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(54) **RADIAL ROTARY PISTON MACHINE**

RADIAL-KREISKOLBENMASCHINE

MACHINE À PISTON ROTATIF RADIAL

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Description

Technical Field

[0001] The invention relates to a radial rotary piston machine, which can be used as a pump, compressor, vacuum pump or motor.

Background Art

[0002] Rotary piston machines are known, particularly pumps or compressors, which comprise a rotor of circular section, in which chambers for pistons are formed, the pistons being mounted on circular cams to produce their linear reciprocating motion, and these cams are mounted on a shaft, which is eccentrically positioned in relation to the rotor. The eccentricity of axis of the shaft from axis of the rotor is equal to the eccentricity of the cam from the axis of the shaft.

[0003] Pumps or compressors of said type are disclosed, for example, in documents US 1 853 394, US 1 910 876 and US 4 723 895.

[0004] Document US 1 853 394, discloses a rotary machine or pump, including a casing, a circular chamber within said casing having inlet and, outlet ports at opposite sides thereof. A cylinder rotatably confined within said chamber having an axial opening, a pair of working chambers extending at right angles to each other, diametrically through said cylinder and at opposite sides of said opening thereof. Pistons, within said working chambers having circular openings therein, and a revoluble shaft having a pair of diametrically related integral eccentrics. Eccentrics operating within said piston openings. Said shaft being eccentrically mounted with respect to the axis of said circular chamber. The respective diameters of said eccentrics, piston openings and axial cylinder opening being substantially equal and the diameters of said rotatable cylinder and said eccentrics being limited to dimensions, in which the axial opening of said rotatable cylinder is covered by each of said reciprocating pistons throughout its full stroke. Object of the invention according to this document is to provide an exceptionally efficient rotary machine for raising, transferring or compressing liquids or gases.

[0005] Subsequent document US 1 910 867, of the same applicant, which refers to the document US 1 853 394, then discusses in more detail properties of described rotary pump.

[0006] It is essential, with the pumps described in these documents, for the axial opening in the cylinder to be continuously covered by the pistons and never to be exposed, and thus no fluid could flow from one chamber of the cylinder to the other. This condition makes impossible to design a pump with the cylinder in one single piece, having a ratio of the pump rotor diameter and piston stroke of less than 5 to 1. This is because an assembling of the rotor with pistons can only be achieved by axially moving the drive shaft through the central

opening of the rotor and circular openings in the pistons. In order to make such assembly possible, the central opening must have such cross section that the drive shaft with the eccentrics can easily rotate therein. In addition, the lateral distance between the piston chambers must be approximately the same as the diameter of the piston, to allow the drive shaft to rotate to the proper alignment of its eccentrics with respect to the circular openings of the pistons, after one of the eccentrics has been moved through the circular opening of one of the pistons. Consequently, pumps with the ratio of less than 5 to 1 would be provided with an opening of such dimension that the reciprocating pistons would not continuously cover this opening and thus these pumps would be unusable. Design of the pump in Figures 5 to 10 of the document US 1 910 867 has the ratio of approximately 6 to 1. In order to assemble pumps of this type with the ratio of less than 5 to 1, the rotor must be split to allow assembly with a smaller central opening.

[0007] However, the split rotor must show the same characteristics as a single piece rotor, and thus assembly of separate parts of the split rotor must be produced very precisely with minimal tolerances and also sufficiently rigid. Such embodiment increases manufacturing demands and thus also production costs.

[0008] Document US 4 723 895 discloses a method of and an apparatus for effecting volume control suitable for use with a compressor for compressing a compressible fluid, such as a refrigerant of the refrigeration cycle. A compressor is described in this document having a principle of operation of machines according to US 1 853 394, US 1 910 876. Respective rotating parts of the compressor are journalled by ball or roller bearings. The shaft of the compressor is formed integrally with circular cams. Each cam has such construction that the cam diameter is reduced without varying the eccentricity of the cam by causing a portion of the cam diametrically opposed to the protuberance of the cam to be disposed in a position nearer to the centre of the shaft than its outer circumferential surface, and reliefs for assembling the pistons with the shaft are formed at the outer circumferential surface of the shaft in the vicinity of the portion of the cam diametrically opposed to the protuberance of the cam.

[0009] Said reliefs of the shaft are important for allowing the reduction in diameter of openings formed in the pistons, into which the cams are inserted to render possible the assembly of the shaft, the pistons and the rotor in described arrangement. Disadvantage of the compressor design according to the document US 4 723 895 resides in its construction complexity.

[0010] Document US 2015/0098841 A1 discloses a spin pump with spun-epicyclic geometry, having pistons driven by eccentrics of circular section, as known from the above-mentioned documents. This pump uses a split rotor, however, not in order to provide a longer piston travel, but in order to allow an assembly of the described pump without a need to divide the piston into two pieces.

[0011] Intake and discharge with the above-described

pump designs is provided by rotating a rotor in cylindrical hole, where the body of the rotor opens and closes intake and discharge radial openings on cylindrical surface of the cylindrical hole in the housing - stator of the pump.

[0012] For the pump to operate correctly, it is necessary to produce very precise, tight, bearing of the rotor in the cylindrical hole in the housing - stator of the pump, both due to providing a seal between the intake and discharge parts, and due to smooth rotation of the rotor and drive shaft with circular cams. This requirement is extremely important, particularly in the case where these machines are intended for operation without a lubricant, that is as so-called oil-free. Providing the necessary precision places higher demands on production requirements.

[0013] Not following the tight tolerances can result in leaks and uneven running of the machine, as is "jamming" in positions out of tolerances.

[0014] Such deficiency can be overcome to some extent by providing a transmission with ratio 2:1 between the shaft and the rotor of the pump. Although such timing gear can facilitate the running and load of working parts of the pump, for example substantial lateral load on pistons, it however may be deleterious to the simplicity and efficiency of the machine, as is for example mentioned in the US 2015/0098841 A1.

[0015] Document US 2015/0098841 A1 also discloses a pump embodiment where the piston bore ends in rotor are coupled to heads. Valve plates may include valves that regulate fluid inflow and fluid outflow routed to respective side ports in bearing plates. Thus, at least one valve is coupled to one of the piston bores. In an embodiment, one of the valves is an outlet valve on a piston head and another valve is an inlet valve on a piston, whereby inflow may be drawn through the central crankcase portion of the pump and outflow discharged through the head. This embodiment exploits check valves known and used in heads of piston compressors. In the embodiment described, adverse effects derived from a rotation of the valve plate around the axis of rotation of the rotor, i.e. centrifugal/centripetal forces, which would increase with the distance of the valve plate from the axis of rotation of the rotor, can add to drawbacks of the known check valves originating particularly from their own design. In this case, the rotor does not have to be of cylindrical shape.

[0016] A compressor pump structure is known from documents US 2019/0242381 A1 and US 2019/0226482 A1. A compressor pump structure has a cylinder sleeve provided between an upper flange and a lower flange; a cylinder is provided inside the cylinder sleeve; a piston is slidably arranged inside the cylinder; a volume-variable chamber is formed among the cylinder sleeve, the cylinder and the piston; a rotating shaft passes through the piston, the axis of the rotating shaft being eccentrically disposed with respect to the axis of the cylinder with a fixed eccentricity; the rotating shaft drives the piston and the cylinder to rotate; and the piston slides within the cylinder while rotating so as to change

the volume of the volume-variable chamber. Further disclosed is a compressor which comprises a compressor pump structure.

[0017] Object of the invention is rotary piston machine that can be used as a pump, compressor, vacuum pump or motor, which is characterized by simplicity in manufacturing, while practically eliminating all disadvantages and limitations resulting from designs in the above-described documents. Such rotary piston machine would allow production particularly of pumps, compressors and vacuum pumps for a wide range of applications and pressure ranges while maintaining the same construction arrangement.

[0018] It is also desirable for such construction, particularly of a compressor or vacuum pump, to be able to operate without a lubricant, or else in so-called oil-free operation.

Disclosure of Invention

[0019] Said object is achieved by a radial rotary piston machine according to the invention as claimed in claim 1, comprising a frame, at least one opening for inlet of a medium into the machine and at least one opening for discharge of a medium out of the machine, where the frame comprises end plates between which a rotor is placed, this rotor comprises axial opening for a shaft of the machine and further comprises at least two angularly offset piston chambers transversely to the rotor axis, the shaft of the machine extends through the axial opening in the rotor and is mounted in bearings in the end plates of the frame, circular cams are arranged on the shaft, the shaft being positioned eccentrically to the rotor, where the eccentricity of the axis of rotation of the shaft from the axis of the rotor is equal to the eccentricity of the axis of the circular cam from the axis of rotation of the shaft, each piston is arranged for reciprocal movement in the piston chamber in the rotor and mounted rotatively on the circular cam on the shaft, where the piston chamber ends are closed by heads, the head or the rotor comprise at least one passage for inlet and discharge of a medium from the piston chamber, which are opened and closed by valve means. Rotary piston machine according to the invention is characterized in that the head and/or the rotor comprise at least one passage for inlet and discharge of a medium to and from the piston chamber leading on one end in axial direction to the end plate of the frame, and which is opened and closed at its axial opening by valve means in the form of separate arcuate slots.

[0020] Preferably, the piston chamber is provided with an insert, and this insert is connected with the head of the piston chamber.

[0021] Preferably, the insert extends along the piston chamber to the proximity of the shaft of a pump, compressor or vacuum pump.

[0022] Preferably, the valve means in the form of separate arcuate slots are provided in a valve plate positioned between the rotor end and the end plate of the

frame.

