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(71) Applicant: **Sulzer Management AG**
8401 Winterthur (CH)

(72) Inventors:
- **Welschinger, Thomas**
  78315 Radolfzell (DE)
- **Luis, Antonio**
  3295-000 São Paulo (BR)

(74) Representative: **IPS Irsch AG**
Langfeldstrasse 88
8500 Frauenfeld (CH)

(54) **ROTARY PUMP FOR CONVEYING A FLUID**

(57) A rotary pump for conveying a fluid is proposed, comprising a pump housing (2) with an inlet (3) for receiving the fluid having a suction pressure (SP) , and an outlet (4) for discharging the fluid having a discharge pressure (DP), further comprising an impeller (5) for conveying the fluid from the inlet (3) to the outlet (4) and for pressurizing the fluid from the suction pressure (SP) such, that the fluid is discharged with the discharge pressure (DP), and a shaft (6) for rotating the impeller (5) about an axial direction (A), wherein the impeller (5) is configured as an overhung impeller (5), wherein a pressure chamber (15) is arranged upstream of the impeller (5) between the inlet (3) and the impeller (5), wherein the pressure chamber (15) is delimited by a stationary part (18) and a rotary part (16), wherein the stationary part (18) is configured to be stationary with respect to the pump housing (2), wherein the rotary part (16) is fixedly connected to the shaft (6), wherein the stationary part (18) and the rotary part (16) are configured to overlap with respect to the axial direction (A), such that a relief passage (19) is provided between the rotary part (16) and the stationary part (18), wherein the relief passage (19) extends from the pressure chamber (15) to a low pressure location (17), and wherein at least one balance line (30) is provided, which is configured for supplying the fluid having the discharge pressure (DP) to the pressure chamber (15).

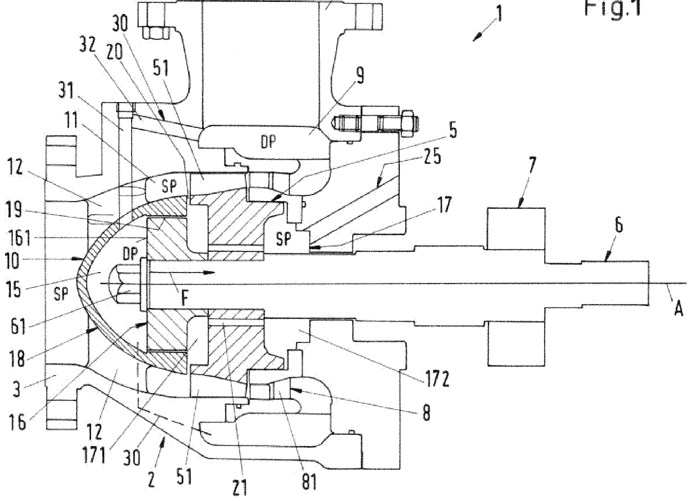

Fig.1

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Description

[0001] The invention relates to a rotary pump for conveying a fluid in accordance with the preamble of the independent patent claim.

[0002] Rotary pumps for conveying a fluid, for example a liquid such as water, are used in many different industries. Examples are the oil and gas industry, the hydrocarbon processing industry, the power generation industry, the chemical industry, the water and wastewater industry or the pulp and paper industry. Rotary pumps have a hydraulic unit comprising at least one impeller and in many cases a volute or a diffuser. A shaft is provided for rotating the impeller(s). The at least one impeller may be configured for example as a radial impeller or as an axial or semi-axial impeller or as a helico-axial impeller. A specific type of a rotary pump is a rotary pump with overhung impeller(s). In an overhung impeller pump the impeller(s) is/are mounted on or near the end of the shaft that rotates the impeller meaning that the shaft overhangs its bearings.

[0003] A rotary pump may be designed as a single stage pump having only one impeller mounted to the shaft or as a multistage pump comprising a plurality of impellers, wherein the impellers are arranged one after another on the shaft. In many applications overhung impeller pumps are designed as single stage pumps. However, in other applications the overhung impeller pump may be configured as a two stage pump with two impellers fixed at or near one end of the shaft.

[0004] Furthermore, multiphase pumps are known configured as single stage or as multistage pumps and both in a overhung design and a between-bearing design. Multiphase pumps are used in applications, where it is necessary to convey a multiphase process fluid which comprises a mixture of a plurality of phases, for example a liquid phase and a gaseous phase. An important example is the oil and gas processing industry where multiphase pumps are used for conveying hydrocarbon fluids, for example for extracting the crude oil from the oil field or for transportation of the oil/gas through pipelines or within refineries.

[0005] Fossil fuels are usually not present in pure form in oil fields or gas fields, but as a multiphase mixture which contains liquid components, gas components and possibly also solid components. This multiphase mixture of e.g. crude oil, natural gas, chemicals, seawater and sand has to be pumped from the oil field or gas field. For such a conveying of fossil fuels, multiphase pumps are used which are able to pump a liquid-gas mixture which may also contain solid components, sand for example.

[0006] In particular in overhung impeller pumps there is often a high axial thrust acting on the shaft which needs to be supported by an axial bearing, which is also referred to as a thrust bearing. This is specifically true for pumps having an axial or a semi-axial or a helico-axial impeller. The high axial load requires strong and large axial bearing, which are expensive. In some applications the axial thrust acting on the shaft is as large that it is no longer possible to use antifriction bearings as axial bearings. Then, more complicated and more expensive axial or thrust bearings are required, for example tilting pad bearings. These bearings require an additional lubrication system for the bearing, which increases the costs and the complexity of the pump.

[0007] It is therefore an object of the invention to propose a rotary pump for conveying a fluid, the pump having an overhung impeller, wherein the axial thrust that has to be carried by the axial bearing (thrust bearing) is considerably reduced.

