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(54) **Rotary positive displacement pump with fixed shafts and rotating sleeves**

Verdrängerpumpe mit festen Bolzen und Drehhülsen

Pompe rotative à déplacement positif dotée d'arbres fixes et de manchons rotatifs

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Description

Technical Field

[0001] The invention relates to a rotary lobe pump with a first rotor and a second rotor arranged in a rotor casing such that a rotation of the rotors effects pumping of a liquid.

Backaround Art

[0002] Today rotary positive displacement pumps in form of e.g. rotary lobe pumps or circumferential piston pumps are known in the art and are traditionally used in e.g. sanitary, food and medical applications. The pumps have dual shafts for lobes or rotary pistons that are arranged in the pump. Lobes or rotary pistons that are arranged on a shaft are also referred to as "rotors".

[0003] A rotation of the rotors is timed by timing gears so that the rotors do not come into contact with one another. The rotors are arranged in a rotor casing that is sealed for sanitary reasons and the dual shafts are supported with bearings disposed outside of the sealed casing. Distal ends of the shafts are located in the rotor casing and because of e.g. seals arranged between the rotors and bearings, there is a considerable distance between the rotors and the bearings. As a result, operation of the pumps is typically limited to pressures of less than 200 psi, since higher operational pressures may result in engagement between the rotors or between the rotors and the casing or a so called head plate that closes the casing. Thus, a distance between the bearings for the shafts and the rotors on the shafts limits the pressures at which these pumps can operate.

[0004] Accordingly, there is a need for an improved rotary positive displacement pump, in particular in form of a rotary lobe pump (RLP) or a circumferential piston pump (CPP), which has a design that provides improved bearing placement for enabling the pump to operate under relatively higher pressure conditions. Additionally or alternatively, there is a need for a RLP or CPP pump that may be given a more compact design while still being capable of handling relatively high operational pressures.

[0005] These needs have been addressed in the prior art and a number of solutions are disclosed, for example in patent document US6095781. The prior art presents some solutions to the problem. However, there is still a need for an improved positive displacement pump and in particular for an improved RLP pump or CPP pump that properly supports the rotors (lobes alt. the circumferential pistons) while still being compact and easily installable in various applications.

[0006] Further background art is reflected by patent documents EP0666422, US2880676 and US4490102, as well as US2868442.

Summary

[0007] It is an object of the invention to at least partly overcome one or more of the above-identified limitations of the prior art. In particular, it is an object to provide a lobe pump that properly supports rotors in form of lobes that effect pumping of a liquid.

[0008] To solve these objects a rotary lobe pump according to independent claim 1 is provided. The pump comprises a pump housing that has a rotor casing with inlet and an outlet, wherein a first rotor and a second rotor are arranged in the rotor casing such that a rotation of the rotors effects pumping of a liquid from the inlet to the outlet. The pump also comprises: a first shaft arranged in and fixedly connected to the pump housing, a first shaft sleeve that is rotatably arranged on the first shaft, and a first gear that is connected to the first shaft sleeve, wherein the first rotor is connected to the first shaft sleeve; and a second shaft arranged in and fixedly connected to the pump housing, a second shaft sleeve that is rotatably arranged on the second shaft, and a second gear that is connected to the second shaft sleeve, wherein the second rotor is connected to the second shaft sleeve and the second gear is in mesh with the first gear, for effecting simultaneous rotation of the rotors.

[0009] The pump is advantageous in that the rotating sleeves on the fixed shafts facilitate a compact pump design. A compact design is in turn beneficial since it saves space at the site where the pump is installed. Also, in comparison to conventional RLP or CPP pumps, a compact pump requires less material for many of its components as well as requires less lubrication for the gears. Typically, the pump may be made at least 50% shorter than most conventional RLP and CPP pumps.

[0010] A number of additional advantages may be obtained, in particular if one or more of the features described below is implemented. Then, for example, a distance between the rotor and a bearing that supports the sleeve at a support point closest to the rotor may be kept to a minimum. This distance is sometimes referred to as "overhang". A small overhang may reduce moments about the bearing, may reduce a load on the bearing and may reduce a deflection of the shaft on which the sleeve is arranged. This may improve pump performance, reduce overall loads on bearings and the overall material needed for manufacturing the pump. Additionally, some bearings may be placed between the respective sleeve and axle, directly under load areas of the rotors and gears, which may reduce bending moments and loads that typically are present in conventional RLP and CPP pumps. Also, use of so called pre-loaded tapered roller bearings may be reduced, which potentially provides reduced friction, reduced torque and reduced power requirements when the pump is operated. This in turn offers both cooler operating conditions and energy savings.

[0011] The pump comprises a gear casing in which the first gear and the second gear are arranged, wherein the first shaft sleeve and the second shaft sleeve extend from

the gear casing to the rotor casing. The first shaft and the second shaft may each extend from the gear casing to the rotor casing.

[0012] The pump may comprise a pinion arranged in the pump hosing and in mesh with the second gear, such that a rotation of the pinion effects a rotation of the gears and thus a rotation of the sleeves and the rotors. The pinion may be connected to a rotatable drive shaft. The drive shaft may be a drive shaft of a motor unit.

[0013] The first shaft sleeve may comprise a threaded end section on which a rotor nut is screwed for securing the first rotor to the first shaft sleeve. The second shaft may also comprise a threaded end section on which a rotor nut is screwed for securing the second rotor to the second shaft.

[0014] The pump may comprise a rotor bearing that is, as seen in a radial direction of the first shaft, arranged intermediate the first shaft and the first shaft sleeve, at a section of the first shaft sleeve that is at least partly located between the first rotor and the first shaft. A further rotor bearing may be, as seen in a radial direction of the second shaft, arranged intermediate the second shaft and the second shaft sleeve, at a section of the second shaft sleeve that is at least partly located between the second rotor and the second shaft.

[0015] The pump may comprise at least one bearing that is, as seen in a radial direction of the first shaft, arranged intermediate the first shaft and the first shaft sleeve, at a section of the first shaft sleeve that is located at least partly between the first gear and the first shaft. In detail, the pump may comprise a first gear bearing, a first thrust bearing and a second thrust bearing of which each is, as seen in a radial direction of the first shaft, at least partly arranged intermediate the first shaft and the first shaft sleeve, at a section of the first shaft sleeve that is at least partly located between the first gear and the first shaft. Similar bearing(s) may be arranged intermediate the second shaft and the second shaft sleeve.

[0016] The first shaft may comprise an annular protrusion that limits an axial movement of the first shaft sleeve. The annular protrusion may be, as seen in a radial direction of the first shaft, located in front of the first gear. The second shaft may have a similar protrusion.

[0017] The first shaft sleeve may be arranged over the first shaft from a first side of the first shaft, and a sleeve nut may arranged over the first shaft from a second side of the first shaft and may be connected to the first shaft sleeve such that the sleeve nut limits an axial movement of the first shaft sleeve. The second shaft sleeve may be connected to a similar sleeve nut in a corresponding manner.

[0018] The first shaft sleeve may engage a first side of the annular protrusion and the sleeve nut may engage a second side of the protrusion that is opposite the first side. Corresponding features may be implemented for the second shaft sleeve. Optionally, each of the first shaft, the second shaft, the first shaft sleeve, the second shaft sleeve, the first gear, the second gear, the first rotor and the second rotor may be fully arranged within the pump housing.

[0019] Other objectives, features, aspects and advantages of the invention will appear from the following detailed description as well as from the drawings.

Brief Description of the Drawings

[0020] Embodiments of the invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 is a first cross-sectional side view of a rotary positive displacement pump according to a first embodiment,
Fig. 2 is a front view of a the pump of Fig. 1, showing a line A-A that defines the cross-sectional view of Fig. 1,
Fig. 3 is a perspective view of the pump of Fig. 1,
Fig. 4 is an exploded, perspective view of the pump of Fig. 1,
Fig. 5 is a second cross-sectional side view of the pump of Fig. 1,
Fig. 6 is a front view of a the pump of Fig. 1, showing a line B-B that defines the cross-sectional view of Fig. 5,
Fig. 7 is a cross-sectional back view of a the pump of Fig. 1, as seen along line C-C of Fig. 5,
Fig. 8 is a cross-sectional view of a rotary positive displacement pump according to a second embodiment,
Fig. 9 an exploded, perspective view of the pump of Fig. 8, and
Fig. 10 is a cross-sectional view of a rotary positive displacement pump according to a third embodiment where it is connected to a motor unit.

