arms of the universal-joint spider included in the disk element are formed as semi-axles which are connected by their corresponding end into the spherical part at the centre of the disk element, where on the other end of each semi-axle there is a bearing of the spider arm of the universal-joint spider.

[0013] In the first preferred embodiment of the invention each bearing of the spider arm at the end of each semi-axle of the universal-joint is formed as a so called sleeve bearing comprising an inner bearing sleeve, which is located rotatably in the outer bearing sleeve in the joint of the corresponding rotor half.

[0014] According to the invention both inner and outer bearing sleeves are replaceable.

[0015] Preferably the outer bearing sleeves are ceramic bearing sleeves.

[0016] Most preferably both inner and outer bearing sleeves are ceramic bearing sleeves.

[0017] Preferably the ceramic bearing sleeves are

mounted by means of an adhesive joint.

[0018] Optionally the bearing sleeves can be mounted by means of a snap ring (retaining ring).

[0019] The bearing sleeves made of metal are preferably mounted by means of an interference fit - it means, that the inner bearing sleeve is mounted by means of an interference fit onto the spider arm of the universal-joint spider and the outer bearing sleeve is mounted by means of an interference fit into the joint of the rotor half (i.e. at the end of the prong of the fork.)

[0020] In the second preferred embodiment the bearings at the end of the semi-axles of the universal-joint are needle roller bearings. The needle roller bearings are used for example for pumping the fluid medium with lubricating properties, such as oils, fuels, etc.

[0021] In the preferred embodiment the semi-axles of the universal-joint are connected to the spherical part at the centre of the disk element by an interference fit.

[0022] In another preferred embodiment the semi-axles of the universal-joint are connected to the spherical part at the centre of the disk element by a threaded joint.

Brief description of drawings

[0023] The present invention is below described in detail with the help of an exemplary embodiment with references to the accompanying schematic drawings, in which:

Figure 1 shows an axonometric exploded view of the rotary piston pump according to the present invention;

Figure 2 shows an axonometric exploded view of the rotary piston of the rotary piston pump according to Figure 1;

Figure 3 shows an axonometric view of the rotary piston of the rotary piston pump according to Figures 1 and 2 as viewed from the side of one of the rotor halves; and

Figure 4 shows an axonometric view of the rotary piston according to

Figure 3 as viewed from the side of the other rotor half.

Description of embodiments

[0024] For the sake of clarity and simplicity of the drawings, bearings and seals of the axles of the rotor halves are omitted, also the fixation means of the pump housing and other components thereof are omitted.

[0025] The following references are made mainly to Figure 1. The housing of the rotary piston pump consists of two housing halves 1 and 2, comprising two concave spherical surfaces 3 and 4, which form a part of the spherical piston chamber, when the housing halves are mounted together. On the outer side of the housing halves 1 and 2 there are the corresponding covers 5 and 6, which comprise exit and inlet orifices for the medium to be pumped. The surfaces of the covers 5 and 6 facing the corresponding housing halves 3 and 4 are spherical and form the rest of the spherical piston chamber in the pump housing.

[0026] The pump housing is split at the plane of the rotation axes of axles 11 and 12 of rotor halves 9 and 10 of the rotary piston. The bearings and seals of the axles 11 and 12 are not shown in drawings. One of the axles of the rotor halves is connected to the drive motor of the pump, which is usually an electric motor (not shown).

[0027] The following references are made mainly to Figure 2. The rotary piston consists of the two rotor halves 9 and 10, which are connected by a universal-joint spider included in the disk element 13. Both rotor halves 9 and 10 comprise two coaxial joints 14. Inside each of the joints 14 there is a spider arm 15 with a bearing.