[0008] The subject matter of the invention satisfying this object is characterized by the features of the independent claim.

[0009] Thus, according to the invention, a rotary pump for conveying a fluid is proposed, comprising a pump housing with an inlet for receiving the fluid having a suction pressure, and an outlet for discharging the fluid having a discharge pressure, further comprising an impeller for conveying the fluid from the inlet to the outlet and for pressurizing the fluid from the suction pressure such, that the fluid is discharged with the discharge pressure, and a shaft for rotating the impeller about an axial direction, wherein the impeller is configured as an overhung impeller, wherein a pressure chamber is arranged upstream of the impeller between the inlet and the impeller, wherein the pressure chamber is delimited by a stationary part and a rotary part, wherein the stationary part is configured to be stationary with respect to the pump housing, wherein the rotary part is fixedly connected to the shaft, wherein the stationary part and the rotary part are configured to overlap with respect to the axial direction, such that a relief passage is provided between the rotary part and the stationary part, wherein the relief passage extends from the pressure chamber to a low pressure location, and wherein at least one balance line is provided, which is configured for supplying the fluid having the discharge pressure to the pressure chamber.

[0010] The pressure chamber arranged between the inlet of the pump and the impeller of the pump together with the relief passage, through which the fluid may leak from the pressure chamber to the low pressure location works as a balancing device for at least partially balancing the axial thrust that is generated by the impeller(s) during operation of the pump. During operation the pressure chamber, which is arranged on the low pressure side of the impeller, is supplied with the pressurized fluid having the discharge pressure. The rotary part delimiting the pressure chamber at least partially balances the axial thrust that is generated by the rotating impeller. The rotary part is fixedly connected to the shaft of the pump in a torque proof manner. The rotary part defines a front side and a back side. The front side is the side facing and delimiting the pressure chamber. The back side is the side facing the low pressure location. The back side or the low pressure location is for example in fluid communication with the inlet, so that the suction pressure prevails at the low pressure location. During operation there is a leakage flow through the relief passage from the pressure chamber along the rotary part to the low pressure location. Due to the balance line the discharge pressure prevails in the pressure chamber, which is higher than the pressure prevailing at the low pressure location, e. g. suction pressure. The pressure difference between the pressure chamber and the low pressure location results in a axial force or an axial thrust which is directed in the opposite direction as the axial thrust generated by the rotating impeller(s). Thus, the axial thrust that has to be carried by the axial or thrust bearing is at least considerably reduced.

[0011] According to a preferred embodiment the low pressure location is connected to a suction pressure line, which is configured to adjust the pressure at the low pressure location to the suction pressure. As an example the suction pressure line may connect the low pressure location to the inlet. This is a simple measure to ensure that the suction pressure also prevails at the low pressure location.

[0012] Furthermore, it is preferred that the impeller is configured as an axial impeller or as a semi-axial impeller or as a helico-axial impeller. Since the axial thrust created by these types of impellers is considerably high, the invention is particularly suited for pumps having an axial, a helico-axial or a semi-axial impeller.

[0013] According to a preferred configuration the rotary pump comprises a discharge chamber for receiving the fluid from the impeller, wherein the discharge chamber is in fluid communication with the outlet, and wherein the balance line is connected to the discharge chamber. By means of the balance line it is achieved in quite a simple manner that during operation the discharge pressure prevails in the pressure chamber.

[0014] Furthermore, it is preferred that the rotary pump comprises a diffuser for receiving the fluid from the impeller. Viewed in the flow direction of the fluid, the diffuser is arranged downstream of the impeller, more particular between the impeller and the discharge chamber. As it is known in the art the static diffuser transforms kinetic energy (velocity) into pressure.

[0015] According to a particularly preferred embodiment the stationary part comprises a flow guiding element widening with respect to the radial direction, when viewed from the inlet, wherein the flow guiding element is configured to guide the fluid from the inlet to a annular suction chamber in front of the impeller.

[0016] Furthermore, it is preferred that the rotary pump comprises a plurality of ribs for fixing the flow guiding element to the pump housing, wherein each rib extends from the flow guiding element in radial direction to the pump housing. For example, the rotary pump comprises four ribs, which are equidistantly distributed along the circumference of the flow guiding element.

[0017] Regarding the embodiment having the flow guiding element being fixed to the pump housing by means of the ribs it is preferred that the at least one balance line is arranged inside one of the ribs, because this is quite a simple solution to connect the balance line to the pressure chamber.

[0018] Depending upon the amount of fluid that has to be supplied to the pressure chamber it might be advantageous that the rotary pump comprises a plurality of balance lines, wherein preferably each balance line is arranged inside one of the ribs. Of course it is also possible that more than one balance line is arranged in the same rib.

[0019] In some embodiments the rotary part is configured as a separate component, which is fixed to the shaft and arranged between the impeller and an end of the shaft. This separate rotary part, too, is configured in such a manner that it is delimiting the pressure chamber. The rotary part is connected to the shaft in a torque proof manner.

[0020] In other embodiments the rotary part is formed integrally with the impeller. In other words, the impeller is configured in such a manner the impeller also constitutes the rotary part delimiting the pressure chamber.

[0021] According to a preferred configuration, the low pressure location comprises an annular chamber which is arranged axially adjacent to the impeller on the side facing away from the inlet. In this configuration the impeller and the rotary part are arranged with respect to the axial direction between the pressure chamber and the annular chamber, so that an axial face of the rotary part delimits the pressure chamber and an axial face of the impeller delimits the annular chamber.

