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(54) **A submerged pump having a bearing lubricated by discharged fluid**

(57) A target fluid discharged from a pump (12) is partially diverted, by a lead-in duct (58), into a housing chamber (49) including a motor (32) therein. A top bearing (50) supporting a motor shaft (36) is placed in the lead-in duct (58), and lubricated by the target fluid flowing through the lead-in duct (58). A top seal (60) is installed downstream from the top bearing (50) in the lead-in duct (58). The top seal (60) has a slight gap from the motor shaft (36) to form a throttle structure which increases a flow resistance. The throttle structure maintains a pressure in an area near the top bearing (50), to thereby suppress presence of gases.

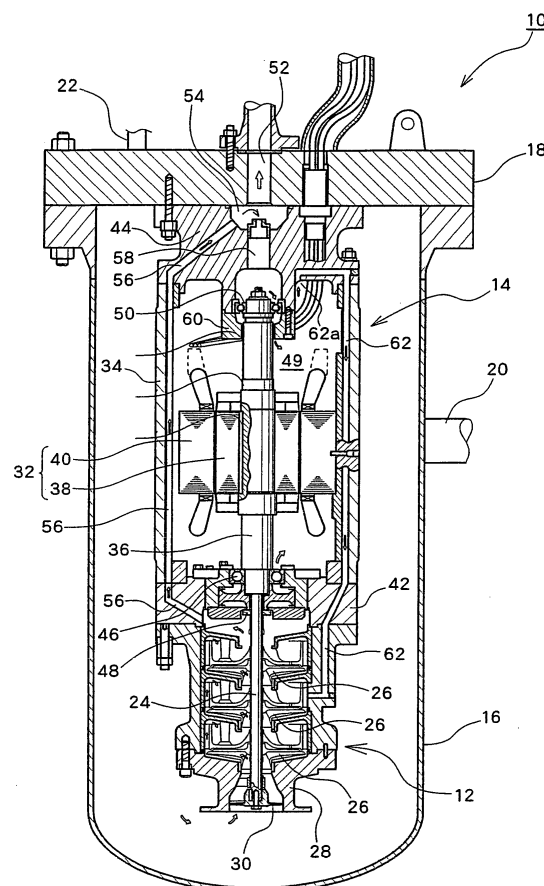


Fig. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The entire disclosure of Japanese Patent Application No. 2003-338540 including specification, claims, drawings and abstract is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a submerged pump integrally configured by a pump and a motor to drive the pump, and soaked in a reserved target fluid, for use in pumping up the target fluid.

Description of the Related Art

[0003] To pump up liquefied natural gas (LNG), liquefied petroleum gas, or the like, there has been utilized a submerged pump in which a pump, such as a centrifugal pump, and a motor for driving the pump are integrated into one unit. Such a submerged pump is used in a state that it is entirely immersed in the target fluid to be pumped by the pump itself. The submerged pump is therefore so configured so as to allow entry of the target fluid into regions around a stator and a rotor of the motor and around bearings for shafts of the motor and the pump in order to utilize the target fluid for cooling, lubrication, or the like.

[0004] In one example pump, a target fluid discharged by a pump is conveyed to a bearing located at an upper end of a shaft to lubricate the bearing. Such a pump is described in Japanese Utility Model Application No. Hei 5-26949 (Japanese Utility Model Laid-Open Publication No. Hei 6-80896).

[0005] However, in such submerged pump, when the target fluid contains a easily vaporizable constituent, it is not uncommon for the bearing to be lubricated insufficiently due to vaporization of the constituent in the vicinity of the bearing, leading to malfunction of, or trouble in, the submerged pump.

SUMMARY OF THE INVENTION

[0006] This invention provides a submerged pump in which a bearing is advantageously protected against insufficient lubrication.

