

Description

The invention relates to a centrifugal pump for delivering hot liquids, having at least one shaft passage through the pump housing to the outside, which is provided with an axial ring seal disposed inside a sealing chamber which contains the delivered liquid and which is separated from the pump housing by a spacing section with narrow shaft clearance, and comprises means for creating a circulation of liquid inside the sealing chamber for flushing the sliding surface zone of the axial ring seal.

Highly stressed axial ring seals are flushed so as to eliminate the heat arising in the sliding surface zone. In the known pump indicated in the introduction (DE-A-21 40 959) the flushing is effected by liquid circulation inside the sealing chamber. For this purpose a delivery screwthread is provided on a rotating part of the axial ring seal, which thread co-operates with the narrow seal housing and creates an axial flow in the sealing chamber which is recirculated through a passage connecting the ends of the sealing chamber, so that it encounters the sliding surface zone of the axial ring seal. The heat absorbed by the flushing flow is given off to the ambient air in the vicinity of the recirculation passage. Heat supply by liquid exchange with the delivery flow of the pump is practically excluded because the sealing chamber is in communication with the pump only through a narrow shaft clearance.

This arrangement is suitable for liquids such as coolant oil. However, when used for hot water, difficulties arise at the axial ring seal. The invention embraces the recognition of the critical reason for this. Even if the sealing chamber is completely filled with hot water at the start of operation, gas can be gradually separated therefrom which accumulates in the sealing chamber. This process does not terminate when the amount of liquid situated in the sealing chamber has given off its gas content, because a very slight liquid exchange with the pump constantly takes place and, therefore, small amounts of gas are also constantly

separated which, because of the design, cannot be flushed out of the sealing chamber. As a result of the centrifugal action of the liquid rotating in the sealing chamber with the axial ring seal, the separated gas tends to accumulate at the axial ring seal and to interfere with the flushing action required there. Cooling and lubrication of the sliding surface zone are thereby jeopardized.

This problem does not arise in pumps which are different to the type defined above and in which the sealing chamber is in flushing communication with the delivery flow, because any separations and also any solid foreign bodies are then removed from the sealing chamber. For example, a pump is known (DE-A-34 38 662) in which the sealing chamber is in communication through a first passage with a high-pressure zone and through a second passage with low-pressure zone of the pump. In another known pump (DE-A-31 37 692), by the formation of a tubular wall inside the sealing chamber a circulation path is formed which serves for flushing away foreign substances, such as sand, from the axial ring seal. It is not clear here how the sealing chamber is connected with the pump chamber. However, since it cannot be assumed that the seal flushing flow would concentrate the foreign substances and would recirculate them to the axial ring seal, a flushing connection with the pump chamber must be present.

Finally, it is known (FR-A-2 288 241) to provide the sealing chamber, which is separated from the pump chamber by a narrow shaft clearance, with a flushing and cleaning aperture disposed at the top which would be suitable for the removal of gas accumulations when the pump is inoperative however, there is no corresponding reference in respect of use.

Therefore, it is the object of the invention, on the basis of the recognition described above, to render a centrifugal pump of the type indicated in the preamble of Claim 1 suitable for use with gas-containing liquids.

This object of the invention is achieved by the combination of the features that

- means for stabilising the circulation of liquid at a distance from the axial ring seal,
- a receiving chamber for separated gas, which is of large-capacity, has stabilised flow and which can be vented, and
- devices for removing accumulated gas are provided.

A first operating aspect of the invention is the intensive flow impingement of at least the sliding surface zone of the axial ring seal so as to remove therefrom gas bubbles which settle on the axial ring seal or accumulate in the vicinity thereof. Known flushing devices are resorted to for this purpose.

A second operating aspect of the invention is the stabilising of the circulation of liquid at a distance from the axial ring seal for the purpose of enabling the gas bubbles removed from the axial ring seal to be separated. This can be achieved in a manner known to the person skilled in the art, in particular by providing large flow cross-sections at a distance from the axial ring seal.

Finally, one operating aspect of the invention lies in providing a sufficiently large-capacity receiving chamber for separated gas, which is preferably disposed in the upper zone of the sealing chamber. It has to be of stabilised flow so that the gas situated there cannot be dragged back into circulation. Furthermore, it must be ventable so that the gas can be removed at least periodically. It is pointed out that a communication must be provided between the portions of the circulation path in which the gas separation takes place and the gas-receiving chamber, so that the gas can pass from the flow circuit into the receiving chamber.