[0023] Preferably, the rotor end is provided by a slide sealing plate with an aperture for passage of a medium to and from the passage in the head and/or rotor.

[0024] Preferably, the piston is provided at each of its ends by a piston ring.

[0025] Preferably, the piston ring is jointless, where the piston end is provided removable for insertion of this jointless piston ring.

Brief Description of Drawings

[0026] The invention is for better understanding shown in accompanying drawings, in which:

Fig. 1 shows axonometric section view of radial rotary piston machine, specifically a compressor;

Fig. 2 shows axonometric expanded view of the machine of Fig. 1;

Fig. 3 shows axonometric expanded view of the valve means of the machine;

Fig. 4 shows axonometric view of the piston of the machine;

Fig. 5 shows axonometric view of the rotor of the machine without the slide sealing palate at one end of the rotor.

Fig. 6 shows axonometric expanded view of the rotor of the machine with the slide sealing plates at both ends of the rotor and the valve plates;

Fig. 7 schematically shows working phase of the machine with the inlet and discharge of a medium closed;

Fig. 8 schematically shows working phase of the machine with the intake and discharge of a medium opened;

Fig. 9 shows overall outside view of the radial rotary piston machine of Fig. 1, in a frame in the form of closed casing with openings for inlet and discharge of the air, and with protruding shaft of the machine.

Fig. 10 shows axonometric section view of a variant of the radial rotary piston machine having pistons without piston rings, in the piston chamber without the insert, without the slide sealing plates at the ends of the rotor, and with the passage for inlet and discharge of a medium to or from the piston chamber, provided in the rotor;

Fig. 11 shows axonometric expanded view of the machine of Fig. 10.

Mode(s) for Carrying Out the Invention

[0027] Radial rotary piston machine according to the invention is explained more in detail in examples of embodiments shown in drawings.

[0028] A machine shown in Fig. 1 to 6 is specifically a compressor, and a rotary machine shown in Fig. 10 and 11 can be a pump, or also a small size compressor.

[0029] The machine according to the examples shown

is provided with two pistons 4, each reciprocally movable in one chamber 22 of a rotor 2, where chambers 22 are mutually arranged under 90° angle.

[0030] The machine, compressor according to Fig. 1 to 6, comprise a frame 1, in the shown example, in the form of two-piece casing. A rotor 2 is rotatively mounted in bearings 12 in end plates 11 of the frame 1. Axial opening 21 for a shaft 5 of the machine and chambers 22 for pistons 4 are provided in the rotor 2.

[0031] The shaft 5 extends through axial opening 21 of the rotor 2 and is rotatably mounted in bearings 15 in the end plates 11 of the frame 1. The shaft 5 protrudes through the end plate 11 of the frame 1 on one side, where it is sealed for example by a common shaft seal.

Circular cams 51 are arranged on the shaft 5. The shaft 5 is positioned eccentrically to the rotor 2, where the eccentricity of the axis of rotation of the shaft 5 from the axis of rotation of the rotor 2 is equal to the eccentricity of the axis of the circular cam 51 from the axis of rotation of the shaft 5.

[0032] Circular cams 51 are mounted on the shaft 5 through detachable keyed joint. This is preferable with regard to the production and also to assembling of the machine. However, it is equally possible to provide the shaft 5 with integral cams 51 as commonly known in the prior art.

[0033] A piston 4 is rotatively mounted on the circular cam 51. The piston 4 has opening 41 to be mounted on the circular cam 51. This opening 41 passes transversely through the centre of the piston 4. Thus, the piston 4 has two ends, where the piston 4 is equipped with a piston ring 43 on each of the two ends. The piston ring 43 is placed in a groove 42 provided in the piston 4. The piston ring 43 with a joint or jointless can both be equally used. When jointless piston ring 43 is used, relative end of the piston 4 is made removable in order to make the groove 42 accessible for insertion of such jointless piston ring 43.

[0034] In the example shown, the piston 4 is provided with one piston ring 43 on each of its ends. One piston ring 43 on each end of the piston 4 is sufficient, however, greater number of piston rings 43 can be chosen if required, be it necessary regarding dimensions, or material of the piston rings 43, or applications, which the machine according to the invention will be used for.

[0035] The piston ring 43 provides tightness of the piston 4 in the piston chamber 22 in the rotor 2, or tightness of the piston 4 in an insert 31 of the piston chamber 22. It was surprisingly found that the piston ring 43 also provides for smooth running of the machine without a need to follow extremely tight tolerances in mutual positions of related rotating and moving parts, that is, the rotor 2, the shaft 5, circular cams 51, and pistons 4, as required in machines according to the prior art. Such required tight tolerances can be followed without any considerable problems in machines having small dimensions, however, it is problematic to follow such tight tolerances in larger machines, while these require special and costly manufacturing. Not following the required

tolerances means for the prior art machines that due to insufficient alignment of relative rotating and moving parts a jamming of these parts and uneven running can occur during the rotation. This can be avoided either by increasing the power input on the shaft, or also by including e.g. toothed transmission between the shaft 5 and the rotor 2. Additional transmission thus virtually takes over driving the rotor 2 instead of pistons 4.

[0036] When the piston 4 is placed in the chamber 22, or the insert 31, by means of the piston rings 34, related rotating moving parts, when the machine is running, are continually aligned in mutual ideal positions ensuring smooth operation of the machine. Then, manufacturing tolerances in order of hundredths of a millimetre are sufficient, which by any manner do not increase production costs due to a need of special precise manufacturing. Thus, the machine runs completely smoothly, while the piston 4 tightness is fully maintained, in fact, even from the machine start-up.

[0037] The piston chamber 22 in the rotor 2 is closed by a head 3. The head 3 is arranged on the rotor 2 detachably, and is provided on each end of the chamber 22. In the example shown, the head 3 is provided with the insert 33 of the piston chamber 22. In this case, the insert 31 creates the inner space of the chamber 22, in which the piston 4 is moving, and therefore, tight sliding placement of the piston 4 is formed by inner wall of the insert 31 and the piston ring 43. Preferably, the insert can be provided such that it extends to the closest possible proximity of the shaft 5, of course not disregarding a displacement of axes of rotation of the shaft 5 and the rotor 2.

[0038] The insert 31 is preferable regarding its simple replacement when worn-out, thus it is not necessary to replace, or optionally re-bore, the whole rotor 2, when directly chambers 22 are worn-out in case the pistons 4 move directly in the chambers 22 without the inserts 31. Further, the insert 31 allows that an interconnection of the chambers 22 through the axial opening 21 in the rotor 2 cannot occur in case of greater dimensions of the machine and longer travels of the piston 4, when the piston 4 edge could pass under the outline of the axial opening 21, thus creating undesired leak of a medium from the piston chamber 22 to this axial opening 21. Then, this allows to produce the machine without for example a requirement for split rotor 2 in order to achieve the least possible diameter of axial opening 21 of the rotor 2.

[0039] At least one passage 32 is provided in the head 3 for inlet and discharge of a medium to and from the piston chamber 22, in this example, the chamber 22 with the insert 31. When the piston chamber 22 does not include the insert 31, this passage 32 can be provided also in the head 3 only, or partially in the head 3 and partially in the body of the rotor 2, or in the body of the rotor 2 only, as will be described later in the example of embodiment according to Fig. 10 and 11.

[0040] The passage 32 provided in the body of the rotor 2 only can somehow decrease volumetric efficiency of the compressor, however in the case of pumps, or

blowers this is negligible.

[0041] The passage 32 for inlet and discharge of a medium to and from the piston chamber 22 is axially opening in direction to the end plate 11 of the frame 1, that is axially in regard to the rotor 2 and the shaft 5.

[0042] The description is the same also for the second piston 4 and the second chamber 22 for the piston 22 of the machine according to this example of embodiment.

[0043] Inlet and discharge of a medium to and from the piston chamber 22, in this example the chamber 22 with the insert 31, is controlled by valve means for opening and closing of the inlet and discharge of a medium to and from the chamber 22. These valve means are provided in the form of separate arcuate slots 61 opening the passage 32 for inlet and discharge of a medium to and from the chamber 22. Closing of the passage 32 is carried by a solid part, the part between the separate arcuate slots 61, of the body in which the separate arcuate slots 61 are provided.

[0044] In the example shown, the arcuate slots 61 are preferably arranged in a valve plate 6, positioned between the rotor 2 and the bearing plate 11 of the frame 1. The valve plate 6 is preferably lodged in a groove 16 in the end plate 11 of the frame 1. However, the groove 16 is not essential for placing the valve plate 6. The valve plate 6 must be for proper functioning secured against its own turning only. In the example shown, the position of the valve plate 6 is secured against turning by at least one locking pin 63 interfering the plate 6 and the end plate 11. In order to secure position of the plate 6 it is of course possible to use also other known suitable means.

[0045] Valve plate 6 of the type described is used in hydraulic axial piston pumps, however its application in radial rotary piston machines is not disclosed elsewhere, and in fact excluded in compressors known in the prior art.

[0046] In the example shown, preferably a sealing plate 7 is attached to the end of the rotor 2, in order to provide reliable sealing of the head 3 and/or the rotor 2 against the valve plate 6, with regard to the passage 32 for inlet and discharge of a medium. The sealing plate 7 comprises an aperture 71, in fact apertures 71, for passage of a medium to and from the passage 32 for inlet and discharge of a medium to and from the piston chamber 22. Preferably in the case of the compressor, a sealing 322 can be provided around axial opening of the passage 32 to prevent accidental leaks of pressure air between the sealing plate 7 and the head 3 and/or the rotor 2. It is equally preferable when similar sealing 64 is provided around the arcuate slot 61 on the valve plate 6 against the end plate 11.