[0022] It is a further preferred measure that the impeller comprises a plurality of relief bores, with each relief bore extending completely through the impeller with respect to the axial direction. By means of the relief bores it is also possible to connect the low pressure location with the inlet, such that the suction pressure also prevails at the low pressure location. Said relief bores may be provided as an alternative to the suction pressure line. However, it is also possible that the rotary pump comprises both the suction pressure line and the relief bores in the impeller.

[0023] Preferably, each relief bore discharges into the low pressure location.

[0024] According to a preferred embodiment the rotary pump is configured for conveying a multiphase process fluid, for example a mixture of a liquid phase and a gaseous phase. The ratio of the gaseous phase in the multiphase process fluid is commonly described by the dimensionless gas volume fraction (GVF) designating the volume ratio of the gas in the multiphase process fluid. The rotary pump according to the invention may be configured for example to convey a multiphase process fluid having a GVF of up to 40% or even more.

[0025] For many applications it is preferred that the rotary pump is configured as a single stage pump having exactly one impeller. However, it is also possible to configure the rotary pump according to the invention as a multistage pump, e.g. as a two stage pump having two impellers arranged one after another on the shaft.

[0026] Further advantageous measures and embodiments of the invention will become apparent from the dependent claims.

[0027] The invention will be explained in more detail hereinafter with reference to embodiments of the invention and with reference to the drawings. There are shown in a schematic representation:

Fig. 1: a schematic cross-sectional view of a first embodiment of a rotary pump according to the invention,

Fig. 2: a perspective view of a helico-axial impeller,

Fig. 3: a cross-sectional view of a semi-axial impeller, and

Fig. 4: a schematic cross-sectional view of a second embodiment of a rotary pump according to the invention.

[0028] Fig. 1 shows a schematic cross-sectional view of a first embodiment of a rotary pump according to the invention, which is designated in its entity with reference numeral 1. The rotary pump 1 is designed as a single stage multiphase pump 1 for conveying a multiphase process fluid, for example a mixture of a liquid phase and a gaseous phase.

[0029] The rotary pump 1 comprises a pump housing 2 with an inlet 3 and an outlet 4. The inlet 3 is arranged on a suction side and receives the fluid having a suction pressure SP. The outlet 4 is arranged on a discharge side and discharges the fluid having a discharge pressure DP, wherein the discharge pressure DP is larger than the suction pressure SP. The pump 1 further comprises an impeller 5 having a plurality of blades 51 for conveying the fluid from the inlet 3 to the outlet 4 and for pressurizing the fluid from the suction pressure SP such that the fluid is discharged at the outlet 4 with the discharge pressure DP.

[0030] Since the first embodiment of the rotary pump 1 comprises only one impeller 5 the pump is configured as a single stage pump.

[0031] The impeller 5 is fixedly mounted in a torque proof manner to a shaft 6 for rotating the impeller 5 about an axial direction A. The axial direction A is defined by the rotation axis of the shaft 6. A direction perpendicular to the axial direction A is referred to as a radial direction.

[0032] A bearing unit 7 is provided for supporting the shaft 6 with respect to the axial direction A and with respect to the radial direction. The bearing unit 7 may comprise one or more radial bearing(s) (not shown) and an axial bearing (not shown). A radial bearing is also referred to as journal bearing, and an axial bearing is also referred to as a thrust bearing. The radial bearing(s) is/are supporting the shaft 6 with respect to the radial direction, and the axial bearing is supporting the pump shaft 5 with respect to the axial direction A. All bearings may be designed as antifriction bearings. Of course, it is also possible that at least one of the bearings is designed as another type of bearing, e.g. as a hydrodynamic bearing.

[0033] The impeller 5 is configured as a overhung impeller 5, meaning that the impeller 5 is mounted to the shaft 6 at or near an end 61 of the shaft 6. Thus, the shaft 6 that rotates the impeller 5 overhangs its bearings, which are arranged in the bearing unit 7.

[0034] The impeller 5 is configured as an axial impeller 5 and more particular, as a helico-axial impeller 5. This will be explained in more detail later on.

[0035] Downstream of the impeller 5 a stationary diffuser 8 is arranged having a plurality of stationary diffuser vanes 81 for guiding the fluid exiting the helico-axial impeller 5. The diffuser 8 is also configured as a helico-axial diffuser 8. As it is known in the art the diffuser 8 transforms kinetic energy of the fluid (velocity) into hydrostatic pressure. Downstream of the diffuser 8 the fluid is guided into an annular discharge chamber 9, which is arranged radially outwardly of the diffuser 8, and which surrounds the diffuser 8. The discharge chamber 9 is in fluid communication with the outlet 4 of the pump 1, so that the pressurized fluid may be discharged with the discharge pressure DP from the discharge chamber 9 through the outlet 4.

[0036] As already mentioned the impeller 5 of the first embodiment of the rotary pump 1 is preferably configured as an axial impeller 5 and more specifically as an helico-axial impeller 5. Helico-axial impellers 5 and helico-axial multiphase pumps 1 as such are known in the art. Fig. 2 shows a perspective view of the helico-axial impeller 5 and the stationary helico-axial diffuser 8 arranged downstream and adjacent to the impeller 5 with respect to the axial direction A. In Fig. 2 a part of the pump housing 2 has been removed to render visible the helico-axial impeller 5. The helico-axial impeller 5 has at least one, but usually the plurality of blades 51. Each blade 51 extends helically around a hub of the impeller 5 or the shaft 6, respectively.

[0037] The rotary pump 1 further comprises a flow guiding element 10, which is arranged in front of the impeller 5 between the inlet 3 and the impeller 5. The flow guiding element 10 has a generally cuplike shape and is preferably rotationally symmetric with respect to the axial direction A. When viewed from the inlet 3 towards the impeller 5 the flow guiding element 10 is widening with respect to the radial direction, so that the fluid entering the pump 1 through the inlet 3 in the axial direction A is smoothly guided by the flow guiding element 10 into an annular suction chamber 11, which is arranged directly in front of the impeller 5 with respect to the axial direction A. From the annular suction chamber 11 adjacent to the impeller 5 the fluid enters the impeller 5 in a generally axial direction A.

