

A SHIP'S PROPULSION ARRANGEMENT AND METHOD

The present invention relates to such a ship's propulsion and/or steering unit arrangement, at least partly surrounded by water, that comprises an electric motor in a substantially sealed chamber formed by the unit walls, a propeller shaft associated with said electric motor having a propeller or a similar device fitted outside said chamber for transmitting the electric motor's power as motion energy into the surrounding water. The present invention further relates to a method for managing fluid flows in the propulsion and/or steering unit presented above. The present invention also relates to an arrangement for improving the efficiency of the cooling of a propulsion device's motor in a propulsion and/or steering unit as discussed above.

Previously known are propulsion units for ships or similar devices operating on a water surface, said devices comprising outside the actual hull a substantially sealed chamber within which an in most cases electrical motor is arranged. The motor shaft functions either directly or by means of a suitable gearing as a propeller shaft, which outside the chamber has a propeller fitted for transforming the motor power into a flow of water driving the ship. In most modern arrangements, this kind of chamber is, in addition, fitted rotatably about the vertical axis, in which case the device at the same time functions both as a ship's propulsion and steering means. The applicant provides devices of this kind with the trade mark *Azipod*^(TM).

Such so-called pods are disposed underneath the water surface, at least as concerns their substantial part, and usually there is arranged a connection to the inside of the hull through a vertical shaft tube or similar. At least when the ship is in water, the entrance e.g. for maintenance takes place via this connection, which often is rather cumbersome. Since, however, an underwater shaft arrangement is associated with the arrange-

ment, in which arrangement one part of the shaft is inside the chamber and the other part outside, there always is a certain possibility of leakage, in which case this kind of leakage must be detected and any possible raising of the water level in the chamber must be stopped. Since the chamber often is disposed in a substantially cold water, there is at the same time a risk that e.g. humidity in the cooling air is condensed at the chamber walls, which also results in water accumulating on the bottom of the chamber. Due to these reasons, the arrangement has this far required specific control and pumping arrangements to be arranged in the chamber.

In the same way, also during operation there is a need to perform in the chamber different maintenance measures associated with the functioning of the motor and the rest of the equipment, the purpose of which is on the one hand an ensuring of sealing and on the other hand a continuous maintaining of different lubrication and similar functions.

Further, motor arrangements having a structure of the aforementioned type have been developed, in which the heat generated by the electric motor is, at least for its substantial parts, conducted directly into the surrounding water. In such a structure, the motor body functions as an intermediate means for transmission of heat, in which case the surface of the pod, in turn, functions as a cooler. In that case, one of the problems has involved poor transmission of heat from the stator into the motor body and from it further into the pod housing.

In order to overcome the aforementioned disadvantages and to achieve a simple, dependable and easy-to-use management arrangement of the operating conditions of a propulsion device, an arrangement according to the present invention has been developed, the characteristic features of which being disclosed in the accompanying claims and particularly in the characterizing portion of the independent claims. Thus, the

propulsion and/or steering unit arrangement according to the present invention is characterized by the fact that it includes means for pressurizing said substantially sealed chamber with air or the like especially gaseous medium, the thermal conductivity of which increases at with a pressurization thereof. Correspondingly, the method according to the present invention for managing flows of fluids is characterized by the fact that said substantially sealed chamber is sealed on the one hand against water pressure from outside and on the other hand against other compartments of the ship, that the chamber is pressurized with a gaseous medium, that one performs monitoring of the pressure in the chamber and that one monitors the composition of any medium escaping from the chamber in a controlled manner due to pressure. The cooling method according to the present invention is characterized by the fact that the cooling of the motor is improved by increasing the pressure of the gaseous medium in the motor compartment in such a manner that the thermal conductivity of a gaseous medium increases, which causes heat to be more efficiently transmitted into the motor body, specially from the area of the stator winding overhangs, and from it through the chamber walls directly into the surrounding water.

In the following, the present invention will be described in more detail with reference, by way of example, to one embodiment and a schematic drawing representing it.

As shown in the Figure, a propulsion unit 3 substantially surrounded by water is arranged outside a ship's hull 1, said propulsion unit comprising a chamber 4 which is substantially sealed at least against a surrounding mass of water 2, said chamber having an electric motor or similar power unit intended for driving the ship, which is not described in more detail herein. Fitted on a shaft 7 rotated in bearings 6 by said electric motor 5, fairly schematically presented in the Figure, are one or more propeller means 8, which as known per se, and which are also shown only schematically. The propeller

means 8 transforms, in a manner known per se, the rotational energy transmitted by the motor 5 to the shaft into a flow of water driving the ship.

