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(54) **METHOD AND APPARATUS RELATED TO SERVICING OF LIQUID RING PUMPS**

VERFAHREN UND VORRICHTUNG IM ZUSAMMENHANG MIT DER WARTUNG VON
FLÜSSIGKEITSRINGPUMPEN

PROCÉDÉ ET APPAREIL SE RAPPORTANT À L'ENTRETIEN DE POMPES À ANNEAU LIQUIDE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to methods and apparatus for decoupling liquid ring pump components from liquid ring pumps, for example to enable or facilitate maintenance services to be performed on the liquid ring pump and components thereof.

BACKGROUND

[0002] Liquid ring pumps are a known type of pump. Liquid ring pumps typically include a housing that defines a chamber, a shaft passing into the chamber, an impeller mounted to the shaft, and a drive system such as a motor operably connected to the shaft to drive the shaft. The impeller and shaft are positioned eccentrically within the chamber.

[0003] In operation, the chamber is partially filled with an operating liquid. When the drive system drives the shaft and the impeller, a liquid ring is formed on the inner wall of the chamber thus providing a seal that isolates individual volumes between adjacent impeller vanes. The impeller and shaft are eccentric to the liquid ring. This results in a cyclic variation of the volumes enclosed between adjacent vanes of the impeller and the liquid ring.

[0004] In a portion of the chamber where the liquid ring is further away from the shaft, there is a larger volume between adjacent impeller vanes which results in a smaller pressure therein. This allows the portion where the liquid ring is further away from the shaft to act as a gas intake zone. In a portion of the chamber where the liquid ring is closer to the shaft, there is a smaller volume between adjacent impeller vanes which results in a larger pressure therein. This allows the portion where the liquid ring is closer to the impeller to act as a gas discharge zone.

[0005] Examples of liquid ring pumps include single-stage liquid ring pumps and multi-stage liquid ring pumps. Single-stage liquid ring pumps involve the use of only a single chamber and impeller. Multi-stage liquid ring pumps (e.g. two-stage) involve the use of multiple chambers connected in series.

[0006] Preferably, liquid ring pumps undergo maintenance procedures. For example, pump bearings may be periodically lubricated. Also, liquid ring pumps may be regularly cleaned to remove solid matter (such as dirt, sand, or lime deposits) that has entered and collected in the liquid ring pump through the operating liquid and/or the pumped gases.

[0007] Also, liquid ring pumps may undergo repair procedures to repair or replace damaged or failed components. Components of the liquid ring pump, including but not limited to bearings, belt drives, and seals, may become damaged or fail, for example, as a result of cavitation, erosion, and/or corrosion.

[0008] US 2013/0290251 A1 discloses the installation

of a mechanical seal in a liquid ring pump.

SUMMARY OF THE INVENTION

[0009] Typically, a liquid ring pump is installed such that, in operation, the shaft of the liquid ring pump is substantially horizontal (e.g. substantially parallel with a surface upon which the liquid ring pump is located or installed). Maintenance and/or repair procedures for a liquid ring pump tend to involve disassembly or loosening of at least part of the liquid ring pump. However, conventionally, such disassembly of the liquid ring pump while the shaft is oriented horizontally tends to risk unwanted bending of the shaft. Such bending of the shaft may damage the shaft and may also cause the impeller vanes to collide with the walls of the housing, which may damage the vanes and/or housing.

[0010] Conventionally, to alleviate this problem, maintenance and/or repair procedures typically include suspending the liquid ring pump above the ground, and rotating it through about 90° so that its shaft is substantially vertical. Maintenance and/or repair of the liquid ring pump, including partial disassembly, are then performed.

[0011] However, apparatus for lifting, rotating, and suspending a liquid ring pump is large and costly. Furthermore, there tends to be an increased likelihood that component parts disassembled or loosened during maintenance may fall from the suspended liquid ring pump and become damaged.

[0012] The present inventors have realised that it would be beneficial to provide a maintenance or repair procedure for a liquid ring pump that may be implemented while the shaft of the liquid ring pump is oriented horizontally, and which also reduces or eliminates unwanted shaft bending. The present inventors have further realised that it would be beneficial to provide a way of at least partially disassembling a liquid ring pump while the shaft of the pump is oriented horizontally in a way that reduces or eliminates unwanted shaft bending.

[0013] The present inventors have realised that it would be beneficial to provide a maintenance or repair procedure for a liquid ring pump that avoids lifting, rotating, and suspending above the ground the liquid ring pump.

[0014] In a first aspect, the present invention provides a method for decoupling a liquid ring pump component from a liquid ring pump. The liquid ring pump comprises a housing defining an annular chamber and a shaft passing into the chamber. The liquid ring pump component is disposed around the shaft and coupled between the shaft and the housing. The method comprises: coupling, using a first fixing member, a first end of the shaft to the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least a radial direction; and, thereafter, sliding the component along the shaft in a direction along the shaft from the housing towards the first end of the shaft, thereby spacing apart the housing and the component.

[0015] The liquid ring pump component may be configured to, when the liquid ring pump component is disposed around the shaft and coupled between the shaft and the housing, prevent or oppose movement of the shaft relative to the housing in a radial direction and/or axial direction.

[0016] An impeller comprising a plurality of impeller blades or vanes may be mounted to the shaft and located within the chamber such that rotation of the shaft causes the impeller to rotate within the chamber.

[0017] The method may further comprise, while the component and the housing are spaced apart, inspecting, cleaning, repairing or replacing the component or a further component of the liquid ring pump. The method may further comprise sliding the component along the shaft in a direction along the shaft from the first end of the shaft towards the housing, and coupling the component between the shaft and the housing.

[0018] The first fixing member may be a member selected from the group of members consisting of: a fixing bracket configured to fixedly attach between the first end of the shaft and the housing, and a support member configured to be coupled between the shaft and a surface upon which the liquid ring pump is located.

[0019] The first fixing member may be a bracket comprising a base member, two side members extending substantially perpendicularly from opposite ends of the base member, and two arms, each arm being attached to a respective side member at the opposite end of that side member to the base member, the arms extending outwards from the side members substantially parallel to the base member. Coupling the first end of the shaft to the housing may comprise bolting the fixing bracket to the shaft and the housing. Bolting the fixing bracket to the shaft and the housing may comprise inserting a bolt into a hole in the housing, the hole being a hole via which a bearing assembly or bearing assembly cover is bolted to the liquid ring pump.

[0020] The method may further comprise coupling, using a second fixing member, the shaft to the housing. The second fixing member may be configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction. The second fixing member may be coupled to the shaft at a position along the length of the shaft that is further away from the first end than the component. The method may further comprise decoupling the first fixing member from the first end of the shaft, and removing the component from the shaft at the first end of the shaft. The method may further comprise: inspecting, cleaning, repairing or replacing the removed component, thereby to provide a reconditioned or replacement component; disposing the reconditioned or replacement component around the shaft at the first end of the shaft; coupling, using a fixing member, a first end of the shaft to the housing, the fixing member configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction; decoupling the second fixing member from the shaft; sliding the re-

conditioned or replacement component along the shaft in a direction along the shaft from the first end of the shaft towards the housing; coupling the reconditioned or replacement component between the shaft and the housing; and, thereafter, decoupling the fixing member from the first end of the shaft.

[0021] The second fixing member may be a member selected from the group of members consisting of: a fixing bracket configured to fixedly attach between the shaft and the housing, and a support member configured to be coupled between the shaft and a surface upon which the liquid ring pump is located.

[0022] The component may be a mechanical seal.

[0023] The method may further comprise: prior to coupling the first end of the shaft to the housing using the first fixing member, removing, from the liquid ring pump at or proximate to the first end of the shaft, one or more liquid ring pump components selected from the group of components consisting of: a bearing cover, a bolt, a spacer, a washer, a bearing assembly, a bearing, a seal, a lantern ring, a V-ring, and a circlip. The method may further comprise inspecting, cleaning, repairing or replacing the removed one or more liquid ring pump components, thereby to provide a reconditioned or replacement one or more liquid ring pump components.

[0024] Coupling, using the first fixing member, the first end of the shaft to the housing may further prevent or oppose axial and/or rotational movement of the shaft relative to the housing.

[0025] The shaft may be retained in a substantially horizontal orientation during the method. The term "horizontal" may refer to being parallel to the plane of the horizon, or parallel to the plane of a surface upon which the liquid ring pump is located or installed.

[0026] The method may further comprise: coupling, using a third fixing member, a second end of the shaft to the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least a radial direction, the second end of the shaft being opposite to the first end; and, thereafter, sliding a further component along the shaft in a direction along the shaft from the housing towards the second end of the shaft, thereby spacing apart the housing and the component. The steps of coupling the second end of the shaft to the housing and sliding the further component along the shaft towards the second end of the shaft may overlap temporally at least to some extent with the steps of coupling the first end of the shaft to the housing and sliding the component along the shaft towards the first end of the shaft.

[0027] In a further aspect, the present invention provides a system comprising: a liquid ring pump comprising a housing defining an annular chamber, a shaft coupled to the housing and passing through the housing into the chamber, and a component disposed around the shaft and coupled between the shaft and the housing and configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction; and a fixing member configured to couple together a first end

of the shaft and the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least the radial direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

Figure 1 is a schematic illustration (not to scale) of a liquid ring pump;

Figure 2 is a process flow chart showing certain steps of a maintenance and/or repair procedure for the liquid ring pump;

Figure 3 is a schematic illustration (not to scale) showing a bearing cover being removed from the liquid ring pump;

Figure 4 is a schematic illustration (not to scale) showing a bearing assembly being removed from the liquid ring pump;

Figure 5 is a schematic illustration (not to scale) showing an exploded view of the bearing assembly;

Figure 6 is a schematic illustration (not to scale) illustrating a fixing bracket being attached to the liquid ring pump;

Figure 7 is a schematic illustration (not to scale) illustrating the fixing bracket attached to the liquid ring pump;

Figure 8 is a schematic illustration (not to scale) illustrating removal of a mechanical seal from a housing of the liquid ring pump;

Figure 9 is a schematic illustration (not to scale) showing a support member coupled to the liquid ring pump;

Figure 10 is a schematic illustration (not to scale) illustrating the fixing bracket and the mechanical seal being removed from the liquid ring pump;

Figure 11 is a schematic illustration (not to scale) illustrating a reconditioned mechanical seal and the fixing bracket being attached to the liquid ring pump; and

Figure 12 is a schematic illustration (not to scale) showing a reconditioned bearing assembly being attached to the liquid ring pump.

