ABSTRACT

A ship's propeller, drive shaft and bearing support design which will locate the bearing from its traditionally forward position to a position within the center of gravity of the propeller and seal the bearing from sea water with non-rubbing parts comprising a labyrinth seal is described.
MARINE PROPELLER STERN BEARING-SHAFT DESIGN AND SEAL ARRANGEMENT

BACKGROUND OF THE INVENTION

The development of cargo vessels and particularly tanker vessels has taken giant strides in recent years to the point that the "Super Tankers" of a few years ago are small by comparison with those vessels now under construction. On the other hand, the design of marine propulsion systems still relies upon one or more propellers, a shaft and bearing arrangement which can accept their required loads and stresses. Furthermore, more reliable lubrication of the bearing and improved seal assemblies are constantly being sought to reduce well known problems associated with even small vessels.

SUMMARY OF THE INVENTION

The present invention is concerned with a marine propeller, shaft and bearing support means which will more completely satisfy the needs of modern day ship operation. Thus the present invention is particularly concerned with a propeller and shaft support means and seal arrangement that will reduce heretofore experienced vibration problems and unreliable lubrication of the support bearing. In one aspect the present invention is concerned with locating the bearing support for a large ship's propeller with respect to the stern frame so that the bearing is more in vertical alignment with the forces acting upon the propeller.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts diagrammatically the stern view of a vessel particularly at the stern frame which supports the propeller in combination with the propeller drive shaft.

FIG. 11 diagrammatically depicts in substantially greater detail a half portion of the stern arrangement including propeller drive shaft, support bearing and seal arrangement generally depicted in FIG. 1.

FIG. III diagrammatically shows in cross-sectional arrangement a labyrinth seal used in the assembly of FIG. II.

FIG. IV diagrammatically shows a detail of the drive ring intermediate a propeller hub and the drive shaft.

DESCRIPTION OF SPECIFIC EMBODIMENTS

A ship's propeller has traditionally been secured to the end of a shaft which issues from a stern tube at the after end of a vessel. The weight of such a propeller can vary immensely and large ships' propellers working in the stern aperture, due to the cantilever suspension cause the unsupported end of the shaft to vary from alignment and such variation is amplified as forces acting on the propeller are varied. Thus the propeller shaft may bend or whip as often referred to during use thus complicating problems of alignment, bearing design, undesired vibration as well as increasing the problems with respect to seals and lubrication. Thus any design improvement reducing these problems is a welcome improvement.

The present invention is concerned with an improved design changing the relationship of propeller, shaft and bearing support so as to move the location of the bearing from its traditionally forward position to a position within the center of gravity of the propeller and effecting improved sealing of the bearing to exclude undesired travel of lubricant and sea water through the seal. Thus the present concept improves upon excluding sea water from the lubricated bearing. In yet another aspect the change in relationship between the propeller, shaft and bearing support is identified with reducing propeller induced vibration, increasing the permissible power which may be transmitted through a single shaft-propeller arrangement and increasing the time between dry-docking the vessel for servicing propeller bearings and seals. Other advantages of the improved assembly will be more apparent from the following discussion.

FIG. I generally depicts the stern view of a vessel particularly at the propeller location. The propeller 2 with its hub 4 is connected through a drive ring 6 to the propeller tail shaft 8. Retaining nut 10 maintains drive ring 6 and the shaft through a spline connection in rigid contact with one another. The described propeller, hub, drive ring and shaft assembly is supported by a bearing 12 between the propeller hub and the journal which is an extension of the stern frame 14 through which the shaft extends. The journal may be a part of the stern frame or a stern tube may be inserted in and rigidly connected to the stern frame whichever is more suitable during construction. The bearing 12 is sealed from sea water by seal 18 more completely discussed hereinafter. FIG. II diagrammatically depicts in greater detail a half portion of the arrangement of propeller, shaft, bearing and sealing arrangement generally discussed with respect to FIG. I, and FIG. III provides even greater detail of the sealing arrangement to be used in the improved propeller stern design of this invention.