Detailed description

[0021] With reference to Figs 1-4 a rotary positive displacement pump 1 in form of a rotary lobe pump 1 is illustrated (referred to as "pump 1 "). The cross-sectional view of Fig. 1 is seen along line A-A o Fig. 2, which figure illustrates the pump 1 from its front. Fig. 1 illustrates how components of the pump 1 are arranged in relation to each other. The exploded view of Fig. 4 complements Fig. 1 and does not necessarily show all the components in their respective order of assembly.

[0022] The pump 1 comprises a pump housing 2 that has a gear casing 12 to which a cover 20 is attached, such that a gear chamber 13 is formed between the gear casing 12 and the cover 20. The attachment of the cover 20 to the gear casing 12 is typically accomplished by conventional screws (not shown). The pump housing 2 has also a rotor casing 4 to which a front cover 8 is attached, such that a rotor chamber 5 is formed between the rotor casing 4 and the front cover 8. The rotor casing 4 is attached to the gear casing 12 by a first set of screws

62 (see Fig. 4) and the front cover 8 is attached to the rotor casing 4 by a second set of screws 63. The rotor casing 4 has an inlet 401 and an outlet 402, such that a fluid may enter via the inlet 401, pass through the rotor chamber 5 and exit via the outlet 402. The pump 1 may be operated in either direction. This means that the functions of the inlet 401 and outlet 402 may be reversed, i. e. that the inlet may act as an outlet while the outlet may act as an inlet.

[0023] A first shaft 16 and a second shaft 17 are connected to the pump housing 2, or more specifically connected to the gear casing 12 with a set of screws, such as screws 60. Both shafts 16, 17 are fixedly connected to the gear casing 12 and extend from the gear casing 12, through openings in the cover 20 and through openings in the rotor casing 4. Thus, one end of the respective shafts 16, 17 abuts and is fixed to the gear casing 12 while an opposite end of the respective shafts 16, 17 extends into the rotor casing 4. Specifically, the shafts 16, 17 extend from the gear casing 12, through the gear chamber 13 and to the rotor casing 4, i.e. into the rotor chamber 5.

[0024] In detail, the first shaft 16 has a first side 163 that is distant from the gear casing 12 and a second side 164 that abuts the gear casing 12. The first shaft 16 is symmetrical about a geometrical center axis A1 and has, essentially, a cylindrical shape that is tapered near the first side 163. The center axis A1 defines a radial direction R1 of the first shaft 16. The second side 164 extends into a circular cut-out in the gear casing 12 and the screws 60 extend from an outer side of the gear casing 12, through the gear casing 12 and into the first shaft 16. The screws 60 then fix the first shaft 16 to the gear casing 12 to an inner side of the gear casing 12 that defines the gear chamber 13. The first shaft 16 has an annular protrusion 162 that is located near the second side 164. The annular protrusion 162 may be integral with the first shaft 16 as well as may be embodied e.g. as a circlip that is arranged in a groove in the first shaft 16. In the latter case the circlip forms the annular protrusion. The second shaft 17 is per se identical to the first shaft 16 and is arranged in a corresponding circular cut-out in the gear casing 12. The second shaft 17 is thus also symmetrical about a geometrical center axis A2 that defines a radial direction R2 of the second shaft 17.

[0025] A first shaft sleeve 14 is rotatably arranged on the first shaft 16 and a second shaft sleeve 15 is rotatably arranged on the second shaft 17. The sleeves 14, 15 extend from the gear casing 12, through the openings in the cover 20, through the openings in the rotor casing 4 and into the rotor casing 4. Thus, one end of the respective sleeves 14, 15 is located in the gear casing 12 while an opposite end of the respective shafts sleeves 14, 15 extends into the rotor casing 4. In other words, a first end 143 of the first shaft sleeve 14 is located in the rotor chamber 5 while an opposite, second end 144 of the first shaft sleeve 14 is located in the gear chamber 13. The first end 143 is closed while the second end 144 is open such that the first shaft 16 may be inserted in the first shaft sleeve 14 via the second end 144.

[0026] The first shaft sleeve 14 is then arranged over the first shaft 16 from the first side 163 of the first shaft 16. A sleeve nut 22 is arranged over the first shaft 16 from the second side 164 of the first shaft 16 and is connected to the first shaft sleeve 14 such that the sleeve nut 22 limits an axial movement of the first shaft sleeve 14. Specifically, a first side 165 of the annular protrusion 162 engages the first shaft sleeve 14 while a second side 166 of the annular protrusion 162 engages the first sleeve nut 22. The first side 165 is a side of the annular protrusion 162 that is opposite the second side 166. The engagement between the sides 165, 166 of the annular protrusion 162 and the first shaft sleeve 14 respectively the first sleeve nut 22 is typically accomplished via bearings that are arranged at both sides 165, 166 of the annular protrusion 162.

[0027] The first sleeve nut 22 has the form of an annular ring with outer threads. The outer threads of the first sleeve nut 22 engages inner threads of the first shaft sleeve 14, which inner threads are located at the second end 144 of the first shaft sleeve 14.

[0028] The second shaft sleeve 15 is per se identical to the first shaft sleeve 14 and is fixed to the second shaft 17 by a second sleeve nut 23 that is identical to the first sleeve nut 22.

[0029] A first rotor 6 is arranged on the first shaft sleeve 14 at the end of the first shaft sleeve 14 that is located in the rotor chamber 5. A second rotor 7 is arranged on the second shaft sleeve 15 at an end of the second shaft sleeve 15 that is located in the rotor chamber 5. The rotors 6, 7 are connected to the sleeves 14, 15 such that the sleeves 14, 15 extend through a respective rotor 6, 7. Obviously, the rotors 6, 7 are arranged in the rotor casing 4 that defines the rotor chamber 5 together with the front cover 8. The rotors 6, 7 are connected to the sleeves 14, 15 by conventional keys (not shown) that are inserted in matching slots in the rotors 6, 7 and sleeves 14, 15.

[0030] Additionally, a first rotor nut 10 secures the first rotor 6 to the first shaft sleeve 14. The first rotor nut 10 is embodied like a threaded nut where one end of the first rotor nut 10 is closed. The other, open end of the first rotor nut 10 is screwed onto outer threads 145 that are located on the first end 143 of the first shaft sleeve 14. Thus, it may be said that the first shaft sleeve 14 comprises a threaded end section 143 on which the first rotor nut 10 is screwed. The first rotor nut 10 and the first end 143 of the first shaft sleeve 14 on which the first rotor nut 10 is screwed extend into an indentation in the front cover 8, such that minimal clearance is accomplished between rotatable parts in form of the first rotor 6 and the first rotor nut 10 and fix parts in from of the rotor casing 4 and the front cover 8. A second rotor nut 11, which is identical to the first rotor nut 10, is in a similar manner screwed onto the second shaft sleeve 15 for securing the second rotor 7 to the second shaft sleeve 15.

[0031] When the sleeves 14, 15 rotate the rotors 6, 7 rotate and effect pumping of a liquid from the inlet 401 to the outlet 402. The rotors 6, 7, the rotor casing 4 and the front cover 8 are given a shape such that pumping per se is effected like in a conventional RLP type pump where dual rotors are arranged in a rotor casing. As may be seen, each of the rotors 6, 7 comprises three lobes.

[0032] A first gear 18 is arranged on the first shaft sleeve 14 and a second gear 19 is arranged on the second shaft sleeve 15. The gears 18, 19 are connected on the outside of a respective end of the sleeves 14, 15 such that the sleeves 14, 15 extend through a respective gear 18, 19. The ends of the sleeves 14, 15 to which the gears 18, 19 are connected are located in the gear chamber 13, i.e. the gears 18, 19 are arranged in the gear casing 12 and at ends of the sleeves 14, 15 that are opposite the ends where the rotors 6, 7 are arranged.

[0033] The gears 18, 19 are connected to the sleeves 14, 15 by conventional keys (not shown) that are inserted in matching slots in the gears 18, 19 and sleeves 14, 15. The second gear 19 is in mesh with the first gear 18, i.e. the gears 18, 19 are in mesh with each other, for effecting simultaneous rotation of sleeves 14, 15 and the rotors 6, 7. The gears 18, 19 may also be referred to as timing gears 18, 19, and a rotation of the rotors 6, 7 is timed by the gears 18, 19 so that the rotors 6, 7 do not come into contact with one another.