DETAILED DESCRIPTION

[0029] Figure 1 is a schematic illustration (not to scale)

of an example single stage liquid ring pump 2 that will be used to illustrate an embodiment of a maintenance and/or repair procedure.

[0030] The liquid ring pump 2 comprises a housing 4 that defines a substantially cylindrical chamber 6, a shaft 8 extending into the chamber 6, and an impeller 10 fixedly mounted to the shaft 8. The liquid ring pump 2 further comprises a gas inlet 12 fluidly connected to a gas intake of the chamber 6, and a gas outlet (not shown in the Figures) fluidly connected to a gas output of the chamber 6.

[0031] During operation of the liquid ring pump 2, the shaft 8 rotates thereby rotating the impeller 10 within the chamber 6. As the impeller 10 rotates, an operating liquid (not shown in the Figures) is forced against the walls of the chamber 6 thereby to form a liquid ring that seals and isolates individual volumes between adjacent impeller vanes. Also, gas 14 (such as air) is drawn into the chamber 6 via the inlet 12 and the gas intake of the chamber 6. This gas flows into the volumes formed between adjacent vanes of the impeller 10. The rotation of the impeller 10 compresses the gas contained within the volume as it is moved from the gas intake of the chamber 6 to the gas output of the chamber 6, where the compressed gas exits the chamber 6.

[0032] The housing 4 comprises a first end portion 16, a second end portion 18, and a central portion 20 disposed between the first and second end portions 16, 18. The first and second end portions 16, 18 are located at opposite axial ends of the central portion 20.

[0033] The chamber 6 is defined by interior walls of the central portion 20 of the housing 4. The longitudinal axis of the shaft 8 is offset, i.e. eccentric, relative to the axis of the central portion 20.

[0034] The first end portion 16 comprises a first mechanical seal 22 disposed between the shaft 8 and the walls of the chamber 6. The first mechanical seal 22 forms a seal between the shaft 8 and the walls of the chamber 6 thereby to prevent or oppose leakage of the gas and operating liquid out of the chamber 6 at the first end portion 16. The first mechanical seal 22 is arranged to prevent or oppose radial movement of the shaft 8, i.e. in a direction that is substantially perpendicular to the longitudinal axis of the shaft 8. The first mechanical seal 22 may prevent or oppose axial movement of the shaft 8. The first mechanical seal 22 is configured to permit rotation of the shaft 8 about its longitudinal axis.

[0035] The first end portion 16 further comprises a first bearing assembly 24 disposed around the shaft 8 and axially outward of the first mechanical seal 22. The first end portion 16 further comprises a first bearing cover 26 which houses the first bearing assembly 24 and covers a first end of the shaft 8 at the first end portion 16. The first bearing cover 26 is at the outboard end of the liquid ring pump 2.

[0036] The second end portion 18 comprises a second mechanical seal 28 disposed between the shaft 8 and the walls of the chamber 6. The second mechanical seal

28 forms a seal between the shaft 8 and the walls of the chamber 6 thereby to prevent or oppose leakage of the gas and operating liquid out of the chamber 6 at the second end portion 18. The second mechanical seal 28 is arranged to prevent or oppose radial movement of the shaft 8, i.e. in a direction that is substantially perpendicular to the longitudinal axis of the shaft 8. The second mechanical seal 28 may prevent or oppose axial movement of the shaft 8. The second mechanical seal 28 is configured to permit rotation of the shaft 8 about its longitudinal axis.

[0037] The second end portion 18 further comprises a second bearing assembly 30 disposed around the shaft 8 and axially outward of the second mechanical seal 28. The second end portion 18 further comprises a second bearing cover 32 which houses the second bearing assembly 30 and covers a second end of the shaft 8 (opposite to the first end of the shaft 8) at the second end portion 18.

[0038] The second end portion 18 further comprises a lantern ring 34 coupled to the housing 4 and around the shaft 8, the second bearing assembly 30, and the second bearing cover 32. The lantern ring 34 is a perforated hollow ring that, in operation, is used to couple the pump to the motor, supports the motor and the drive end casing, to the base frame.

[0039] Figure 2 is a process flow chart showing certain steps of an embodiment of maintenance and/or repair procedure for a liquid ring pump. In this embodiment, the maintenance and/or repair procedure is performed on the liquid ring pump 2 shown in Figure 1 and described in more detail earlier above.

[0040] In this embodiment, for the sake of brevity, the maintenance and/or repair procedure is described as being performed on the first end portion 16 of the liquid ring pump 2 only. However, it will be appreciated by those skilled in the art that the below described maintenance and/or repair procedure may be performed at other areas of the liquid ring pump 2 instead of or in addition to being performed at the first end portion 16. For example, in other embodiments the maintenance and/or repair procedure is performed on the second end portion 18 of the liquid ring pump 2 instead of or in addition to being performed at the first end portion 16. The maintenance and/or repair procedure being performed at the second end portion 18 may be performed in series, in parallel, or partially overlapping temporally with the maintenance and/or repair procedure being performed at the first end portion 16. The maintenance and/or repair procedure performed at the second end portion 18 may be performed to inspect, clean, maintain, or replace liquid ring pump one or more components located at the second end portion 18 selected from the group of components comprising the second mechanical seal 28, the second bearing assembly 30, the second bearing cover 32, the lantern ring 34, washers, seals, bearings, bolts, coupling mechanisms, V-rings, and circlips.

[0041] At step s2, a user (i.e. a human that is perform-

ing the maintenance and/or repair procedure) removes the first bearing cover 26 from the liquid ring pump 2.

[0042] Figure 3 is a schematic illustration (not to scale) showing the first bearing cover 26 being removed from the liquid ring pump 2. In this embodiment, the first bearing cover 26 is attached to the housing 4 at the first end portion 16 by a first plurality of bolts 36. At step s2, the user removes from the liquid ring pump 2 the first plurality of bolts 36, followed by the first bearing cover 26, as indicated in Figure 3 by solid arrows and the reference numeral 38.

[0043] At step s4, the user removes the first bearing assembly 24 from the liquid ring pump 2.

[0044] Figure 4 is a schematic illustration (not to scale) showing the first bearing assembly 24 being removed from the liquid ring pump 2. In this embodiment, the first bearing assembly 24 fits around the shaft 8 and attaches to the housing 4 at the first end portion 16 by a second plurality of bolts 40. A first washer 42 and a first spacer 44 are coupled to an end of the shaft 8 between the first bearing assembly 24 and the first bearing cover 26. At step s4, the user removes from the liquid ring pump 2, in turn, the second plurality of bolts 40, the first washer 42 and the first spacer 44, and the first bearing assembly 24, as indicated in Figure 4 by solid arrows and the reference numeral 46.

[0045] At step s5, the user reconditions the first bearing assembly 24 if required. For example, the user may inspect, clean, repair and/or replace some or all of the components of the first bearing assembly 24 that has been removed from the liquid ring pump 2. In some embodiments, the user replaces the first bearing assembly 24 with a new bearing assembly.

[0046] Figure 5 is a schematic illustration (not to scale) showing an exploded view of the first bearing assembly 24. In this embodiment, the first bearing assembly 24 comprises a second washer 50, a second spacer 52, a bearing 54, a bearing spacer 56, a lip seal 58, and a bearing assembly housing 60. The user may disassemble some or all of the first bearing assembly 24 to perform maintenance, inspection, cleaning, repair or replacement. The user may inspect, clean, repair, and/or replace one or more of the component parts 50-60 of the first bearing assembly 24 prior to reassembling the first bearing assembly 24, thereby to provide a reconditioned first bearing assembly 24.

[0047] At step s6, the user attaches a fixing bracket to the liquid ring pump 2 (which has had the first bearing cover 26 and first bearing assembly 24 removed).

[0048] Figure 6 is a schematic illustration (not to scale) illustrating the fixing bracket 62 being attached to the liquid ring pump 2.

[0049] In this embodiment, the fixing bracket 62 is made of a metal.

[0050] In this embodiment, the fixing bracket 62 comprises a square U-shaped central portion having a base member 64 and two side members 66 extending substantially perpendicularly from opposite ends of the base

member 64. The fixing bracket 62 further comprises two arms 68. Each arm 68 is attached to a respective side member 66, at the opposite end of that side member 66 to the base member 64. The arms 68 extend outwards from the side members 66 substantially parallel to the base member 64.

[0051] In this embodiment, the fixing bracket 62 comprises three holes, namely a first hole 71, a second hole 72, and a third hole 73. The first hole 71 passes through the base member 64 substantially equidistant between the ends of the base member 64. The second and third holes 72, 73 each pass through a respective arm 68 of the fixing bracket 62.

[0052] The fixing bracket 62 is attached to liquid ring pump 2 via three bolts, namely a first bolt 81, a second bolt 82, and a third bolt 83.

[0053] The first bolt 81 passes through the first hole 71 in the base member 64, and into a bore in the first end of the shaft 8, thereby fixedly attaching the base member 64 to the shaft 8. The second bolt 82 passes through the second hole 72 of the fixing bracket 62 and into a bore in the housing 4, thereby fixedly attaching an arm 68 of the fixing bracket 62 to the housing 4. The third bolt 83 passes through the third hole 73 of the fixing bracket 62 and into a bore in the housing 4, thereby fixedly attaching an arm 68 of the fixing bracket 62 to the housing 4. This attachment of the fixing bracket 62 to the shaft 8 and the housing 4 via the first, second, and third bolts 81-83 is indicated in Figure 6 by solid arrows and the reference numeral 84. Preferably, the bores in the housing 4 into which the second and third bolts 82, 83 are inserted are the same bores as those used by two bolts from the first or second pluralities of bolts 36, 40 (which were removed earlier in the process of Figure 2).

