

PROPELLER ARRANGEMENT

TECHNICAL FIELD

Embodiments herein relate to propeller arrangements, and in particular to propeller arrangements comprising a propeller, a propeller shaft assembly comprising a shaft
5 portion extending from a distal side of the propeller, a support member arranged to be connected to a hull of the marine vessel, and a bearing arrangement interconnecting the support member and the shaft portion.

BACKGROUND

Marine vessels, such as cargo vessels, supply vessels, navy marine vessels and pleasure
10 vessels, of today are generally furnished with a propulsion system with a propeller connected to an engine of the vessel via a shaft assembly which is supported in a stern tube of the vessel by means of at least one bearing.

The bearings support the weight of the propeller shaft and of the propeller. In many large
15 marine vessels, the propellers used are very large and heavy, and the bearings as well as the other parts of the propeller arrangements are subjected to great strain, such as torsional and bending stress, during operation of the propeller arrangement.

In particular, the torsional stress exerted to the different components of the propeller
20 arrangements during operation are challenging, and the different components of the propeller arrangements have to be designed and constructed in a way to cope with the torsional stress. This often leads to complex designs of the different components.

In general, operating very large propellers at low rotational speeds is particularly
25 demanding to the bearings supporting the propeller shaft assembly. As an example, continuously operating a propeller having a diameter of at least six meters at less than 10 revolutions per minute is considered operating a large propeller at a low rotational speed. Common problems with known arrangements are bearing fatigue damage and shaft elements fatigue life reduction.

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As such, there is a need for improvements of the prior art propeller arrangements.

SUMMARY

In view of the discussion above, it is an object for embodiments herein to provide a propeller arrangement which addresses one or more of the above drawbacks, or which provides for a useful alternative.

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According to a first aspect, the object is at least partially achieved by means of a propeller arrangement for a marine vessel, which propeller arrangement comprises a propeller, a propeller shaft assembly comprising a shaft portion extending from a distal side of the propeller, a support member arranged to be connected to a hull of the marine vessel, and
 10 a bearing arrangement interconnecting the support member and the shaft portion. The support member comprises at least one cooling fluid conduit for accommodating and circulating a first cooling fluid within the support member and further to the shaft portion and/or to the bearing arrangement.

- 15 The provision of a support member implies that a bearing for supporting the shaft assembly is positioned outside of the torsional domain of the propeller arrangement, and the load exerted to other bearings of the propeller arrangement is reduced. Thanks to the possibility to cool down the first cooling fluid by means of circulating it within the support member, the first cooling fluid the first cooling fluid itself is cooled in an efficient way, and
 20 can also cool the bearing arrangement efficiently. Therefore the risk of burning of the bearing is reduced.

- According to an embodiment of the first aspect the shaft portion is tubular and comprises at least one passage for guiding the first cooling fluid from an interior space of the shaft
 25 portion to the bearing arrangement, so as to allow the first cooling fluid to lubricate the bearing arrangement. The use of one single fluid as both lubricant and cooling fluid for the bearing results in a simplified arrangement in which the risk for overheating of the lubricant is reduced. The temperature of the lubricant is important to bearing functionality e.g. because the viscosity of the lubricant depends on its temperature, and keeping the
 30 lubricant at a low temperature is thus very profitable. According to this embodiment, the bearing lubrication fluid can be kept at low temperature where its viscosity is maintained sufficiently high for allowing the bearing to work in a hydrodynamic mode. Operating a large propeller at a low rotational speed, which in general results high stresses exerted to the different components of the propeller arrangements and heating of the bearing

lubrication fluid, is thereby facilitated. The minimum allowed running speed of large propellers may therefore be reduced.

According to an embodiment of the first aspect the bearing arrangement has a housing
 5 comprising at least one channel for guiding a second cooling fluid through the bearing housing. Thereby, a second cooling system for the bearing is achieved such that the bearing is cooled in a two-stage manner. This results in an even more efficient cooling, and a reduced risk for burning of the bearing.

10 According to an embodiment of the first aspect the at least one channel has an inlet arranged to receive the second cooling fluid from an exterior of the housing. Thereby, ambient water may be used as a second cooling fluid.

According to an embodiment of the first aspect the support member comprises means for
 15 monitoring and/or controlling the load subjected to the bearing arrangement. Since the support structure is connected to the hull, the load subjected to the bearing arrangement can thus be monitored and/or controlled without docking the vessel.