In a pump which is of a different type to that defined above (GB-A-1 174 767) and whose sealing chamber is disposed vertically above the pump chamber, to maintain the self-priming capacity of the pump it is known to connect the central impeller zone with the sealing chamber through large bores, so that gas bubbles accumulating in the impeller zone and passing into the sealing chamber can be removed therefrom through a venting duct which is optionally connected to a vacuum pump.

To ensure that the gas can be removed from the sealing chamber this latter comprises ribs which project from the outside radially inwards towards the seal and which prevent rotation of the liquid contained in the sealing chamber, so that the gas can be separated from the liquid and can accumulate in the upper part of the sealing chamber where the venting duct is connected. The sliding surface zone of the seal is also situated in this upper part of the sealing chamber at the same height as the connection of the venting duct. The known arrangement could not be taken as a model in solving the problem on which the invention is based, namely obviating the operating difficulties of the pump of the type defined at the beginning when used for certain liquids, because it is of a different type to that defined above and there would be no reason to look for proposals from known devices for maintaining the self-priming capacity of pumps. The known arrangement is also misleading insofar as it leads to the accumulation of gas in the sliding surface zone of the seal and thus leads to precisely those difficulties which are to be obviated by the invention.

Preferably, the sealing housing is divided into an inner zone and an outer zone, which together form the circulation path and which have at least one connection near to the sliding surface of the axial ring seal and also one connection situated axially remote therefrom. The division can be effected by a wall which may be substantially tubular and which, as already mentioned, is known per se. However, as will be described below, it can be effected using other means which do not provide a wall between the zones.

According to the invention, the intensive flow impingement of the axial ring seal can be improved in that at least one rib is provided which extends to a slight distance (for example 1 to 2 mm) from the periphery of the axial ring seal, and the edge of which induces substantial turbulence at the periphery of the seal, whereby the gas bubbles situated there are detached so that they can be removed with the flow circulation. For this purpose it has been found to be advantageous if the rib is disposed below shaft level, i.e. in

the geodetically lower zone of the sealing chamber and/or extends at an angle to the axial direction.

It may be sufficient if only one such rib is provided, particularly if the inner and outer zones of the sealing chamber are separated from one another by a tubular wall. A plurality of ribs can also project, without particular separation between the two zones, from the sealing wall towards the axial ring seal, whereby chambers are formed between the individual ribs and the sealing chamber boundary; said chambers form near to the axial ring seal an inner narrow zone and outwardly a wide zone so that the circulation flow passes internally along the periphery of the axial ring seal and, in particular at the ribs, it passes rapidly and turbulently and outwards in a stabilised manner.

The ribs may contain perforations so that the gas separated between them can ascend to the gas-receiving chamber.

If the inner and outer zones of the sealing chamber are separated by a substantially tubular wall, in per se known manner a delivery screwthread can be provided for the purpose of intensifying the circulation, which acts between the wall and a member rotating with the axial ring seal. Particularly during the starting phase of the pump, this results in an intensive throughflow which ensures complete and rapid venting.

The gas-receiving chamber and/or the flow stabilisation therein can be formed by at least one rib which extends transversely to the peripheral direction situated in the outer zone of the sealing chamber, preferably in its upper zone, and which preferably, viewed in the direction of rotation of the pump, is disposed upstream of the upper crown, for example at about 45° . The gas can accumulate in the stabilised chamber downstream of the rib. The rib is intended to leave free a passage of small cross-section which enables the gas to pass into the receiving chamber, without impairing the flow stabilising action. This small passage cross-section is preferably formed by a gap between the rib and the outer boundary of the partial zone containing the rib.

According to another feature of the invention, the sealing chamber is connected to a high-pressure zone in the pressure zone of the pump. Moreover, when the receiving chamber is connected with a lower pressure zone of the pump, a restrictor is preferably provided in this latter connection, which for example may be formed by a plain bearing which is disposed between the pump and the spacing section. The connection with the high-pressure zone of the pump can be formed by a special by-pass duct. The result of this arrangement is that a pressure is created in the axial ring seal chamber, which corresponds approximately to the high pressure in the pump. A prerequisite therefor is that the restrictor action of the by-pass duct is distinctly lower than the restrictor action of the plain bearing and/or restrictor section. Accordingly, the medium in the axial ring seal chamber is caused to be further away from the boiling condition and, therefore, safer operation of the axial ring seal is possible.

It is not necessary for the entire gas-receiving volume to be situated inside the sealing chamber. According to the invention a venting plug is disposed in the sealing chamber, which makes available additional receiving volume and is provided with venting means. However, in this case too in conformity with the above statements, an outer stabilised-flow receiving chamber for separated gas has to be provided inside the sealing chamber, from which the gas can enter the venting plug.