[0038] The flow guiding element 10 is arranged stationary with respect to the pump housing 2. Preferably, a plurality of ribs 12 is provided for fixing the flow guiding element 10 to the pump housing 2. Each rib 12 extends from the flow guiding element 10 in radial direction to the pump housing 2. Each rib 12 is fixed to the pump housing 2 with one of its ends and fixed to the flow guiding element 10 with the other of its ends. In the first embodiment of the rotary pump 1 there are four ribs 12 provided, which are equidistantly distributed along the circumference of the flow guiding element 10.

[0039] During operation of the rotary pump 1 the fluid having the suction pressure SP enters the pump 1 through the inlet 3 in the axial direction A and is then guided by the flow guiding element 10 to the annular suction chamber 11, which is arranged upstream and adjacent to the impeller 5. The impeller 5 with the blades 51 pressurizes the fluid and conveys the fluid to the diffuser 8. Downstream of the diffuser 8 the fluid is guided to the discharge chamber 9 and from there exits the rotary pump 1 through the outlet 4 with the discharge pressure DP.

[0040] According to the invention the rotary pump 1 further comprises a pressure chamber 15 which is arranged upstream of the impeller 5 between the inlet 3 and the impeller 5. Thus, the pressure chamber 15 is arranged at the suction side of the pump 1 or the impeller 5. During operation of the pump 1 the pressure chamber 15 is supplied with pressurized fluid having the discharge pressure DP. The fluid is allowed to leak from the pressure chamber 15 along a rotary part 16, which is fixedly connected to the shaft 6, in axial direction A to a low pressure location 17, where a low pressure prevails being smaller than the discharge pressure DP. The larger discharge pressure DP acting on an axial face 161 of the rotary part 16 in the pressure chamber 15 results in a force F acting on the shaft 6 in the axial direction A towards the low pressure location 17. Thus, the force F counteracts and at least partially balances the axial force generated by the rotating impeller 5. According to the representation in Fig. 1 the force F acts to the right, whereas the axial force generated by the impeller acts to the left.

[0041] In the first embodiment of the rotary pump 1 the pressure chamber 15 is delimited by a stationary part 18 and the rotary part 16, which is fixed to the shaft 6 in a torque proof manner. The rotary part 16 has the axial face 161 which delimits and faces the pressure chamber 15. The stationary part 18 is configured to be stationary with respect the pump housing 2. Preferably the stationary part 18 comprises the flow guiding element 10 or the stationary part 18 constitutes the flow guiding element 10.

[0042] As it can be seen in Fig. 1 the stationary part 18 and the rotary part 16 are configured to overlap with respect to the axial direction A, such that an annular relief passage 19 is formed between the rotary part 16 and the stationary part 18. With respect to the axial direction A the relief passage 19 extends from the pressure chamber 15 to the low pressure location 17. The relief passage 19 is also referred to as labyrinth. The relief passage 19, or the labyrinth, respectively, is arranged on the suction side of the impeller 5, i.e. upstream of the impeller 5 between the inlet 3 and the impeller 5 with respect to the axial direction A

[0043] Preferably, the pressure prevailing at the low pressure location 17 is the suction pressure SP.

[0044] In the first embodiment of the rotary pump 1, the rotary part 16 is configured as a separate component which is fixed to the shaft 6 and arranged with respect to the axial direction A between the impeller 5 and the end 61 of the shaft 6. The end 61 of the shaft 6 is located within the pressure chamber 15.

[0045] The low pressure location 17 comprises two annular chambers extending around the shaft 6, namely a first annular chamber 171 which is interposed between the rotary part 16 and the impeller 5 with respect to the axial direction A, and a second annular chamber 172 which is arranged axially adjacent to the impeller 5 on the side of the impeller 5 facing away from the inlet 3. This means, with respect to the axial direction A the impeller 5 is interposed between the first annular chamber 171 and the second annular chamber 172. The first annular chamber 171 is in fluid communication with the annular suction chamber 11 by means of an annular gap 20 arranged between the stationary part 18 and the impeller 5 with respect to the axial direction A. The annular gap 20 ensures that the suction pressure SP prevails in the first annular chamber 171. The relief passage 19 extends from the pressure chamber 15 to the first annular chamber 171 of the low pressure location 17.

[0046] Between the impeller 5, which is rotating during operation, and the stationary diffuser 8 a further labyrinth (annular gap) is provided, through which a part of the fluid pressurized by the impeller 5 leaks into the second annular chamber 172 of the low pressure location 17, where the suction pressure SP prevails.

[0047] The impeller 5 comprises a plurality of relief bores 21, wherein each relief bore 21 extends completely through the impeller 5 with respect to the axial direction. Preferably, each relief bore 21 extends parallel to the pump shaft 6. In the first embodiment of the rotary pump 1 each relief bore 21 connects the first annular chamber 171 with the second annular chamber 172. Thus, the relief bores 21 ensure that the suction pressure SP also prevails in the second annular chamber 172.

[0048] As an additional optional measure or as an alternative to the relief bores 21 it is also possible to connect the low pressure location 17 to a suction pressure line 25, which is configured to adjust the pressure at the low pressure location 17 to the suction pressure SP. As an example the suction pressure line 25 may connect the second annular chamber 172 of the low pressure location 17 to the inlet 3 or any other location, where the suction pressure SP prevails.