[0054] Figure 7 is a schematic illustration (not to scale) illustrating the fixing bracket 62 attached to the liquid ring pump 2. In this embodiment, the fixing bracket 62 fixedly attaches the shaft 8 to the housing 4 such that relative movement therebetween is prevented or opposed. Preferably, the fixing bracket 62 prevents the shaft 8 from rotating about its axis, i.e. the fixing bracket 62 prevents rotation of the shaft 8 relative to the housing 4. Preferably, the fixing bracket 62 prevents axial movement of the shaft 8 relative to the housing 4. Preferably, the fixing bracket 62 prevents radial movement of the shaft 8 relative to the housing 4.

[0055] At step s8, the user removes (e.g. detaches or decouples) the first mechanical seal 22 from the housing 4.

[0056] Figure 8 is a schematic illustration (not to scale) illustrating removal of the first mechanical seal 22 from the housing 4. In this embodiment, the first mechanical seal 22 is detached from the housing 4 and slid along the shaft 8 from the housing 4 towards the fixing bracket 62. Thus, the first mechanical seal 22 is moved such that it is spaced apart from the housing 4. This removal of the first mechanical seal 22 from the housing 4 is indicated in Figure 8 by solid arrows and the reference numeral 86.

[0057] At step s10, the user couples a support member between the shaft 8 and the surface upon which the liquid ring pump 2 is installed (e.g. the ground).

[0058] Figure 9 is a schematic illustration (not to scale) showing the support member 90 coupled between the shaft 8 and the surface 92 upon which the liquid ring pump 2 is installed. In some embodiments, the liquid ring pump is attached (e.g. by bolts) to the surface 92.

[0059] In this embodiment, the support member 90 is an elongate metal member.

[0060] The support member 90 is coupled to the shaft 8 at a position along the shaft 8 between the first mechanical seal 22 and the housing 4. Thus, the support member 90 does not impede the later removal of the first mechanical seal 22 from the first end of the shaft 8.

[0061] The support member 90 fixedly couples the shaft 8 to the surface 92 onto which the housing 4 is secured. Thus, the shaft 8 is securely coupled to the housing via the support member 90. Preferably, the support member 90 prevents the shaft 8 from rotating about its axis, i.e. the support member 90 prevents rotation of the shaft 8 relative to the housing 4. Preferably, the support member 90 prevents axial movement of the shaft 8 relative to the housing 4. Preferably, the support member 90 prevents radial movement of the shaft 8 relative to the housing 4.

[0062] At step s12, the user removes the fixing bracket 62 from the liquid ring pump 2. In this embodiment, the fixing bracket 62 is detached from the end of the shaft 8 and from the housing 4.

[0063] At step s14, the user removes the first mechanical seal 22 from the shaft 8.

[0064] Figure 10 is a schematic illustration (not to scale) illustrating the fixing bracket 62 and the first mechanical seal 22 being removed from the liquid ring pump 2. In this embodiment, at step s14 the user removes from the liquid ring pump 2 the first, second, and third bolts 81, 82, 83, followed by the fixing bracket 62, followed by the first mechanical seal 22, as indicated in Figure 10 by solid arrows and the reference numeral 94.

[0065] At step s15, the user reconditions the mechanical seal 22 if required. For example, the user may inspect, clean repair and/or replace some or all of the components of the first mechanical seal 22. In some embodiments, the user may replace the first mechanical seal 22 with a new mechanical seal.

[0066] At step s16, the user places the reconditioned mechanical seal onto the first end of the shaft 8 outward of the support member 90.

[0067] At step s18, the user attaches the fixing bracket 62 to the liquid ring pump 2 (which has the first bearing cover 26 and assembly 24 removed).

[0068] Figure 11 is a schematic illustration (not to scale) illustrating the reconditioned first mechanical seal 22' and the fixing bracket 62 being attached to the liquid ring pump 2. In this embodiment, the reconditioned mechanical seal 22' is first placed onto the first end of the shaft 8, and the fixing bracket 62 is subsequently at-

tached to the shaft 8 and the housing 4 by the first, second, and third bolts 81, 82, 83 in the same way as performed at step s6 (and described in more detail earlier above with reference to Figure 6). The reconditioned first mechanical seal 22' is thus located between the fixing bracket 62 and the support member 90. This attachment of the reconditioned first mechanical seal 22' and the fixing bracket 62 to the liquid ring pump 2 is indicated in Figure 11 by solid arrows and the reference numeral 96.

[0069] At step s20, the user removes the support member 90 from between the shaft 8 and the surface 92. Thus, the support member 90 is decoupled from the shaft 8. Relative positions of the shaft 8 and the housing 4 are maintained by the fixing bracket 62.

[0070] At step s22, the user installs the reconditioned first mechanical seal 22' in the liquid ring pump 2. In this embodiment, the reconditioned first mechanical seal 22' is slid along the shaft 8 into the housing 4. The reconditioned first mechanical seal 22' is then coupled between the housing 4 and shaft 8 in the same way as it was before it was removed and reconditioned at step s14 and s15 respectively.

[0071] At step s24, the user removes the fixing bracket 62 from the liquid ring pump 2. In this embodiment, the fixing bracket 62 is detached from the end of the shaft 8 and from the housing 4. Correct positioning between the shaft and the housing 4 is provided by the reconditioned first mechanical seal 22'.

[0072] At step s26, the user attaches the reconditioned first bearing assembly 24 to the liquid ring pump 2.

[0073] Figure 12 is a schematic illustration (not to scale) showing the reconditioned first bearing assembly 24' being attached to the liquid ring pump 2. In this embodiment, the reconditioned first bearing assembly 24' fits around the shaft 8 and attaches to the housing 4 at the first end portion 16 by the second plurality of bolts 40. Thus, the reconditioned first bearing assembly 24' is coupled to the housing 4 and shaft 8 in the same way as it was before it was removed and reconditioned at steps s4 and s5 respectively.

[0074] In this embodiment, the first washer 42 and the first spacer 44 are coupled to the first end of the shaft 8 in the same way as they were before they were removed at step s4. In some embodiments, the first washer 42 and/or the first spacer 44 are reconditioned (e.g. cleaned or repaired) prior to reattachment to the liquid ring pump 2. In some embodiments, the first washer 42 and/or the first spacer 44 are replaced by new parts which are then attached to the liquid ring pump 2.

[0075] The attachment of the reconditioned first bearing assembly 24', the first washer 42, and the first spacer 44 to the liquid ring pump 2 is indicated in Figure 12 by solid arrows and the reference numeral 98.

[0076] At step s26, the user reattaches the first bearing cover 26 to the liquid ring pump 2.

[0077] In this embodiment, the first bearing cover 26 is reattached to the housing 4 at the first end portion 16 by the first plurality of bolts 36. Thus, the first bearing

cover 26 is coupled to the housing 4 and shaft 8 in the same way as it was before it was removed at step s2.

[0078] In some embodiments, the first bearing cover 26 is reconditioned (e.g. cleaned or repaired) prior to reattachment to the liquid ring pump 2. In some embodiments, the first bearing cover 26 is replaced by a new part which is then attached to the liquid ring pump 2.

[0079] Thus, a maintenance and/or repair procedure for a liquid ring pump is provided.

[0080] Advantageously, the above-described maintenance and/or repair procedure may be performed while the shaft of the liquid ring pump is substantially horizontal, e.g. substantially parallel to the surface upon which the liquid ring pump is installed. In other words, maintenance and/or repair of the liquid ring pump may be performed with the liquid ring pump in its installed state. During the procedure, the shaft is secured in its substantially horizontal position such that movement of the shaft relative to the housing is prevented or opposed. This tends to reduce the likelihood of components of the liquid ring pump being damaged during the procedure. For example, undesirable bending of the shaft which may damage the shaft tends to be reduced or eliminated. Also, the likelihood of the impeller vanes mounted to the shaft impacting the walls of the housing, which may damage the vanes and/or housing, tends to be reduced or eliminated.

[0081] Furthermore, the above-described maintenance and/or repair procedure tends to avoid the conventionally implemented process of suspending the liquid ring pump above the ground, and rotating it through about 90° so that the shaft is substantially vertical. Thus, a need for apparatus for lifting, rotating, and suspending the liquid ring pump tends to be avoided. Also, a risk that component parts disassembled or loosened during maintenance fall from the liquid ring pump and become damaged is reduced or eliminated. This further tends to improve the safety of personnel carrying out maintenance or repair of the liquid ring pump.

[0082] The above-described maintenance and/or repair procedure tends to require fewer personnel and less equipment compared to conventional techniques.

[0083] The above-described maintenance and/or repair procedure tends to provide for faster maintenance and/or repair of a liquid ring pump compared to conventional techniques.

[0084] It should be noted that certain of the process steps depicted in the flowchart of Figure 2 and described above may be omitted or such process steps may be performed in differing order to that presented above and shown in Figure 2. Furthermore, although all the process steps have, for convenience and ease of understanding, been depicted as discrete temporally-sequential steps, nevertheless some of the process steps may in fact be performed simultaneously or at least overlapping to some extent temporally.

[0085] In the above embodiments, the maintenance and/or repair procedure is implemented on a single stage liquid ring pump. However, in other embodiments, the

maintenance and/or repair procedure is implemented on a different type of liquid ring pump, e.g. a multi-stage liquid ring pump. In some embodiments, the maintenance and/or repair procedure is implemented on a liquid ring pump that has different components to those described above, or components that may be arranged or connected together in a different way.

[0086] In the above embodiments, the maintenance and/or repair procedure may be performed to inspect, clean, maintain, repair or replace liquid ring pump components including but not limited to the first mechanical seal, the first bearing assembly, the first bearing cover, and/or washers and seals located at the first end portion. However, in other embodiments inspection, cleaning, maintaining, or replacement of one or more other liquid ring pump components is performed instead of or in addition to those described above, for example, coupling mechanisms, housings, washers, spacers, seals, bearings, belts, belt drives, V-rings, circlips, bolts, and nuts.