According to an embodiment of the first aspect the propeller arrangement comprises a
 20 pitch changing mechanism for controlling the pitch settings of at least one propeller blade of the propeller, and a hydraulic fluid distribution unit arranged to supply a hydraulic fluid to the pitch changing mechanism from the distal side of the propeller. Thereby, arrangements comprising controllable pitch propellers having the advantages of the first aspect can be manufactured in a simple way, taking profit of the support member. When
 25 the hydraulic fluid distribution unit is positioned in that way, it is not subjected to the torsional stresses that it would have been if positioned somewhere between the propeller and the main engine.

According to an embodiment of the first aspect the hydraulic fluid distribution unit is
 30 arranged to supply the first cooling fluid to the pitch changing mechanism. Thereby, a simplified arrangement is achieved.

According to an embodiment of the first aspect the support member is part of one of a rudder stock, a hydrofoil bracket or a propeller nozzle of the marine vessel. Thereby, one

single component may have several functions, resulting in a simplified arrangement which may be manufactured in a cost-efficient way

According to a second aspect, the object is at least partially achieved by means of a
5 propeller arrangement comprising a propeller having a hub and at least one propeller
blade connected to the hub, the propeller being adapted to be connected to a shaft
assembly via a proximal side of the propeller, and a pitch changing mechanism for
controlling the pitch settings of the at least one propeller blade. The pitch changing
mechanism is operating said pitch settings of the at least one propeller blade via a distal
10 side of the propeller, which distal side is positioned opposite to the proximal side.

According to an embodiment of the second aspect the propeller arrangement comprises a
hydraulic fluid distribution unit adapted to supply a hydraulic fluid to the pitch changing
mechanism at a distal side of the propeller. Thereby, the shaft assembly does not have to
accommodate pipes for conveying hydraulic fluid from the hydraulic fluid distribution unit
15 to the pitch changing mechanism, and may have a more simple construction than what is
the case for prior art arrangements.

According to an embodiment of the second aspect the propeller arrangement comprises
a propeller shaft assembly comprising a shaft portion extending from a distal side of the
20 propeller, a support member arranged to be connected to a hull of a marine vessel, and a
bearing arrangement interconnecting the support member and the shaft portion. The
presence of a support structure ensures that deflection of the shaft is minimized and the
life of the bearings may be prolonged. Furthermore, the presence of a support structure
enables moving the hydraulic fluid distribution unit out of the torsional domain. Thereby,
25 the hydraulic fluid distribution unit may have a simpler construction, than if it would have
been positioned between the propeller and the engine of the vessel. This simpler
construction does not have to take torsional vibrations into consideration.

According to an embodiment of the second aspect the support member comprises at least
30 one cooling fluid conduit for accommodating and circulating a first cooling fluid within the
support member and further to the shaft portion and/or to the bearing arrangement.
Thanks to the possibility to cool down the lubrication fluid of this bearing by means of
circulating it within the support member, the lubrication fluid will not become too warm,
and the risk of burning of the bearing is reduced. The lubrication fluid can be kept at low

temperature where its viscosity is maintained sufficiently high for allowing the bearing to work in a hydrodynamic mode.

According to an embodiment of the second aspect the shaft portion is tubular and
 5 comprises at least one passage for guiding the first cooling fluid from an interior space of the shaft portion to the bearing arrangement, so as to allow the first cooling fluid to lubricate the bearing arrangement. Moreover the use of one single fluid as both lubricant and cooling fluid for the bearing results in a simplified arrangement, in which the risk for overheating of the lubricant is reduced.

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According to an embodiment of the second aspect the bearing arrangement has a housing comprising at least one channel for guiding a second cooling fluid through the bearing housing. Thereby, a second cooling system for the bearing is achieved such that the bearing is cooled in a two-stage manner. This results in an even more efficient
 15 cooling, and a reduced risk for burning of the bearing.

According to an embodiment of the second aspect the support member accommodates a controlling unit for manually controlling the pitch settings of the at least one propeller blade. Since the support member is connected to the hull, this makes it possible to
 20 manually control the pitch settings of the propeller in emergency situations and/or in case of breakdown of the hydraulic system for changing the pitch settings. Then it is possible sail safely to nearest harbor without towing the vessel.