[0049] For supplying the pressurized fluid having the discharge pressure DP to the pressure chamber 15 at least one balance line 30 is provided. Preferably, the at least one balance line 30 is connected to the discharge chamber 9 and extends from there to the pressure chamber 15, so that the pressurized fluid having the discharge pressure DP may flow from the discharge chamber 9 through the balance line 30 into the pressure chamber 15. Basically, there are many possible embodiments for the balance line 30. For example, each fluid communication between the discharge chamber 9 or the outlet 4 and the pressure chamber 15 may constitute the balance line 30.

[0050] In the first embodiment of the rotary pump 1 the at least one balance line 30 is arranged inside one of the ribs 12 fixing the flow guiding element 10 to the pump housing 2. The balance line 30 may comprise a first bore 31 extending in radial direction through one of the ribs 12 into the pressure chamber 15, and a second bore 32 connecting the first bore 31 with the discharge chamber 9. During operation of the pump 1 the pressurized fluid having the discharge pressure DP flows from the discharge chamber 9 through the second bore 32 and the first bore 31 into the pressure chamber 15. From the pressure chamber 15 the fluids flows through the annular relief passage 19 to the first annular chamber 171 of the low pressure location 17 where the suction pressure SP prevails. Consequently, there is a pressure drop over the relief passage 19 from the discharge pressure DP prevailing in the pressure chamber 15 to the suction pressure SP prevailing in the low pressure location 17, more particular in the first annular chamber 171. The difference of the discharge pressure DP times the axial face 161 exposed to the discharge pressure DP on the one side and the suction pressure SP times the face of the rotary part 16 delimiting the first annular chamber 171 and exposed to the suction pressure SP on the other side generates the force F, which at least decreases the axial thrust that has to be carried by the axial bearing for the shaft 6.

[0051] Depending on the flow of fluid, which is required to maintain the discharge pressure DP in the pressure chamber 15 it might be advantageous to provide more than one balance line 30, each of which supplies the pressurized fluid to the pressure chamber 15. For example, in the first embodiment of the rotary pump 1 in each of the ribs 12 a balance line 30 may be provided as it is indicated by the dashed line with the reference numeral 30 in Fig. 1. Preferably, each balance line 30 is connected to the discharge chamber 9. In other embodiments there may be at least one rib 12, in which more than one balance line is provided. In still other embodiments there is at least one rib 12, in which a balance line is arranged and at least one rib 12, in which no balance line is arranged.

[0052] The single stage rotary pump 1 shown in Fig. 1 is designed as a horizontal pump, meaning that during operation the shaft 6 is extending horizontally, i.e. the axial direction A is perpendicular to the direction of gravity. In particular, the rotary pump 1 shown in Fig. 1 may be designed for example, as a pump 1 of the pump type OH2 according to API 610.

[0053] It has to be understood that the invention is not restricted to this type of rotary pump 1. In other embodiments, the rotary pump may be configured as a multistage pump, in particular as a two stage pump having two overhung impellers. Furthermore, the rotary pump according to the invention may also be configured as a single phase pump for conveying a single phase fluid, in particular a liquid.

[0054] In a variant of the first embodiment of the rotary pump 1 the impeller 5 is configured as a semi-axial impeller 5. Semi-axial impellers are sometimes also referred to as mixed flow impellers. Fig. 3 shows a cross-sectional view of an semi-axial impeller 5. The semi axial impeller 5 comprises a hub 52 and a plurality of blades 51 arranged on the hub 52. The fluid flows towards the impeller 5 in the axial direction A. The inflow of the fluid is indicated by the arrow with the reference numeral I. The hub 52 and the blades 51 are configured such that the fluid exits the impeller 5 in a direction, which is between the axial direction A and the radial direction. The direction, in which the fluid exits the impeller 5 is indicated by the arrow with the reference numeral O. As can be seen the angle between the arrow O and the axial direction A is larger than zero and smaller than 90°, e.g. approximately 45°. The semi-axial impeller 5 similar to the helico-axial impeller 5 is also suited to handle multiphase process fluids, so that the semi-axial impeller 5 efficiently conveys the fluid even if the fluid contains a gaseous phase. In Fig. 3 only the impeller 5 is shown. The other components, for example the flow guiding element 10 are not shown and may be configured in an analogous manner as it has been described with respect to Fig. 1.

[0055] Fig. 4 shows a schematic cross-sectional view of a second embodiment of a rotary pump 1 according to the invention.

[0056] In the following description of the second embodiment of the rotary pump 1 only the differences to the first embodiment are explained in more detail. The explanations with respect to the first embodiment and its variant are also valid in the same way or in analogously the same way for the second embodiment. Same reference numerals designate the same features that have been explained with reference to the first embodiment or functionally equivalent features.

[0057] Compared to the first embodiment, it is the main difference, that in the second embodiment of the rotary pump 1 the rotary part 16 is formed integrally with the impeller 5. In other words the impeller 5 is configured to also constitute the rotary part 16 delimiting the pressure chamber 15. Since the impeller 5 and the rotary part 16 are integrally formed as a single component the relief bores 21 are arranged more outwardly with respect to the radial direction and compared to the first embodiment The relief bores 21 are arranged with a distance in the radial direction from the rotation axis of the shaft 6 which is at least as large as the distance of the relief passage 19 from the rotation axis of the shaft. Furthermore, the first annular chamber 171 of the low pressure location 17 is arranged between the stationary part 18 and the impeller 5. In the second embodiment, too, the first annular chamber is in fluid communication with the annular suction chamber 11 by means of the annular gap 20.