[0087] In the above embodiments, the fixing bracket is made of metal. However, in other embodiments, the fixing bracket comprises a different material instead of or in addition to metal.

[0088] In the above embodiments, the fixing bracket comprises a square U-shaped central portion with two arms extending from the end of that square U-shaped central portion. However, in other embodiments the fixing bracket has a different shape.

[0089] In the above embodiments, the fixing bracket attaches to the shaft and the housing via three bolts which pass through respective holes in the fixing bracket. However, in other embodiments, the fixing bracket is fixedly attached to the shaft and/or the housing in a different appropriate way, for example, via a different number of bolts. The fixing bracket may have a different number of holes for receiving a different number of bolts.

[0090] In the above embodiments, at steps s6 and s18, the fixing bracket is attached between an end of the shaft and the housing, thereby to prevent or oppose relative movement of the shaft and housing. However, in other embodiments, at one or both of these steps, relative movement of the shaft and housing is prevented or opposed in a different way. For example, in some embodiments, at one or both of steps s6 and s18, a support member (or other structure) is attached between the end of the shaft and the surface upon which the liquid ring pump is installed (e.g. the ground), thereby to prevent or oppose relative movement of the shaft and housing.

[0091] In the above embodiments, the support member is made of metal. However, in other embodiments, the support member comprises a different material instead of or in addition to metal.

[0092] In the above embodiments, the support member is an elongate member. However, in other embodiments the support member has a different shape.

[0093] In the above embodiments, at step s10, the support member is attached between the shaft and the surface upon which the liquid ring pump is installed, thereby

to prevent or oppose relative movement of the shaft and housing. The support member is coupled to the shaft at an intermediate position along the length of the shaft between the first mechanical seal and the housing. However, in other embodiments, at step s10, relative movement of the shaft and housing is prevented or opposed in a different way. For example, in some embodiments, at steps s10, a fixing member is attached directly between the shaft and the housing, thereby to prevent or oppose relative movement of the shaft and housing. The fixing member may attach to the shaft at the intermediate position along the length of the shaft between the first mechanical seal and the housing.

[0094] In the above embodiments, many of the above described method steps are performed by a human user using any appropriate tools. However, in other embodiments one or more of the above described method steps is performed by a different entity, for example a computer-controlled robot arm.

[0095] In the above embodiments, the mechanical seal is removed from the liquid ring pump at an end of the shaft. However, in other embodiments, the mechanical seal is not removed from the liquid ring pump. For example, in some embodiments, a maintenance operation (e.g. cleaning or repair) may be performed on the mechanical seal while that mechanical seal remains disposed on the shaft. Thus, in some embodiments, steps s10-s14 and s16-s20 may be omitted from the maintenance and/or repair procedure.

[0096] In some embodiments, while the mechanical seal is spaced apart from the housing, a maintenance operation is performed on the housing of the liquid ring pump, or on a component on or within the housing that is accessible by virtue of the mechanical seal being spaced apart from the housing.

Claims

1. A method for decoupling a liquid ring pump component from a liquid ring pump, the liquid ring pump comprising a housing defining an annular chamber and a shaft passing into the chamber, the component being disposed around the shaft and coupled between the shaft and the housing, the method comprising:

coupling, using a first fixing member, a first end of the shaft to the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least a radial direction; and, thereafter, sliding the component along the shaft in a direction along the shaft from the housing towards the first end of the shaft, thereby spacing apart the housing and the component.

2. A method according to claim 1, further comprising:

- while the component and the housing are spaced apart, inspecting, cleaning, repairing or replacing the component or a further component of the liquid ring pump; and, thereafter, sliding the component along the shaft in a direction along the shaft from the first end of the shaft towards the housing; and coupling the component between the shaft and the housing.
3. A method according to claim 1 or 2, wherein the first fixing member is a member selected from the group of members consisting of: a fixing bracket configured to fixedly attach between the first end of the shaft and the housing, and a support member configured to be coupled between the shaft and a surface upon which the liquid ring pump is located.
4. A method according to claim 3, wherein:
- the first fixing member is a bracket comprising a base member, two side members extending substantially perpendicularly from opposite ends of the base member, and two arms, each arm being attached to a respective side member at the opposite end of that side member to the base member, the arms extending outwards from the side members substantially parallel to the base member; and coupling the first end of the shaft to the housing comprises bolting the fixing bracket to the shaft and the housing.
5. A method according to claim 4, wherein bolting the fixing bracket to the shaft and the housing comprises inserting a bolt into a hole in the housing, the hole being a hole via which a bearing assembly or bearing assembly cover is bolted to the liquid ring pump.
6. A method according to any of claims 1 to 5, further comprising:
- coupling, using a second fixing member, the shaft to the housing, the second fixing member configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction, wherein the second fixing member is coupled to the shaft at a position along the length of the shaft that is further away from the first end than the component;
- decoupling the first fixing member from the first end of the shaft; and removing the component from the shaft at the first end of the shaft.
7. A method according to claim 6, further comprising:
- inspecting, cleaning, repairing or replacing the removed component, thereby to provide a reconditioned or replacement component;
- disposing the reconditioned or replacement component around the shaft at the first end of the shaft;
- coupling, using a fixing member, a first end of the shaft to the housing, the fixing member configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction;
- decoupling the second fixing member from the shaft;
- sliding the reconditioned or replacement component along the shaft in a direction along the shaft from the first end of the shaft towards the housing;
- coupling the reconditioned or replacement component between the shaft and the housing; and, thereafter, decoupling the fixing member from the first end of the shaft.
8. A method according to claim 6 or 7, wherein the second fixing member is a member selected from the group of members consisting of: a fixing bracket configured to fixedly attach between the shaft and the housing, and a support member configured to be coupled between the shaft and a surface upon which the liquid ring pump is located.
9. A method according to any of claim 1 to 8, wherein the component is a mechanical seal.
10. A method according to any of claims 1 to 9, further comprising:
- prior to coupling the first end of the shaft to the housing using the first fixing member, removing, from the liquid ring pump at or proximate to the first end of the shaft, one or more liquid ring pump components selected from the group of components consisting of: a bearing cover, a bolt, a spacer, a washer, a bearing assembly, a bearing, a seal, a lantern ring, a V-ring, and a circlip; and inspecting, cleaning, repairing or replacing the removed one or more liquid ring pump components, thereby to provide a reconditioned or replacement one or more liquid ring pump components.
11. A method according to any of claims 1 to 10, wherein coupling, using the first fixing member, the first end of the shaft to the housing further prevents or opposes axial and/or rotational movement of the shaft relative to the housing.
12. A method according to any of claims 1 to 11, wherein the shaft is retained in a substantially horizontal ori-

entation.

13. A method according to any of claims 1 to 12, further comprising:

coupling, using a third fixing member, a second end of the shaft to the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least a radial direction, the second end of the shaft being opposite to the first end; and, thereafter, sliding a further component along the shaft in a direction along the shaft from the housing towards the second end of the shaft, thereby spacing apart the housing and the component.

14. A method according to claim 13, wherein the steps of coupling the second end of the shaft to the housing and sliding the further component along the shaft towards the second end of the shaft overlap temporally at least to some extent with the steps of coupling the first end of the shaft to the housing and sliding the component along the shaft towards the first end of the shaft.

15. A system comprising:

a liquid ring pump comprising:

a housing defining an annular chamber; a shaft coupled to the housing and passing through the housing into the chamber; and a component disposed around the shaft and coupled between the shaft and the housing and configured to prevent or oppose movement of the shaft relative to the housing in at least a radial direction; and

the system being **characterised by** a fixing member configured to couple together a first end of the shaft and the housing thereby to prevent or oppose movement of the shaft relative to the housing in at least the radial direction.

Patentansprüche

1. Verfahren zum Entkoppeln einer Flüssigkeitsringpumpen-Komponente von einer Flüssigkeitsringpumpe, wobei die Flüssigkeitsringpumpe ein Gehäuse, das eine ringförmige Kammer definiert, und eine Welle, die in die Kammer führt, aufweist, wobei die Komponente um die Welle herum angeordnet und zwischen der Welle und dem Gehäuse gekoppelt ist, wobei das Verfahren umfasst:

Koppeln eines ersten Endes der Welle mit dem

Gehäuse mithilfe eines ersten Befestigungselements, um dadurch eine Bewegung der Welle relativ zum Gehäuse mindestens in radialer Richtung zu verhindern oder ihr entgegenzuwirken; und

anschließendes Verschieben der Komponente entlang der Welle vom Gehäuse in Richtung des ersten Endes der Welle, wodurch das Gehäuse und die Komponente beabstandet werden.

2. Verfahren nach Anspruch 1, ferner umfassend:

Inspizieren, Reinigen, Reparieren oder Austauschen der Komponente oder einer weiteren Komponente der Flüssigkeitsringpumpe, während die Komponente und das Gehäuse voneinander beabstandet sind; und anschließendes Verschieben der Komponente entlang der Welle vom ersten Ende der Welle in Richtung des Gehäuses; und Koppeln der Komponente zwischen der Welle und dem Gehäuse.

3. Verfahren nach Anspruch 1 oder 2, wobei das erste Befestigungselement ein Element ist, das aus der Gruppe von Elementen ausgewählt ist, die besteht aus: einem Befestigungsbügel, der zur festen Anbringung zwischen dem ersten Ende der Welle und dem Gehäuse ausgebildet ist, und einem Stützelement, das zur Kopplung zwischen der Welle und einer Oberfläche, auf der sich die Flüssigkeitsringpumpe befindet, ausgebildet ist.

4. Verfahren nach Anspruch 3, wobei:

das erste Befestigungselement ein Bügel ist, der ein Basiselement, zwei Seitenelemente, die sich im Wesentlichen senkrecht von gegenüberliegenden Enden des Basiselements aus erstrecken, und zwei Arme aufweist, wobei jeder Arm an einem jeweiligen Seitenelement an dem dem Basiselement gegenüberliegenden Ende dieses Seitenelements befestigt ist, wobei sich die Arme von den Seitenelementen im Wesentlichen parallel zum Basiselement nach außen erstrecken; und

das Koppeln des ersten Endes der Welle mit dem Gehäuse ein Anschrauben des Befestigungsbügels an die Welle und das Gehäuse umfasst.