[0028] The universal-joint spider is formed into the disk element 13 as follows. In the centre of the disk element there is a spherical part 16. Four holes 17 into the spherical part 16 are made - each hole is intended for fixing into it the corresponding end 19 of semi-axle 18 for forming one corresponding spider arm 15 of the universal-joint spider. In the embodiment as shown in the drawings each semi-axle 18 is fitted into the corresponding hole 17 in the spherical part 16 of the disk element 13 by means of an interference fit. But also a threaded joint can be used, which enables easier replacement of the semi-axles during repairs.

[0029] The pairs spider arms 15 are in pairs coaxial to each other - the axes of said pairs of arms are mutually perpendicular and said axes are positioned in the imaginary centre plane of the disk part of the disk element 13.

[0030] In each semi-axle 18 the other end of it forms a spider arm 15. The two coaxial semi-axles 18 with their arms 15 on the opposite sides of the spherical part 16 are intended to be connected by means of a bearing into one of the joints 14 of one rotor half and the other two coaxial semi-axles 18 with their arms 15 on the opposite sides of spherical part 16 are intended to be connected by means of a bearing into one of the joints 14 of the other rotor half.

[0031] As can be seen from Figure 2, the disk element 13 includes cutouts 20 and 21 made for the semi-axles 18. The cutout 20 receives the cylindrical part of the semi-axle 18 and the cutout 21 receives the joint 14 of the corresponding rotor half 9 or 10. The joint 14 is placed into the cutout 21 by means of a loose fit.

[0032] The bearing of the spider arm 15 comprises two sleeves in the embodiment of the drawings - an inner bearing sleeve 22 and an outer bearing sleeve 23. The inner bearing sleeve 22 is fixed onto the spider arm 15 and the outer bearing sleeve 23 is fixed into the joint 14 of the corresponding rotor half.

[0033] When operating the bearing sleeve 22 can rotate inside the bearing sleeve 23.

[0034] When the bearing sleeves made of metal are used, the corresponding inner bearing sleeve 22 is fixed onto the spider arm 15 by means of an interference fit

and also the outer bearing sleeve 23 is fixed into the joint 14 of the rotor half by means of an interference fit.

[0035] When ceramic bearings are used, where one or both of the bearing sleeves 22, 23 being made of ceramic material, said bearing sleeves are fixed by means of an adhesive joint. The ceramic bearing sleeves are used for example when pumping abrasive medium.

[0036] When needle roller bearings are used, said bearings are fixed into the joint 14 and onto the spider arm 15 by means of a fit specified by the bearing manufacturer.

[0037] The rotor halves 9 and 10 of the rotary piston have the same design and they have symmetrical shape in relation to their corresponding axles 11 and 12. On the side of the axles 11 and 12 the rotor halves 9 and 10 have a spherical shape corresponding to the shape of the concave spherical surfaces 3 and 4 in the housing halves 1 and 2. The end faces 24 of both rotor halves 9, 10 have a cuneiform shape, where the imaginary crest of the cuneiform shape is parallel to the imaginary common axis of the coaxial pair of joints 14 of the corresponding rotor half 9, 10.

[0038] The end face 24 includes a spherical concave part 25, the shape of which corresponds to the spherical part 16 in the centre of the disk element 13. The imaginary centre point of the spherical concave part 25 is located on the rotating axis of the axles 11, 12 of the corresponding rotor halves 9, 10 and at the same time also the imaginary axis of the pair of the coaxial joint 14 of the corresponding rotor half 9, 10 runs through said centre point.

[0039] As can be seen from Figures 3 and 4, the end faces 24 of the rotor halves 9 and 10 comprise recesses correspondingly shaped to receive the joint 14 and the semi-axle 18. The perimeter of the disk element 13 corresponds to the diameter of the spherical piston chamber and said disk element is placed into said chamber by means of a loose fit.

[0040] When the rotary piston is rotating, the distance between the sides of the disk element 13 between the rotor halves 9 and 10 and the end faces 24 of the rotor halves 9 and 10 are constantly changing. Thus making the volumes of the spatial compartments on both sides of the cuneiform end face 24 of the corresponding rotor halves 9 and 10 change, wherein said spatial compartments are confined by the spherical inner surface of the piston chamber, the corresponding side of the disk element 13 opposite to the corresponding end face 24 and a part of the end face 24.