[0047] Above description related to the valve means is the same also for the other end of the rotor 2.

[0048] The passage 32, i.e. passages 32, for inlet and discharge of a medium to or from the piston chamber 22, in the embodiment shown with the sealing plate 7 the apertures 71 for inlet and discharge of a medium are opened or closed respectively against the arcuate slots

61 of the valve plate 6. Then, the arcuate slots 61 respectively communicate with an opening 13 for inlet of a medium to the machine and an opening 14 for discharge a medium from the machine, which are arranged on the frame 1 of the machine.

[0049] In the example of embodiment of the machine shown in Fig. 1 to 6, the opening 13 for inlet of a medium to the machine is formed after connecting a two-pieces casing, which produces closed enclosure for the compressor. The opening 13 connects inner space of the casing with a source of a medium, in this case the ambient air. The opening 14, i.e. openings 14, for discharge of a medium from the machine are provided in the end plates 11 of the casing, while in this case they are led out from the groove 16 wherein the valve plate 6 is lodged.

[0050] Regarding the valve means, a variant of embodiment is possible for example without the valve plate 6, where the arcuate slots 61 would be provided directly in the end plates 11 of the frame 1. Equally, a variant of embodiment is possible without the slide sealing plate 7 at the end of the rotor 2, where a slide surface would be directly end surface of the rotor 2, whereon the passage 32 for inlet and discharge of a medium to and from the piston chamber 22 would be provided. Such variant will be for a better understanding described in the next example of embodiment, which is shown in Fig. 10 and 11.

[0051] However, in general, the valve plate 6 and the slide sealing plate 7 preferably provide sealing means that can be easily replaced when worn-out.

[0052] In the example of embodiment of the machine shown, all rotative mounts are provided with roller bearings. Plain bearings can equally be used, or combinations of roller and plain bearings if required.

[0053] Radial rotary piston machine, the compressor, in described example of embodiment shown in Fig. 1 to 6 is working in the following way.

[0054] The shaft 5 connected to a drive (not shown) rotates the circular cams 51, which drive the pistons 4 in reciprocating motion in their chambers 22 with the inserts 31. The pistons 4 at the same time rotate the rotor 2. Due to presence of the piston rings 43 the compressor runs completely smoothly and evenly also with standard tolerances in positions and alignment of related rotative parts.

[0055] Fig. 7 and 8 show positions of rotative parts when turning the shaft 5 for 180°, where for a simpler illustration one extreme position of one of the pistons 4 is chosen as starting position, i.e. the position at the end of the piston 4 travel in the chamber 22. This starting position is shown in Fig. 7.

[0056] In the given starting position, the cam 51 is in extreme position of its highest eccentricity, thus the piston 4 is in the extreme position at the end of its travel. One end of the piston 4 is thus in the position closest to the head 3. The other end of the piston 4 is then in the farthestmost position from the head 3. Body of the valve plate 6 closes in this position the passages 32 for inlet and discharge of a medium to and from the piston chamber 22. In this case,

when the sealing plate 7 is present, the apertures 71 for passage of a medium are closed. In the phase described, the air is on one side in fact completely pushed out from the chamber 22 and on the other side, drawn in into the highest working volume of the chamber 22.

[0057] Turning the shaft 5 further, the aperture on one side passes by the edge of the arcuate slot 61 while connecting the chamber 22 with the air inlet. In the example shown, the air inlet is provided by the opening 13 in the compressor casing, which supplies the air into the inner space of the casing. The air is guided from the inner space of the casing by inlet grooves 62 into the arcuate slot 61 in the valve plate 6.

[0058] At the same time, on the other side, the aperture 71 passes the edge of the other arcuate slot 61 while connecting the chamber 22 with the air discharge. In the example shown, the air discharge is provided by the opening 14 in the end plate 11 of the casing, where this opening leads to a channel 17 in the end plate 11 on the side of the valve plate 6.

[0059] The arcuate slots 61 in the valve plate 6 shown in drawings are segmented, i.e. it is not continuous arcuate slot 61. The reason is to maintain strength of the valve plate 6, while material of the plate 6 between segments of the arcuate slot 61 does not affect the passage of a medium to and from the piston chamber 22 in any way. Anywhere the construction allows it, the slots 61 can be provided as continuous. Separation of the arcuate slots 61 regarding the separation of inlet and discharge parts for a medium must of course be maintained.

[0060] In the case of a pump, i.e. pumping fluids, due to their incompressibility, opening of the chamber 22 into the passages 32 must occur simultaneously. In the case of compressors, according to requirements for output pressure, edge of the discharge arcuate slot 61 can be moved such that the passage 32, in this case the aperture 71, is closed by the body of the valve plate 6 longer, resulting in compression of the air while lowering the working volume of the chamber 22.

[0061] By turning the shaft 5 further, lowering of the chamber 22 volume above the piston 4 occurs on one end of the piston 4 and enlarging of the chamber 22 volume above the piston 4 occurs on the other end of the piston 4, thus the air is pressed out on one side and drawn in on the other side.

[0062] In the position shown in Fig. 8. the piston 4 is in the middle position, passages 32, in this case also apertures 71, are fully opened.

[0063] By turning the shaft 5 further, volume of the chamber 22 on one end of the piston 4 is lowered, thus pressing the air out of the chamber 22 continues, and volume of the chamber 22 on the other end of the piston 4 is enlarging, thus drawing the air in into the chamber 22 continues.

[0064] The air is pressed out through the passage 32, in this example further also through the aperture 71 in the sealing plate 7 into the arcuate slot 61 and from this into

the opening 14 for discharge of a medium from the machine.

[0065] After the entire cycle is completed, i.e. with two revolutions of the shaft 5, the piston 4 is again in the position closest to the head 3 on one end, and in the farthest position from the head 3 on the other end. Body of the valve plate 6 in this position closes the passages 32, in this case the apertures 71 such that the air backflow between the chambers 22 above respective ends of the piston 4 cannot occur.

[0066] The way of operation described is the same also for variants of the machine, where for example the valve plate 6 and slide sealing plate 7 will not be used and the valve means will be provided directly in the frame 1 of the machine, in fact in the end plates 11.

[0067] In regard of a compressor, the most preferable is to create the frame 1 in the form of the casing as shown in overall outside view in Fig. 9. This way, compact machine is produced, where such casing protects rotating parts of the machine and also contributes to lowering the machine noise. Furthermore, in case of the compressor, the rotor 2 is able to cool itself by own rotation in the surrounding drawn in medium, the air, such that no additional cooling equipment, such as a fan, is necessary. Unlike known piston compressor, this compressor is capable of uninterrupted operation, Cooling efficiency can further be increased also by injecting of a small amount of oil into the air drawn in.

[0068] In order to illustrate efficiency of the machine, the compressor, according to the example shown, particular dimensions and parameters of the compressor already produced are presented below.

[0069] Outer dimensions of the compressor casing, shown in Fig. 9 are 140 x 140 x 180 mm. Compressor displacement is 90 cm³ per 1 revolution of the shaft 5. The compressor was driven by electric motor with 1,5 kW output. Noise, compressor output in l/min., and input were measured. Particular values measured at 800 rev./min. were:

- noise 54 dBA, without acoustic covering
- compressor output 60 l/min. at pressure 2 bar, input 280 W
- compressor output 40 l/min. at pressure 8 bar, input 520 W

[0070] Overall, operation of the compressor was tested within revolutions ranging from 200 to 3500 rev./min. Maximum pressure measured so far was 16 bar.

[0071] It can be derived from the arrangement of the machine according to the invention that with dimensions of the outer casing being 200 x 200 x 270 mm the compressor will have displacement of 305 cm³/rev., and with dimensions of the outer casing being 250 x 250 x 350 mm the compressor will have displacement of 720 cm³/rev. The compressor having relatively small outer dimensions will provide multiple times larger displacement volume.

[0072] When required, the frame 1 can also be for example provided such that it will not form compact casing, but will form a frame structure providing necessary mutual position and rigidity of the end plates 11. The opening 13 for inlet of a medium to the machine will be then appropriately provided on a body of the end plate 11.

[0073] Fig. 10 and 11 show a variant of radial rotary piston machine according to the invention, that is complete rotor part of the machine with the shaft 5, with the pistons 4 without the rings 43, with piston chambers 22 without the insert 31, without the slide sealing plates at the end of the rotor 2, and with the passage for inlet and discharge of a medium to and from the chamber 22 in the rotor 2 only. The machine with such rotor part can be for example a pump, or a compressor having small dimensions, where tight tolerances can be followed due to the tightness and alignment of rotative parts of the machine. Pumps having larger dimensions looser tolerances are possible, as such tolerances are balanced by the working fluid. Valve means, i.e. the arcuate slots 61, optionally valve plate 6, and also the slide sealing plate 7, and their optional combinations for this example of the machine are the same as described in the example of embodiment according to Fig. 1 to 6. The frame of the machine, as required, can be provided as the casing, or also in the form of the frame structure, providing necessary mutual position and rigidity of the end plates 11 as described above.

[0074] The way of operation of the machine according to the example of embodiment shown in Fig. 10 and 11 is the same as described above, of course with the difference that parts present in the example of embodiment shown in Fig. 10 and 11 are considered.

[0075] Radial rotary piston machine according to the invention can be a compressor, pump, vacuum pump, or optionally also a motor.

[0076] Due to valve means described also reverse running of the machine is possible without any additional arrangements, when in fact, only the function of the opening 13 for inlet of a medium to the machine is turned to the function of the opening 14 for discharge of a medium and vice versa.