According to an embodiment of the second aspect the support member is part of one of a
 25 rudder stock, a hydrofoil bracket or a propeller nozzle of the marine vessel. Thereby, one single component may have several functions, resulting in a simplified arrangement which may be manufactured in a cost-efficient way.

According to embodiments herein, the propeller arrangement is a propulsion
 30 arrangement.

According to third aspect, the object is at least partially achieved by means of a marine vessel comprising a propeller arrangement according to any the first two aspects. The advantages and benefits of a marine vehicle according to the third aspect are the same as
 35 for the first two aspects.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, embodiments herein will be described in greater detail by way of example
5 only with reference to attached drawings, in which

Fig. **1** is a schematic side view of a propeller arrangement according to a first embodiment.

Fig. **2** is a detail view of a portion of the arrangement shown in Fig. **1**.

Fig. **3** is a schematic cross-sectional view, taken along line A-A of Fig. **2**.

10 Fig. **4** is a schematic cross-sectional view, taken along line B-B of Fig. **1**.

Fig. **5** is a schematic side view of a propeller arrangement according to a second embodiment.

Fig. **6** is a schematic side view of a propeller arrangement according to a third embodiment.

15 Fig. **7** is a schematic side view of a propeller arrangement according to a fourth embodiment

Fig. **8** is a detail view of a portion of the arrangement shown in Fig. **7**.

Fig. **9** is a schematic cross-sectional view, taken along line A-A of Fig. **8**, in which view some of the parts shown in Fig. **8** are omitted.

20 Fig. **10** is a schematic cross-sectional view, taken along line B-B of Fig. **7**.

Fig. **11** is a schematic side view of a propeller arrangement according to a fifth embodiment.

Fig. **12** is a schematic side view of a propeller arrangement according to a sixth embodiment.

25 Still other objects and features of embodiments herein will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits hereof, for which reference should be made

to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

DEFINITIONS

5 As used herein the following terms have the following meanings:

The terms "proximal" and "distal" are used with reference to an axial direction of the propeller. The "proximal side" of a propeller is the side receiving the propeller shaft which is in working cooperation with a drive source of the propeller, such as a diesel engine, or
10 an electrical motor. The "distal side" of the propeller is positioned opposite to the proximal side.

In the exemplary embodiments shown in the drawings herein, the proximal side of the propeller is thus the forward side of the propeller, whereas the distal side is the aft side of
15 the propeller.

The "torsional domain" of the propeller arrangement extends from the engine, which is the torque source, to the propeller, which is the torque absorber.

20 DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments herein will be described more fully hereinafter with reference to the accompanying drawings. In the drawings, like numbers refer to like elements.

In Fig. 1, a rear portion of a marine vessel, with a propeller arrangement **100** according to
25 an embodiment herein is schematically shown. The marine vessel may e.g. be a cargo vessel or a supply vessel.

The propeller arrangement comprises a propeller **110** having a hub **111** and at least one propeller blade **112** extending from the hub **111**. The hub may e.g. have a cylindrical,
30 conical or barreled shape. The propeller **110** shown in Fig. 1 comprises four propeller blades **112**, extending from the hub **111**. According to some embodiments herein, the propeller diameter, i.e. the diameter of the imaginary circle scribed by the blade tips as the propeller rotates, is at least **4** meters.

The propeller has a proximal side **114** extending to a proximal end **116** of the propeller **110**, and a distal side **115** extending to a distal end **117** of the propeller **110**. In the embodiment shown in Fig. 1, the proximal end **116** of the propeller **110** is a proximal end
 5 of the propeller hub **111** and the distal end **117** of the propeller **110** is a distal end of the hub **111**.

The propeller **110** is connected to an engine (only the crank shaft **10** of which is shown) of the marine vessel via a propeller shaft assembly **120** which is supported in a stern tube of
 10 the marine vessel. The propeller shaft assembly **120** has a first portion **121** which is positioned adjacent to the proximal end **116** of the propeller **110**. This first portion **121** is supported by an aft stern tube bearing **11** and is received in an opening in the proximal end **116** of the propeller hub **111**.

15 The propeller shaft assembly **120** extends through the propeller **110** and has a second portion **122** which extends beyond the distal end **117** of the propeller **110**.