[0007] A submerged pump according to the present invention comprises a lead-in duct through which a target fluid discharged from a pump is partially directed to flow through a bearing supporting a shaft of a motor almost at an upper end of the shaft and then conveyed into a housing in which the motor is installed, and a throttle structure installed downstream from the bearing in the lead-in duct.

[0008] Further, in the submerged pump, an entrance of a reflux channel for returning, to a pump unit, the target fluid existing in the housing in which the motor is installed is disposed at a place situated higher than the bearing located near the upper end of the motor shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 schematically shows a configuration of a submerged pump 10 according to an embodiment; Fig. 2 shows a detailed structure near an upper end of a motor shaft in the submerged pump 10; and Fig. 3 shows another detailed structure near the upper end of the motor shaft in the submerged pump.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring now to drawings, a preferred embodiment of this invention will be described below. Fig. 1 schematically shows a configuration of a submerged pump 10 according to this embodiment. The submerged pump 10 has a structure in which a pump unit 12 including a pump for boosting a pressure of a target fluid to be pumped up and a motor unit 14 for driving the pump are contained in a pot 16. An opening at the top of the pot 16 is covered by a head plate 18. The target fluid is introduced from an intake pipe 20 into the pot 16, while gases are removed through a degassing pipe 22 to enable the pot 16 to fill with the target fluid. The submerged pump 10 should be placed in the same vertical position as illustrated in Fig. 1 in actual use. In other words, the submerged pump 10 is placed so that the pump unit 12 will be located below the motor unit 14.

[0011] The pump unit 12 includes a multistage centrifugal pump in which a plurality of centrifugal pumps 26 are arranged on a common pump shaft 24. A lower part of the multistage centrifugal pump, more specifically, a suction port of the centrifugal pump 26 on the first stage is attached to a suction pipe 28 which includes, in the inside thereof, a inducer 30 mounted to the pump shaft 24 and actuated with the pump shaft 24.

[0012] The motor unit 14 located above the pump unit 12 includes an electric motor 32 for driving the multiphase centrifugal pump and a housing cylinder 34 placed so as to enclose the motor 32. The motor 32 comprises a motor shaft 36 shared as the pump shaft 24, a rotor 38 fixed to the motor shaft 36, and a stator 40 fixed on the housing cylinder 34. The bottom of the housing cylinder 34 is joined to an attachment plate 42, and the pump unit 12 is also joined to the attachment plate 42 to be integral with the motor unit 14. The top of the housing cylinder 34, on the other hand, is connected to a discharge manifold 44. Thus, the housing cylinder 34, the attachment plate 42, and the discharge manifold 44 constitute a housing in which the motor 32 is installed.

[0013] The target fluid is pressurized in the pump unit

12. The attachment plate 42 holds a bottom bearing 46 which is a rolling bearing rotatably supporting the motor shaft 36, and includes a bottom seal 48 for suppressing the flow of pressurized target fluid into the motor unit 14. Because a small gap is present between bottom seal 48 and the pump shaft 24, a small amount of the target fluid enters a housing chamber 49, which is a space formed in the housing of the pump unit 12. This small amount of target fluid flows through the bottom bearing 46 while lubricating the bottom bearing 46. The discharge manifold 44 holds a top bearing 50 rotatably supporting the motor shaft 36 in the proximity of an upper end of the motor shaft 36. Further, in the discharge manifold 44, there is provided a discharge port 54 communicating with a discharge hole 52 formed in the head plate 18. The target fluid delivered from the multistage centrifugal pump is conveyed to the discharge port 54 through a discharge channel 56 running around components, such as, for example, the stator 40 of the motor unit 14, and then pumped to the outside.

[0014] The discharge manifold 44 comprises a lead-in duct 58 for diverting the target fluid from the discharge port 54 into the housing chamber 49. The top bearing 50 is installed in the lead-in duct 58, and a top seal 60 is installed downstream from the top bearing 50. These components associated with the lead-in duct 58 will be described below. An entrance 62a to a reflux channel 62 for returning the target fluid contained in the housing chamber 49 to the pump unit 12 is provided in the housing chamber 49, at a location higher than the top bearing 50, preferably at a topmost part of the housing chamber 49. Through the reflux channel 62, gases accumulated in the housing chamber 49 is collected and conveyed to the pump unit 12 together with the target fluid.