[0077] Design of the radial rotary piston machine according to the invention also allows for producing a compressor as multi-stage compressor, for example to obtain higher pressures. In the example of the compressor described and shown, the chambers 22 and the pistons 4 have the same dimensions, i.e. working volume of each chamber 22 is equally large.

[0078] In the case of multi-stage compressor, it is possible to provide one chamber 22 with larger volume, i.e. also with bigger piston 4 and one chamber with smaller volume, i.e. also with smaller piston 4. Then, intake of a medium would be realized into the chamber 22 with larger volume, and discharge from this larger chamber 22 would be supplied to the intake of a media into the chamber 22 with smaller volume. Then, discharge of high-pressure media would be the discharge

of a media from the chamber 22 with smaller volume.

[0079] Embodiments of the machine comprising more chambers 22 with pistons 4, or with different mutual angle as in the examples already described are not excluded. However, in such cases, this will concern design solutions of piston chambers 22 only and their arrangement in the rotor 2, while the essence of the solution will remain with all its advantages.

[0080] Radial rotary piston machine according to the invention can be manufactured with technologies commonly available and used and with conventional materials.

[0081] Individual parts of the machine can also be produced using 3D printing without any problems. Use of special materials is anticipated only in special applications as for example oil-free compressors, pumps or compressors for extreme loads and similar.

Industrial Applicability

[0082] Radial rotary piston machine according to the invention can be used as a compressor, pump, vacuum pump, or also a motor.

[0083] Radial rotary piston machine as a compressor can be used for a wide range of applications in a wide range of pressures and flow rates, as for example, blowers, low-pressure, middle-pressure or high-pressure compressors.

[0084] Radial rotary piston machine as a vacuum pump can be used as efficient vacuum pump to create negative pressure, as well as multi-stage vacuum pump to reach high vacuum. The vacuum pump is simply provided only by connecting the intake to a volume where a negative pressure is required without a demand for any further design adjustments.

Claims

1. A radial rotary piston machine comprising a frame (1), at least one opening (13) for inlet of a medium into the machine and at least one opening (14) for discharge of a medium out of the machine, where the frame (1) comprises end plates (11) between which a rotor (2) is placed, this rotor comprises axial opening (21) for a shaft (5) of the machine and further comprises at least two angularly offset piston (4) chambers (22) transversely to the rotor (2) axis, the shaft (5) of the machine extends through the axial opening (21) in the rotor (2) and is mounted in bearings in the end plates (11) of the frame (1), circular cams (51) are arranged on the shaft (5), the shaft (5) being positioned eccentrically to the rotor (2), where the eccentricity of the axis of rotation of the shaft (5) from the axis of the rotor (2) is equal to the eccentricity of the axis of the circular cam (51) from the axis of rotation of the shaft (5), each piston (4) is arranged for reciprocal movement in the piston (4) chamber

(22) in the rotor (2) and mounted rotatively on the circular cam (51) on the shaft (5), where the piston (4) chamber (22) ends are closed by heads (3), the head (3) or the rotor (2) comprise at least one passage (32) for inlet and discharge of a medium from the piston (4) chamber (22), which are opened and closed by valve means **characterized in that** the passage (32) for inlet and discharge of a medium to and from the piston (4) chamber (22) is led in axial direction to the end plate (11) of the frame (1), and is opened at its end by valve means in the form of separate arcuate slots (61) and closed by a solid part, between the separate arcuate slots (61), of a body in which the separate arcuate slots (61) are provided.

2. The radial rotary piston machine according to claim 1, **characterized in that** the piston chamber (22) is provided with an insert (31), and this insert (31) is connected with the head (3) of the piston chamber (22).
3. The radial rotary piston machine according to claim 2, **characterized in that**, the insert (31) extends along the piston chamber (22) to the proximity of the shaft (5) of the machine.
4. The radial rotary piston machine according to any of preceding claims, **characterized in that** the separate arcuate slots (61) are provided in a valve plate (6) positioned between the rotor (2) end and the end plate (11) of the frame (1).
5. The radial rotary piston machine according to any of preceding claims, **characterized in that** the rotor (2) end is provided by a slide sealing plate (7) with an aperture (71) for passage of a medium to and from the passage (32) in the head (3) and/or rotor (2).
6. The radial rotary piston machine according to any of preceding claims, **characterized in that** the piston (4) is provided at each of its ends by a piston ring (43).
7. The radial rotary piston machine according to claim 6, **characterized in that** the piston ring (43) is jointless, where the piston (4) end is provided removable for insertion of this jointless piston ring (43).

Patentansprüche

1. Radialkolbenrotationsmaschine, die einen Rahmen (1), mindestens eine Öffnung (13) für den Eintritt des Mediums in die Maschine und mindestens eine Öffnung (14) für den Austritt des Mediums aus der Maschine aufweist, wo der Rahmen (1) Stirnseiten (11) aufweist, zwischen denen in Drehlagerungen ein Rotor (2) gelagert ist, dieser Rotor eine axiale Öffnung (21) für eine Welle (5) der Maschine auf-

weist und ferner quer zur Achse des Rotors (2) mindestens zwei winkelseitige Kammern (22) für die Kolben (4) aufweist, die Welle (5) der Maschine die axiale Öffnung (21) im Rotor (2) durchgeht und in den Drehlagerungen in den Stirnseiten (11) des Rahmens (1) gelagert ist, auf der Welle (5) kreisförmige Nocken (51) angeordnet sind, die Welle (5) in Bezug auf den Rotor (2) exzentrisch gelagert ist, wobei die Exzentrizität der Drehachse der Welle (5) von der Achse des Rotors (2) der Exzentrizität der Achse des kreisförmigen Nockens (51) von der Drehachse der Welle (5) gleich ist, jeder Kolben (4) in der Kammer (22) für den Kolben (4) im Rotor (2) verschiebbar umkehrbar und im kreisförmigen Nocken (51) auf der Welle (5) drehbar gelagert ist, wo die Enden der Kammer (22) für den Kolben (4) mit den Köpfen (3) verschlossen sind, der Kopf (3) oder der Rotor (2) mindestens einen Übergang (32) für Zufuhr und Austritt des Mediums aus der Kammer (22) des Kolbens (4) aufweisen, die durch Ventilmittel geöffnet und geschlossen werden, **dadurch gekennzeichnet, dass** der Übergang (32) für Zufuhr und Austritt des Mediums aus der Kammer (22) des Kolbens (4) in axialer Richtung zur Stirnseite (11) des Rahmens (1) ausmündet und an seinem Ende durch Ventilmittel in Form von getrennten bogenförmigen Öffnungen (61) geöffnet und durch einen vollen Teil zwischen den getrennten bogenförmigen Öffnungen (61) des Körpers geschlossen wird, in dem die getrennten bogenförmigen Öffnungen (61) gebildet sind.

2. Radialkolbenrotationsmaschine nach Anspruch 1, **dadurch gekennzeichnet, dass** die Kammer (22) für den Kolben mit einem Einsatz (31) ausgestattet ist und dieser Einsatz (31) mit dem Kopf (3) der Kammer (22) verbunden ist.
3. Radialkolbenrotationsmaschine nach Anspruch 2, **dadurch gekennzeichnet, dass** der Einsatz (31) die Kammer (22) für den Kolben bis in die Nähe der Welle (5) der Maschine durchgeht.
4. Radialkolbenrotationsmaschine nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die getrennten bogenförmigen Öffnungen (61) in einer Ventilplatte (6) ausgebildet sind, die zwischen dem Ende des Rotors (2) und der Stirnseite (11) des Rahmens (1) gelagert ist.
5. Radialkolbenrotationsmaschine nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Ende des Rotors (2) eine Gleitdichtplatte (7) mit einer Öffnung (71) für die Übertragung des Mediums in und aus dem Übergang (32) im Kopf (3) und/oder Rotor (2) aufweist.
6. Radialkolbenrotationsmaschine nach einem der vo-

rangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Kolben (4) an jedem Ende einen Kolbenring (43) aufweist.

7. Radialkolbenrotationsmaschine nach Anspruch 6, **dadurch gekennzeichnet, dass** der Kolbenring (43) ungeteilt ist, wobei das Ende des Kolbens (4) zum Einsetzen des ungeteilten Kolbenringes (43) abnehmbar ausgebildet ist.

Revendications

1. Machine rotative à piston radial comprenant un bâti (1), au moins une ouverture (13) pour l'entrée du fluide dans la machine et au moins une ouverture (14) pour la sortie du fluide de la machine, où le bâti (1) comprend des faces (11) entre lesquelles un rotor (2) est disposé dans les logements pivotants, ledit rotor comprend une ouverture axiale (21) pour l'arbre (5) de la machine, et au moins deux chambres (22) montées de manière transversale par rapport à l'axe du rotor (2) et décalées angulairement l'une par rapport à l'autre pour les pistons (4), l'arbre (5) de la machine traverse l'ouverture axiale (21) du rotor (2) et est disposé dans les logements pivotants sur les faces (11) du bâti (1), des cames circulaires (51) sont disposées sur l'arbre (5), l'arbre (5) est disposé de manière excentrée par rapport au rotor (2), tandis que l'excentricité de l'axe de rotation de l'arbre (5) par rapport à l'axe du rotor (2) est égale à l'excentricité de l'axe de rotation de la came circulaire (51) par rapport à l'axe de rotation de l'arbre (5), chaque piston (4) est disposé de manière réversible dans une chambre (22) pour le piston (4) dans le rotor (2) et de manière pivotante sur la came circulaire (51) sur l'arbre (5), où les extrémités de la chambre (22) pour le piston (4) sont fermées par les têtes (3), la tête (3) ou le rotor (2) comprennent au moins un passage (32) pour l'entrée et la sortie du fluide de la chambre (22) du piston (4), ouvertes et fermées par les soupapes, **caractérisée en ce que le** passage (32) pour l'entrée et la sortie du fluide de la chambre (22) du piston (4) débouche dans la direction axiale vers la face (11) du bâti (1), s'ouvre à son extrémité par des soupapes sous forme d'ouvertures séparées courbées (61) et se ferme par une partie pleine, entre les ouvertures séparées courbées (61) du corps dans lequel les ouvertures séparées courbées (61) sont formées.
2. Machine rotative à piston radial selon la revendication 1, **caractérisée en ce que** la chambre (22) pour le piston est pourvue d'un insert (31), et cet insert (31) est relié à la tête (3) de la chambre (22).
3. Machine rotative à piston radial selon la revendication 2, **caractérisée en ce que** l'insert (31) traverse

la chambre (22) pour le piston jusqu'à la proximité de l'arbre (5) de la machine.