A bearing arrangement **140** interconnects the second shaft portion **122** and a first end of a support member **130**. A second end of the support member is connected to a hull **2** of the
 20 vessel. Mounting flanges **139** and a sealing packing may be arranged to secure the support member to the hull **2** in a proper way. As shown in Fig. 1 the support member may be positioned adjacent to a rudder **3** of the vessel. The support member **130** in the embodiment shown in Fig. 1 is not connected to the rudder **3** however. According to other embodiments, such as the one of Fig. 5, the support member is connected to the rudder
 25 **3**. Since the torsional domain of the propeller arrangement **100** extends from the engine of the vessel to the propeller **110**, the bearing arrangement **140** is positioned outside of this torsional domain.

A detail view of the first end of the support member **130** and the bearing arrangement **140**
 30 is shown in Fig. 2. The bearing arrangement **140** has a bearing housing **141** which may be integrally formed with the support member **130**. A sealing member **126** is arranged between the bearing arrangement **140** and the propeller hub (not shown). The portion of the support member **130** which houses the bearing arrangement **140** may have a variety of shapes, such as a hydrodynamic optimized shape to reduce the water resistance.

The second shaft portion **122** is tubular, with an internal space **123** surrounded by a wall **124**. The second shaft portion **122** functions as the journal **122** of a journal bearing **140** with a bearing housing **141** surrounding the journal **122**.

- 5 In the following, an arrangement for cooling and lubricating the bearing arrangement **140** by means of a first cooling fluid will be described.

The support member **130** comprises an inlet conduit **131** for transporting a first cooling fluid from the second end of the support member **130** towards the bearing arrangement
10 **140**. The inlet conduit **131** is shown in Figs. **1** and **2**.

The cooling fluid arriving to the interior space **123** of the second shaft portion **122** is used to cool the bearing arrangement **140** from the interior space **123** of the second shaft portion **122**.

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A cross section of the bearing arrangement **140** is shown in Fig. **3**. Between the wall **124** of the second shaft portion **122** and the bearing housing **141** there is a lubricant accommodating space **143** arranged to accommodate a lubricating fluid.

- 20 The wall **124** of the second shaft portion **122** comprises a passage **125**. The passage allows the first cooling fluid to pass from the interior space **123** to the lubricant accommodating space **143** between wall **124** of the second shaft portion **122** and the bearing housing **141**. Thereby, the first cooling fluid will also function as a bearing lubricant.

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As shown in Fig. **1**, there may be a difference in altitude between the bearing arrangement **140** and a support member receiving portion of the hull **2**. The first cooling fluid is heated in the bearing arrangement **140**, and the first cooling fluid leaving the bearing arrangement **140** will therefore have a lower density than the first cooling fluid
30 entering the bearing arrangement **140**. As long as there is a difference in altitude between the bearing arrangement **140** and a support member receiving portion of the hull **2** the first cooling fluid leaving the bearing arrangement **140** will automatically rise towards the hull, within the support member **130**, whereas cooling fluid having a lower temperature and thereby a higher density will descend towards the bearing arrangement **140**. A pump
35 assembly (not shown) may be arranged to facilitate circulation of the first cooling fluid.

During its passage through the support member **130**, the first cooling fluid will be cooled. As shown in Fig. 1, an outlet conduit **132** may be arranged adjacent to the second end of the support member **130** to allow the cooling fluid to leave the support member **130**. The first cooling fluid rising towards the hull **2** within the support member **130** may flow freely within a hollow space **133** defined within the support member **130**. When the first cooling fluid has passed through the outlet conduit **132**, it will be circulated back towards the bearing arrangement via the inlet conduit **131**. The first cooling fluid may flow in a closed circuit. According to some embodiments, the first cooling fluid flows in a closed circuit within the support member **130** and in an area adjacent to the second end of the support member **130**.

The first cooling fluid may be oil having a viscosity of at least **50** cSt. The first cooling fluid may have a variety of compositions. According to an embodiment, mineral oil is used, but also other kinds of cooling fluids can be used, as long as they will function properly as lubricants as well.

As shown in Fig. 1, a bearing adjusting disc **137** may be arranged within or next to the support member **130**. The bearing adjusting disc **137** may be used to adjust a vertical position of the bearing arrangement. Furthermore, a load sensor **138** may be arranged within or next to the support member **130**, as shown in Fig. 1. The load sensor may be used to monitor the load applied to the bearing arrangement **140**. According to some embodiments an arrangement **138** for monitoring as well as controlling the load is used.