[0034] As seen in a direction from the first side 163 to the second side 164 of the first shaft 16, a rotor bearing 24, a circlip 52, a gear bearing 28, a thrust ring 40, a first thrust bearing 32, a first thrust washer, a second thrust washer, a second thrust bearing 33 and a third thrust washer are arranged between the first shaft 16 and the first shaft sleeve 14. The thrust washers are denoted by reference numeral 36. As seen in the radial direction R1 of the first shaft 16, the annular protrusion 162 is located in front of the first gear 18, and is used for limiting or preventing an axial movement of the first shaft sleeve 14 when the pump 1 is operated.

[0035] The rotor bearing 24 is arranged around the first shaft 16 near the first side 163 of the first shaft 16, which first side 163 has a smaller diameter than other parts of the first shaft 16. The circlip 52 holds the rotor bearing 24 on place on the first shaft 16. As seen in the radial direction R1 of the first shaft 16, the rotor bearing 24 is arranged intermediate the first shaft 16 and the first shaft sleeve 14, at a section 141 of the first shaft sleeve 14 located between the first rotor 6 and the first shaft 16. Thus, the rotor bearing 24 is arranged between the first shaft 16 and the first rotor 6, at a location intermediate the first shaft 16 and the first shaft sleeve 14. This means that forces from the first rotor 6 are, via the first shaft sleeve 14, transferred in a radial direction to the rotor bearing 24, such that no or very small moments are transferred on the rotor bearing 24.

[0036] The gear bearing 28 is arranged around the first shaft 16, at a position relatively close to the second side 164 of the first shaft 16. As seen in the radial direction R1 of the first shaft 16, the gear bearing 28 is arranged intermediate the first shaft 16 and the first shaft sleeve 14, at a section 142 of the first shaft sleeve 14 at least partly located between the first gear 18 and the first shaft 16. Thus, the gear bearing 28 is (at least partly) arranged between the first shaft 16 and the first gear 18, at a location intermediate the first shaft 16 and the first shaft sleeve 14. This means that forces from the first gear 18 are, via the first shaft sleeve 14, transferred in a radial direction to the gear bearing 28, such that very small moments are transferred on the gear bearing 28.

[0037] The first thrust bearing 32 is in the radial direction R1 arranged between the first shaft 16 and the first shaft sleeve 14. As seen in an axial direction of the first shaft 16, the first thrust bearing 32 is arranged between the first side 165 of the annular protrusion 162 and an axial engagement surface 167 of the first shaft 16.

[0038] The second thrust bearing 33 is in the radial direction R1 arranged between the first shaft 16 and the first shaft sleeve 14. As seen in an axial direction of the first shaft 16, the second thrust bearing 33 is arranged between the second side 166 of the annular protrusion 162 and the first sleeve nut 22.

[0039] The thrust ring 40 is arranged between the axial engagement surface 167 of the first shaft 16 and the first thrust bearing 32. The three thrust washers 36 are arranged between the first shaft 16 and the first shaft sleeve 14, of which the first thrust washer is located between the first thrust bearing 32 and the annular protrusion 162, the second thrust washer is located between the annular protrusion 162 and the second thrust bearing 33, and the third thrust washer is located between the second thrust bearing 33 and the first sleeve nut 22.

[0040] Further components including a rotor bearing, a circlip, a gear bearing, a thrust ring, a first thrust bearing, a second thrust bearing and three thrust washers are arranged between the second shaft 17 and the second shaft sleeve 15. These components are identical to corresponding components that are arranged between the first shaft 16 and the first shaft sleeve 14, both in respect of their structure and in respect of how there are arranged between the second shaft 17 and the second shaft sleeve 15.

[0041] A seal 56 is arranged between the first shaft sleeve 14 and the rotor casing 4, at a location where the first shaft sleeve 14 and first shaft 16 extend through the opening in the rotor casing 4. The first seal 56 seals the rotor chamber 5 around the first shaft sleeve 14 and ensures that no fluid leaks from the rotor chamber 5. The first seal 56 may have the form of any suitable, conventional seal that is capable of providing a seal between an opening and a rotating, circular object that extends through the opening. The seal 56 has a rotating part (indicated by reference numeral 56' in Fig. 4) and a static part (indicated by reference numeral 56" in Fig. 4).

[0042] A first lipseal 44 is arranged between the first shaft sleeve 14 and the cover 20, at a location where the first shaft sleeve 14 and first shaft 16 extend through the

opening in the cover 20. A second lipseal 45 is arranged between the sleeve nut 22 and the first shaft 16. The first lipseal 44 seals the gear chamber 13 around the first shaft sleeve 14 and the second lipseal 45 seals the gear chamber 13 around the first shaft 16, for ensuring that lubrication that typically is present in the gear chamber 13 does not leak. The first lipseal 44 and the second lipseal 45 may have the form of any suitable, conventional lipseal that is capable of providing a seal between a fix, circular object and a rotating, circular object.

[0043] The pump 1 has also a seal arranged between the second shaft sleeve 15 and the rotor casing 4, a lipseal arranged between the second shaft sleeve 15 and the cover 20, and lipseal arranged between the second sleeve nut 23 and the second shaft 17. This seal and lipseals are per se identical to the seal 56 respectively the lipseals 44, 45 and have corresponding functions.

[0044] The pump 1 has also a number of O-rings and gaskets for providing a proper sealing between various components. For example, O-rings are arranged between the rotor nuts 10, 11 and the rotors 6, 7, in grooves in surfaces of the rotor nuts 10, 11 that faces the respective rotor 6, 7. Dual gaskets are arranged between the front cover 8 and the rotor casing 4, in grooves of the rotor casing 4. Instead of dual gaskets dual O-rings may be used, or a single gasket or a single O-ring in a single groove in the rotor casing 4 or in the front cover 8. Another gasket is arranged between the cover 20 and the gear casing 12: Further gaskets and O-rings may be implemented for providing proper seals between the components of the pump 1.

[0045] With further reference to Figs 5-7, the pump 1 comprises a pinion 74 that is in mesh with the second gear 19. The pinion 74 is arranged in the pump housing 2. Specifically, the pinion 74 is arranged in the gear chamber 13. The pinion 74 is arranged on a first end 711 of a drive shaft 71 and a conventional key may be used for locking the pinion 74 to the drive shaft 71. The gear casing 12 has an opening that allows the pinion 74 to be inserted into the pump housing 2 until it reaches the second gear 19 such that the pinion 74 is in mesh with the second gear 19. The drive shaft 71 extends out from the opening in the gear casing 12. A drive casing 70 is connected to the gear casing 12 by a set of screws 64, at a location that surrounds the opening for the drive shaft 71 in the gear casing 12. A first bearing 72 and a second bearing 73 are arranged in the drive casing 70. The bearings 72, 73 are typically conventional thrust bearings or tapered roller bearings. The pinion 74 is arranged at the first end 711 of the drive shaft 71 and the drive shaft 71 extends from the pinion 74, into the drive casing 70, through the first bearing 72, through the second bearing 73 and out of the drive casing 70 such that a second end 712 is located outside the drive casing 70.

[0046] The drive shaft 71 is symmetrical about a geometrical center axis A3 and has an elongated, cylindrical shape. The center axis A3 defines a radial direction R3 of the drive shaft 71. The first bearing 72 and the second bearing 73 support the drive shaft 71 and allow it to rotate about the center axis A3 while fixing the drive shaft 71 in an axial direction. The drive casing 70, the bearings 72, 73 and the drive shaft 71 are connected to each other by virtue of a shaft nut 75 that is screwed onto the drive shaft 71 from the second end 712. The shaft nut 75 then engages and presses the second bearing 73 in a direction towards the first bearing 72, and an annular protrusion on the drive shaft 71 engages and presses the first bearing 72 in direction towards the second bearing 73. However, the bearings 72, 73 are arranged in annular cut-outs in the drive casing 70 where engagement surfaces of the cut-outs prevent the bearings 72, 73 from moving in a direction towards each other. This provides an efficient connection between the drive casing 70, the bearings 72, 73 and the drive shaft 71. The bearings 72, 73 are arranged near a respective end of the drive casing 70 and the drive casing 70 is sealed by first lip seal 76 and second lip seal 77 that are located outside the bearings 72, 73, at a respective end of the drive casing 70.