4. Machine rotative à piston radial selon l'une des revendications précédentes, **caractérisée en ce que** les ouvertures séparées courbées (61) sont formées dans une plaque de soupape (6) disposée entre l'extrémité du rotor (2) et la face (11) du bâti (1). 5
5. Machine rotative à piston radial selon l'une des revendications précédentes, **caractérisée en ce que** l'extrémité du rotor (2) est pourvue d'une plaque d'étanchéité coulissante (7) avec une ouverture (71) pour le passage du fluide dans et hors du passage (32) dans la tête (3) et/ou le rotor (2). 10 15
6. Machine rotative à piston radial selon l'une des revendications précédentes, **caractérisée en ce que** le piston (4) est muni à chaque extrémité d'un anneau (43) de piston. 20
7. Machine rotative à piston radial selon la revendication 6, **caractérisée en ce que** l'anneau (43) de piston n'est pas divisé, tandis que l'extrémité du piston (4) est formée de manière amovible pour permettre l'insertion de l'anneau (43) de piston non divisé. 25

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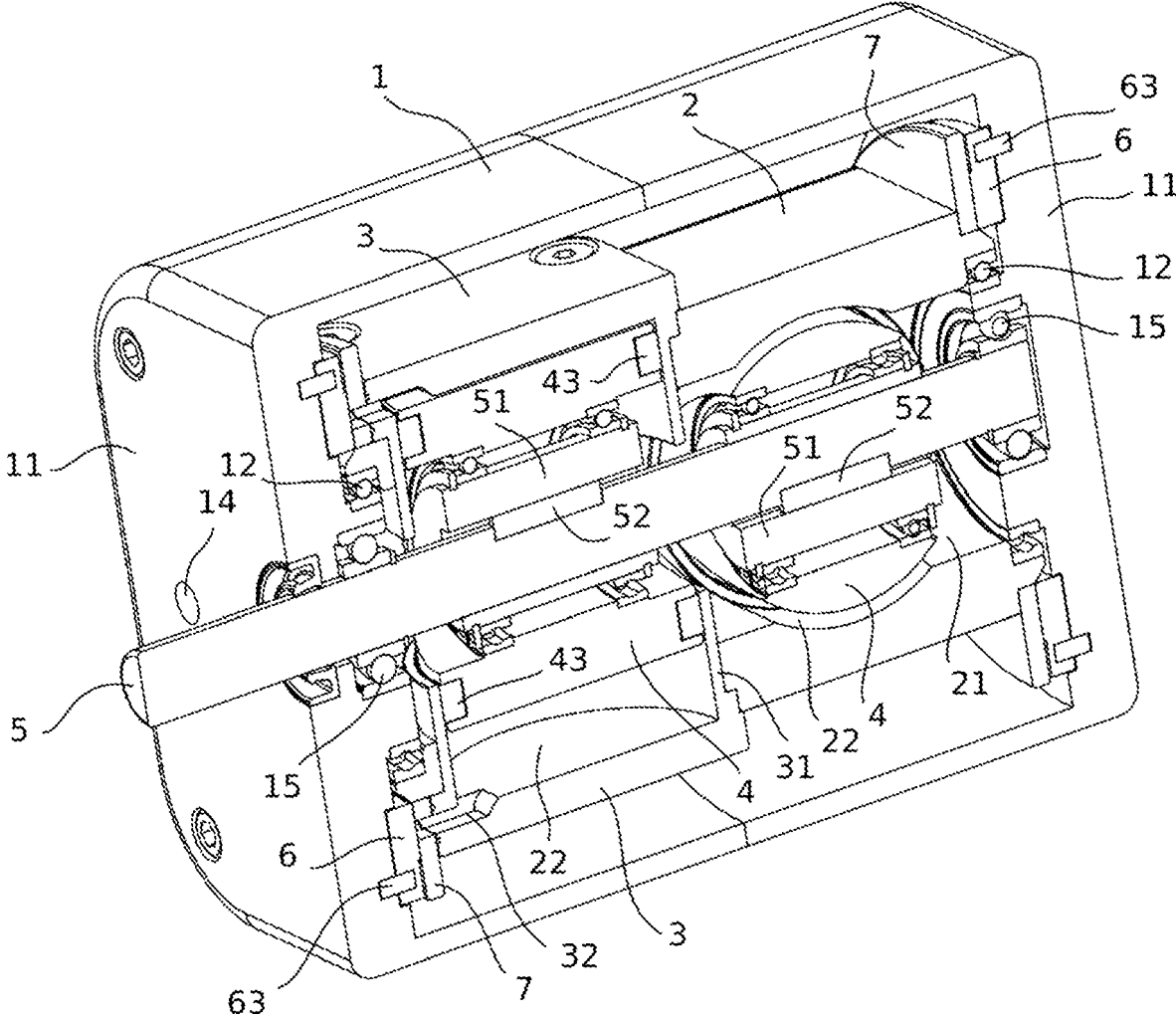