In the following an arrangement for cooling the bearing arrangement by means of a second cooling fluid will be described.

As shown in Fig. 3, the bearing housing **141** comprises a plurality of passages **142**. The passages **142** extend in an axial direction of the bearing housing **141** and are arranged to accommodate a second cooling fluid. The passages **142** may have inlets arranged to receive the second cooling fluid incoming from an exterior of the bearing arrangement **140**. Correspondingly, the passages may have outlets for discharging the first cooling fluid to the exterior of the bearing arrangement **140**. The cooling arrangement achieved by means of the passages **142** will then be an open circuit arrangement. When the propeller **100** is submersed into water and rotates, ambient water may enter into the passages **142**

automatically. Guiding means may be provided to facilitate guiding of water towards the inlets.

A second embodiment is shown in Fig. 5. The embodiment shown in Fig. 5 differs from the embodiment of Fig. 1 in the configuration of the support member 130. The support member 130 shown in Fig. 5 is connected to a non-rotating part of the rudder 3. The non-rotating part of the rudder is connected to a rudder stock. According to other embodiments, the support member 130 is connected to the rudder stock or is integrally formed with the rudder stock.

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A third embodiment is shown in Fig. 6. In the embodiment shown in Fig. 6, the support member 130 is part of a propeller nozzle.

In Fig. 7, a rear portion of a marine vessel, with a propeller arrangement 100 according to an embodiment herein is schematically shown. The marine vessel may e.g. be a cargo vessel or a supply vessel. The propeller arrangement comprises a propeller 110 having a hub 111 and at least one propeller blade 112 extending from the hub 111. The hub may e.g. have a cylindrical, conical or barreled shape. The propeller 110 shown in Fig. 7 comprises four propeller blades 112, extending from the hub 111. According to some embodiments herein, the propeller diameter, i.e. the diameter of the imaginary circle scribed by the blade tips as the propeller rotates, is at least 4 meters.

The propeller has a proximal side 114 extending to a proximal end 116 of the propeller 110, and a distal side 115 extending to a distal end 117 of the propeller. In the embodiment shown in Fig. 7, the proximal end 116 of the propeller 110 is a proximal end of the propeller hub 111 and the distal end 117 of the propeller 110 is a distal end of the hub 111.

The propeller 110 is connected to an engine (only the crank shaft 10 of which is shown) of the marine vessel via a propeller shaft assembly 120 which is supported in a stern tube of the marine vessel. The propeller shaft assembly 120 has a first portion 121 which is positioned adjacent to the proximal end 116 of the propeller 110. This first portion 121 is supported by an aft stern tube bearing 11 and is received in an opening in the proximal end 116 of the propeller hub 111.

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The propeller shaft assembly **120** extends through the propeller **110** and has a second portion **122** which extends beyond the distal end **117** of the propeller **110**.

A bearing arrangement **140** interconnects the second shaft portion **122** and a first end of a support member **130**. A second end of the support member is connected to a hull **2** of the vessel. Mounting flanges **139** and a sealing packing may be arranged to secure the support member to the hull **2** in a proper way. As shown in Fig. **7** the support member may be positioned adjacent to a rudder **3** of the vessel. The support member **130** in the embodiment shown in Fig. **7** is not connected to the rudder **3** however. Since the torsional domain of the propeller arrangement **100** extends from the engine of the vessel to the propeller **110**, the bearing arrangement **140** is positioned outside of this torsional domain.

A detail view of the first end of the support member **130** and the bearing arrangement **140** is shown in Fig. **8**. The bearing arrangement **140** has a bearing housing **141** which may be integrally formed with the support member **130**. A sealing member **126** is arranged between the bearing arrangement **140** and the propeller hub (not shown). The portion of the support member **130** which houses the bearing arrangement **140** may have a variety of shapes, such as a hydrodynamic optimized shape to reduce the water resistance.

The second shaft portion **122** is tubular, with an internal space **123** surrounded by a wall **124**. The second shaft portion **122** functions as the journal **122** of a journal bearing **140** with a bearing housing **141** surrounding the journal **122**.

The propeller **110** shown in Fig. **7** is a controllable pitch propeller. The propeller arrangement **100** comprises a hydraulic pitch changing mechanism **150** arranged to change the pitch settings of the propeller blades **112**. The pitch changing mechanism **150** is shown in Fig. **8**. In Fig. **8**, a hydraulic fluid distribution unit **160** arranged to distribute hydraulic fluid to the pitch changing mechanism **150** is also indicated. The hydraulic fluid distribution unit **160** in this embodiment is an oil distribution (OD) box.