[0041] Thus four spatial zones with changing volumes are formed due to the rotation of the rotary piston, which are used to suck the medium to be pumped into the piston chamber when the volume of the corresponding zone is increasing and which are used to force the medium to be pumped out of the piston chamber when the volume of the corresponding zone is decreasing.

[0042] In order to simplify repairs of the pump according to the invention, especially to simplify the replacement of the bearings, the semi-axles 18 comprise two cutouts 26 preferably on the opposite sides of the semi-axle 18 in order to allow the bearing sleeve 22 or the needle roller bearing to be removed from the spider arm 15.

[0043] Also in the embodiment, where the semi-axles 18 are fixed into the holes 17 of the spherical part 16 of the disk element 13 by means of a threaded joint, those cutouts 26 can be used to unscrew or tighten said threaded joint of the semi-axles.

[0044] The present invention is not limited to the exemplary embodiments described above, but in the scope of the accompanying claims several other embodiments are possible.

List of reference numbers

[0045]

1, 2 housing half
3, 4 spherical concave surface
5, 6 cover
7, 8 orifice
9, 10 rotor half
11, 12 axle of the rotor half
13 disk element
14 joint of the rotor half for the bearing
15 spider arm
16 spherical part at the centre of the disk element
17 hole for connecting semi-axle at the centre of the disk element
18 semi-axle
19 end of the semi-axle
20, 21 cutout in the disk element
22 inner bearing sleeve
23 outer bearing sleeve
24 end face
25 spherical concave part
26 cutout in the semi-axle

Claims

1. A rotary piston pump comprising pump housing having inlet and outlet orifices for the medium to be pumped, said housing comprising in a spherical piston chamber of the pump housing two rotor halves of the rotary piston connected by a universal-joint spider, wherein the rotation axes of the rotor halves are at an angle in relation to each other and said universal-joint spider is included in the disk element between said rotor halves, wherein the spherical pump chamber is divided by said disk element between the corresponding opposite end faces of the rotor halves, the spherical wall of the pump chamber and the sides of the disk element into four mutually separated spatial compartments having a changing volume due to the rotation of the rotor, ***characterized in*** **that** spider arms of the universal-joint spider included in the disk element are formed by semi-

axles inserted into the spherical part at the centre of the disk element, wherein at the other end of each semi-axle there is a bearing of the universal-joint spider arm.

2. The rotary piston pump according to claim 1, ***characterized in*** **that** the bearing at the end of each semi-axle of the universal-joint spider comprises an inner bearing sleeve, which is located rotatably in the outer bearing sleeve in the joint of the corresponding rotor half.

3. The rotary piston pump according to claim 1, ***characterized in*** **that** said inner and outer bearing sleeves are replaceable.

4. The rotary piston pump according to claim 2 or 3, ***characterized*** **in that** said outer bearing sleeves are ceramic bearing sleeves.

5. The rotary piston pump according to claim 2 or 3, ***characterized*** **in that** both inner and outer bearing sleeves are ceramic bearing sleeves.

6. The rotary piston pump according to claim 1, ***characterized*** **in that** each bearing at the end of the semi-axle of the universal-joint spider is a needle roller bearing.

7. The rotary piston pump according to any of the preceding claims 1 to 6, ***characterized*** **in that** the semi-axles of the universal-joint spider are fitted into the spherical part of the disk element by means of an interference fit.

8. The rotary piston pump according to any of the preceding claims 1 to 6, ***characterized*** **in that** the semi-axles of the universal-joint spider are connected into the spherical part of the disk element by means of a threaded joint.