Fig. 1

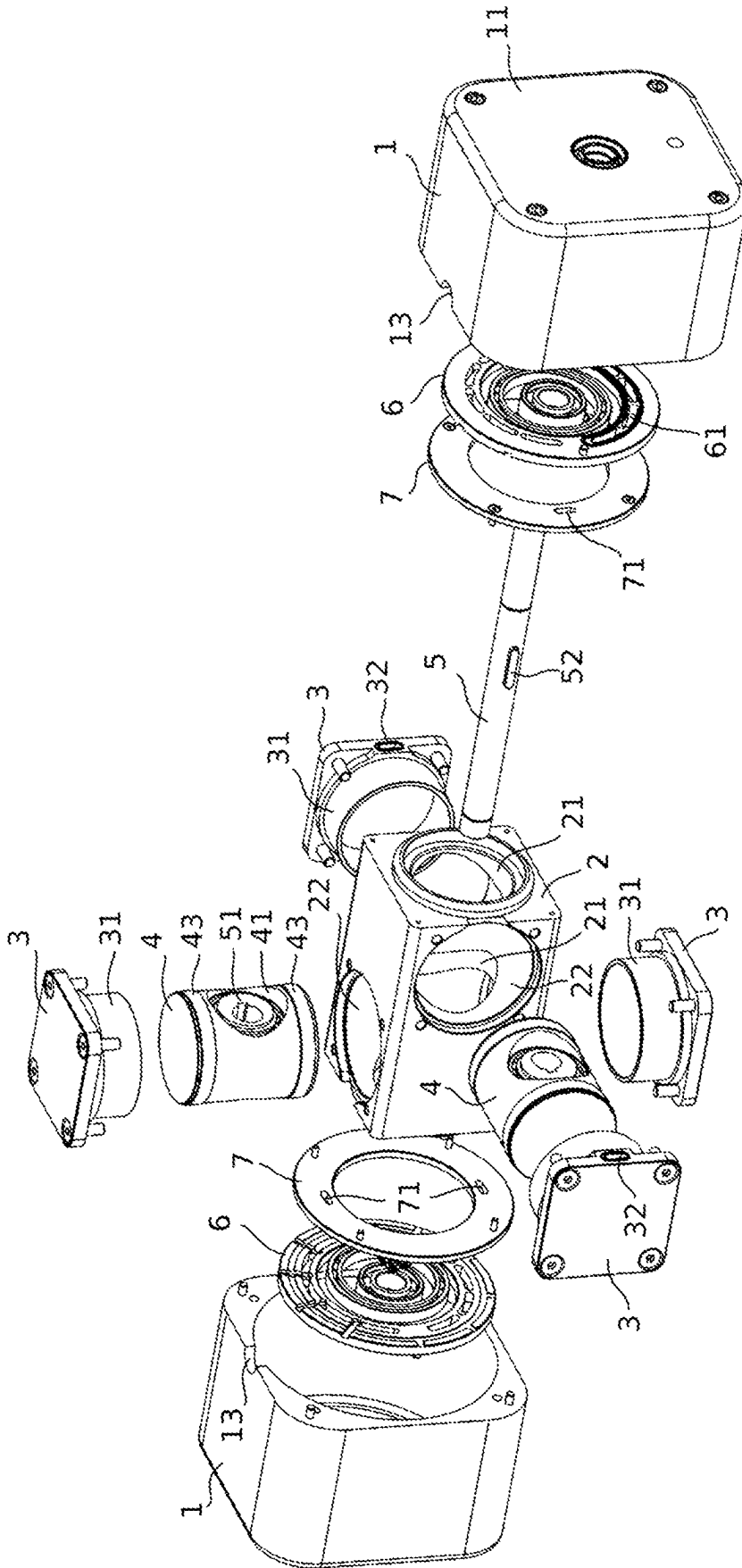


Fig. 2

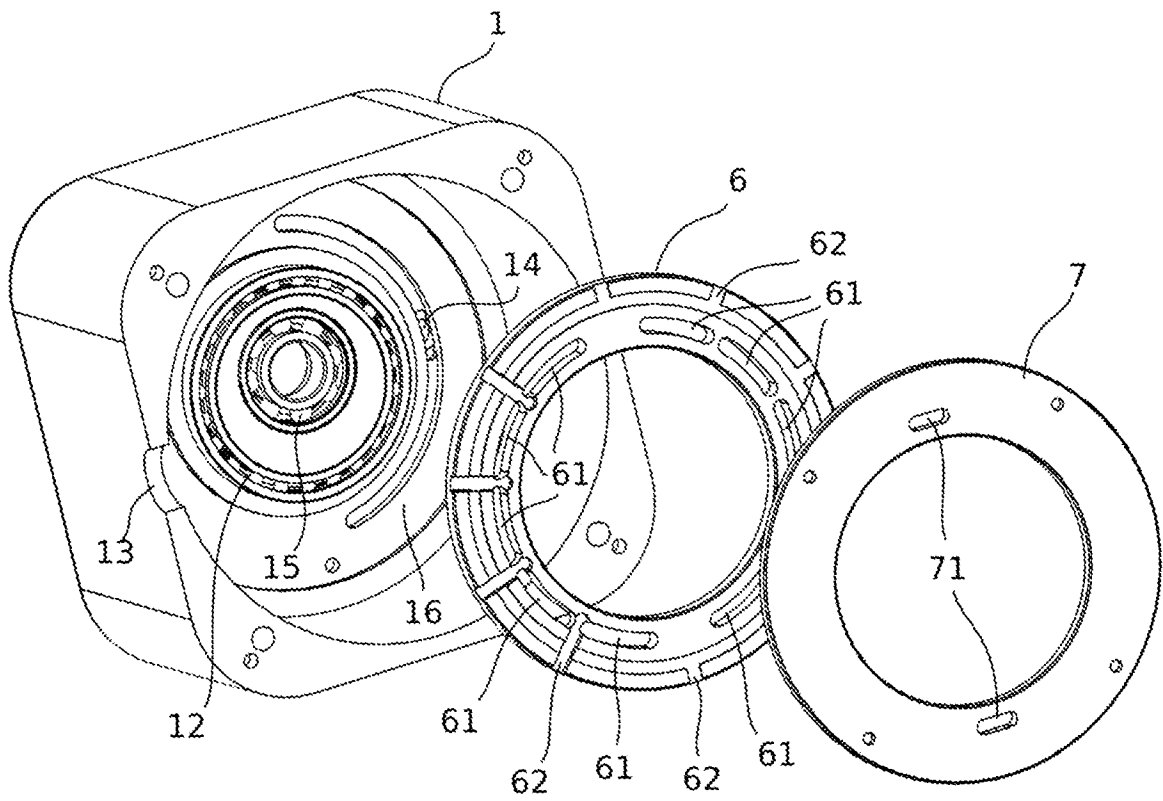


Fig. 3

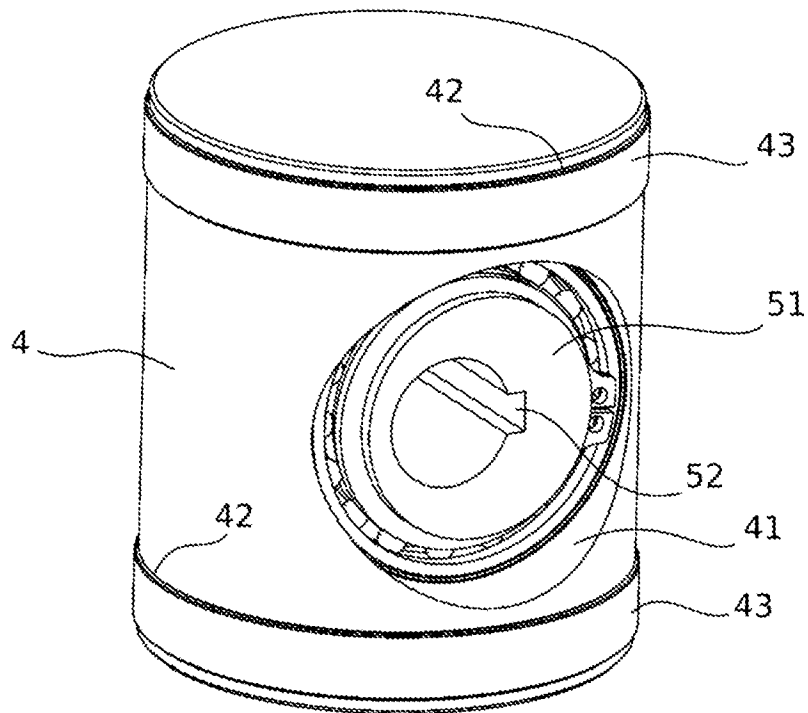


Fig. 4

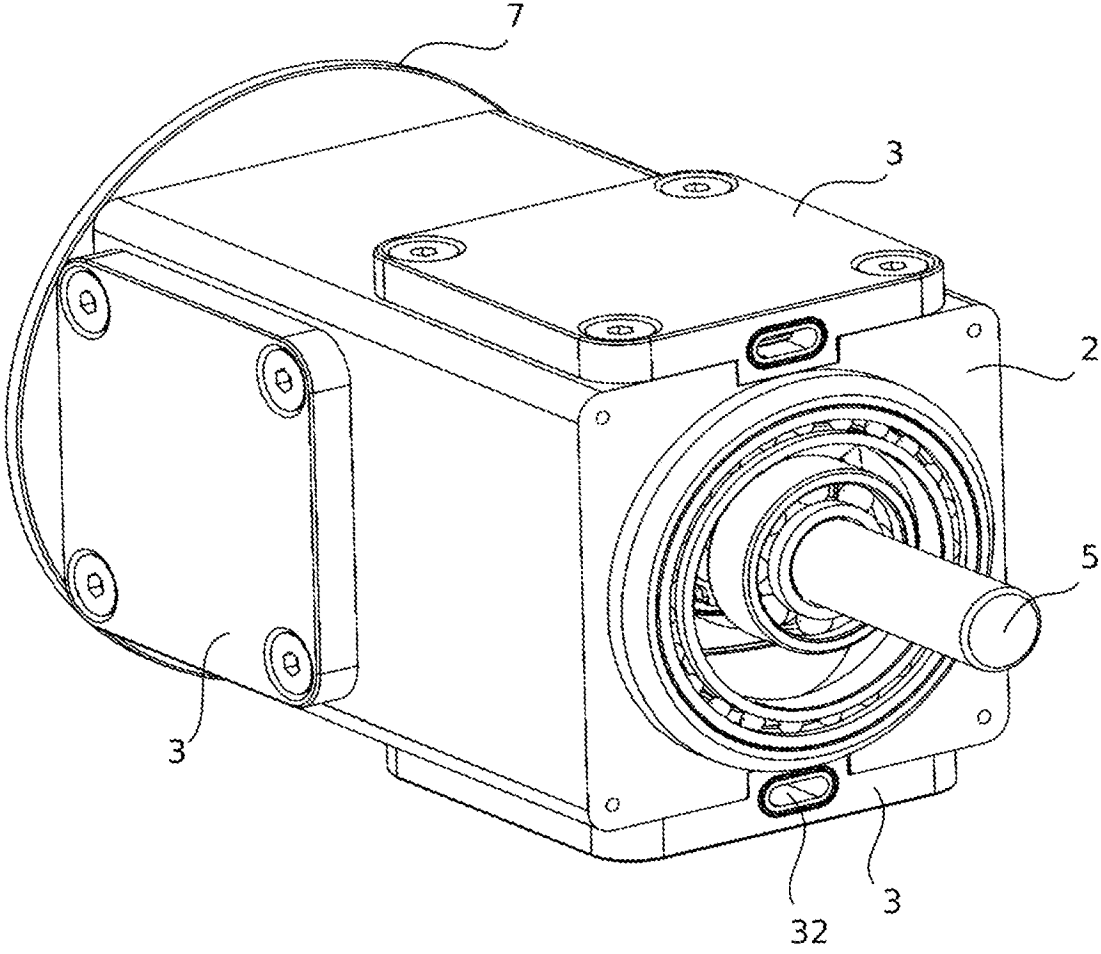