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According to the embodiment shown in Fig. **8**, the hydraulic fluid distribution unit **160** is arranged within the support member **130**, aft of the bearing arrangement **140**. Thereby, it is positioned out of the torsional domain of the propeller arrangement.

In many known arrangements, the hydraulic fluid distribution unit **160** is positioned adjacent to the propeller shaft assembly **120** somewhere between the propeller **110** and the engine of the vessel, i.e. in the torsional domain. Then, the hydraulic fluid distribution unit **160** has to be designed so as to cope with the torsional vibration stress subjected to
 5 it, and the propeller shaft assembly must comprise conduits for leading the hydraulic fluid from the hydraulic fluid distribution unit to the propeller.

When the hydraulic fluid distribution unit **160** is positioned as indicated in Fig. **7**, the propeller shaft assembly **120** does not have to comprise any hydraulic fluid conduits, and
 10 may be designed in a simpler and more robust way. Thereby, more cost-efficient propeller arrangement may be manufactured. Designing the shaft assembly in a more robust way may prolong the life time of the shaft assembly.

Furthermore, due to its position outside the torsional domain, the hydraulic fluid
 15 distribution unit **160** according to embodiments herein is not subjected to the torsional stress which is subjected to hydraulic fluid distribution units of known arrangements. Since the effect of torsional stress does thus not have to be taken into account when designing the hydraulic fluid distribution member **160** according to embodiments herein it can be designed in a simpler and more cost efficient way, than what is the case for known
 20 arrangements.

The support member **130** may comprise hydraulic pitch control pipes **151** used to transport hydraulic fluid to and from the hydraulic fluid distribution unit **160** and/or the pitch changing mechanism **150**. The hydraulic pitch control pipes **151** are indicated in Figs. **7**, **8**
 25 and **10**.

The support member may comprise a controlling unit **136** for manually controlling the pitch settings of the at least one propeller blade **112**. Since the support member is connected to the hull **2**, this makes it possible to manually control the pitch settings of the
 30 propeller in emergency situations and/or in case of breakdown of the hydraulic pitch changing mechanism **150**. The controlling unit **136** may comprise wires used to manually change the pitch settings. Such wires are indicated in Figs. **8** and **10**.

The propeller arrangement with a controllable pitch propeller according to the above
 35 description may also comprise a cooling arrangement as described below.

The support member **130** comprises an inlet conduit **131** for transporting a first cooling fluid from the second end of the support member **130** towards the bearing arrangement **140**. The inlet conduit **131** is shown in Figs. **7** and **8**.

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The cooling fluid arriving to the interior space **123** of the second shaft portion **122** is used to cool the bearing arrangement **140** from the interior space **123** of the second shaft portion **122**.

- 10 A cross section of the bearing arrangement **140** is shown in Fig. **9**. Between the wall **124** of the second shaft portion **122** and the bearing housing **141** there is a lubricant accommodating space **143** arranged to accommodate a lubricating fluid.

- The wall **124** of the second shaft portion **122** comprises a passage **125**. The passage
15 allows the first cooling fluid to pass from the interior space **123** to the lubricant accommodating space **143** between wall **124** of the second shaft portion **122** and the bearing housing **141**. Thereby, the first cooling fluid will also function as a bearing lubricant.

- 20 As shown in Fig. **7**, there may be a difference in altitude between the bearing arrangement **140** and a support member receiving portion of the hull **2**. The first cooling fluid is heated in the bearing arrangement **140**, and the first cooling fluid leaving the bearing arrangement **140** will therefore have a lower density than the first cooling fluid entering the bearing arrangement **140**. As long as there is a difference in altitude between
25 the bearing arrangement **140** and a support member receiving portion of the hull **2** the first cooling fluid leaving the bearing arrangement **140** will automatically rise towards the hull, within the support member **130**, whereas cooling fluid having a lower temperature and thereby a higher density will descend towards the bearing arrangement **140**. A pump assembly (not shown) may be arranged to facilitate circulation of the first cooling fluid.