The propulsion unit 3 is advantageously fitted on the hull 1 so that it can be turned by means of a vertical shaft formed in conjunction with the upper body 9, in which case the propeller flow can at the same time, by turning the propulsion unit, be directed sideways, due to which a change of direction of the propulsive force can be utilized for maneuvering the ship. This structure known per se is, however, not substantial with regard to the present invention, and the arrangement according to the present invention can also be applied e.g. to non-turning propulsion arrangements. These have, however, in common the fact that the propulsion arrangement forms a separate chamber 4, of which a substantial part is usually located in water 2 below the water surface.

In order that the devices 5, 6, 7 in the chamber 4 would remain dry, there is a shaft gasket 10 fitted in connection with to said shaft 7 for preventing water from passing from the surrounding mass of water 2 along the shaft 7 into the chamber 4. With such shaft gaskets 10 it is in practice difficult to achieve a perfect sealing, since in such a sealing solid walls or similar structures of the chamber 4 connect to a rotating shaft 7 that are associated with one another. Therefore, at least by wearing, there is a certain clearance to be found in the shaft gasket 10, which at the same time provides an access for the water outside the chamber into the chamber 4 in such a manner that water is gradually accumulated on the bottom of the chamber 4, and such water has to be removed by specific arrangements. Correspondingly, the lubrication of the bearings 6 is difficult to implement to be perfectly sealed in the long term, in which case lubricant is dripping from the bearings with time, and such lubricant must also be removed from the chamber.

By means of the arrangement according to the present invention both problems, in a way due to insufficient sealing, have been solved simply and dependably. In practice this means that an excess pressure is artificially provided in the chamber, said pressure in an optimal situation corresponding at least to the external pressure especially prevailing outside the chamber 4, and in some advantageous cases also to the pressure prevailing in the pressure lubrication system of the bearings 6 (not specifically shown in the Figure). Advantageously, the last-mentioned pressure is separately adapted to correspond to the average water pressure prevailing outside the chamber 4 at the level of the shaft sealing 10. In this manner, by suitably pressurizing the chamber 4, any passing of water via the shaft gasket 10 to the chamber 4 can in practice be eliminated. The pressures being balanced, the arrangement at the same time prevents e.g. lubricating oil of the bearings from passing 6 into the surrounding water.

According to the present invention, the pressurizing of the chamber 4 significantly improves the heat conduction from the area of the stator winding overhang. A gaseous medium under pressure conducts heat considerably efficiently into the motor 5 body. When the motor 5 body in this structure preferably is in a direct contact with the walls of the chamber 4, the heat will be efficiently conducted, in this manner, to the surrounding water. In this manner heat exchanger arrangements used so far can be avoided while at the same time the relative efficiency of the motor 5 can be increased.

In practice, the pressurization of the chamber 4 can be effected in various ways, of which the Figure shows one advantageous embodiment. The arrangement disclosed in the Figure thus comprises pressure source means 12 suitably provided in a separate device compartment 11, which means may comprise a compressor, a pressure container or similar known means, which are governed by a control unit 13 in a controlled manner. Processing means 14 such as a water trap or similar,

that may be used when necessary, for a flowing medium such as air or other gas pressurized by said pressure source 12 are preferably connected to the pressure source. While a gaseous substance is usually considered the most preferred flowing medium, the arrangement according to the invention can, in some special cases, also be applied by means of liquid mediums such as certain oils, cooling liquids or the like, or by a combined use of gas and liquid. Characteristic for the present invention is, however, that the whole sealed interior of the chamber 4 is pressurized by means of the medium in question, which thus fills at least a substantial part of the chamber. According to one embodiment, the pressurizing arrangement according to the present invention is also utilized as a part of a fire extinguishing system.

Advantageously, the pressure of a medium such as air or other gas in the chamber is higher than the atmospheric pressure in the ship's compartment 15 above the chamber, preferably at least substantially the same as the pressure of the surrounding water 2 at the propeller shaft 7 level. This pressure is usually clearly higher than any pressure used for maintaining the flow of air for cooling a possibly air-cooled electric motor. Typically, the pressure caused by pressurizing is higher than the hydrostatic pressure between the chamber's 4 bottom and the level of the ship's interior 15, favorably higher than the hydrostatic pressure of the water surrounding the chamber 4, and preferably higher than the dynamic pressure of the surrounding water as measured at the level of the chamber's bottom. Typically, this kind of pressure is of the order of 0.1 to 1 bar higher than the pressure which corresponds to the hydrostatic pressure near the shaft gasket 10. The excess pressure required by a hydrostatic pressure e.g. at a depth of four meters, in comparison to the atmospheric pressure, would thus be of the order of 0.5 to 1.4 bar, according to the present invention.