5. Verfahren nach Anspruch 4, wobei das Anschrauben des Befestigungsbügels an die Welle und das Gehäuse umfasst, eine Schraube in ein Loch im Gehäuse einzuführen, wobei das Loch ein solches ist, über das eine Lageranordnung oder ein Lageranordnungsdeckel an die Flüssigkeitsringpumpe angeschraubt wird.

6. Verfahren nach einem der Ansprüche 1 bis 5, ferner umfassend:

Koppeln der Welle mit dem Gehäuse mithilfe eines zweiten Befestigungselements, wobei das zweite Befestigungselement so ausgebildet ist, dass es eine Bewegung der Welle relativ zum Gehäuse mindestens in radialer Richtung verhindert oder ihr entgegenwirkt, wobei das zweite Befestigungselement mit der Welle an einer Position entlang der Länge der Welle gekoppelt ist, die weiter von dem ersten Ende entfernt ist als die Komponente;

Entkoppeln des ersten Befestigungselements vom ersten Ende der Welle und Entfernen der Komponente von der Welle am ersten Ende der Welle.

7. Verfahren nach Anspruch 6, ferner umfassend:

Inspizieren, Reinigen, Reparieren oder Austauschen der entfernten Komponente, um so eine überholte Komponente oder Ersatzkomponente bereitzustellen;

Anordnen der überholten Komponente oder Ersatzkomponente um die Welle herum am ersten Ende der Welle;

Koppeln eines ersten Endes der Welle mit dem Gehäuse mithilfe eines Befestigungselements, wobei das Befestigungselement dazu ausgebildet ist, eine Bewegung der Welle relativ zum Gehäuse mindestens in radialer Richtung zu verhindern oder ihr entgegenzuwirken;

Entkoppeln des zweiten Befestigungselements von der Welle;

Verschieben der überholten Komponente oder Ersatzkomponente entlang der Welle vom ersten Ende der Welle in Richtung des Gehäuses; Koppeln der überholten Komponente oder Ersatzkomponente zwischen der Welle und dem Gehäuse und

anschließendes Entkoppeln des Befestigungselements vom ersten Ende der Welle.

8. Verfahren nach Anspruch 6 oder 7, wobei das zweite Befestigungselement ein Element ist, das aus der Gruppe von Elementen ausgewählt ist, die besteht aus: einem Befestigungsbügel, der zur festen Anbringung zwischen der Welle und dem Gehäuse ausgebildet ist, und einem Stützelement, das zur Koppelung zwischen der Welle und einer Oberfläche, auf der sich die Flüssigkeitsringpumpe befindet, ausgebildet ist.

9. Verfahren nach einem der Ansprüche 1 bis 8, wobei die Komponente eine Gleitringdichtung ist.

10. Verfahren nach einem der Ansprüche 1 bis 9, ferner

umfassend:

vor dem Koppeln des ersten Endes der Welle mit dem Gehäuse mithilfe des ersten Befestigungselements, Entfernen einer oder mehrerer Flüssigkeitsringpumpen-Komponenten von der Flüssigkeitsringpumpe am oder in der Nähe des ersten Endes der Welle, ausgewählt aus der Gruppe von Komponenten, die besteht aus: einem Lagerdeckel, einer Schraube, einem Abstandshalter, einer Unterlegscheibe, einer Lageranordnung, einem Lager, einer Dichtung, einem Laternenring, einem V-Ring und einem Sicherungsring; und

Inspizieren, Reinigen, Reparieren oder Austauschen der entfernten einen oder mehreren Flüssigkeitsringpumpen-Komponenten, um so eine oder mehrere überholte oder Ersatz-Flüssigkeitsringpumpen-Komponenten bereitzustellen.

11. Verfahren nach einem der Ansprüche 1 bis 10, wobei das Koppeln des ersten Endes der Welle mit dem Gehäuse mithilfe des ersten Befestigungselements ferner eine axiale Bewegung und/oder Drehbewegung der Welle relativ zum Gehäuse verhindert oder ihr entgegenwirkt.

12. Verfahren nach einem der Ansprüche 1 bis 11, wobei die Welle in einer im Wesentlichen horizontalen Ausrichtung gehalten wird.

13. Verfahren nach einem der Ansprüche 1 bis 12, ferner umfassend:

Koppeln eines zweiten Endes der Welle mit dem Gehäuse mithilfe eines dritten Befestigungselements, um dadurch eine Bewegung der Welle relativ zum Gehäuse mindestens in radialer Richtung zu verhindern oder ihr entgegenzuwirken, wobei das zweite Ende der Welle dem ersten Ende gegenüberliegt; und anschließendes Verschieben einer weiteren Komponente entlang der Welle vom Gehäuse in Richtung des zweiten Endes der Welle, wodurch das Gehäuse und die Komponente beabstandet werden.

14. Verfahren nach Anspruch 13, wobei die Schritte des Koppelns des zweiten Endes der Welle mit dem Gehäuse und des Verschiebens der weiteren Komponente entlang der Welle in Richtung des zweiten Endes der Welle sich zeitlich mindestens bis zu einem gewissen Grad mit den Schritten des Koppelns des ersten Endes der Welle mit dem Gehäuse und des Verschiebens der Komponente entlang der Welle in Richtung des ersten Endes der Welle überlappen.

15. Ein System, das Folgendes aufweist:
eine Flüssigkeitsringpumpe mit:

einem Gehäuse, das eine ringförmige Kammer definiert;
einer Welle, die mit dem Gehäuse gekoppelt ist und durch das Gehäuse in die Kammer führt; und
einer Komponente, die um die Welle herum angeordnet und zwischen der Welle und dem Gehäuse gekoppelt ist und dazu ausgebildet ist, eine Bewegung der Welle relativ zum Gehäuse mindestens in radialer Richtung zu verhindern oder ihr entgegenzuwirken; und wobei das System **gekennzeichnet ist durch**
ein Befestigungselement, das so ausgebildet ist, dass es ein erstes Ende der Welle und das Gehäuse miteinander koppelt, um dadurch eine Bewegung der Welle relativ zum Gehäuse in mindestens der radialen Richtung zu verhindern oder ihr entgegenzuwirken.

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Revendications

1. Procédé pour découpler un composant de pompe à anneau liquide d'une pompe à anneau liquide, la pompe à anneau liquide comprenant un boîtier définissant une chambre annulaire et un arbre passant dans la chambre, le composant étant disposé autour de l'arbre et étant couplé entre l'arbre et le boîtier, le procédé comprenant les étapes consistant à :

coupler, à l'aide d'un premier élément de fixation, une première extrémité de l'arbre au boîtier, pour empêcher ainsi ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins une direction radiale ; et
après quoi, faire coulisser le composant le long de l'arbre dans une direction le long de l'arbre, du boîtier vers la première extrémité de l'arbre, éloignant ainsi le boîtier et le composant.

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2. Procédé selon la revendication 1, comprenant en outre les étapes consistant à :

alors que le composant et le boîtier sont éloignés, inspecter, nettoyer, réparer ou remplacer le composant ou un autre composant de la pompe à anneau liquide ; et après quoi
faire coulisser le composant le long de l'arbre dans une direction le long de l'arbre, de la première extrémité de l'arbre vers le boîtier ; et
coupler le composant entre l'arbre et le boîtier.

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3. Procédé selon la revendication 1 ou 2, dans lequel le premier élément de fixation est un élément sélectionné dans le groupe d'éléments comprenant : une

console de fixation configurée pour se fixer, de manière fixe, entre la première extrémité de l'arbre et le boîtier, et un élément de support configuré pour être couplé entre l'arbre et une surface sur laquelle la pompe à anneau liquide est située.

4. Procédé selon la revendication 3, dans lequel :

le premier élément de fixation est une console comprenant un élément de base, deux éléments latéraux s'étendant sensiblement perpendiculairement à partir des extrémités opposées de l'élément de base et deux bras, chaque bras étant fixé à un élément latéral respectif au niveau de l'extrémité opposée de cet élément latéral, à l'élément de base, les bras s'étendant vers l'extérieur à partir des éléments latéraux sensiblement parallèles à l'élément de base ; et l'étape consistant à coupler la première extrémité de l'arbre au boîtier comprend l'étape consistant à boulonner la console de fixation à l'arbre et au boîtier.

5. Procédé selon la revendication 4, dans lequel l'étape consistant à boulonner la console de fixation sur l'arbre et le boîtier comprend l'étape consistant à insérer un boulon dans un trou dans le boîtier, le trou étant un trou grâce auquel un ensemble de palier ou un couvercle d'ensemble de palier est boulonné sur la pompe à anneau liquide.

6. Procédé selon l'une quelconque des revendications 1 à 5, comprenant en outre les étapes consistant à :

coupler, à l'aide d'un deuxième élément de fixation, l'arbre au boîtier, le deuxième élément de fixation étant configuré pour empêcher ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins une direction radiale, dans lequel le deuxième élément de fixation est couplé à l'arbre dans une position le long de la longueur de l'arbre qui est davantage éloignée de la première extrémité que le composant ;
découpler le premier élément de fixation de la première extrémité de l'arbre ; et
retirer le composant de l'arbre au niveau de la première extrémité de l'arbre.