[0015] Fig. 2 shows a detailed configuration of the lead-in duct 58. The lead-in duct 58 directs the target fluid from the discharge port 54 to the top bearing 50 which is a rolling bearing, preferably a ball bearing. The target fluid flows downstream and passes through gaps between an inner race and a rolling element of the top bearing 50 and between an outer race, an inner race and the rolling element. The target fluid passing through the top bearing 50 functions as a lubricant for the top bearing 50. The target fluid flowing past the top bearing 50 reaches the top seal 60 which includes a small clearance 64 between the seal and the outside of the motor shaft 36. Along with the outside perimeter of the motor shaft 36 and the clearance 64, the top seal 60 constitutes a throttle structure in which a flow path in the lead-in duct 58 is narrowed, wherein flow resistance in the lead-in duct 58 increases. This throttle structure causes a pressure differential to develop across the clearance 64, with the result that the area around the top bearing 50 is maintained at a pressure close to the pressure raised by the multistage centrifugal pump, while the inside of the housing chamber 49 is maintained at a relatively lower pressure. In addition, a flow rate of the target fluid passing through the lead-in duct 58 is restricted by

the throttle structure, which suppresses any decrease in discharge from the submerged pump 10, in other words, any decrease in flow rate of the target fluid to be pumped.

[0016] By maintaining the area around the top bearing 50 at a high pressure, the target fluid is protected from vaporizing in the area around the bearing, even if a constituent prone to vaporization is present in the target fluid, which in turn ensures sufficiency of the lubrication of the bearing. Accordingly, the dimensions of each component of the throttle structure, such as, for example, clearance and length, should be set a dimension that will ensure the capability of maintaining a pressure which can prevent, or significantly suppress, vaporization of the target fluid in the area around the bearing. The shape of the flow path in the throttle structure may be, for example, crank-shaped rather than straight. Further, labyrinth structure 66 as shown in Fig. 3 may be formed in the seal 60 so as to alternately dispose narrow and broad gaps.

[0017] Because the gas which occurs in the housing chamber 49 is returned to the reflux channel 62 from the position located higher than the top bearing 50, it is possible to prevent a situation in which lubrication will be affected by lowering of the fluid level by the gas accumulated in the housing chamber 49 to a level reaching the top bearing 50.

[0018] The submerged pump 10 according to this embodiment may be preferably used as a pump for handling LNG which contains carbon monoxide. When the LNG contains carbon monoxide, a gas (carbon monoxide) appears at a lower temperature because the boiling point of carbon monoxide is lower than those of other constituents in the LNG, and lower than the boiling point of another LNG which contains no carbon monoxide. As described above, by installing the throttle structure downstream from the top bearing 50, poor lubrication due to the occurrence of gas in the vicinity of the top bearing 50 can be prevented.

[0019] Although an example three-stage centrifugal pump was described to illustrate a preferred embodiment of the present invention, the number of stages is not so limited, and may be changed as appropriate according to design requirements. Similarly, bearings other than the ball bearing may be used as the top and bottom bearings, and may be selected in consideration of other design requirements.

Claims

1. A submerged pump comprising:

- a pump which discharges a target fluid to be pumped;
- a motor located above said pump to drive said pump through a shaft;
- a housing in which said motor is installed;

a bearing which supports said shaft in the vicinity of an upper end of said shaft;

a lead-in duct through which said target fluid discharged from said pump is directed to flow through said bearing from an area near the upper end of said shaft toward the inside of said housing, and

a throttle structure installed downstream from said bearing in said lead-in duct to increase a flow resistance of said lead-in duct.