[0047] A conventional drive unit (not shown) in form of e.g. an electrical motor or a geared electrical motor may be connected to the second end 712 of the drive shaft 71, such that activation of the drive unit effects a rotation of the drive shaft 71. When the drive shaft 71 rotates the pinion 74 also rotates. The pinion 74 is in mesh with the second gear 19 and the second gear 19 is in mesh with the first gear 18. Thus, both the gears 18, 19 rotate when the drive unit is activated. Since a rotation of the gears 18, 19 effects a rotation of the sleeves 14, 15 and the rotors 6, 7 that are connected to the sleeves 14, 15, pumping of a fluid from the inlet 401 to the outlet 402 is effected.

[0048] The pump 1 has a support 80 that is attached to the gear casing 12 by a set of conventional screws 65. The support 80 has in turn holes that allows the pump 1 to the attached to a suitable surface or support structure.

[0049] In brief, the pump 1 is assembled by first connecting the sleeves to the shafts, the gears to the sleeves and thereafter the shafts to the gear casing. Then the cover is connected to the gear casing, the rotor casing is connected to the gear casing, the rotors are connected to the sleeves and the front cover is connected to the rotor casing. The pinion, the drive shaft and the drive casing are connected to each other as described above such that they form a unit. This unit is then connected to the pump housing via the screws that connects the drive casing to the gear casing. Naturally, bearings, seals, O-rings and other components of the pump 1 are also properly assembled in the pump, such that the described pump 1 is obtained.

[0050] With reference to Figs 8-9 a rotary positive displacement pump 1 in form of a centrifugal piston pump 101 is illustrated (referred to as "pump 101 "). The cross-sectional view of Fig. 8 corresponds to the cross-sectional view of Fig. 1 while Fig. 9 is an exploded, perspective view of the pump 101 of Fig. 8.

[0051] The pump 101 of Figs 8-9 is identical to the pump 1 of Figs 1-7, but for the rotors, which are replaced

by circumferential pistons, and for the front cover 8, which has some protrusions that extend into the circumferential pistons. In detail, the pump 101 has a first circumferential piston 106 and a second circumferential piston 107 that are arranged on the sleeves 14, 15. The first circumferential piston 106 is symmetrical about the center axis A1, has a first piston 1061 and has a second piston 1062. The first circumferential piston 106 has first groove 1063 with a semi-annular shape. The first groove 1063 is arranged in the first piston 1061 at a location near a centre hole of the first circumferential piston 106. The first circumferential piston 106 has also second groove 1064 with a semi-annular shape. The second groove 1064 is arranged in the second piston 1062 at a location near the centre hole of the first circumferential piston 106. The front cover 108 has a semi-annular, first protrusion 1081 that fits into the grooves 1063, 1064 of the first circumferential piston 106 when the piston rotates. The first protrusion 1081 has smaller dimensions than the grooves 1063, 1064, such that a play is accomplished and interaction between the front cover 108 and the first circumferential piston 106 is prevented.

[0052] The second circumferential piston 107 has a shape that corresponds to the shape of the first circumferential piston 106. The front cover 108 has a semi-annular, second protrusion 1082 that corresponds to the first protrusion 1081 and fits into grooves of the second circumferential piston 107 when the piston rotates. The arrangement of the circumferential pistons 106, 107 per se as well as the principle of pumping that is accomplished when the pistons rotate are known.

[0053] With reference to Fig. 10 a rotary positive displacement pump 102 that is connected to a motor unit 200 is illustrated (referred to as "pump 102"). The pump 102 corresponds to the pump of Figs 1-7 with the difference that the pinion 74 is directly arranged on a drive shaft 271 of the motor unit 200 and that no drive casing is used.

[0054] The motor unit 200 may be e.g. an electrical motor or a geared electrical motor. A shaft casing 270 connects the motor unit 200 to the pump 102. The shaft casing 270 protects the drive shaft 271 such that it may not be touched during operation of the pump 102. A lip seal 276 provides a seal between the drive shaft 271 and the shaft casing 270 for ensuring that any lubrication present in the gear chamber does not leak.

[0055] From the description above follows that, although various embodiments of the invention have been described and shown, the invention is not restricted thereto, but may also be embodied in other ways within the scope of the subject-matter defined in the following claims. For example, the pump may be designed such that e.g. bearings, seals and gaskets are located at other positions than those shown, and the various components of the pump may be connected to each other by other means than those described.

Claims

1. A rotary lobe pump comprising a pump housing (2) that has a rotor casing (4) with an inlet (401) and an outlet (402), wherein a first rotor (6) and a second rotor (7) are arranged in the rotor casing (4) such that a rotation of the rotors (6, 7) effects pumping of a liquid from the inlet (401) to the outlet (402), **characterized by**
   a first shaft (16) arranged in and fixedly connected to the pump housing (2), a first shaft sleeve (14) that is rotatably arranged on the first shaft (16), and a first gear (18) that is connected to the first shaft sleeve (14), wherein the first rotor (6) is connected to the first shaft sleeve (14),
   a second shaft (17) arranged in and fixedly connected to the pump housing (2), a second shaft sleeve (15) that is rotatably arranged on the second shaft (17), and a second gear (19) that is connected to the second shaft sleeve (15), wherein the second rotor (7) is connected to the second shaft sleeve (15) and the second gear (19) is in mesh with the first gear (18), for effecting simultaneous rotation of the rotors (6, 7), and
   a gear casing (12) in which the first gear (18) and the second gear (19) are arranged, wherein the first shaft sleeve (14) and the second shaft sleeve (15) extend from the gear casing (12) to the rotor casing (4).

2. A pump according to claim 1, wherein the first shaft (16) and the second shaft (17) extend from the gear casing (12) to the rotor casing (4).

3. A pump according to claim pump 1 or 2, comprising a pinion (74) arranged in the pump hosing (2) and in mesh with the second gear (19), such that a rotation of the pinion (74) effects a rotation of the gears (18, 19), the sleeves (14, 15) and the rotors (6, 7).

4. A pump according to claim 3, wherein the pinion (74) is connected to a rotatable drive shaft (71).

5. A pump according to claim 4, wherein the drive shaft (71) is a drive shaft of a motor unit (200).

6. A pump according to any one of claims 1 - 5, wherein the first shaft sleeve (14) comprises a threaded end section (143) on which a rotor nut (10) is screwed for securing the first rotor (6) to the first shaft sleeve (14).

7. A pump according to any one of claims 1 - 6, comprising a rotor bearing (24) that is, as seen in a radial direction (R1) of the first shaft (16), arranged intermediate the first shaft (16) and the first shaft sleeve (14), at a section (141) of the first shaft sleeve (14) that is at least partly located between the first rotor

(6) and the first shaft (16).

8. A pump according to any one of claims 1 - 7, comprising at least one bearing (28, 32, 33) that is, as seen in a radial direction (R1) of the first shaft (16), arranged intermediate the first shaft (16) and the first shaft sleeve (14), at a section (142) of the first shaft sleeve (14) that is located between the first gear (18) and the first shaft (16).

9. A pump according to any one of claims 1 - 8, comprising a first gear bearing (28), a first thrust bearing (32) and a second thrust bearing (33) of which each is, as seen in a radial direction (R1) of the first shaft (16), arranged intermediate the first shaft (16) and the first shaft sleeve (14), at a section (142) of the first shaft sleeve (14) that is at least partly located between the first gear (18) and the first shaft (16).

10. A pump according to any one of claims 1 - 9, wherein the first shaft (16) comprises an annular protrusion (162) that limits an axial movement of the first shaft sleeve (14).

11. A pump according to claim 10, wherein the annular protrusion (162) is, as seen in a radial direction (R1) of the first shaft (16), located in front of the first gear (18).

12. A pump according to any one of claims 1 - 11, wherein
the first shaft sleeve (14) is arranged over the first shaft (16) from a first side (163) of the first shaft (16), a sleeve nut (22) is arranged over the first shaft (16) from a second side (164) of the first shaft (16) and is connected to the first shaft sleeve (14), such that the sleeve nut (22) limits an axial movement of the first shaft sleeve (14).