Fig. 5

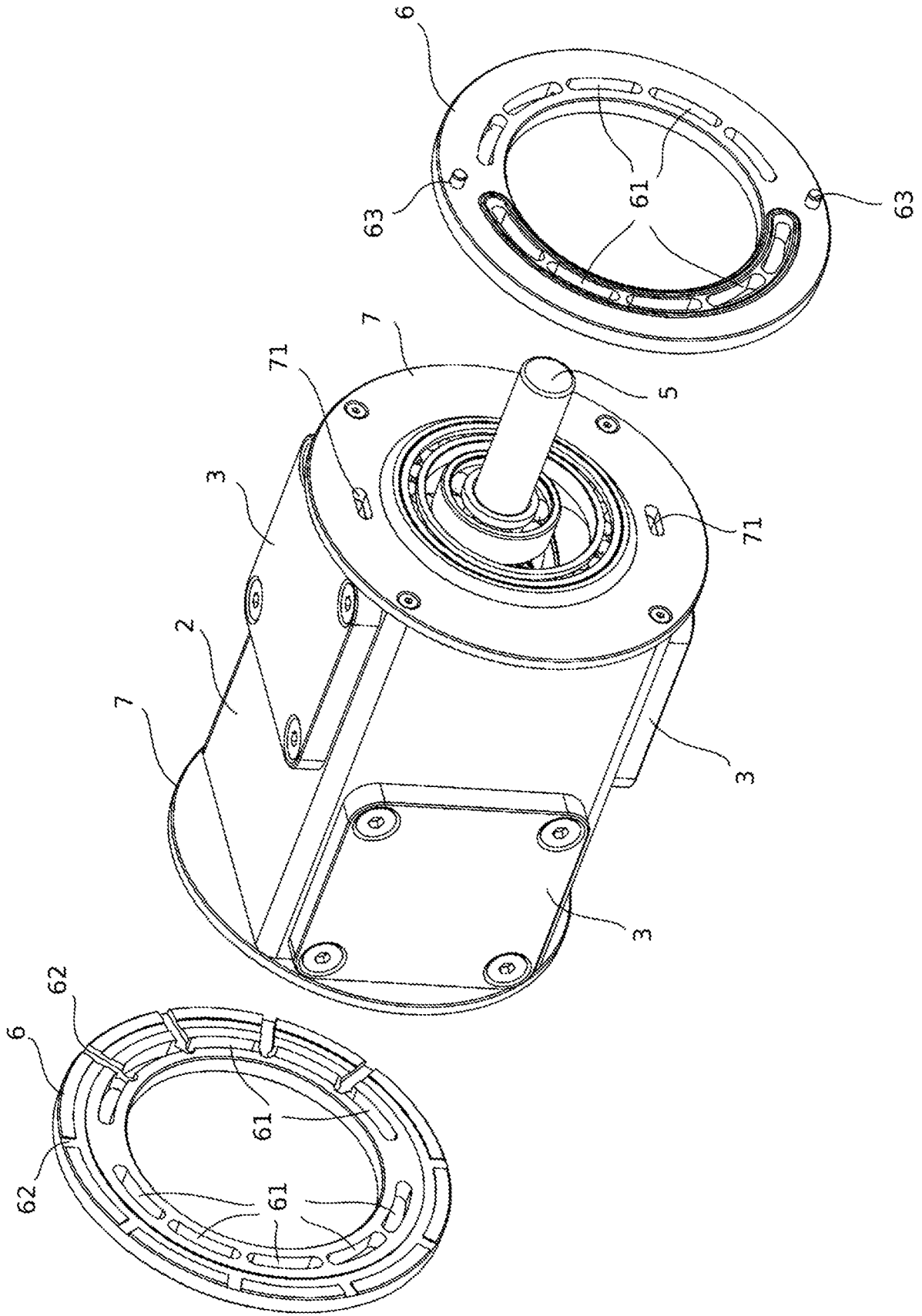


Fig. 6

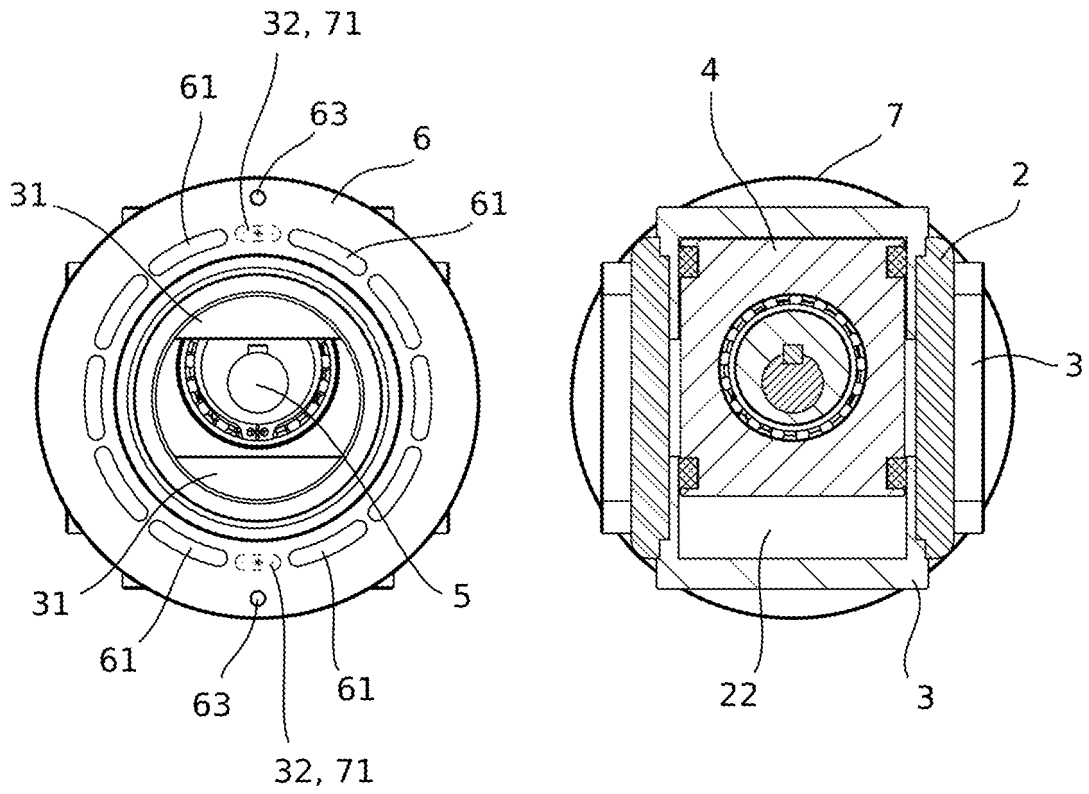


Fig. 7

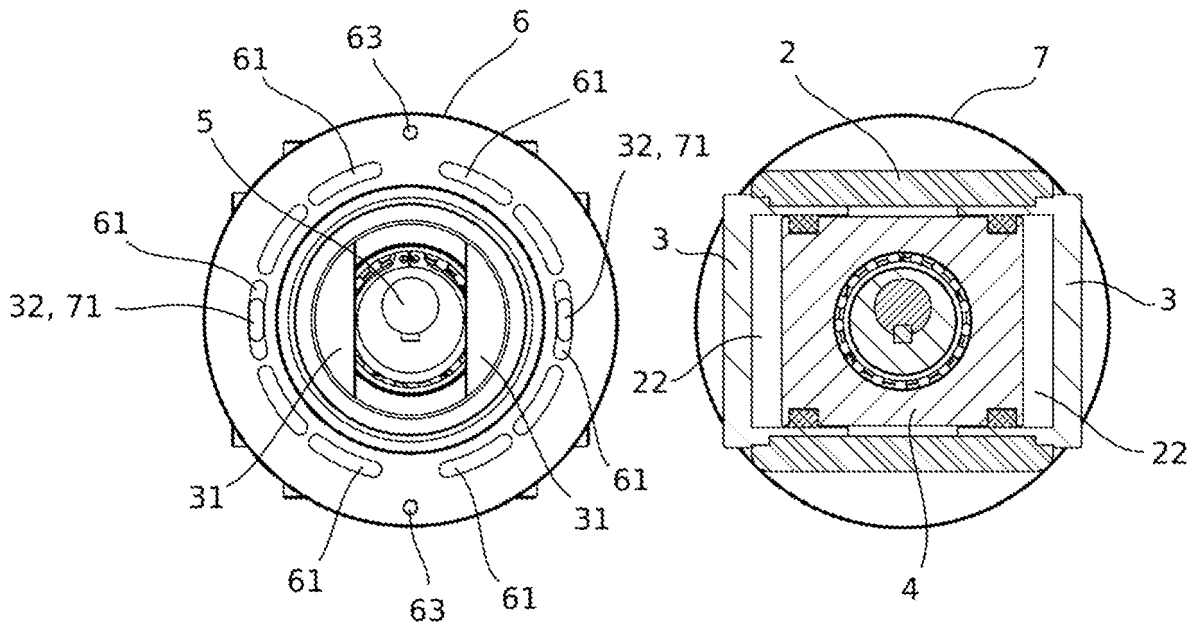


Fig. 8

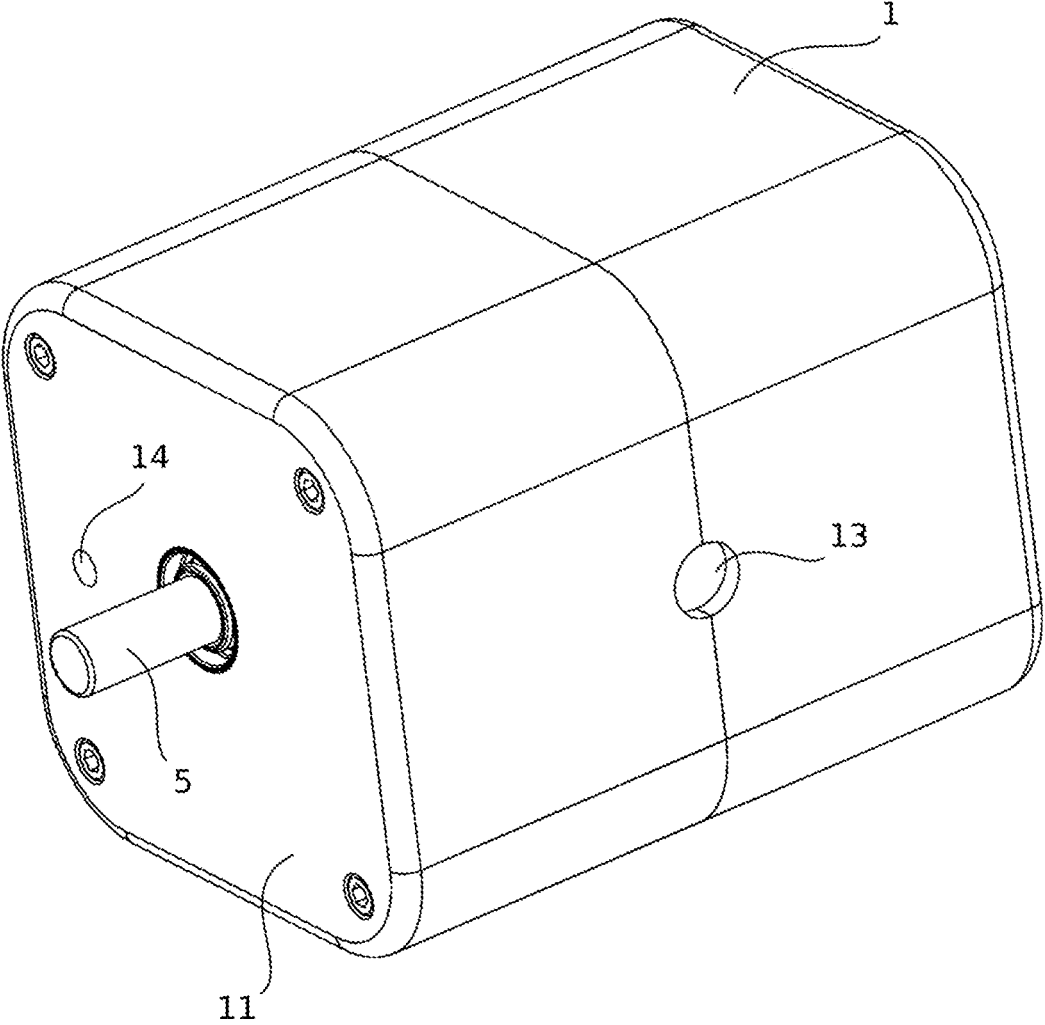