Claims

1. A rotary pump for conveying a fluid, comprising a pump housing (2) with an inlet (3) for receiving the fluid having a suction pressure (SP), and an outlet (4) for discharging the fluid having a discharge pressure (DP), further comprising an impeller (5) for conveying the fluid from the inlet (3) to the outlet (4) and for pressurizing the fluid from the suction pressure (SP) such, that the fluid is discharged with the discharge pressure (DP), and a shaft (6) for rotating the impeller (5) about an axial direction (A), wherein the impeller (5) is configured as an overhung impeller (5), **characterized in that** a pressure chamber (15) is arranged upstream of the impeller (5) between the inlet (3) and the impeller (5), wherein the pressure chamber (15) is delimited by a stationary part (18) and a rotary part (16), wherein the stationary part (18) is configured to be stationary with respect to the pump housing (2), wherein the rotary part (16) is fixedly connected to the shaft (6), wherein the stationary part (18) and the rotary part (16) are configured to overlap with respect to the axial direction (A), such that a relief passage (19) is provided between the rotary part (16) and the stationary part (18), wherein the relief passage (19) extends from the pressure chamber (15) to a low pressure location (17), and wherein at least one balance line (30) is provided, which is configured for supplying the fluid having the discharge pressure (DP) to the pressure chamber (15).

2. A rotary pump in accordance with claim 1, wherein the low pressure location (17) is connected to a suction pressure line (25), which is configured to adjust the pressure at the low pressure location (17) to the suction pressure (SP).

3. A rotary pump in accordance with anyone of the preceding claims, wherein the impeller (5) is configured as an axial impeller or as a semi-axial impeller or as a helico-axial impeller.

4. A rotary pump in accordance with anyone of the preceding claims, comprising a discharge chamber (9) for receiving the fluid from the impeller (5), wherein the discharge chamber (9) is in fluid communication with the outlet (4), and wherein the balance line (30) is connected to the discharge chamber (9).

5. A rotary pump in accordance with anyone of the preceding claims, comprising a diffuser (8) for receiving the fluid from the impeller (5).

6. A rotary pump in accordance with anyone of the preceding claims, wherein the stationary part (18) comprises a flow guiding element (10) widening with respect to the radial direction, when viewed from the inlet (3), wherein the flow guiding element (10) is configured to guide the fluid from the inlet (3) to a annular suction chamber (11) in front of the impeller (5).

7. A rotary pump in accordance with claim 6, comprising a plurality of ribs (12) for fixing the flow guiding element (10) to the pump housing (2), wherein each rib (12) extends from the flow guiding element (10) in radial direction to the pump housing (2).

8. A rotary pump in accordance with claim 7, wherein the at least one balance line (30) is arranged inside one of the ribs (12).

9. A rotary pump in accordance with anyone of claims 7-8, comprising a plurality of balance lines (30), wherein each balance line (30) is arranged inside one of the ribs (12).

10. A rotary pump in accordance with anyone of the preceding claims, wherein the rotary part (16) is configured as a separate component, which is fixed to the shaft (6) and arranged between the impeller (5) and an end (61) of the shaft (6).

11. A rotary pump in accordance with anyone of claims 1-9 wherein the rotary part (16) is formed integrally with the impeller (5).

12. A rotary pump in accordance anyone of the preceding claims, wherein the impeller (5) comprises a plurality of relief bores (21), with each relief bore (21) extending completely through the impeller (5) with respect to the axial direction (A).

13. A rotary pump in accordance with claim 12, wherein each relief bore (21) discharges into the low pressure location (17).

14. A rotary pump in accordance with anyone of the preceding claims, configured for conveying a multiphase process fluid.

15. A rotary pump in accordance with anyone of the preceding claims, configured as a single stage pump having exactly one impeller (5).

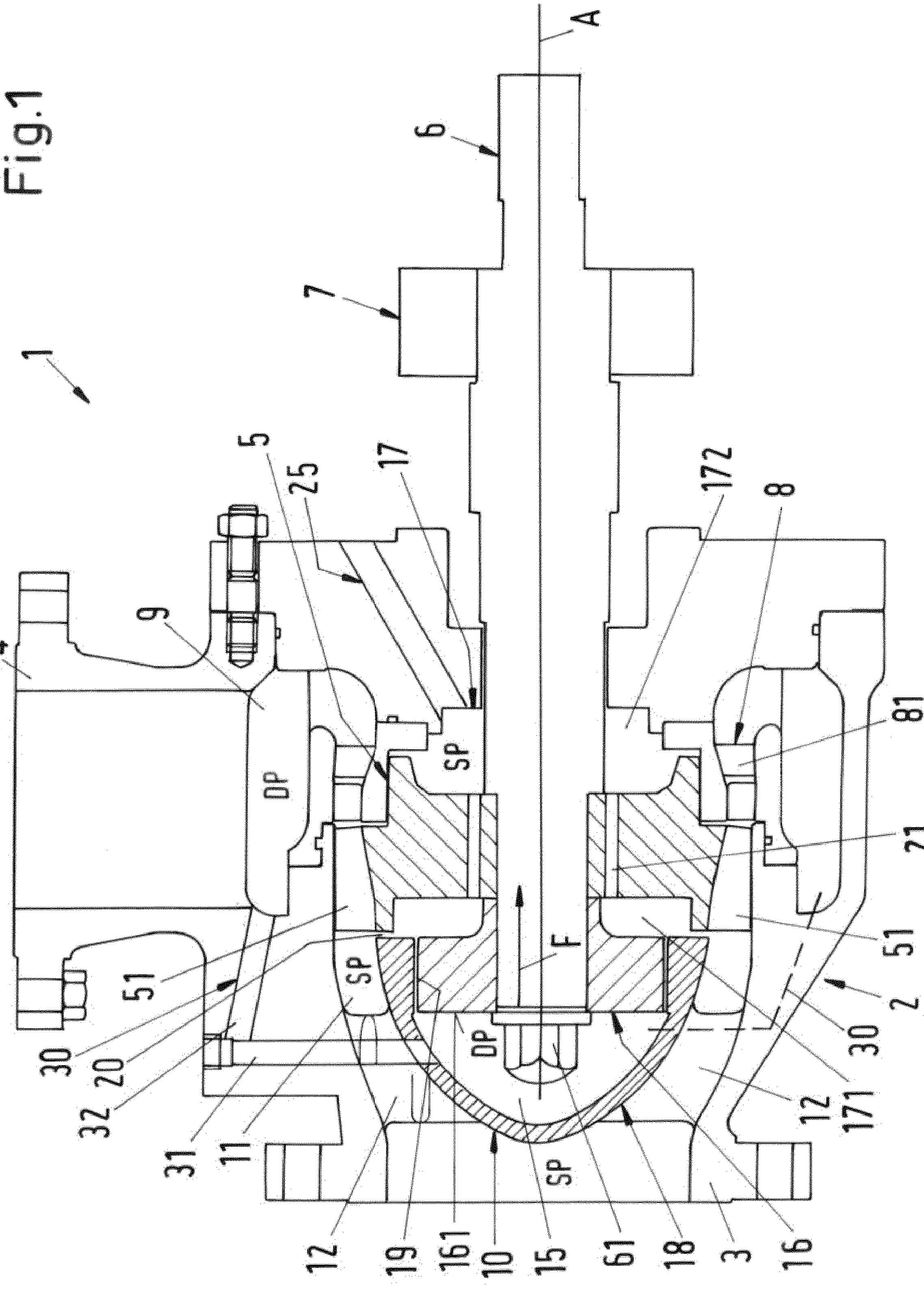
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Fig.1