13. A pump according to claim 11 and 12, wherein the first shaft sleeve (14) engages a first side (165) of the annular protrusion (162) and the sleeve nut (22) engages a second side (166) of the protrusion (162) that is opposite the first side (165).

14. A pump according to any one of claims 1 - 13, wherein each of the first shaft (16), the second shaft (17), the first shaft sleeve (14), the second shaft sleeve (15), the first gear (18), the second gear (19), the first rotor (6) and the second rotor (7) are fully arranged within the pump housing (2).

Patentansprüche

1. Drehkolbenpumpe umfassend ein Pumpengehäuse (2), welches ein Rotorgehäuse (4) mit einem Eingang (401) und einem Ausgang (402) aufweist, wobei ein erster Rotor (6) und ein zweiter Rotor (7) im Rotorgehäuse (4) so angeordnet sind, dass eine Drehung der Rotoren (6, 7) das Pumpen einer Flüssigkeit vom Eingang (401) in den Ausgang (402) bewirkt, **gekennzeichnet durch**
eine erste Welle (16), welche im Pumpengehäuse (2) angeordnet und mit diesem fest verbunden ist, eine erste Wellenhülse (14), welche auf der ersten Welle (16) drehbar angeordnet ist, und ein erstes Zahnrad (18), welches mit der ersten Wellenhülse (14) verbunden ist, wobei der erste Rotor (6) mit der ersten Wellenhülse (14) verbunden ist,
eine zweite Welle (17), welche im Pumpengehäuse (2) angeordnet und mit diesem fest verbunden ist, eine zweite Wellenhülse (15), welche drehbar auf der zweiten Welle (17) angeordnet ist, und ein zweites Zahnrad (19), welches mit der zweiten Wellenhülse (15) verbunden ist, wobei der zweite Rotor (7) mit der zweiten Wellenhülse (15) verbunden ist und das zweite Zahnrad (19) mit dem ersten Zahnrad (18) eingreift, um eine gleichzeitige Drehung der Rotoren (6, 7) zu erzwingen, und
ein Zahnradgehäuse (12), in welchem das erste Zahnrad (18) und das zweite Zahnrad (19) angeordnet sind, wobei die erste Wellenhülse (14) und die zweite Wellenhülse (15) sich vom Zahnradgehäuse (12) zum Rotorgehäuse (4) erstrecken.

2. Pumpe nach Anspruch 1, wobei die erste Welle (16) und die zweite Welle (17) sich vom Zahnradgehäuse (12) zum Rotorgehäuse (4) erstrecken.

3. Pumpe nach Anspruch 1 oder 2, umfassend ein Ritzel (74), welches im Pumpengehäuse (2) angeordnet ist und mit dem zweiten Zahnrad (19) eingreift, sodass eine Drehung des Ritzels (74) eine Drehung der Zahnräder (18, 19), der Hülsen (14, 15) und der Rotoren (6, 7) verursacht.

4. Pumpe nach Anspruch 3, wobei das Ritzel (74) mit einer drehbaren Antriebswelle (71) verbunden ist.

5. Pumpe nach Anspruch 4, wobei die Antriebswelle (71) eine Antriebswelle einer Motoreinheit (200) ist.

6. Pumpe nach einem der Ansprüche 1-5, wobei die erste Wellenhülse (14) einen Gewindeendabschnitt (143) umfasst, auf welchem eine Rotormutter (10) aufgeschraubt ist, um den ersten Rotor (6) an der ersten Wellenhülse (14) zu befestigen.

7. Pumpe nach einem der Ansprüche 1-6, umfassend ein Rotorlager (24), welches, gesehen in der Radialrichtung (R1) der ersten Welle (16), zwischen der ersten Welle (16) und der ersten Wellenhülse (14) angeordnet ist, an einem Abschnitt (141) der ersten Wellenhülse (14), welche mindestens teilweise zwischen dem ersten Rotor (6) und der ersten Welle

(16) angeordnet ist.

8. Pumpe nach einem der Ansprüche 1-7, umfassend mindestens ein Lager (28, 32, 33), welches, gesehen in der Radialrichtung (R1) der ersten Welle (16), zwischen der ersten Welle (16) und der ersten Wellenhülse (14) angeordnet ist, an einem Abschnitt (142) der ersten Wellenhülse (14), welcher zwischen dem ersten Zahnrad (18) und der ersten Welle (16) angeordnet ist.

9. Pumpe nach einem der Ansprüche 1-8, umfassend ein erstes Zahnradlager (28), ein erstes Axiallager (32) und ein zweites Axiallager (33), von welchen jedes, gesehen in einer Radialrichtung (R1) der ersten Welle (16), zwischen der ersten Welle (16) und der ersten Wellenhülse (14) angeordnet ist, an einem Abschnitt (142) der ersten Wellenhülse (14), welcher mindestens teilweise zwischen dem ersten Zahnrad (18) und der ersten Welle (16) angeordnet ist.

10. Pumpe nach einem der Ansprüche 1-9, wobei die erste Welle (16) einen ringförmigen Vorsprung (162) umfasst, welcher eine axiale Bewegung der ersten Wellenhülse (14) begrenzt.

11. Pumpe nach Anspruch 10, wobei der ringförmige Vorsprung (162), gesehen in einer Radialrichtung (R1) der ersten Welle (16), vor dem ersten Zahnrad (18) angeordnet ist.

12. Pumpe nach einem der Ansprüche 1-11, wobei
die erste Wellenhülse (14) über die erste Welle (16) aus einer ersten Seite (163) der ersten Welle (16) angeordnet ist,
eine Hülsenmutter (22) über die erste Welle (16) aus einer zweiten Seite (164) der ersten Welle (16) angeordnet ist und mit der ersten Wellenhülse (14) so verbunden ist, dass die Hülsenmutter (22) eine axiale Bewegung der ersten Wellenhülse (14) begrenzt.

13. Pumpe nach Anspruch 11 und 12, wobei die erste Wellenhülse (14) mit einer ersten Seite (165) des ringförmigen Vorsprungs (162) eingreift und die Hülsenmutter (22) mit einer zweiten Seite (166) des Vorsprungs (162) eingreift, welche der ersten Seite (165) gegenüberliegt.

14. Pumpe nach einem der Ansprüche 1-13, wobei jede der ersten Welle (16), der zweiten Welle (17), der ersten Wellenhülse (14), der zweiten Wellenhülse (15), des ersten Zahnrads (18), des zweiten Zahnrads (19), des ersten Rotors (6) und des zweiten Rotors (7) vollständig innerhalb des Pumpengehäuses (2) angeordnet sind.

Revendications

1. Pompe rotative a lobes comprenant un logement de pompe (2) qui comporte un carter de rotor (4) doté d'une admission (401) et d'une évacuation (402), dans laquelle un premier rotor (6) et un second rotor (7) sont agencés dans le carter de rotor (4) de telle sorte qu'une rotation des rotors (6, 7) engendre le pompage d'un liquide de l'admission (401) jusqu'à l'évacuation (402), **caractérisée par**
un premier arbre (16) agencé dans et fixement raccordé au logement de pompe (2), un premier manchon d'arbre (14) qui est agencé de façon rotative sur le premier arbre (16), et un premier engrenage (18) qui est raccordé au premier manchon d'arbre (14), le premier rotor (6) étant raccordé au premier manchon d'arbre (14),
un second arbre (17) agencé dans et fixement raccordé au logement de pompe (2), un second manchon d'arbre (15) qui est agencé de façon rotative sur le second arbre (17), et un second engrenage (19) qui est raccordé au second manchon d'arbre (15), le second rotor (7) étant raccordé au second manchon d'arbre (15) et le second engrenage (19) étant engrené avec le premier engrenage (18) pour engendrer une rotation simultanée des rotors (6, 7) et
un carter d'engrenages (12) dans lequel le premier engrenage (18) et le second engrenage (19) sont agencés, le premier manchon d'arbre (14) et le second manchon d'arbre (15) s'étendant à partir du carter d'engrenages (12) jusqu'au carter de rotor (4).

2. Pompe selon la revendication 1, dans laquelle le premier arbre (16) et le second arbre (17) s'étendent à partir du carter d'engrenages (12) jusqu'au carter de rotor (4).