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- During its passage through the support member **130**, the first cooling fluid will be cooled. As shown in Fig. **7**, an outlet conduit **132** may be arranged adjacent to the second end of the support member **130** to allow the cooling fluid to leave the support member **130**. The first cooling fluid rising towards the hull **2** within the support member **130** may flow freely
35 within a hollow space **133** defined within the support member **130**. When the first cooling

fluid has passed through the outlet conduit **132**, it will be circulated back towards the bearing arrangement via the inlet conduit **131**. The first cooling fluid may flow in a closed circuit. According to some embodiments, the first cooling fluid flows in a closed circuit within the support member **130** and in an area adjacent to the second end of the support member **130**.

The first cooling fluid may be oil having a viscosity of at least **50** cSt. The first cooling fluid may have a variety of compositions. According to an embodiment, mineral oil is used, but also other kinds of cooling fluids can be used, as long as they will function properly as lubricants as well.

As shown in Fig. **9**, the bearing housing **141** comprises a plurality of passages **142**. The passages **142** extend in an axial direction of the bearing housing **141** and are arranged to accommodate a second cooling fluid. The passages **142** may have inlets arranged to receive the second cooling fluid incoming from an exterior of the bearing arrangement **140**. Correspondingly, the passages may have outlets for discharging the first cooling fluid to the exterior of the bearing arrangement **140**. The cooling arrangement achieved by means of the passages **142** will then be an open circuit arrangement. When the propeller **100** is submersed into water and rotates, ambient water may enter into the passages **142** automatically. Guiding means may be provided to facilitate guiding of water towards the inlets.

Another embodiment is shown in Fig. **11**. The embodiment shown in Fig. **11** differs from the embodiment of Fig. **7** in the configuration of the support member **130**. The support member **130** shown in Fig. **11** is connected to a non-rotating part or the rudder **3**. The non-rotating part of the rudder is connected to a rudder stock. According to other embodiments, the support member is integrally formed with the rudder stock.

Another embodiment is shown in Fig. **12**. In the embodiment shown in Fig. **12**, the support member **130** is part of a propeller nozzle.

According to some embodiments, the hydraulic fluid used by the pitch changing mechanism **150** is the same fluid as the first cooling fluid described above. This integration of several systems facilitates manufacturing of a compact and simple propeller arrangement.

The embodiments herein are not limited to the above described embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention, which is defined
5 by the appending claims.

CLAIMS

1. A propeller arrangement for a marine vessel, the propeller arrangement comprising
 - a propeller;
 - a propeller shaft assembly comprising a shaft portion extending from a distal side of the propeller;
 - a support member arranged to be connected to a hull of the marine vessel;
 - a hollow space defined within the support member;
 - a bearing arrangement housed in the support member and interconnecting the support member and the shaft portion; and
 - at least one cooling fluid conduit disposed within the hollow space and configured to accommodate and circulate a first cooling fluid within the support member and further to the shaft portion and/or to the bearing arrangement;
 - wherein the first cooling fluid leaving the shaft portion and/or the bearing arrangement can flow freely within the hollow space.
2. The propeller arrangement according to claim 1, wherein the shaft portion is tubular and comprises at least one passage for guiding the first cooling fluid from an interior space of the shaft portion to the bearing arrangement, so as to allow the first cooling fluid to lubricate the bearing arrangement.
3. The propeller arrangement according to any of the preceding claims, wherein the bearing arrangement has a housing comprising at least one channel for guiding a second cooling fluid through the bearing housing.
4. The propeller arrangement according to claim 3, wherein the at least one channel has an inlet arranged to receive the second cooling fluid from an exterior of the housing.
5. The propeller arrangement according to any of the preceding claims, wherein the support member comprises means for monitoring and/or controlling the load subjected to the bearing arrangement.
6. The propeller arrangement according to any of the preceding claims, wherein the propeller arrangement comprises
 - a pitch changing mechanism for controlling the pitch settings of at least one propeller blade of the propeller,
 - a hydraulic fluid distribution unit arranged to supply a hydraulic fluid to the pitch changing mechanism from the distal side of the propeller.

7. The propeller arrangement according to claim 6, wherein the hydraulic fluid distribution unit is arranged to supply the first cooling fluid to the pitch changing mechanism.
8. The propeller arrangement according to any of the preceding claims, wherein the support member is part of one of a rudder stock, a hydrofoil bracket or a propeller nozzle of the marine vessel.
9. A marine vessel comprising a propeller arrangement according to any of claims 1-8.