Fig.2

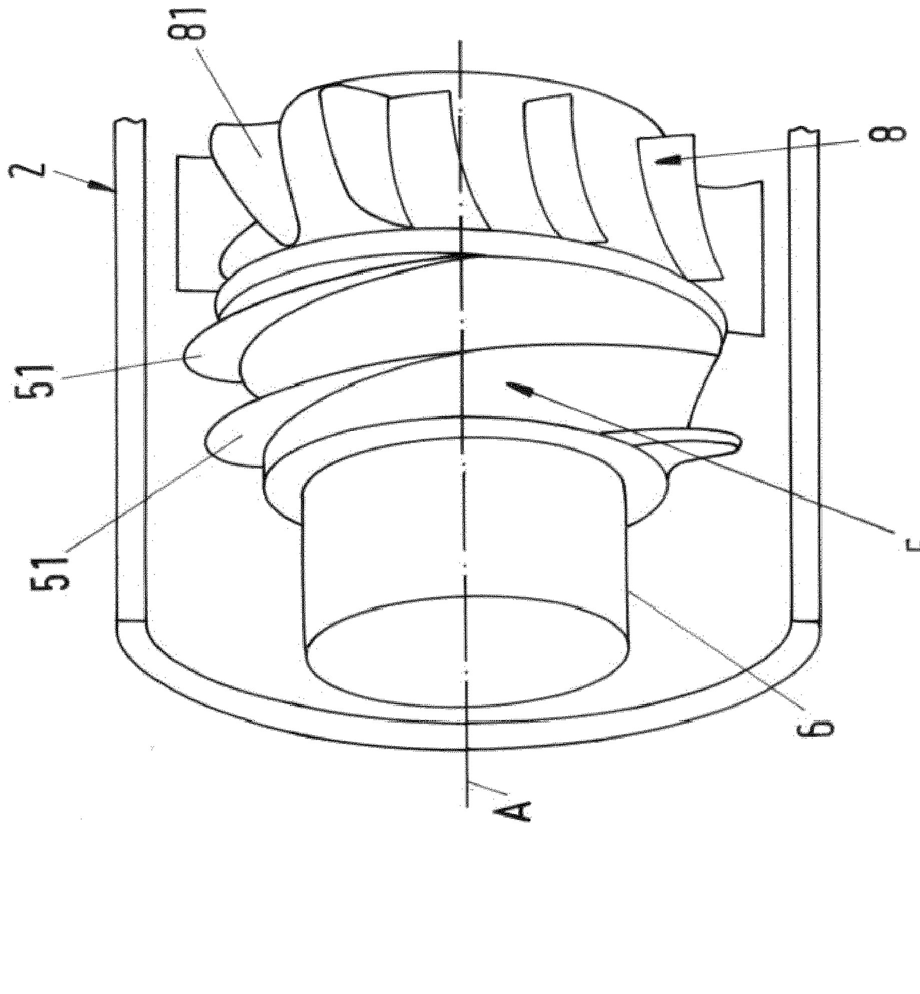
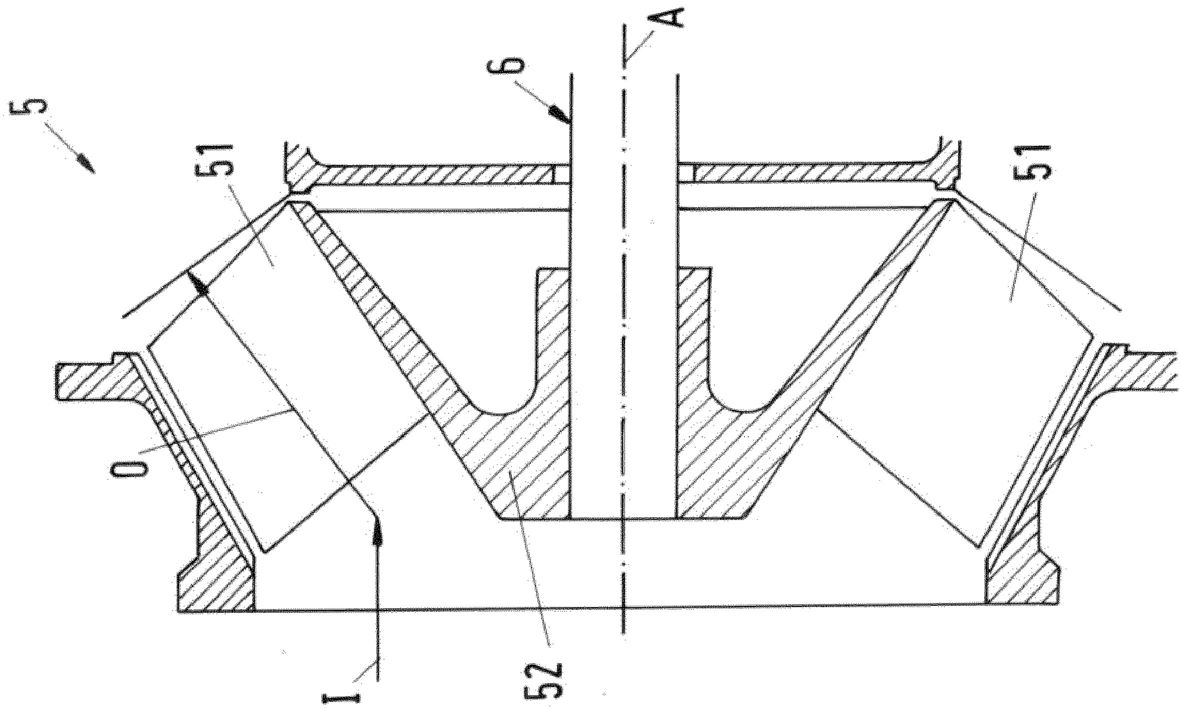