2. A submerged pump according to Claim 1, further comprising a reflux channel for returning said target fluid contained in said housing to the pump, wherein an entrance of the reflux channel is disposed to said housing in a place situated higher than said bearing.
3. A submerged pump according to Claim 1 or Claim 2, wherein said throttle structure includes a seal opposing to a surface of said shaft over a predetermined gap.
4. A submerged pump according to Claim 3, wherein a labyrinth structure is formed in said seal.

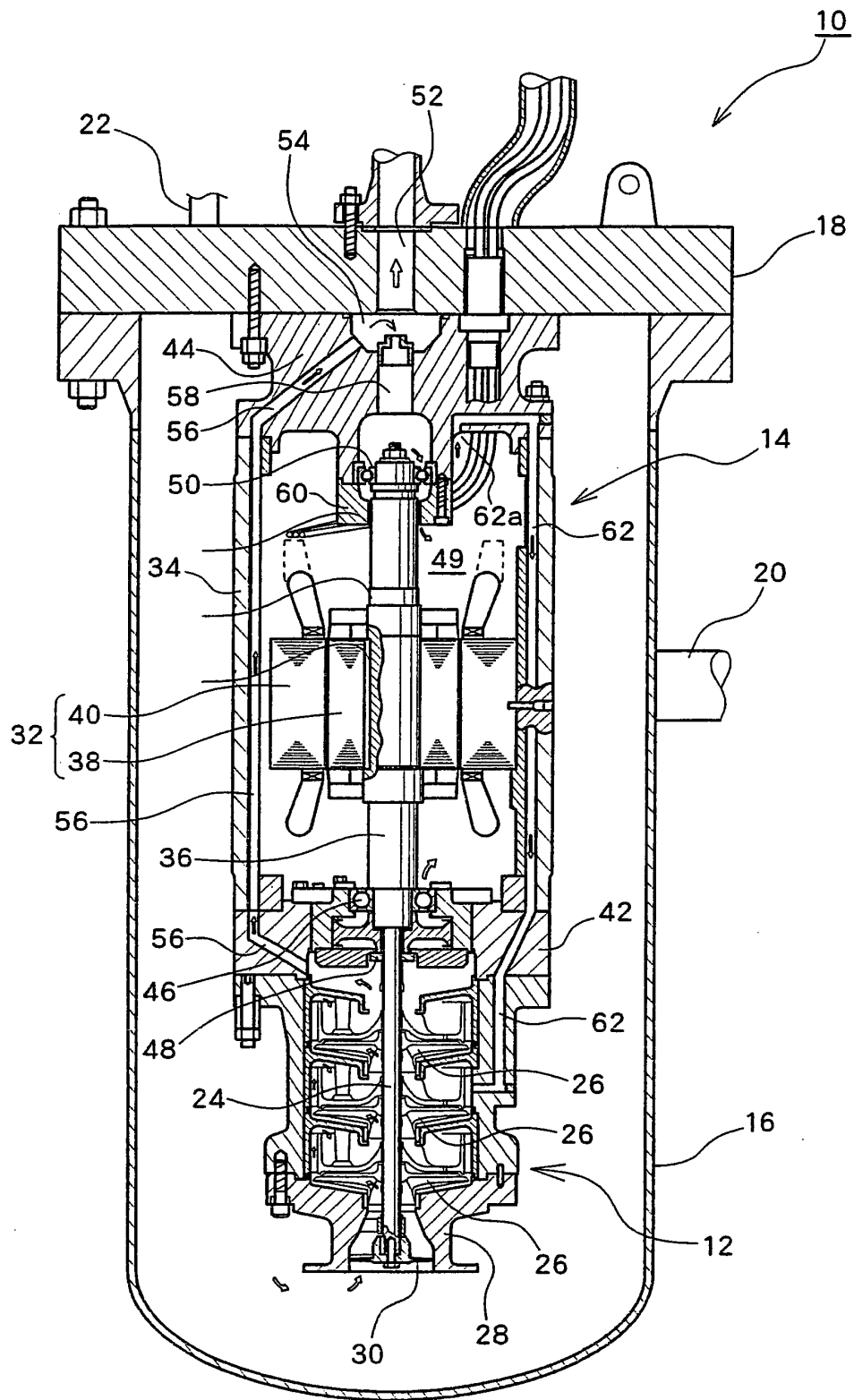


Fig. 1

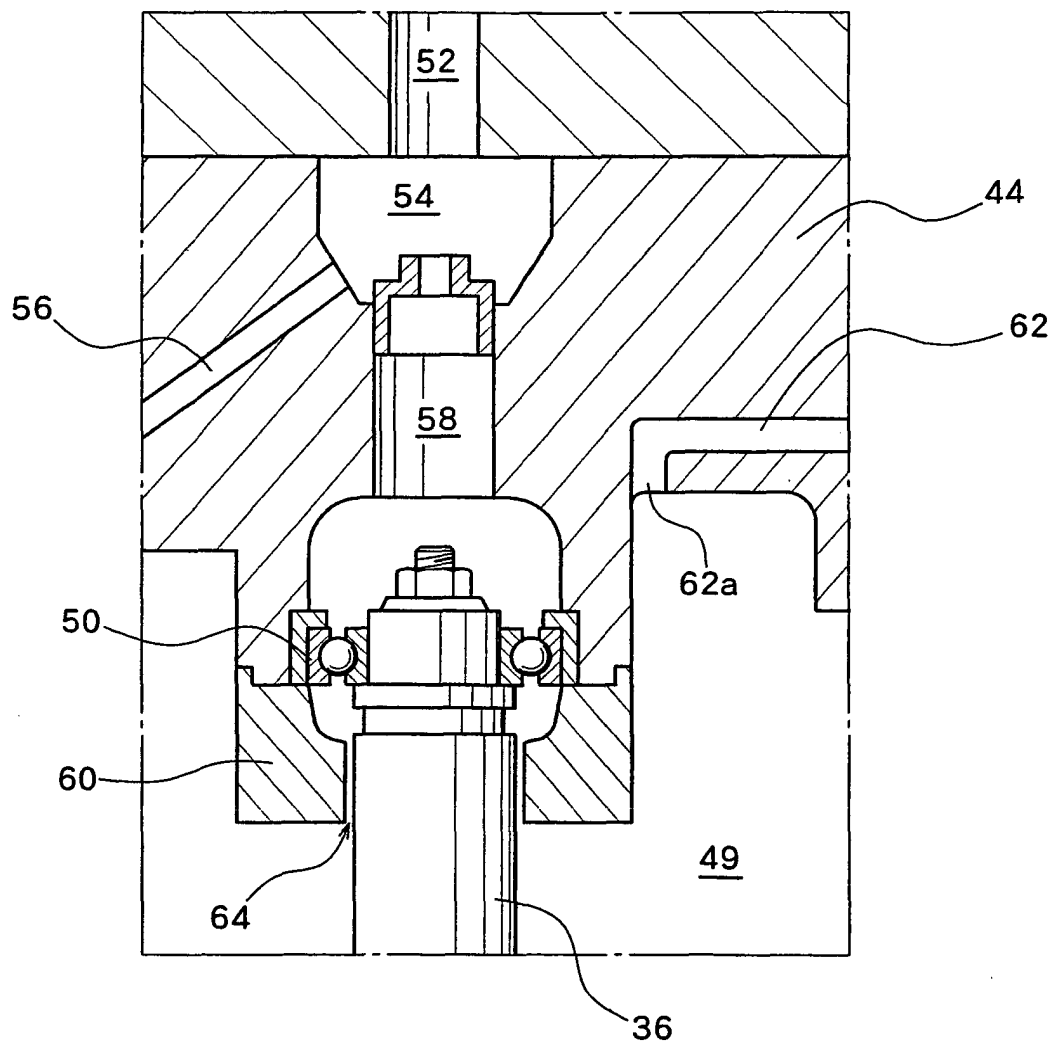


Fig. 2

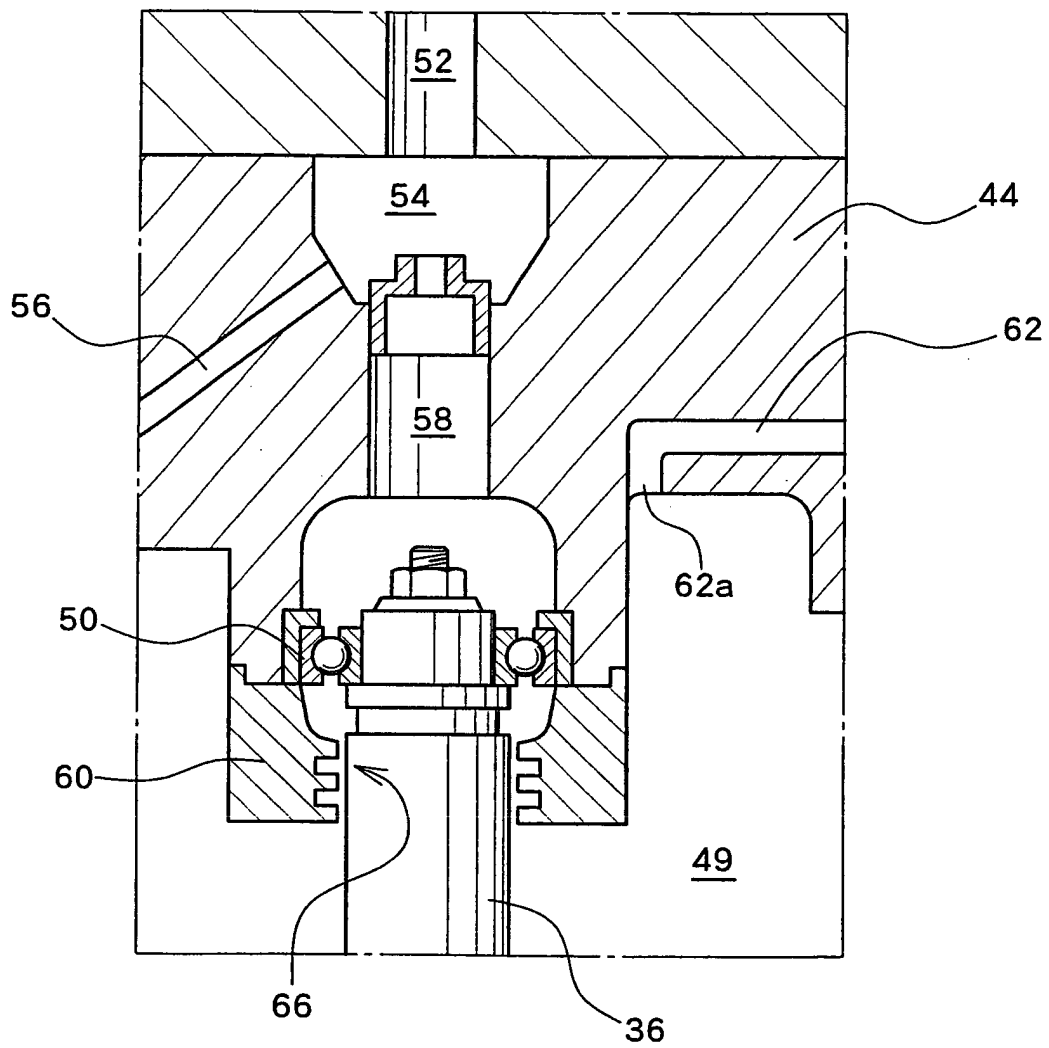


Fig. 3