In practice, the chamber sealing for enabling the forming of

an excess pressure is preferably provided by means of a separate pressure wall 16, which usually has the necessary manholes to permit access for maintenance (not shown). By means of said pressure wall 16 the compartment constituted by the chamber 4 can be closed in such a manner that the overpressure in accordance with the present invention can in a normal case be maintained by a fairly low energy consumption. For illustrative purposes the pressure wall 16 is shown in the Figure so that it is disposed in the middle of an upper body portion 9, in which case the pressurized portion of the chamber 4 is shown by means of half-tone print. Advantageously, the pressure wall 16 is in practice located at the boundary between the hull 1 and the upper body portion 9, as distinct from what is disclosed in the Figure, but the pressure wall can also be located farther down e.g. immediately above the motor 5, or alternatively farther up e.g. in connection with the wall of the device compartment 11. A feeder conduct 17 extending from the pressure source 12 is conducted through the pressure wall 16 into the chamber 4, as shown in the Figure.

The arrangement according to the invention present also enables a removal, from the chamber, of any humidity possibly accumulating in the chamber, e.g. on its bottom, by utilizing the excess pressure, e.g. by means of an extension 19 of a discharge pipe 18 conducted to the bottom, as marked in the Figure with a dashed line. In conjunction with this discharge pipe 18, also e.g. emergency pumping means (not shown) for the chamber 4 and means 20 for analyzing the escaping substance for detecting a leakage can be suitably arranged, as well as valve means 26 for closing the pipe for maintaining the pressure in the chamber 4. According to one embodiment (not specifically shown) of the present invention, the discharge pipe 18, 19 is arranged to be part of a circulation system for the pressurized medium, in which case humidity is continuously removed e.g. from a circulating pressurization gas by treatment means 14 while at the same time the sealing of the

chamber 4 is monitored so that any water or oil possibly showing in the pressurized circulating medium is detected. In the same way it is usually important that the operation of the pressurizing as such is monitored, which is schematically shown in the Figure by a pressure gauge 21 and an alarm signal output 22.

More redundancy is achieved by a shaft gasket arrangement disclosed in the Figure, said arrangement comprising a redundant oil reservoir 23. This oil reservoir is preferably pressurized by means of the same pressurizing system which usually pressurizes the chamber 4, in which case oil is specifically fed 25 to the shaft gasket 10. In certain cases, this enables one to contribute, by means of pressurizing, and specifically using gas that is lighter than air, to the reduction of abrasion losses, specially in the shaft gasket 10. By pressurizing a gravitational oil reservoir 23 to the same pressure with the chamber 4, an overpressure is achieved for the shaft gasket 10 both in relation to the chamber 4 and to the mass of water 2. According to another embodiment of the invention, the arrangement is, in turn, such that the feeding of a pressurized medium is arranged, at least for some parts, in conjunction with separate objects to be lubricated, in which case it is possible to direct an oil mist via the system into the gasket 10 or some other object in the chamber 4.

In yet another (not shown) embodiment of the present invention, the arrangement is, in addition, such that the pressurizing is actively utilized, according to the principles presented above, for implementing other functions such as an oil change for the bearings 6. In that case, the bearing oil is removed up to the device compartment 11, e.g. via separate piping, by means of pressurizing. Correspondingly, the an filling can be performed either by using pressurized oil or e.g. by removing the pressurization from the chamber 4, in which case the oil can be filled gravitationally.

Above an arrangement has been discussed, in which solely one propeller means 8 is associated with said chamber 4, but it must be understood that the invention can be applied also in such arrangements in which the number of propellers is higher e.g. in such a manner that there is a propeller at both ends of the shaft 7. In a corresponding manner, the invention can be modified in various other ways within the scope of the appended claims.

CLAIMS

1. A ship's propulsion and/or steering unit arrangement, at least partly surrounded by water, said arrangement comprising an electric motor (5) arranged in a substantially sealed chamber (4) formed by the walls of the unit, a propeller shaft (7) connected to said electric motor having a propeller or a similar device (8) fitted outside said chamber (4), c h a - r a c t e r i z e d in that means (12, 17) are provided in connection with the arrangement for pressurizing said substantially sealed chamber (4) with air or some other pressurizing gaseous medium.