In the arrangement of FIG. II, a portion of the propeller blade 2 and its associated hub portion 4 is shown bolted to drive ring 6. Drive ring 6 is provided with a protrusion or keys as shown in FIG. IV, which mesh with corresponding depressions in the hub to provide a coupling arrangement therebetween for transmitting torque to the propeller through the drive ring 6 which is spline connected to the propeller shaft 8. The drive ring 6 is fixedly positioned on the shaft end through a splined coupling to transmit torque from the shaft to the drive ring and is positioned on that shaft between an annular lip surface on the shaft and the retaining nut 10 screwed on the end of the shaft. An annular lip surface or thrust surface is provided against which the drive ring is compressed by retaining nut 10. As shown on the drawing the shaft extends through the journal of the stern frame into the ship's hull. A small annular space between the shaft and stern frame acts as an oil return passage. Thus the improved design of this invention has completely eliminated the undesired cantilever problem of the assemblies used heretofore. Therefore the major shaft loads are more satisfactorily distributed and supported by the journal of the stern frame due to the relocation of the load bearing surfaces. This has the advantage of further reducing the propeller induced vibrations which are known to be a problem in prior used arrangements.

The assembly of propeller, shaft, bearing and interconnecting drive ring above described offers further advantage to the ship owner in that the annular seal is free of rubbing surface engagement, while excluding sea water from the bearing and lubricating oil from leaking out into the sea. The operating advantages of the seal will be discussed in greater detail below.

The annular seal is positioned between the forward surface of the propeller hub and a substantially vertical
surface of the stern frame as generally depicted by reference numeral 20 on FIG. II. An annular ring 22 known as a rope guard protects the seal after installation and is rigidly affixed as by welding or other suitable method to the external surface of the stern frame to provide a slight clearance 24 between it and the propeller hub. In the arrangement of FIG. II, oil supply tubes 26 at about the 90 and 270° angle about the extension or journal 14 are provided to supply oil to the forward end of the bearing.

It is to be understood that several different seal arrangements may be used for seal 20. However, a preferred seal for this purpose is shown more particularly in FIG. III. The enlarged seal arrangement depicted by FIG. III is known as a labyrinth seal and comprises an annular assembly of parts which might be constructed from materials such as bronze, rubber, plastic and various combinations thereof which are related between fixed and rotating parts to form a seal having essentially no rubbing parts. A labyrinth is identified as a place full of intricate passageways. It is clear that the seal of FIG. III conforms to this definition. In the arrangement of FIG. III the cross sectional area 14 conforms to a portion of the stern frame journal as shown in FIG. II, cross sectional area 4 corresponds to the forward end of the propeller hub, 22 conforms to the rope guard, 12 represents a forward end of the bearing which is pressed into the propeller hub and passage 26 corresponds to the oil inlet for lubricating the bearing.

The labyrinth seal of FIG. III comprises a rotating portion rigidly attached to the propeller hub as shown and identified as rotating ring and a stationary ring which is rigidly attached to the stern frame. Upon close examination of the figure it will be observed that each of the rings are so positioned with respect to another as to provide for a tortuous path passageway or space therebetween and this tortuous path is made even more tortuous in certain selected horizontal portions thereof being a plurality of male and female annular protrusions related to one another but spaced apart from one another in an amount which will cause a pressure drop to exist in a fluid medium caused to move through the labyrinth passageway. In one specific arrangement such as shown in FIG. III, there is provided at least three independent or separate combinations of labyrinth passageways to provide a tortuous path for fluid flow between spaced apart matching hill and valley variations comprising the stationary and moving rings of the seal. In the arrangement of FIG. III the upper labyrinth passageway formed between the stationary and rotating members will operate to reduce the pressure of sea water entering between the members, the lower labyrinth passageway will operate to reduce the pressure of bearing oil from entering between the members and the intermediate labyrinth passageway will be pressurized with air or desalinated water or fresh water to exclude mixing of sea water and oil therein. The labyrinth passageways above discussed and shown on the drawing may be positioned horizontal to the shaft as shown or vertical thereto or inclined at an angle therefrom. In any of these arrangements it is important that the number of stages of fluid pressure drop developed be sufficient to accomplish the desired exclusion of oil and sea water from passing through the passageway beyond a desired point. Thus it is desirable to exclude sea water from contact with the bearing and oil from discharging into the sea and the combination of labyrinth passageways that will accomplish this through pressure reduction without encountering rubbing contact between stationary and moving parts is all that is required. Of course this seal design and selection will be influenced by the ship's draft.