The venting means can be actuated automatically or manually. Of course, the venting is intended to take place at the location at which the gas accumulates, generally at the geodetically highest point. Additionally, the sealing chamber and/or the venting plug can include one or more sensors for monitoring the operating conditions, thereby enabling, for example, the required venting of the sealing chamber to be controlled or the pump unit to be switched off in the event of danger for the axial ring seal.

The invention will be described below with reference to the embodiments illustrated by way of example in the drawings, in which:

- Figure 1 shows a longitudinal section through the pump;
- Figure 2 shows a longitudinal section through a first embodiment of the sealing assembly;
- Figure 3 shows a cross-section along the line A-A in Fig. 2;
- Figure 4 shows a longitudinal section through a second embodiment of the sealing assembly;
- Figure 5 shows a cross-section along the line B-B in Fig. 4;
- Figure 6 shows a longitudinal section through a third embodiment of a sealing housing, and
- Figure 7 shows a cross-section along the line C-C in Fig. 6.

Figure 1 shows a centrifugal pump with a pump housing comprising, inter alia, a spiral housing 1 and a housing cover 2, and also an associated impeller 3 on a shaft 4 whose exit from the housing is sealed by a axial ring seal 5. The shaft 4 is firstly mounted in a plain bearing 6 disposed outside the pump housing and secondly inside the pump housing in a plain bearing 7. A tubular portion of the housing cover 2, which surrounds the pump shaft 4 with a narrow clearance, is disposed between this bearing and the axial ring seal 5. The axial ring seal 5 is disposed in a sealing chamber 9 inside a seal housing 10 which has a venting device 11 at a geodetically high point. The sealing chamber widens to a large capacity, whereby the amount of liquid contained therein is increased, the supply to the axial ring seal is improved and the gas-receiving capacity is increased. The increased housing surface also provides intensified heat radiation.

The housing cover 2 is formed with a plurality of walls so as to increase the temperature drop. It forms two connections of the sealing chamber with the pump delivery path, i.e. firstly through the plain bearing 7 having a restrictor action with a low-pressure zone and secondly through a special passage 23 with a high-pressure zone. This

passage is connected with the chamber 24 on the seal side of the plain bearing 7. As a result of the restrictor action of the plain bearing, which can also be achieved by a separate restrictor if the plain bearing is omitted at this location, the chamber 24 and thus the sealing chamber 9 is under high pressure. The result of this is that the pressure difference relative to atmospheric pressure is increased and, therefore, any evaporation of medium does not occur in the sealing clearance or until far outside thereof, whereby the chance of malfunction is reduced. Moreover, as a result of the connection of the passage 23 to the chamber 24 on the pump side of the spacing section 8 fresh medium containing gas is prevented from passing through the passage 23 into the sealing chamber 9, whereby no additional gas separation occurs therein.

In the embodiment of the sealing assembly according to Figures 2 and 3, the sealing chamber 9 is divided by a preferably cylindrical wall 12 into an inner zone 13 and an outer zone 14. These zones are connected to one another firstly by the annular gap 15 in the vicinity of the sealing surfaces of the axial ring seal and secondly in a zone situated axially remote therefrom by bores 16. A rib 17 projects inwards from the wall 12 in the inner zone at a geodetically low point, which rib extends to within a few millimetres from the outer periphery of the axial ring seal 5 and, optionally, is arranged to extend at an angle to the longitudinal direction (not axially parallel), so as to improve the flow rate and the wiping action. In the outer zone 14 a rib 18 extends from the wall 12, which lies at about 45° in the direction of rotation upstream of the upper crown, and extends up to the sealing chamber wall to leave a narrow gap 19 so that here a restricted throughflow can take place, particularly of the gas accumulated upstream of the rib.

A circulation flow takes place which passes through the bores 16 from the inner zone into the outer zone and back through the gap 15 to the sliding surface zone of the axial ring seal. The inner rib 17 induces a powerful turbulence at the periphery of the axial ring seal, so that any gas bubbles

separated here are dragged away and conveyed with the circulation flow into the outer zone 14 which has a larger flow cross-section and, in particular in its zone situated to the left of the section line A-A in Figure 2, is heavily stabilised, so that gases are separated, travel upwards and can accumulate in the crown zone under the protection of the rib 19. This zone is stabilised by the rib 18 and by the omission of a bore 16. The gas accumulating here is therefore permanently removed from the circulation flow. The size of this chamber available to accommodate gas is such that it is sufficient for operation over a long period of time.