Fig. 1

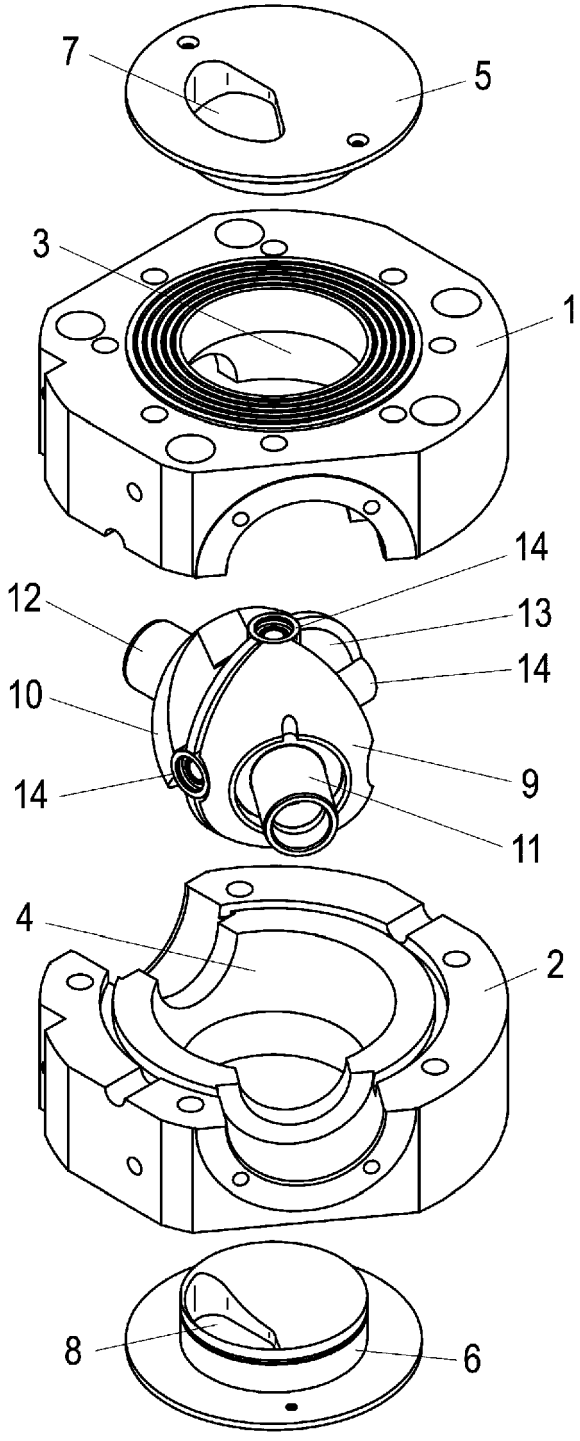


Fig. 2

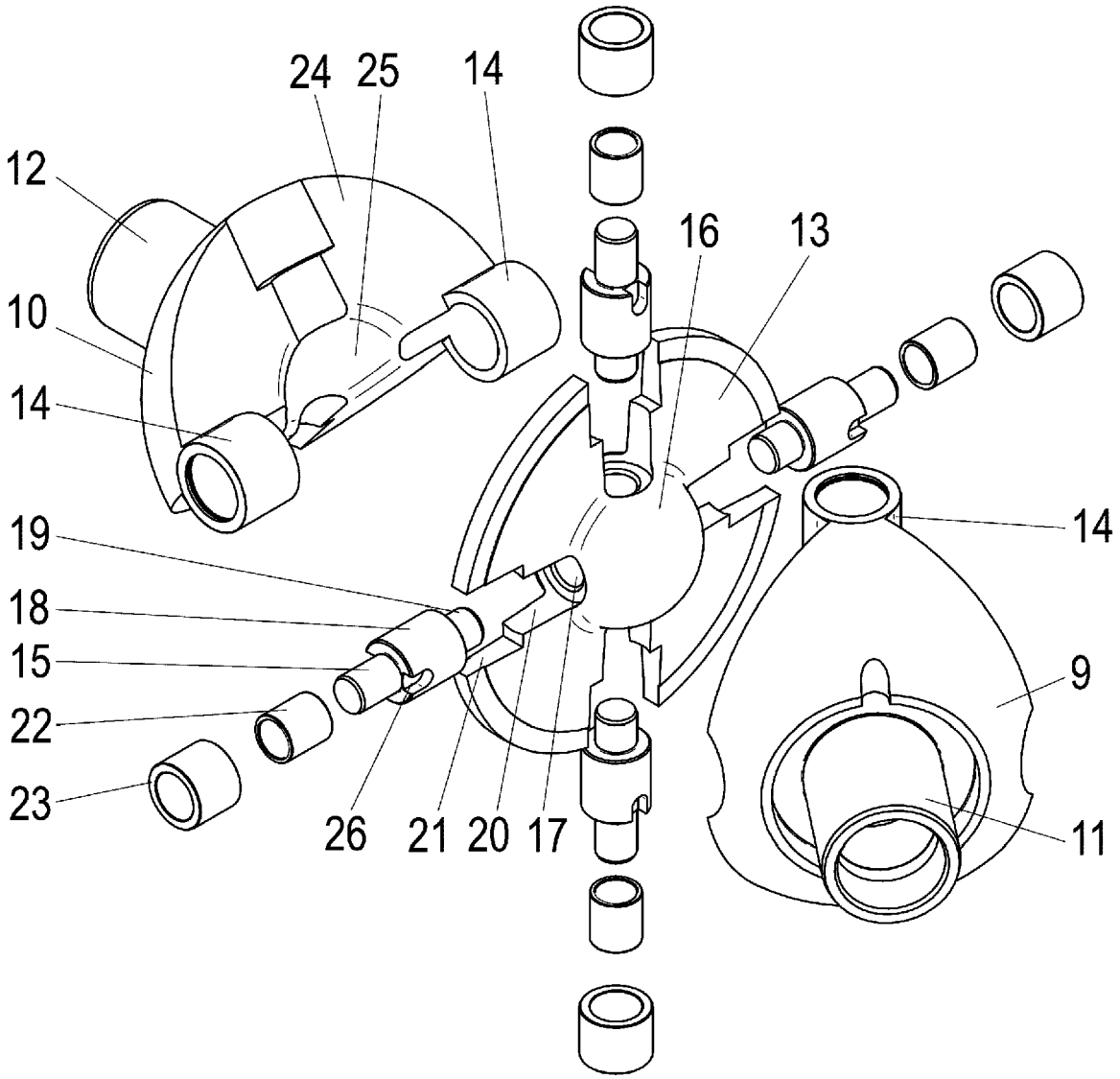


Fig. 3

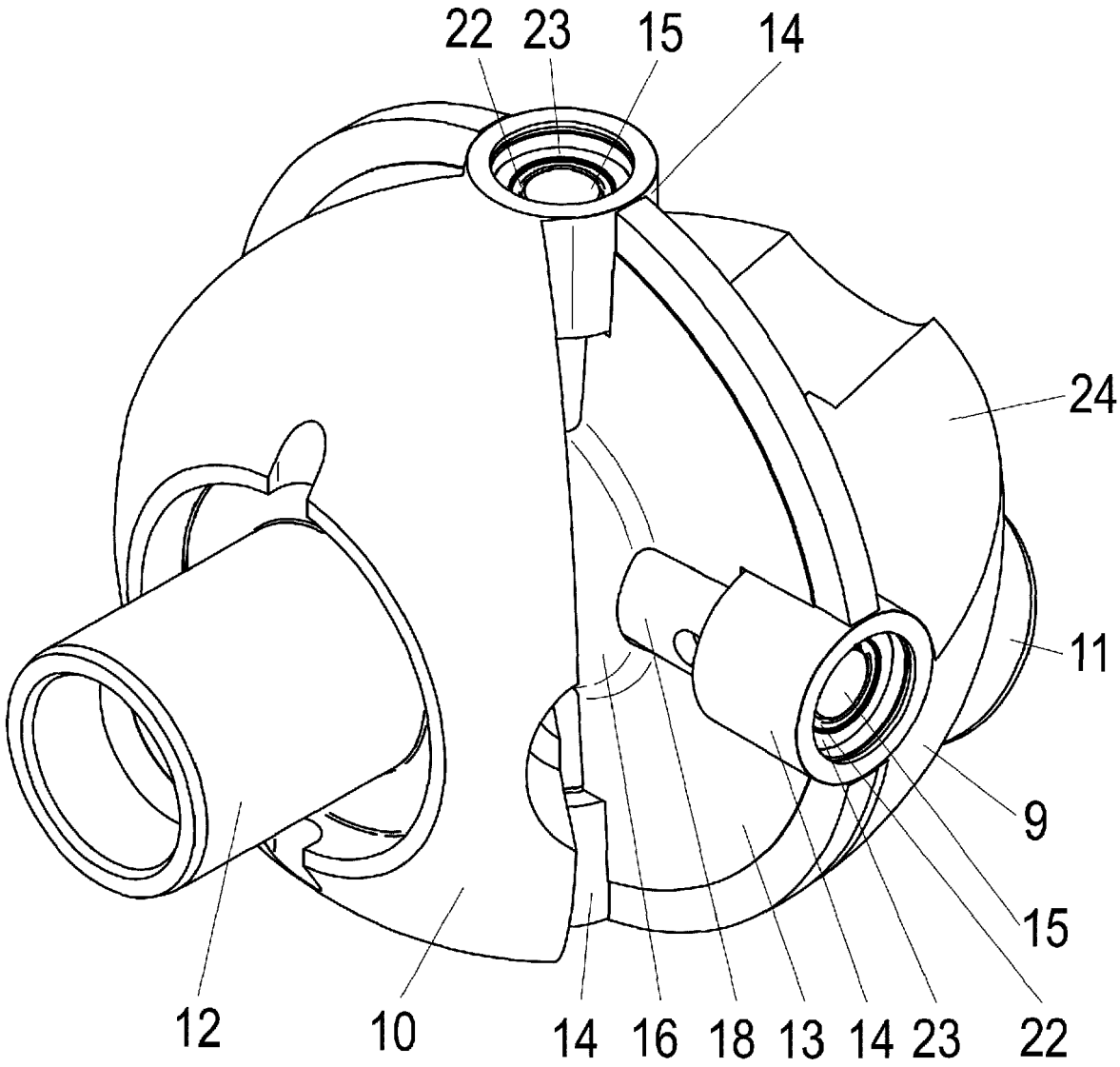
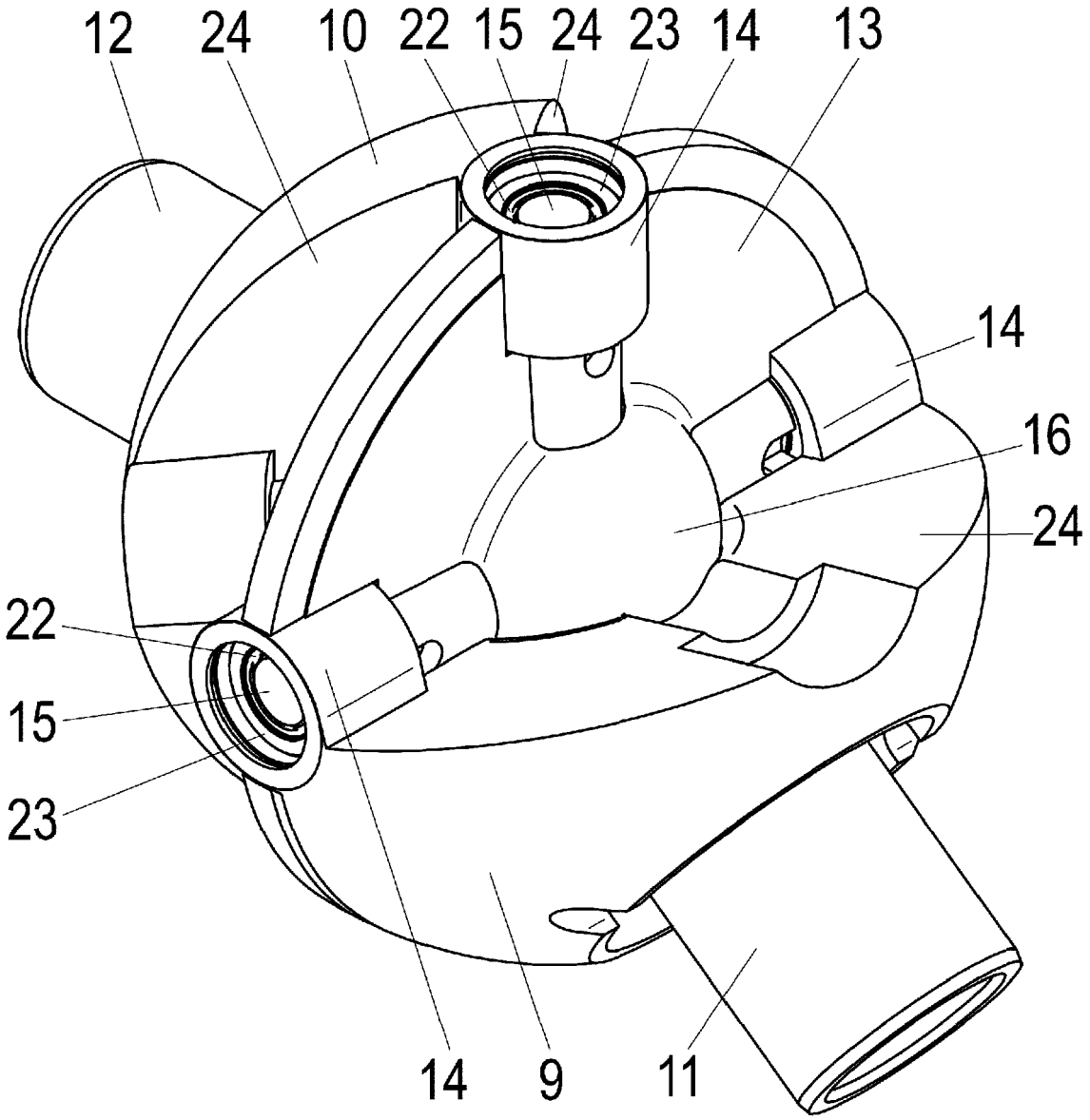


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 3215

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,D	WO 2009/053764 A1 (NAGY ZOLTAN [HU]; NAGY RICHARD [HU]; TOTHPAL-DEMETER MELINDA [HU]) 30 April 2009 (2009-04-30) * page 7, line 14 - page 9, line 5 * * figures 2,3,5-12 *	1-8	INV. F04C3/06 F04C9/00
A	US 5 199 864 A (STECKLEIN GARY L [US]) 6 April 1993 (1993-04-06) * column 3, line 40 - column 5, line 63 * * figures 1-4,6 *	1-8	
A	WO 84/00997 A1 (KEISLER D MICHAEL) 15 March 1984 (1984-03-15) * figures 1-3,12 * * page 8, line 6 - page 10, line 2 * * page 12, line 21 - page 15, line 8 *	1-8	
A	GB 2 115 490 A (SZIRMAY ZOLTAN; NAGY GYULA) 7 September 1983 (1983-09-07) * claim 1; figures 2-6 *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC) F04C F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	24 April 2017	Bocage, Stéphane

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- US 2727465 A **[0004]**
- US 5171142 A **[0004]**
- WO 2009053764 A1 **[0005]**