In the arrangement of FIG. III, sea water will enter through space or opening 24 into the space between rotating member 30 fastened to hub 4 and stationary member 32. The sea water passes through the space 34 into the upper labyrinth seal passageway 36 and passes through space 38 and into an initial portion of the intermediate labyrinth seal passageway 40. An inlet or passageway 42 is provided for introducing air or other suitable fluid such as fresh water to a mid-portion of the intermediate labyrinth. On the other hand, oil introduced by passageway 26 to lubricate bearing 12 passes through opening 44 into the lower labyrinth passageway 46. The oil passes through the labyrinth with loss of pressure eventually passing through space 48 and thence into the end of the intermediate labyrinth 49 opposite to the sea water inlet end 40 wherein essentially balanced pressure conditions will prevail which will exclude substantially any further flow of either sea water or oil. Air or desalinated water introduced through 42 will help to obtain this balanced pressure condition. The water may be passed through passageway 42 to exclude sea water when the ship is docked for example.

FIG. IV is a detail of the drive ring and particularly the face surface between the drive ring and the propeller hub to show the method for coupling these surfaces to accept the loads imposed thereon. In this arrangement a plurality of bolts 50 about the peripheral surface of the drive ring rigidly connect it to the hub and shear forces are resisted by elevated sections or keys 52 with tapered sides which are matched to corresponding female recesses in the hub surface. Thus the bolts resist primarily direct tensile forces imposed in view of the elevated sections or keys 52 provided for particularly resisting the shear forces.

Having thus generally described the improved arrangement and design of an assemblage comprising a ship's propeller, drive shaft, seal and means for supporting the same in a vessel stern frame and discussed specific embodiments thereof, it is to be understood that no undue limitations are to be imposed by reason thereof except as provided by the following claims.

I claim:

1. A marine propulsion assemblage comprising in combination:

   a ship's stern frame comprising a cylindrical journal through which a propeller shaft extends,
   an oil passageway between said shaft and said cylindrical journal,
   a drive ring about the end of the shaft which is fastened thereto through splined connections and a retaining nut holding the drive ring against a thrust surface on said shaft,
   said drive ring spaced apart from the aft end of said cylindrical journal to permit a flow of oil therebetween,
   said drive ring fastened to the aft end of the hub of a ship's propeller circumscribing said cylindrical journal, said hub in contact with a bearing surface between said hub and the external surface of said cylindrical journal,
5 a seal forward of said bearing positioned between said propeller hub and said stern frame to exclude sea water from contacting said bearing.

2. The assemblage of claim 1 wherein the cylindrical journal is a cylindrical stern tube extending from said stern frame.

3. The assemblage of claim 1 wherein the drive ring is bolted to said hub and protruding teeth with matching depression therebetween resist shear loads.

4. The assemblage of claim 1 wherein lubricating oil is supplied to the forward and aft end of said bearing and said bearing is a part of said propeller hub.

5. The assemblage of claim 1 wherein the seal forward of said bearing may be one providing rubbing contact between stationary and moving surfaces to excluding lubricating oil and sea water from passing through the seal.

6. The assemblage of claim 1 wherein the seal comprises a plurality of interconnected labyrinth passageways between stationary and moving surfaces which are out of rubbing contact with one another, each of said labyrinth passageways providing a desired drop in pressure of the fluid passing therethrough and a labyrinth passageway intermediate the plurality of labyrinth passageways provided with means for injecting air or fresh water to provide a region of neutral pressure therein.

7. The assemblage of claim 1 wherein a rope guard is positioned to protect the seal and is rigidly affixed to the stern frame.

8. The assemblage of claim 1 wherein the bearing is positioned in vertical alignment with the center of gravity of the propeller.

9. The assemblage of claim 1 wherein the shaft is supported by the bearing between the hub and the journal and a single annular seal is relied upon to exclude oil from escaping and sea water from contacting the bearing.

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