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[54] **SUBMERGIBLE LIQUID PUMP**

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[51] **Int. Cl.** **F01d 25/32**

[58] **Field of Search** .... 277/25; 415/111, 169 A, 415/89, 168

[56] **References Cited**

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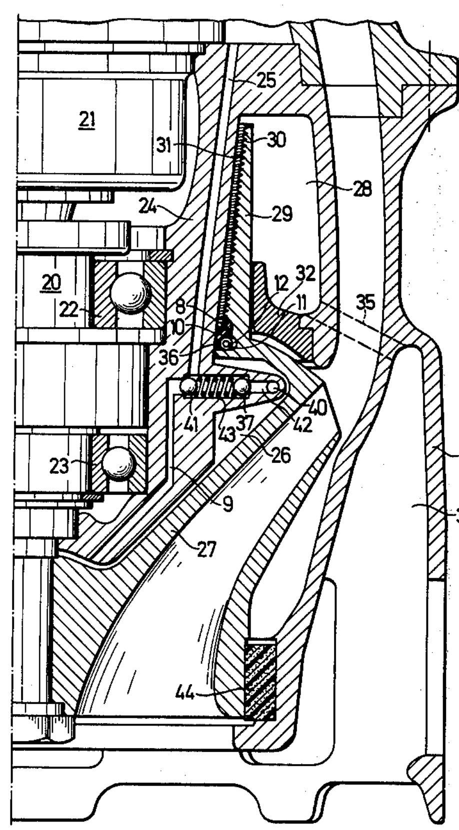
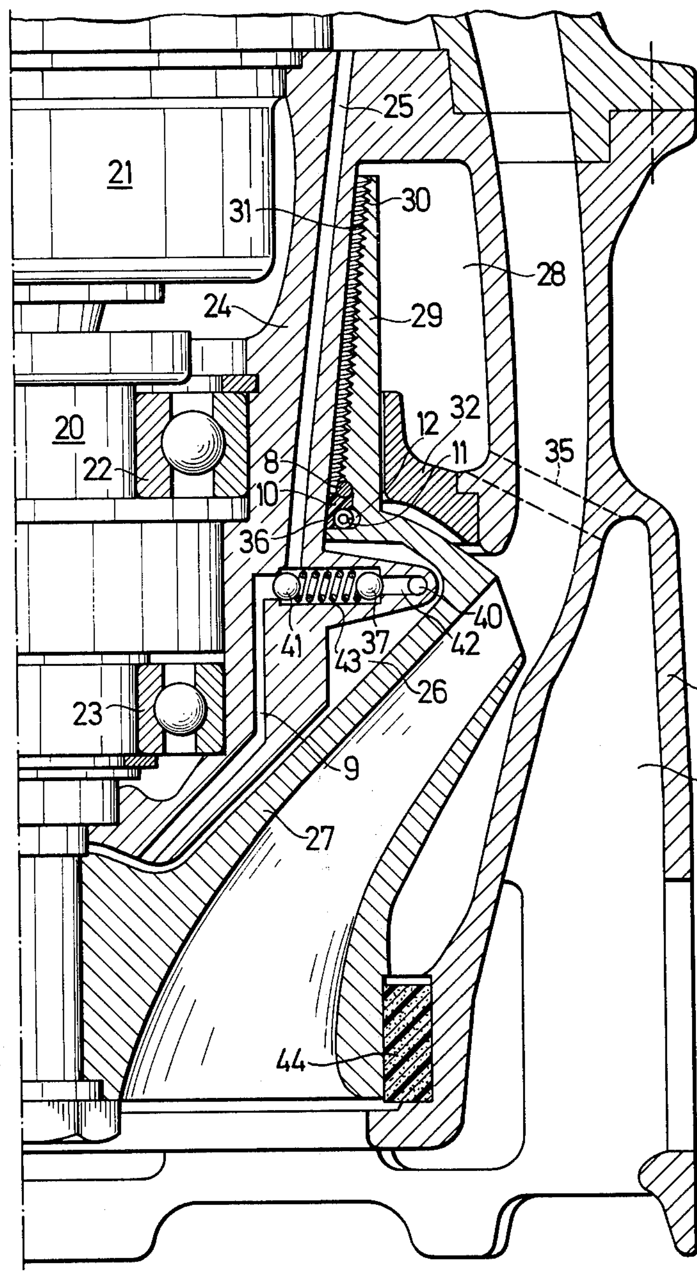
[57] **ABSTRACT**