Fig. 9

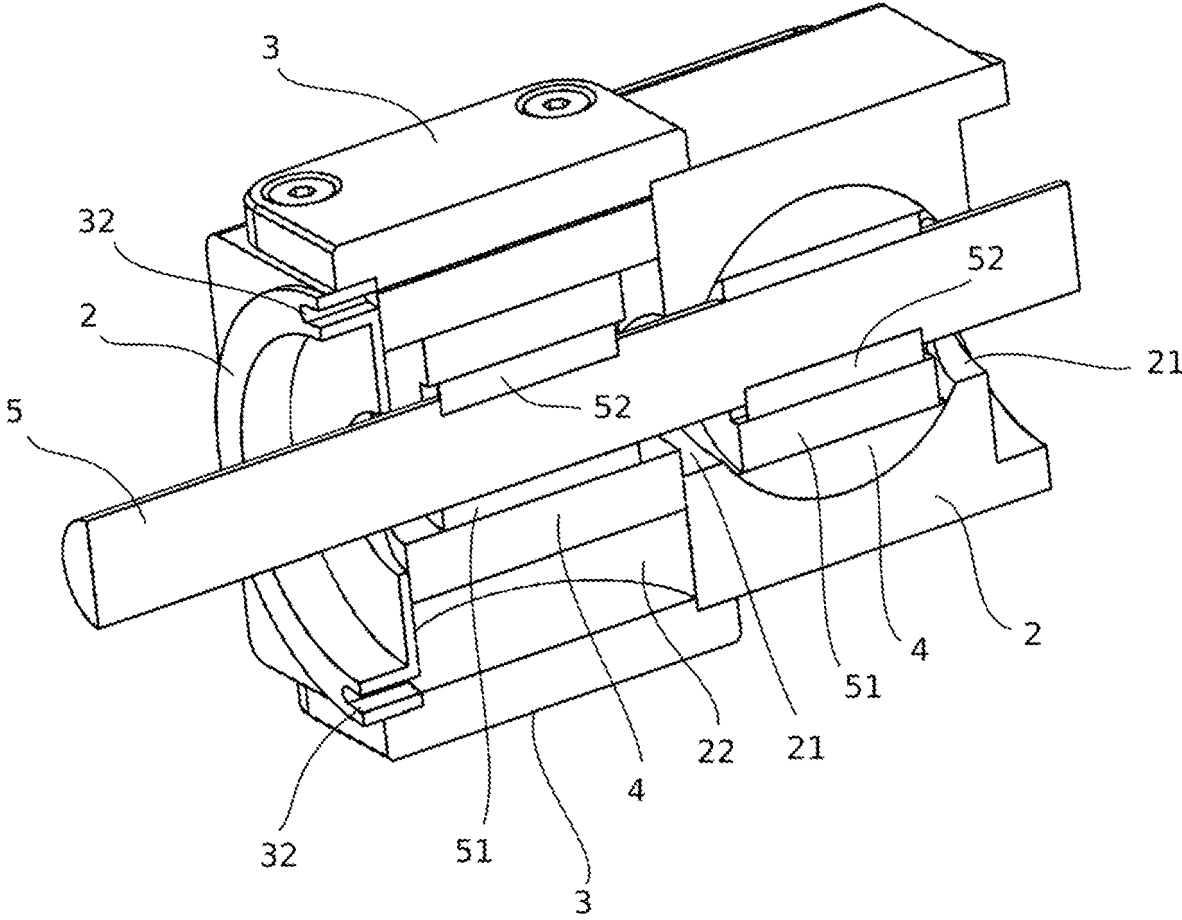


Fig. 10

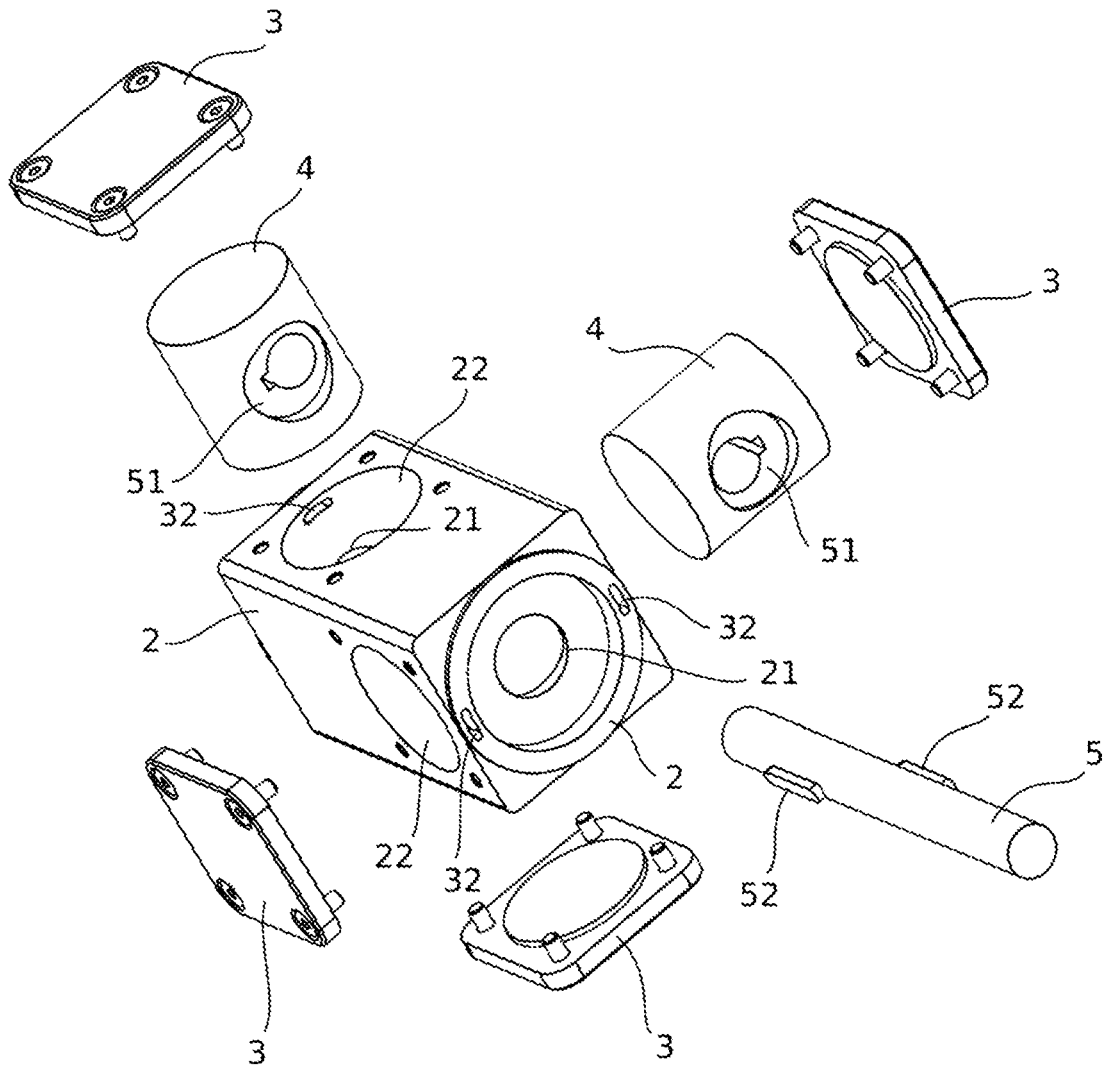


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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