3. Pompe selon la revendication 1 ou 2, comprenant un pignon (74) agencé dans le logement de pompe (2) et engrené avec le second engrenage (19), de telle sorte qu'une rotation du pignon (74) engendre une rotation des engrenages (18, 19), des manchons (14, 15) et des rotors (6, 7).

4. Pompe selon la revendication 3, dans laquelle le pignon (74) est relié à un arbre d'entraînement rotatif (71).

5. Pompe selon la revendication 4, dans laquelle l'arbre d'entraînement (71) est un arbre d'entraînement d'un groupe de moteur (200).

6. Pompe selon l'une quelconque des revendications 1 à 5, dans laquelle le premier manchon d'arbre (14) comprend une section d'extrémité filetée (143) sur laquelle un écrou de rotor (10) est vissé pour fixer le premier rotor (6) au premier manchon d'arbre (14).

7. Pompe selon l'une quelconque des revendications 1 à 6, comprenant un palier de rotor (24) qui, vu dans une direction radiale (R1) du premier arbre (16), est agencé entre le premier arbre (16) et le premier manchon d'arbre (14), au niveau d'une section (141) du premier manchon d'arbre (14) qui est située au moins en partie entre le premier rotor (6) et le premier arbre (16).

8. Pompe selon l'une quelconque des revendications 1 à 7, comprenant au moins un palier (28, 32, 33) qui, vu dans une direction radiale (R1) du premier arbre (16), est agencé entre le premier arbre (16) et le premier manchon d'arbre (14), au niveau d'une section (142) du premier manchon d'arbre (14) qui est située entre le premier engrenage (18) et le premier arbre (16).

9. Pompe selon l'une quelconque des revendications 1 à 8, comprenant un premier palier d'engrenage (28), un premier palier de butée (32) et un second palier de butée (33), chacun d'entre eux étant agencé, vu dans une direction radiale (R1) du premier arbre (16), entre le premier arbre (16) et le premier manchon d'arbre (14), au niveau d'une section (142) du premier manchon d'arbre (14) qui est située au moins en partie entre le premier engrenage (18) et le premier arbre (16).

10. Pompe selon l'une quelconque des revendications 1 à 9, dans laquelle le premier arbre (16) comprend une partie saillante annulaire (162) qui limite le mouvement axial du premier manchon d'arbre (14).

11. Pompe selon la revendication 10, dans laquelle la partie saillante annulaire (162) est située, vu dans une direction radiale (R1) du premier arbre (16), à l'avant du premier engrenage (18).

12. Pompe selon l'une quelconque des revendications 1 à 11, dans laquelle
le premier manchon d'arbre (14) est agencé sur le premier arbre (16) à partir d'un premier côté (163) du premier arbre (16),
un écrou de raccord (22) est agencé sur le premier arbre (16) à partir d'un second côté (164) du premier arbre (16) et est raccordé au premier manchon d'arbre (14) de sorte que l'écrou de raccord (22) limite le mouvement axial du premier manchon d'arbre (14).

13. Pompe selon la revendication 11 et 12, dans laquelle le premier manchon d'arbre (14) met en prise un premier côté (165) de la partie saillante annulaire (162) et l'écrou de raccord (22) met en prise un second côté (166) de la partie saillante (162) opposé au premier côté (165).

14. Pompe selon l'une quelconque des revendications 1 à 13, dans laquelle le premier arbre (16), le second arbre (17), le premier manchon d'arbre (14), le second manchon d'arbre (15), le premier engrenage (18), le second engrenage (19), le premier rotor (6) et le second rotor (7) sont chacun entièrement disposés à l'intérieur du logement de pompe (2).

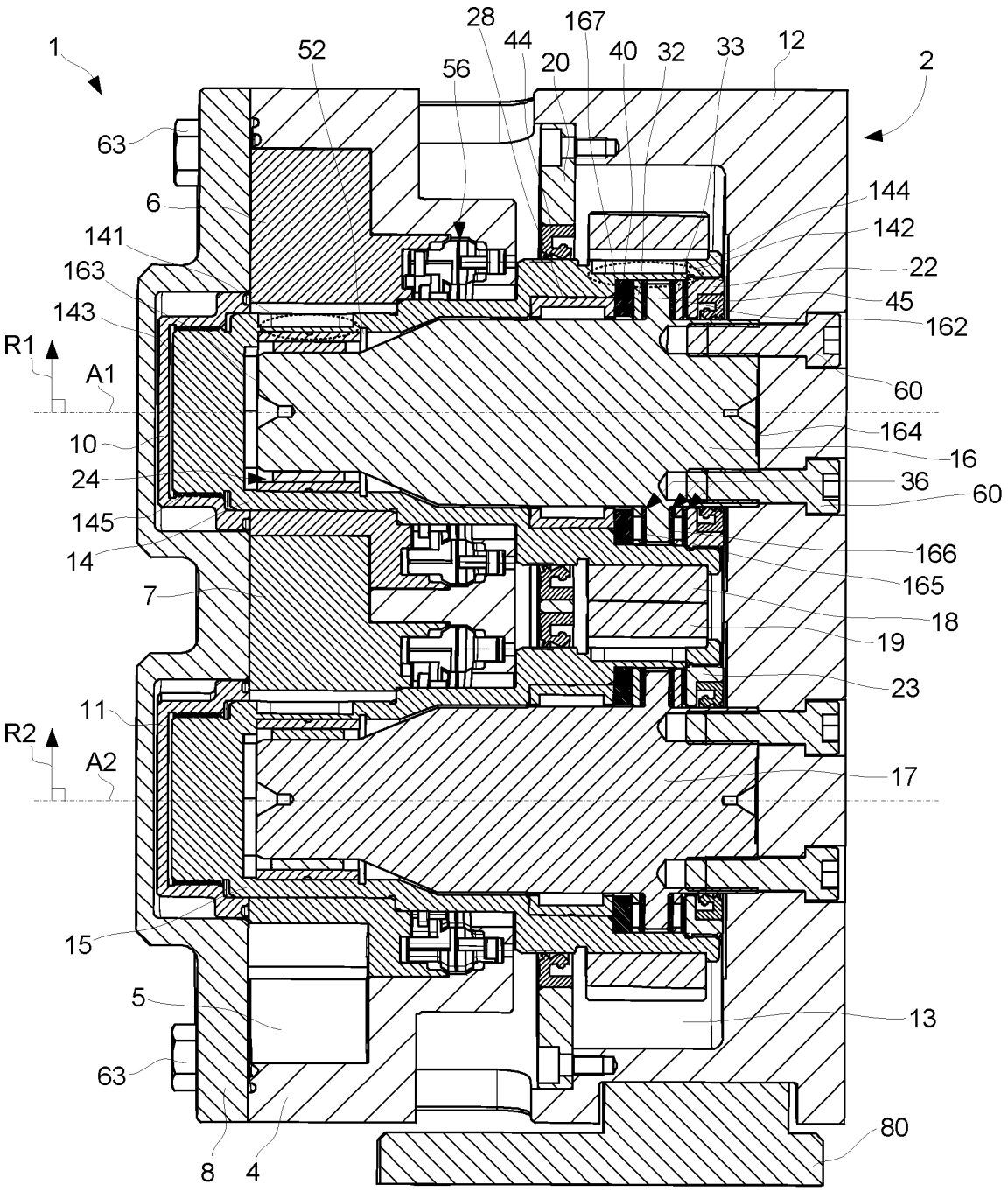

1
2
28
44
167
52
56
20
40
32
33
12
63
6
141
163
143
R1
A1
10
24
145
14
7
11
R2
A2
15
5
63
8
4
144
142
22
45
162
60
164
16
36
60
166
165
18
19
23
17
13
80

Fig. 1 (A-A)