A submergible liquid pump is provided with a leakage-collecting chamber arranged around the drive shaft. The leakage-collecting chamber is defined by a stationary wall and by a wall rotating with the drive shaft. Leakage hurled outwards during operation of the pump is collected with a means arranged in the leakage-collecting chamber and thus removed from the leakage-collecting chamber.

4 Claims, 1 Drawing Figure

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SUBMERGIBLE LIQUID PUMP

The invention relates to a submergible liquid pump having a leakage-collecting chamber arranged around the drive shaft.

In such pump units, which are generally utilized onboard ships, the sealing for the hydraulic oil is, as a rule, a mechanical sealing of extremely good quality. The sealing operates under ideal conditions with controlled oil circulation which means substantially zero leakage and a lifetime of several years of continuous operation. Any oil leakage is conveyed by a throw-off ring on the drive shaft to a separate leakage-collecting chamber which can receive substantially more oil than the amount possibly leaking from bearing housing and stationary hydraulic motor. By means of a neutral pressure gas, the leakage in the leakage-collecting chamber can be transported from the leakage-collecting chamber and, for example, up to the deck of the ship.

The object of the present invention is to improve the sealing arrangement in pumps of the type described introductorily, and also to achieve an automatic transport of leakage to the deck.

In accordance with the invention, this is achieved in that the leakage-collecting chamber is formed as a "rotary" leakage-collecting chamber in that it is defined by a stationary wall and by a wall rotating with the drive shaft. During operation of the pump, any leakage is then hurled outwardly in the leakage-collecting chamber and can be collected by a means arranged in the leakage-collecting chamber connected to a conduit which, for example, can lead up to a vessel on deck. When the pump is operating, any leakage is hurled out by centrifugal force, and forms a ring outermost in the leakage-collecting chamber, at a pressure sufficient to press the leakage up to, for example a vessel.

The wall rotating with the drive shaft in the leakage-collecting chamber can be formed as a separate element mounted to the drive shaft; however, when concerned with a centrifugal pump, it can to advantage be formed by the impeller of the pump.

The means for collecting leakage hurled out during operation can be a pick-up valve. The said pick-up valve may be combined with a check valve for expelling leakage during standstill by means of a neutral pressure gas supplied to the leakage-collecting chamber.

According to the invention, therefore, a valve unit is provided which comprises two check valves having a common spring but having greater seat diameter for the check valve used during standstill when the leakage is expelled by means of a neutral pressure gas. When the leakage-collecting chamber is subjected to gas pressure, the combined valve permits any oil leakage to be transported from the bottom of the leakage-collecting chamber through the largest check valve and up through an oil leakage tube. The opening pressure for the smaller valve is greater, due to the common spring and due to the difference in seat diameter, such that the gas pressure cannot escape this way, that is to say through the actual pick-up valve. During operation, the dynamic pressure of the leakage ring drives the leakage through the smaller valve, the larger valve remaining sealed, and also in this case the leakage will be transported to the deck, on the action of the dynamic pressure.

The leakage-collecting chamber is utilized preferably together with a so-called pressure chamber formed in the bearing housing above the leakage-collecting chamber, in that the wall rotating with the drive shaft, or the impeller, respectively, are provided with an extension in the form of a collar projecting upwards and into the chamber around a wall therein, to form a rotation slot between the leakage-collecting chamber and the pressure chamber.

Preferably, a check valve is arranged in the communication between the pressure chamber and the leakage-collecting chamber, the said check valve being open during operation of the pump.