7. Procédé selon la revendication 6, comprenant en outre les étapes consistant à :

inspecter, nettoyer, réparer ou remplacer le composant retiré, pour fournir ainsi un composant reconditionné ou de remplacement ;
disposer le composant reconditionné ou de remplacement autour de l'arbre au niveau de la première extrémité de l'arbre ;
coupler, à l'aide d'un élément de fixation, une

- première extrémité de l'arbre au boîtier, l'élément de fixation étant configuré pour empêcher ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins une direction radiale ;
- découpler le deuxième élément de fixation de l'arbre ;
- faire coulisser le composant reconditionné ou de remplacement le long de l'arbre dans une direction le long de l'arbre de la première extrémité de l'arbre vers le boîtier ;
- coupler le composant reconditionné ou de remplacement entre l'arbre et le boîtier ; et
- après quoi, découpler l'élément de fixation de la première extrémité de l'arbre.
8. Procédé selon la revendication 6 ou 7, dans lequel le deuxième élément de fixation est un élément sélectionné dans le groupe d'éléments comprenant : une console de fixation configurée pour se fixer, de manière fixe, entre l'arbre et le boîtier, et un élément de support configuré pour être couplé entre l'arbre et une surface sur laquelle la pompe à anneau liquide est située.
9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel le composant est un joint d'étanchéité mécanique.
10. Procédé selon l'une quelconque des revendications 1 à 9, comprenant en outre les étapes consistant à :
- avant de coupler la première extrémité de l'arbre au boîtier à l'aide du premier élément de fixation, retirer, de la pompe à anneau liquide au niveau de ou à proximité de la première extrémité de l'arbre, un ou plusieurs composants de pompe à anneau liquide sélectionnés dans le groupe de composants comprenant : un couvercle de palier, un boulon, un dispositif d'espacement, une rondelle, un ensemble de palier, un palier, un joint d'étanchéité, une lanterne, une bague en V et un anneau de retenue ; et
- inspecter, nettoyer, réparer ou remplacer les un ou plusieurs composants de pompe à anneau liquide retirés, pour fournir ainsi un ou plusieurs composants de pompe à anneau liquide reconditionnés ou de remplacement.
11. Procédé selon l'une quelconque des revendications 1 à 10, dans lequel le couplage, à l'aide du premier élément de fixation, de la première extrémité de l'arbre au boîtier, empêche en outre ou s'oppose au mouvement axial et/ou rotatif de l'arbre par rapport au boîtier.
12. Procédé selon l'une quelconque des revendications 1 à 11, dans lequel l'arbre est retenu dans une orientation sensiblement horizontale.
13. Procédé selon l'une quelconque des revendications 1 à 12, comprenant en outre les étapes consistant à :
- coupler, à l'aide d'un troisième élément de fixation, une seconde extrémité de l'arbre au boîtier pour empêcher ainsi ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins une direction radiale, la seconde extrémité de l'arbre étant opposée à la première extrémité ; et
- après quoi, faire coulisser un autre composant le long de l'arbre dans une direction le long de l'arbre, du boîtier vers la seconde extrémité de l'arbre, éloignant ainsi le boîtier et le composant.
14. Procédé selon la revendication 13, dans lequel les étapes consistant à coupler la seconde extrémité de l'arbre au boîtier et à faire coulisser l'autre composant le long de l'arbre vers la seconde extrémité de l'arbre se chevauchent temporairement au moins en partie, avec les étapes consistant à coupler la première extrémité de l'arbre au boîtier et à faire coulisser le composant le long de l'arbre vers la première extrémité de l'arbre.
15. Système comprenant :
- une pompe à anneau liquide comprenant :
- un boîtier définissant une chambre annulaire ;
- un arbre couplé au boîtier et passant par le boîtier dans la chambre ; et
- un composant disposé autour de l'arbre et couplé entre l'arbre et le boîtier et configuré pour empêcher ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins une direction radiale ; et
- le système étant **caractérisé par** :
- un élément de fixation configuré pour coupler ensemble une première extrémité de l'arbre et le boîtier pour empêcher ainsi ou s'opposer au mouvement de l'arbre par rapport au boîtier dans au moins la direction radiale.