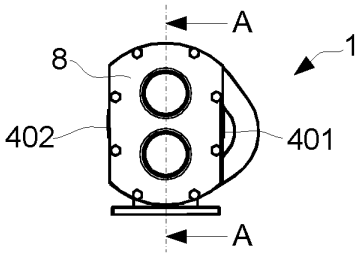

A
1
8
402
401
A

Fig. 2

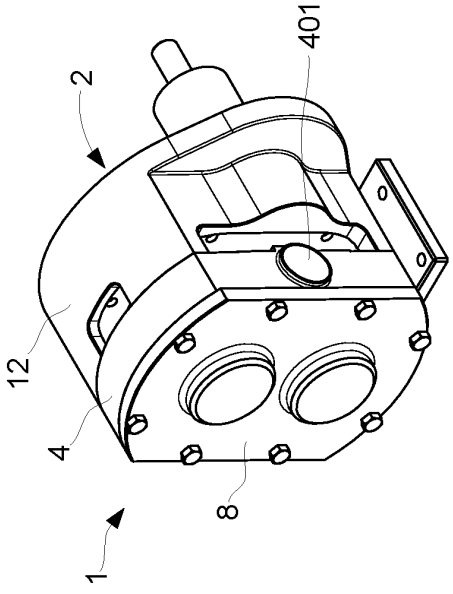
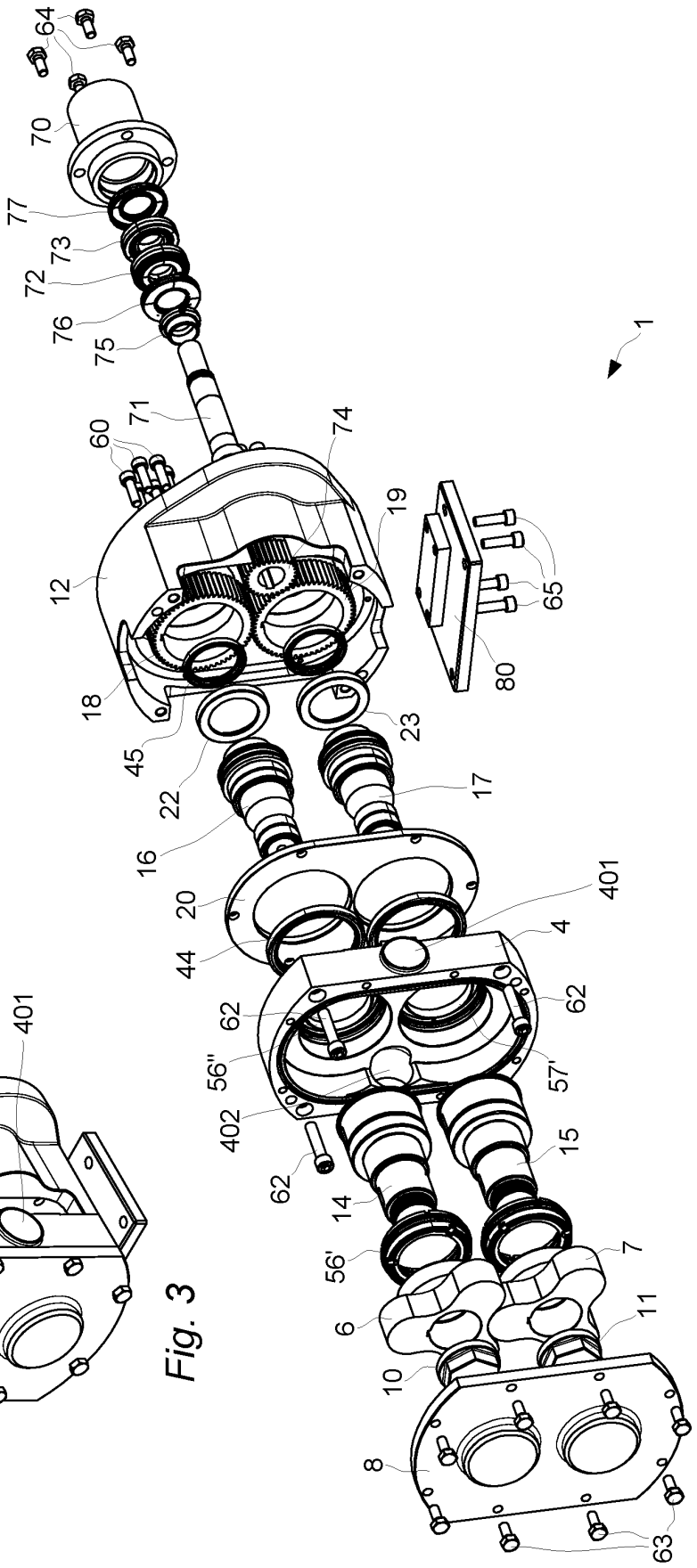

1
2
401
12
4
8

Fig. 3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77
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72
76
75
1
71
60
74
19
65
80
12
18
45
22
23
17
16
20
401
4
44
62
62
56''
57'
402
62
15
14
56'
7
6
11
10
8
63

Fig. 4

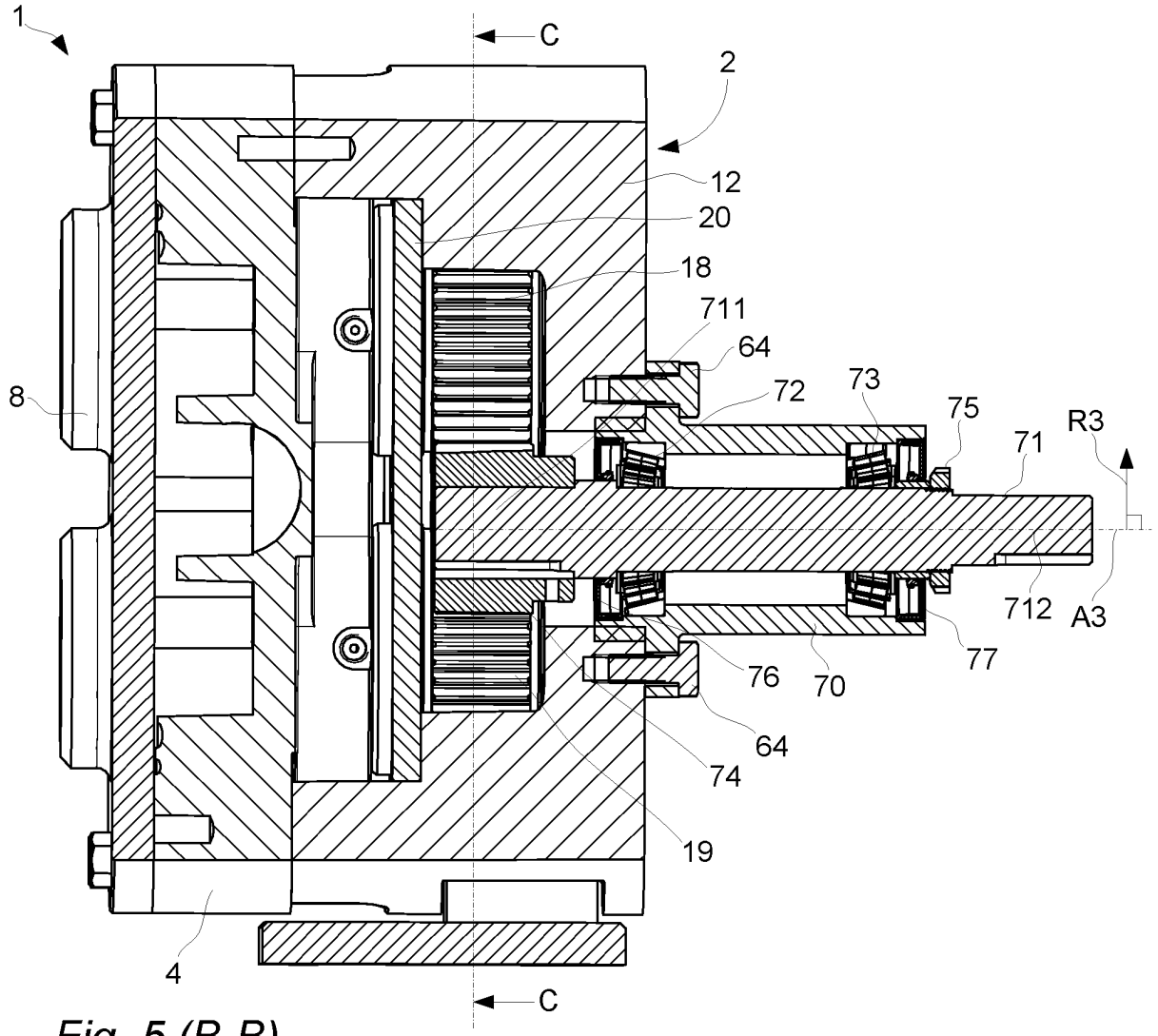


Fig. 5 (B-B)