Fig.3



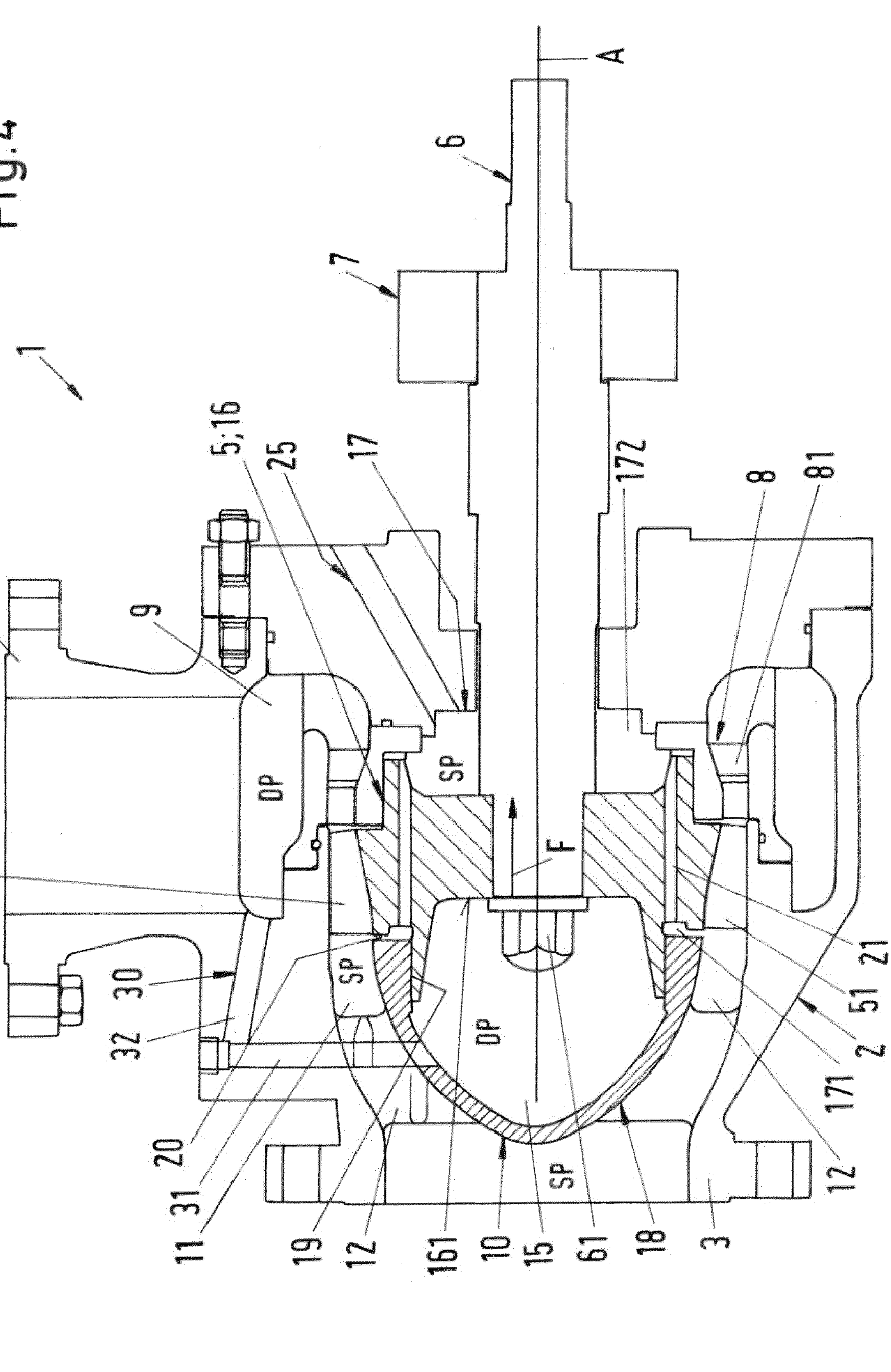

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Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 3843

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Place of search	Date of completion of the search	Examiner
The Hague	9 March 2022	Oliveira, Damien

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