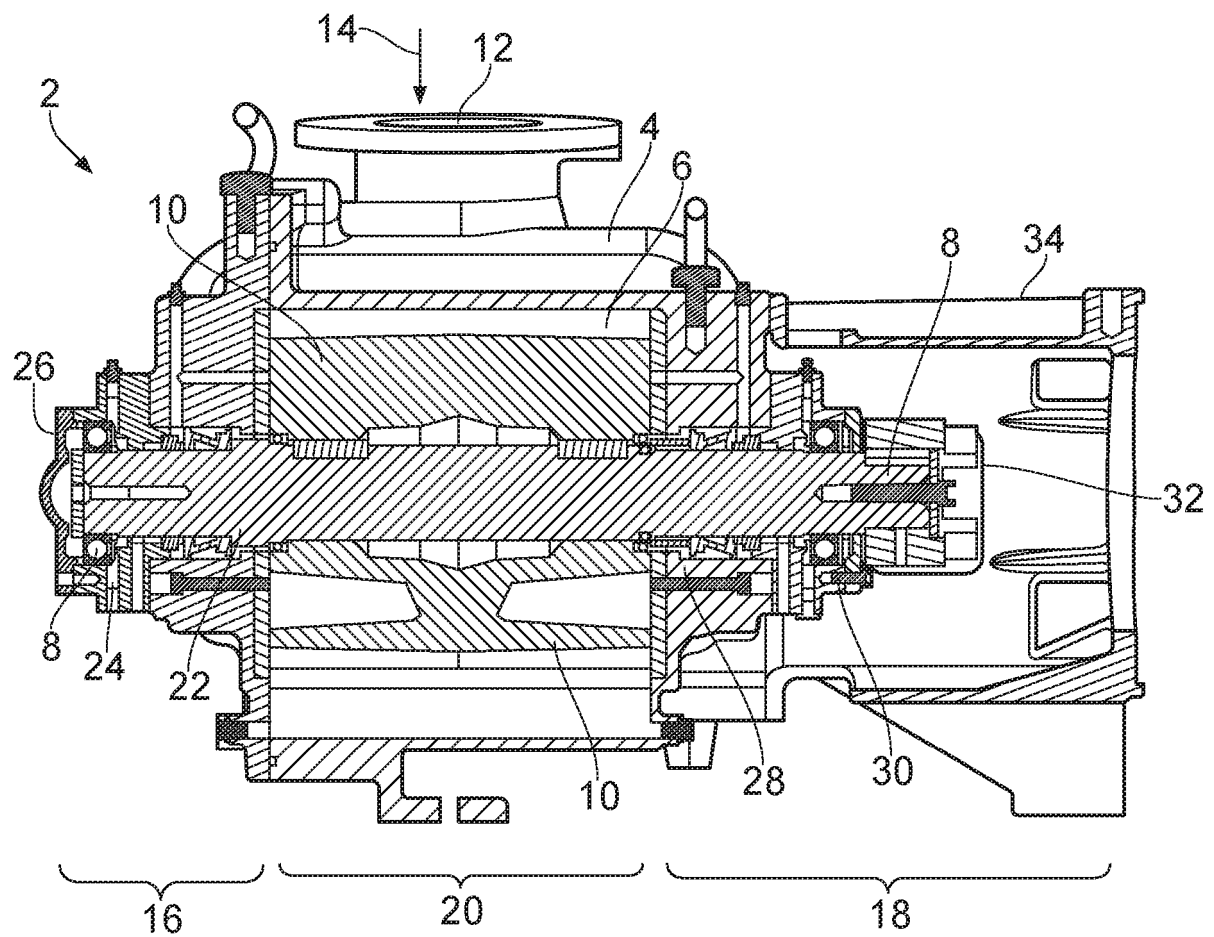


FIG. 1

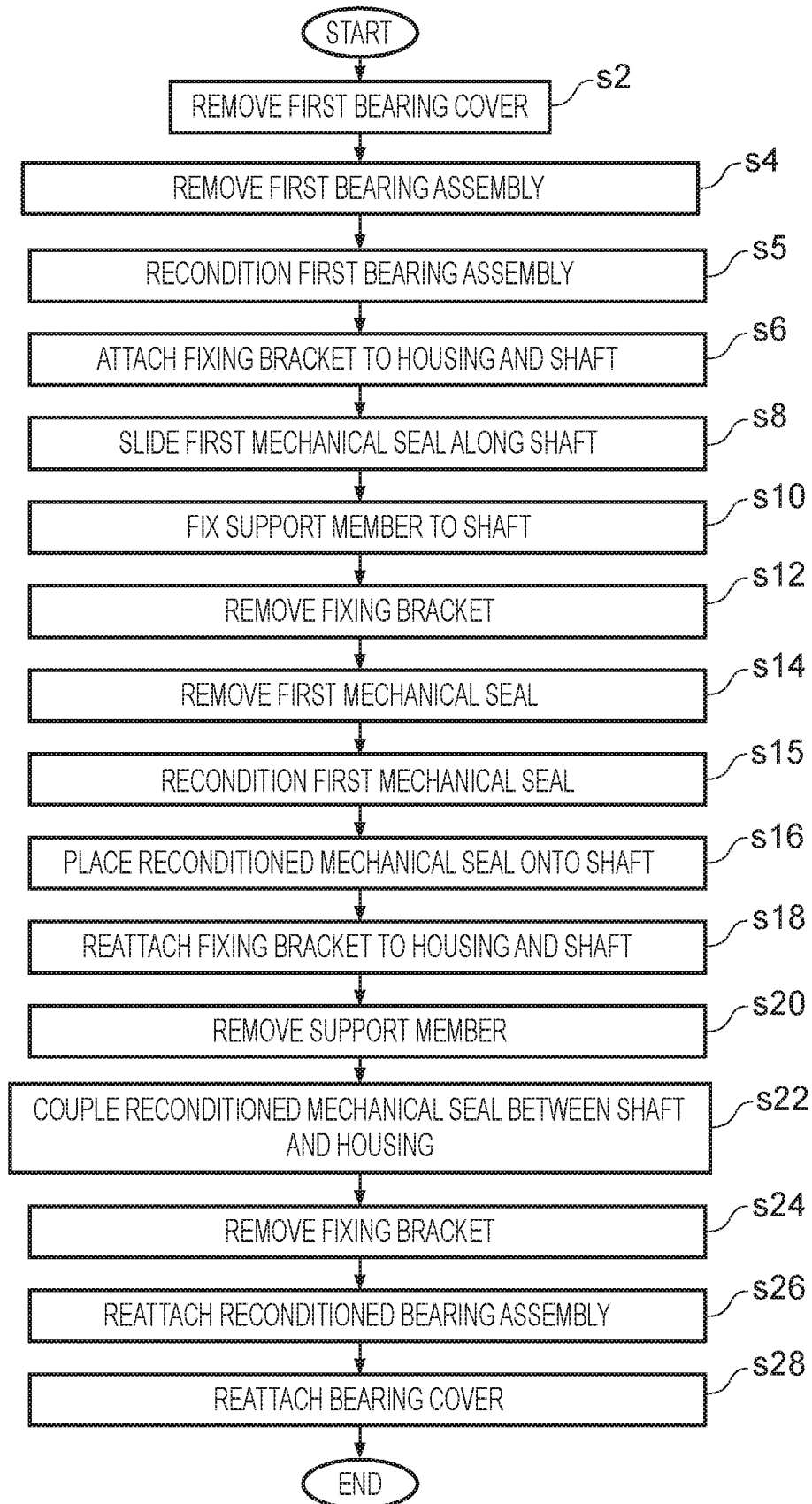


FIG. 2

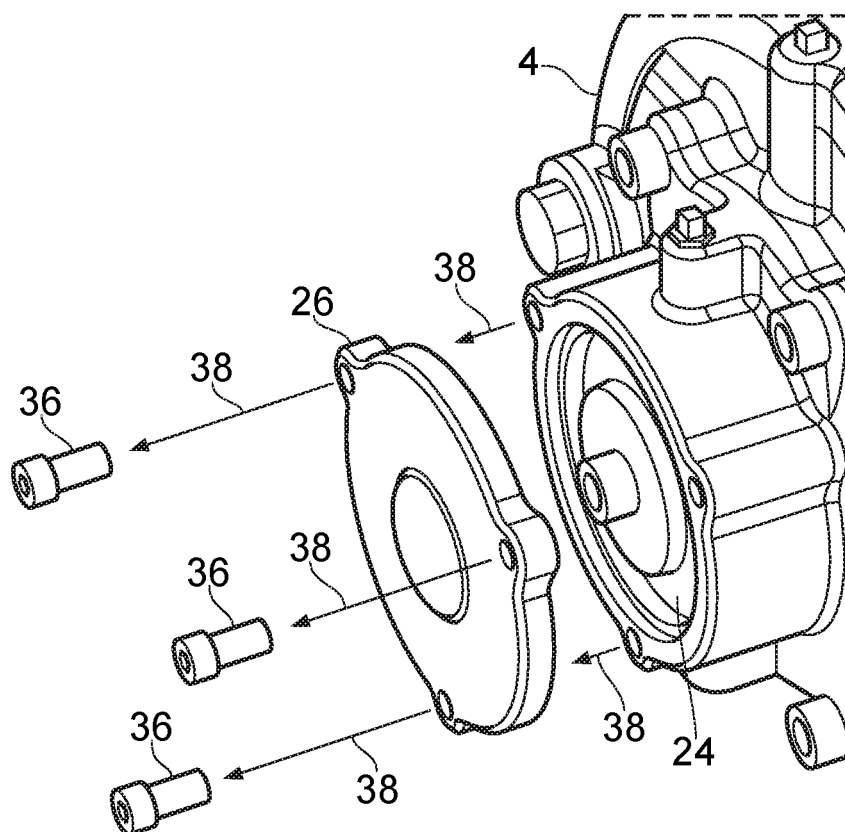


FIG. 3

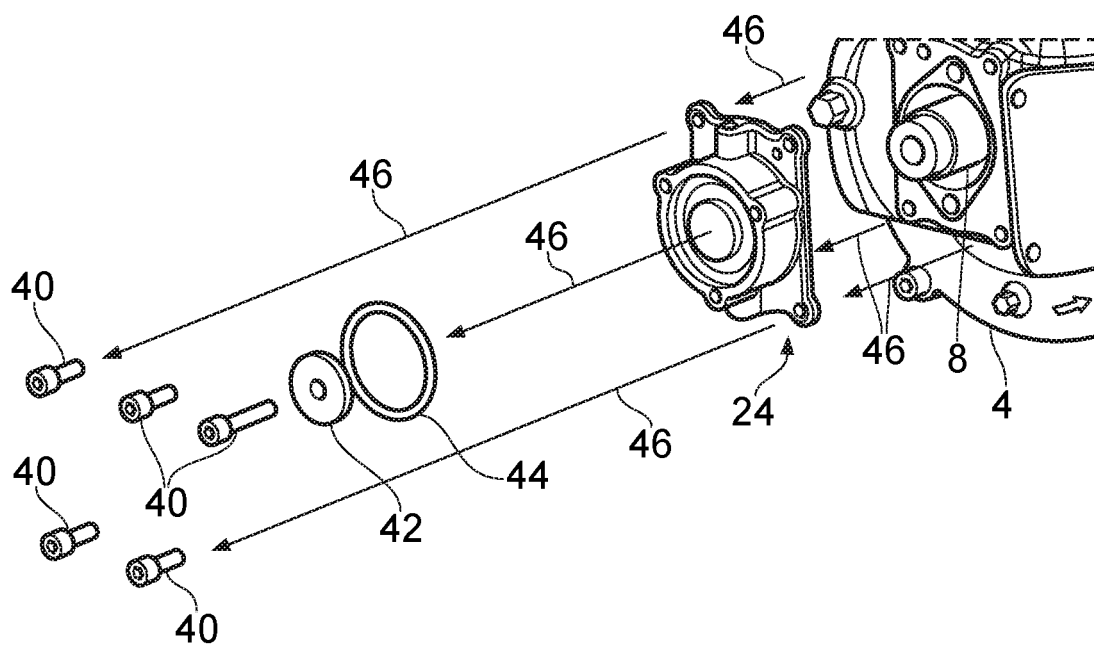


FIG. 4

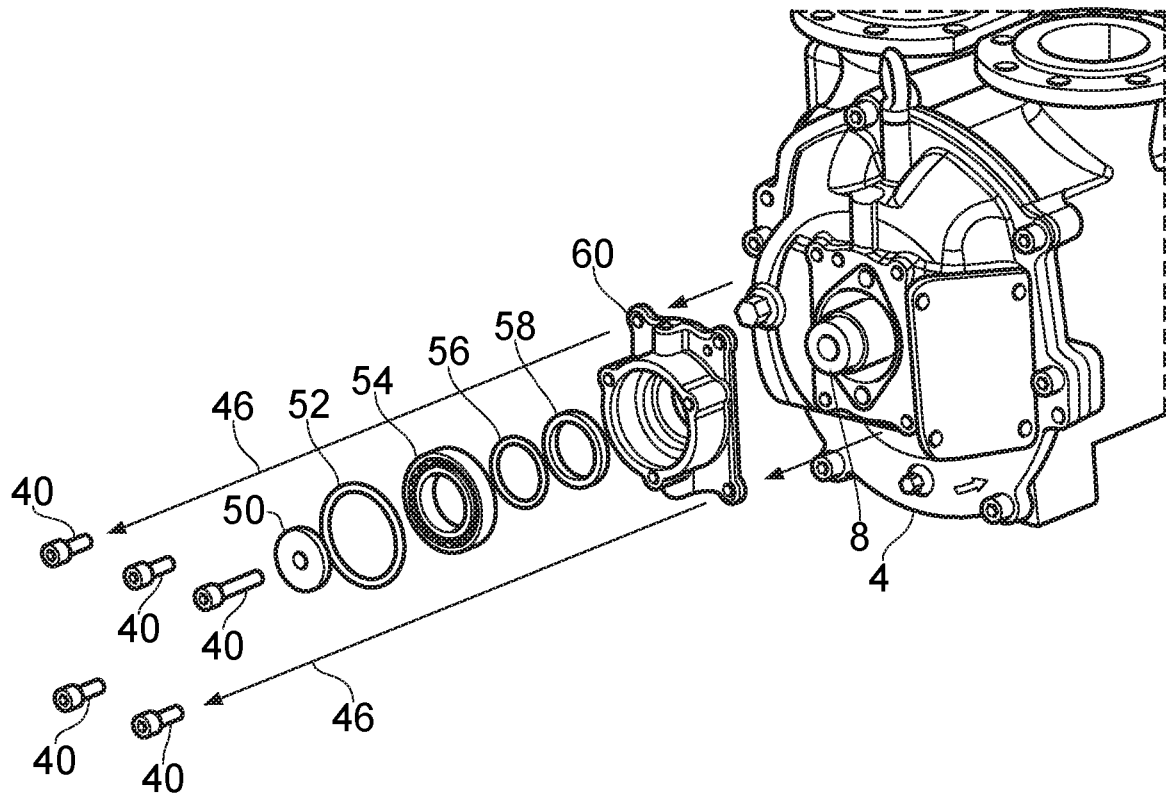


FIG. 5

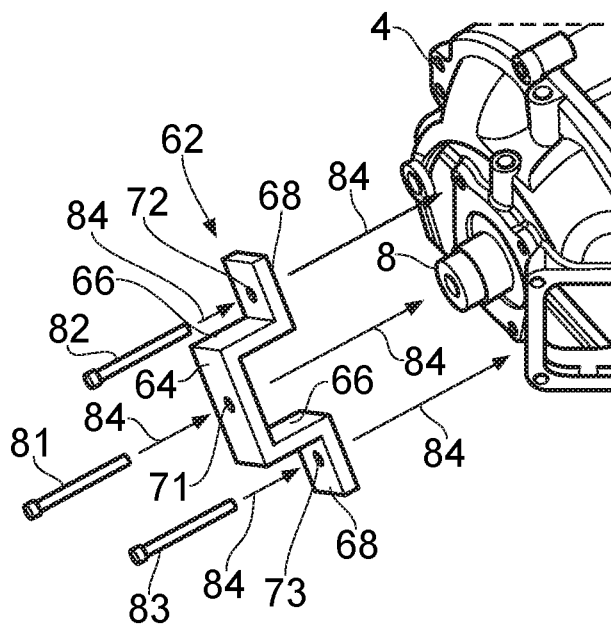


FIG. 6

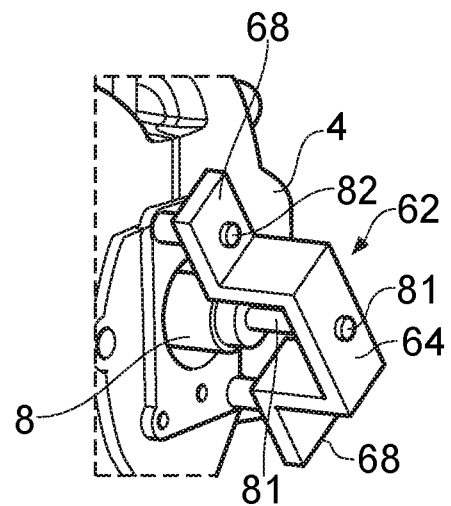


FIG. 7