Unless otherwise indicated below, the embodiment according to Figure 5 is the same as that according to Figures 2 and 3. The wall 12 separating the inner zone 13 from the outer zone 14 is spaced apart from the outer periphery of the axial ring seal 5 by only a few millimetres. A delivery screwthread 20 is provided between a rotating member of the axial ring seal and the wall 12. The bores 16 for connecting the two zones are situated in the flanged portion of the wall 12. The delivery screwthread 20 delivers the liquid in the inner zone to the bores 16 so that, after passing the outer zone 14, it is directed through the annular gap 15 to the sliding surface zone of the axial ring seal. The narrowness of the inner zone 13 in conjunction with the constrained flow ensures the removal of gas separations from the axial ring seal.

In the embodiment according to Figures 6 and 7 two radial ribs 21 are provided in the axial ring seal chamber 9, which extend to within a few millimetres of the outer periphery of the axial ring seal 5. These ribs include perforations 22 which may take the form of bores through the rib surface and/or a clearance in relation to the outer sealing chamber boundary; they enable a flow of liquid and gas to take place therethrough but they stabilise the flow (at least in the crown zone) so that the separated gas can accumulate here. The ribs induce powerful turbulence at the seal periphery so as to drag away the gas separations situated

there. At the same time they effect a flow stabilisation in the zone radially remote from the seal so that the gas can separate and can rise to the crown zone, from where it can be removed in due course through the venting apertures 11.

CLAIMS:

1. A centrifugal pump for delivering hot liquids, having at least one shaft passage through the pump housing (1, 2) to the outside, which is provided with an axial ring seal (5) disposed inside a sealing chamber (9) which contains the delivered liquid and which is separated from the pump housing (1, 2) by a spacing section (8) with narrow shaft clearance, and comprises means (12, 20, 21) for creating a circulation of liquid inside the sealing chamber (9) for flushing the sliding surface zone of the axial ring seal (5), characterised by the provision in combination of the following features

- means (12, 18, 21) for stabilising the circulation of liquid at a distance from the axial ring seal (5),
- a receiving chamber for separated gas, which is of large-capacity, has stabilised flow and which can be vented, and
- devices (11) for removing accumulated gas.

2. A centrifugal pump according to Claim 1, characterised in that the sealing chamber (9) is divided into an inner zone (13) and an outer zone (14), which have a connection (15) near to the sliding surface of the axial ring seal (5) and a connection (16) remote therefrom.

3. A centrifugal pump according to Claim 1 or 2, characterised in that at least one rib (17, 21) is provided which extends to a slight distance from the periphery of the axial ring seal (5).

4. A centrifugal pump according to Claim 3, characterised in that the rib (17, 21) is disposed below shaft level.



5. A centrifugal pump according to Claim 2 or 3, characterised in that the rib (17, 21) extends at an angle to the axial direction.
6. A centrifugal pump according to any one of Claims 1 to 5, characterised in that a plurality of ribs (21) are provided projecting from the sealing chamber wall towards the axial ring seal (5).
7. A centrifugal pump according to any one of Claims 3 to 6, characterised in that the ribs (21) contain perforations.
8. A centrifugal pump according to any one of Claims 1 to 5, characterised in that the inner zone (13) and the outer zone (14) are separated by a substantially tubular wall (12).
9. A centrifugal pump according to Claim 8, characterised in that a delivery screwthread (20) is provided between the wall (12) and a member rotating with the axial ring seal (5).
10. A centrifugal pump according to any one of Claims 6 to 9, characterised in that the outer zone (14) includes at least one rib (18, 21) which extends transversely to the peripheral direction above shaft level and which leaves free a passage (19, 22) of small cross-section.
11. A centrifugal pump according to Claim 10, characterised in that the rib (18, 21) is disposed in the direction of rotation upstream of the crown.
12. A centrifugal pump according to Claim 10 or 11, characterised in that the passage of small cross-section is an outwardly disposed gap (19, 22).
13. A centrifugal pump according to any one of Claims 1 to 12, characterised in that the sealing chamber (9) is



connected to a high-pressure zone in the pump and its possible connection with a low-pressure zone includes a restrictor (7).

14. A centrifugal pump according to Claim 13, characterised in that the connection with the high-pressure zone discharges on the pump side of the spacing section (8).

15. A centrifugal pump according to any one of Claims 1 to 14, characterised in that a venting plug with a venting device is provided in the sealing chamber (9).

16. A centrifugal pump according to any one of Claims 1 to 15, characterised in that the sealing chamber (9) and/or the venting plug includes a sensor for monitoring the operating conditions.