The invention is further explained hereinbelow by means of an embodiment example illustrated on the FIGURE.

The FIGURE illustrates a section through a submergible pump. The essential components illustrated are the bearing housing **24**, the drive shaft **20**, the impeller **27** mounted on the drive shaft in the pump, and the inlet housing **33**.

The drive shaft **20** is mounted in the bearing housing **24** by means of ball bearings **22** and **23**. The drive shaft **20** means from the hydraulic motor **21** indicated.

The impeller **27** together with the bearing housing **24** define a leakage-collecting chamber **26**.

The leakage-collecting chamber can, of course, also be limited by a separate part which is mounted on the drive shaft and rotates therewith and does not constitute any part of the impeller, which may be the case when the suction opening of the impeller faces upwardly, or where a so-called two-way impeller is concerned. The modifications then necessary in the construction are so obvious to a skilled person and are not further illustrated or described therefore.

A pressure chamber **28** is formed in the bearing housing above the leakage-collecting chamber **26**. The upper collar **29** of the impeller **27** extends into the pressure chamber **28** and widens gently upwardly and outwardly. The collar **29** is provided with transport threads **30** which face in towards the rotation slot **31** formed between the collar **29** and the bearing housing **24**. The pressure chamber **28** is defined at the bottom thereof by the upper wear-ring **32** of the pump.

The inlet housing **34** is provided with a casing **33** facing downwardly toward the cargo, said casing forming a pre-compression chamber **34**. The said pre-compression chamber is in communication with the pressure chamber **28** by means of openings **35**.

Neutral pressure gas is supplied to the leakage-collecting chamber **26** through a conduit, not shown. The pressure chamber which is disposed cylindrically around the upper collar **2** of the impeller, is subjected to pressure when the pump is submerged in the cargo, leakage occuring through the wear-ring slot and through the openings **35** from a pre-compression chamber **34** formed by a casing **33**. The said openings have a double function: primarily as side channels for the wear-ring leakage and secondarily as pressure openings between the pre-compression chamber and the pressure chamber. When the pump is submerged in the cargo, the cargo rises rapidly to the wear-ring **32** internally. In the precompression chamber **34**, the air is then subjected to a certain liquid pressure. This pressure is transmitted to the pressure chamber since the liquid flows more slowly through the wear-ring slot than the air flows in from the compression chamber. When the liquid or cargo level is in balance, it will be at a lower level in the pressure chamber than if the pre-compression chamber effect had not been present. In this manner, the greatest possible gascontacted surface on the impeller is achieved, such that the disc-loss is reduced to a minimum even of the neutral gas is not utilized. Obviously, this effect can also be achieved when a separate, completely rotating wall is utilized for defining the leakage-collecting chamber.

The inner, outwardly widening impeller collar **29** which is provided with transport threads represents an extra safety arrangement which comes into force if the pump should inadvertently be disposed in horizontal position for a period of time. The transport threads counteract the penetration of cargo and when the pressure is in balance over the slot, gas will not flow out if liquid cannot penetrate. Oil leakage will automatically be transported to the deck, also in this position.

In the slot between the impeller collar **29** and the bearing housing **24** a check valve **36** is arranged which includes an annular sealing lip **10** made from a resilient material and has self-lubricating properties and is of sufficient hardness and density for the purpose. The sealing lip may be circular or may be divided into segments which do not necessarily need to seal against one another. During standstill, that is to say, when the shaft **20** is stationary, the sealing lip **10** is maintained pressed against the inner cylinder surface in the slot, i.e. against the bearing housing **24**, by means of a surrounding endless helical spring **11.** The helical spring is arranged in a groove **12** in the collar **29.** The spring may be provided with ballast, either in the form of an internal endless tube filled with lead (shot or granulate) and of suitable reciliency, or in another manner. Axially opposing the lip **10**, the sealing element is formed to seal against the outer rotary portion, i.e. against the impeller collar **29**, in this case by means of the O-ring **8** indicated. The whole sealing arrangement is adapted such that the sealing lip and spring are capable of moving radially on the action of the centrifugal force when the impeller rotates, whereby the valve is in open position.