2. An arrangement according to claim 1, c h a r a c t e - r i z e d in that the pressure in the chamber (4) is higher than the pressure in a ship's compartment (15) located above said chamber (4), suitably higher than the hydrostatic pressure prevailing between the chamber's (4) bottom and the level of a discharge pipe (18) located in the interior (15) of the ship, suitably at least substantially the same as the hydrostatic pressure of the water (2) surrounding the chamber (4) at the level of the propeller shaft (7), and preferably 0.1 to 1 bar higher, and/or higher than the dynamic pressure of the surrounding water (2) as measured at the level of the chamber's (4) bottom.

3. An arrangement according to claim 1 or 2, c h a r a c t e - r i z e d in that associated therewith is a pressure source (12) controlled by a pressure control unit (13) and/or means for providing a pressure in the medium, and means (17) for conducting said pressure/medium into said chamber (4), as well as means (16, 26) for closing the chamber (4) pressure-tightly against other compartments (11, 15) of the ship.

4. An arrangement according to any one of claims 1 to 3, c h a r a c t e r i z e d in that the arrangement includes means (18) for circulating the pressurizing medium via the chamber (4) and/or a part of it and back to the outside of the

chamber (4), favorably into an inlet to the pressure source (12), suitably in such a manner that the pressurizing gaseous medium has, in addition to the pressurization, also another feature and/or means (20) serving the arrangements in the chamber (4) for detecting, in a return circulation (18, 19), any extraneous substances possibly mixed with the pressurizing medium, and for appropriately separating such substances therefrom, and/or means for giving an alarm due to such substances.

5. An arrangement according to any one of claims 1 to 4, characterized in that the arrangement comprises means (19, 23, 24, 25) favorably operating together with the pressurization for feeding also other substances, especially liquid or gaseous substances such as oil, gas, water and/or cooling substance or similar in a controlled manner into the sealed chamber (4) and/or to devices (10) located therein, and/or correspondingly for removing such substances therefrom.

6. An arrangement according to any one of claims 1 to 5, characterized in that the feeding (25) of the pressurized medium is specifically arranged at such a point or near such a point where one has implemented an operational sealing between the chamber (4) and the surrounding water (2), specifically in conjunction with a pressure sealing (10) of the propeller shaft (7) and preferably in such a manner that the pressurizing medium as such and/or by means of a substance added to it contributes to the sealing and/or to the function of the gasket.

7. A method for managing fluid flows in a ship's propulsion and/or steering unit arrangement which is at least partly surrounded by water, which unit includes an electric motor (5) arranged in a substantially sealed chamber (4) formed by the walls of the unit, a propeller shaft (7) associated with said electric motor having a propeller or a similar device (8) fitted outside said substantially sealed chamber (4), characterized in that said substantially sealed chamber (4) is sealed (10, 16, 26) on the one hand against the water

pressure from outside and on the other hand correspondingly against the other compartments (11, 15) of the ship, that said chamber is pressurized by means of a flowing gaseous medium, that a monitoring of the pressure in the chamber (4) is performed performing (13, 21) and that the composition of the medium escaping in a controlled manner from the chamber (4) due to pressure is monitored (20).

8. A method according to claim 7, characterized in that in the chamber (4) such a pressure is maintained which pressure substantially as such is capable to push, via discharging means (18, 19), any fluids accumulating in the chamber and/or fluids fed into it out of the chamber (4) and/or from devices located therein, especially from bearings (6).

9. A method according to claim 7 or 8, characterized in that the pressure is directed (24) to a system (23) holding another medium such as oil or similar in such a manner that the medium in question will be transported (25) in an enhanced manner to the an desired object (10) in the chamber (4).

10. A method for improving cooling in a ship's propulsion and/or steering unit at least partly surrounded by water, which unit comprises an electric motor (5) located in a substantially sealed chamber (4) formed by the walls of the unit, a propeller shaft (7) associated with said electric motor having a propeller or a similar device (8) fitted outside said substantially sealed chamber (4), characterized in that a gaseous medium is conducted into said substantially sealed chamber (4), that the thermal conductivity of said gaseous medium is increased by means of a a pressurization of said chamber (4), and that the heat generated by said electric motor (5) is made to pass through the chamber (4) walls directly into the surrounding water (2) by means of the pressurized gaseous medium.