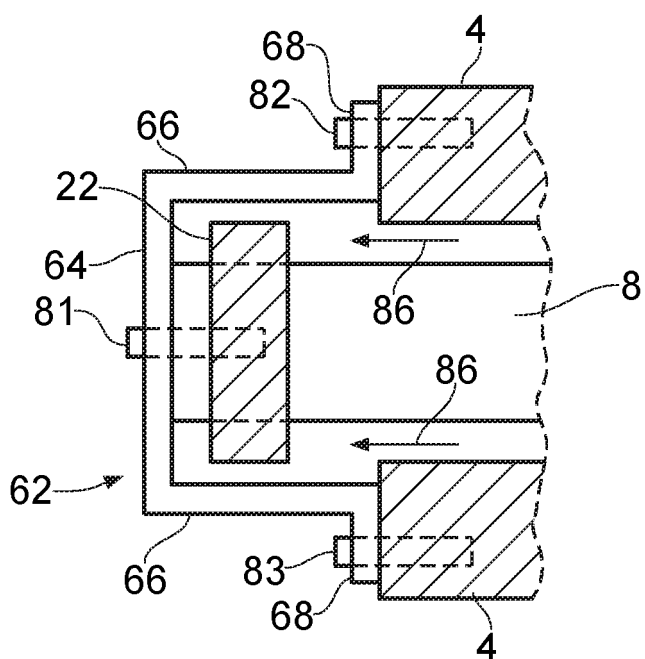


FIG. 8

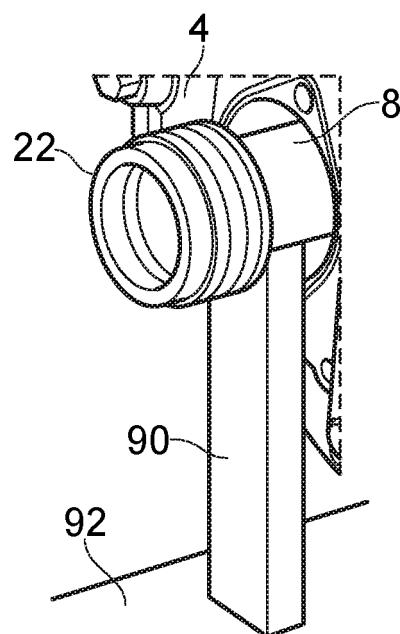


FIG. 9

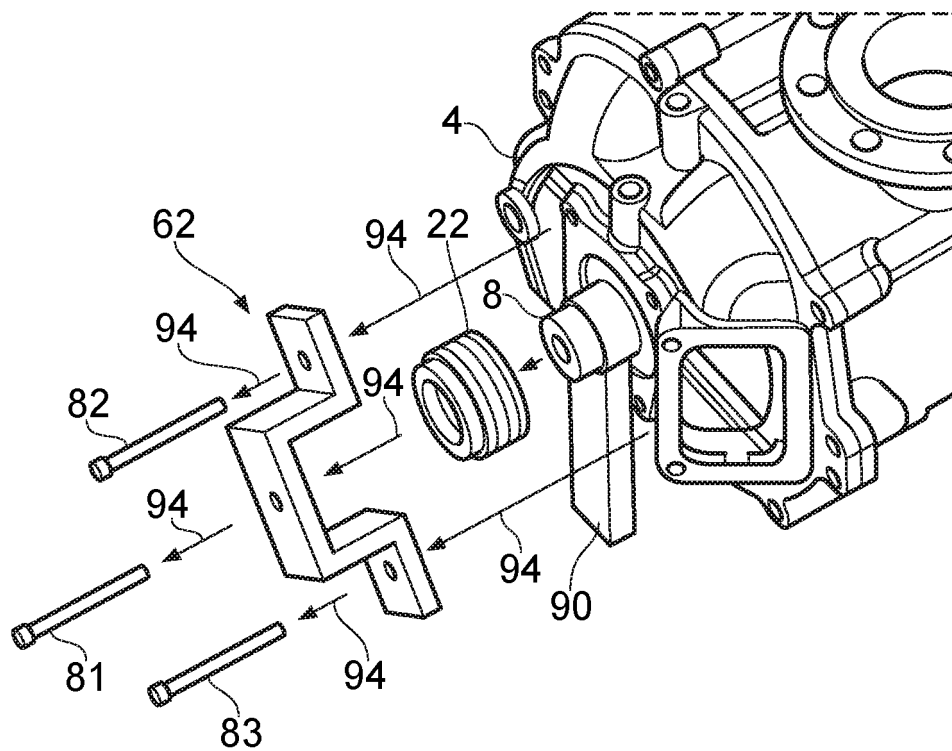


FIG. 10

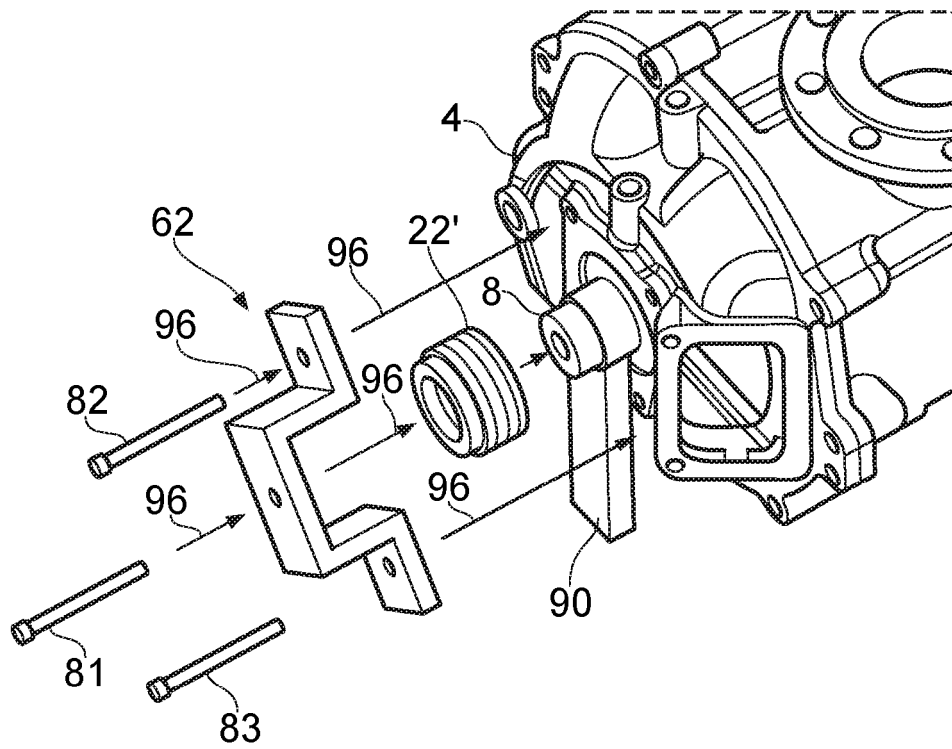


FIG. 11

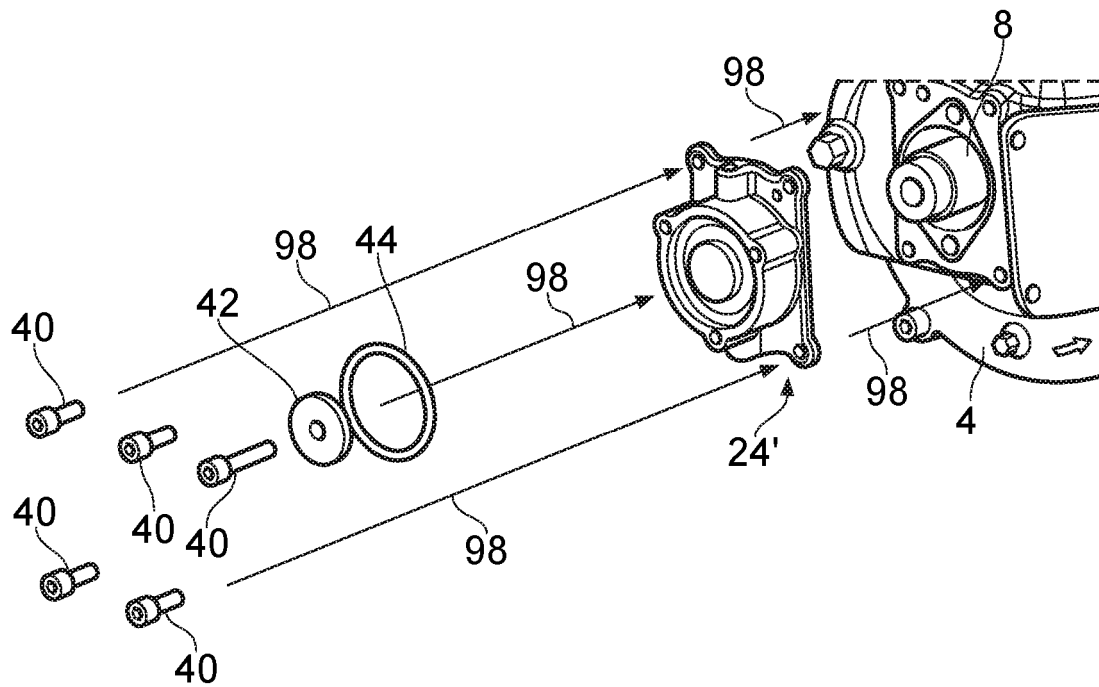


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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