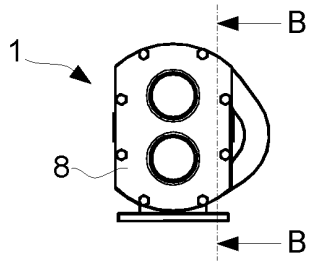


Fig. 6

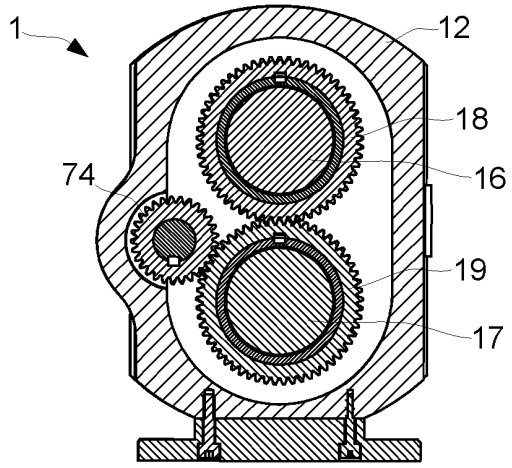


Fig. 7 (C-C)

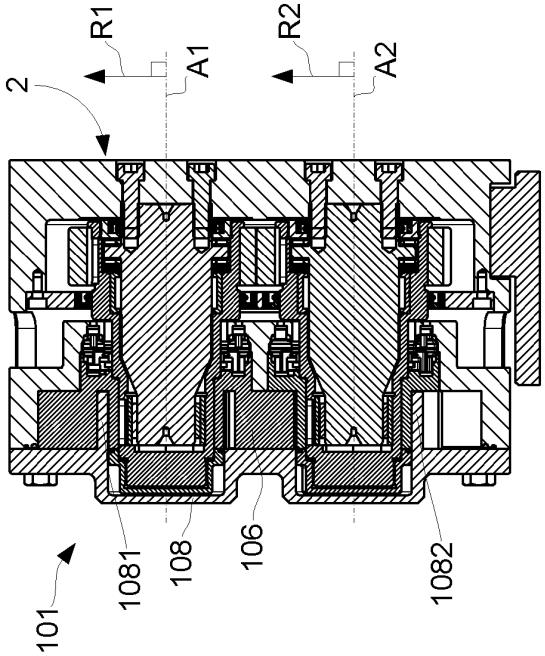
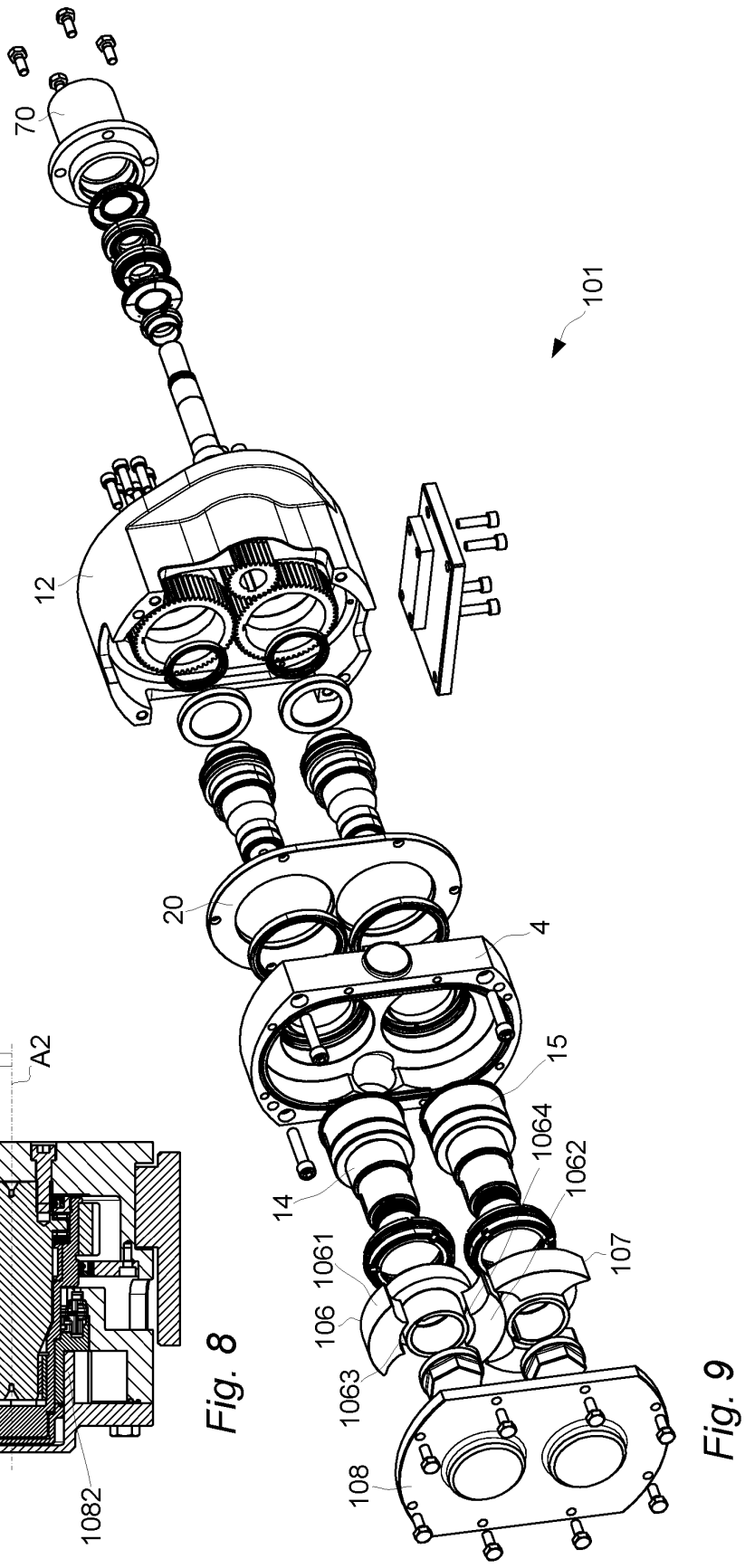

2
R1
A1
R2
A2
101
1081
108
106
1082

Fig. 8


70
101
12
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4
15
1064
1062
14
1061
107
106
1063
108

Fig. 9

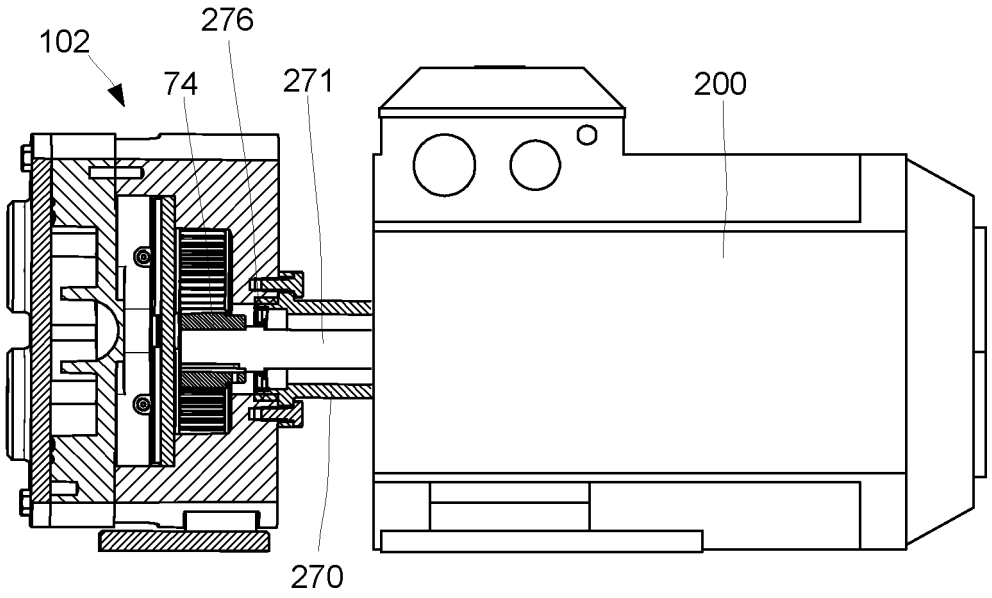

Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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