From the bottom of the leakage-collecting chamber **26**, an oil leakage tube **9** leads up to a check valve **41.** From there, a bore **25** leads up further through the bearing housing. The said bore **25** is connected, in manner not illustrated, to a conduit which leads up to a vessel on deck.

During standstill, neutral gas may be supplied through a conduit (not shown) to the leakage-collecting chamber **26** and any oil leakage present in the leakage-collecting chamber is then forced out through the bore **9**, the check valve **41** and up through the bore **25** to a vessel on deck.

When the pump is in operation, any leakage will be hurled outwardly by centrifugal force in the leakage-collecting chamber and forms a ring outermost in the leakage-collecting chamber, at a pressure which is sufficiently great to press the leakage to a vessel on deck, through a check valve **37.** The said check valve **37** is, through a bore **42**, in communication with a bore **40** which faces towards the liquid flow. When the pressure of the oil leakage ring is sufficiently high, the check valve **27** opens and the leakage may then flow up through the bore **25** to a vessel on deck.

The two check valves **41** and **37** are, as illustrated, assembled as a unit and have a common spring **43.** The inner check valve **41** has a larger seat diameter than the outer check valve **37.** When the leakage-collecting chamber is subjected to gas pressure, during standstill, the arrangement permits any leakage to be conveyed from the bottom of the leakage-collecting chamber through the inner check valve **41** and up to the deck; the opening pressure of the outer valve **37** being greater due to the common spring **43** and due to the difference in seat diameter, so that the gas pressure cannot escape this way. During operation, the dynamic pressure of the leakage ring drives the leakage through the outer check valve **37**, the inner check valve **41** then remaining sealed, and the leakage is therefore conveyed to the deck.

The invention is hereinbefore described in connection with a specific embodiment but is, of course, not restricted thereto. As already mentioned, the rotating wall of the leakage-collecting chamber can be an element which is independent of the impeller, and the construction is then modified as necessary.

Having described my invention, I claim:

1. A submergible liquid pump having a leakage-collecting chamber arranged around a drive shaft of the pump, said leakage-collecting chamber being defined by a stationary wall and by a wall rotating with the said drive shaft, means in the said leakage-collecting chamber for removing collected leakage hurled outwards in the leakage-chamber during operation of the pump by said rotating wall, a bearing housing for the said drive shaft, the said bearing housing defining the said stationary wall, a pressure chamber in the said bearing housing extending around the said drive shaft above the said leakage-collecting chamber, which pressure chamber is downwardly exposed, an extension in the form of a collar projecting upwardly from the said wall rotating with the drive shaft and into the said pressure chamber, the said collar being adjacent a wall of the said pressure chamber thereby forming a rotation slot between the said leakage-collecting chamber and the said pressure chamber, and a pre-compression chamber in the form of a downwardly open casing into which said pressure chamber opens.

2. A submergible pump as claimed in claim **1**, and a check valve in said rotation slot, said check valve being opened during operation of said pump.

3. A submergible pump as claimed in claim **1**, said liquid pump comprising a centrifugal pump with an impeller, said wall rotating with the drive shaft comprising a part of said impeller.

4. A submergible liquid pump having a leakage-collecting chamber arranged around a vertical drive shaft of the pump, said leakage-collecting chamber being defined by a stationary wall and by an upwardly extending wall rotating with the said drive shaft, means in the said leakage-collecting chamber for removing collected leakage hurled outwards in the leakage-chamber during operation of the pump by said rotating wall, said stationary wall and said rotating wall defining a passage which leads from the lowest part of the said leakage-collecting chamber, a first check valve in said means and, a second check valve in the said means, and a common spring for the two said check valves, said first check valve having a greater valve seat diameter than said second check valve.

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