

An arrangement for attaching a ship rudder to a rudder shaft, a rudder shaft, a ship rudder and a method for disassembly of a ship ship rudder from a rudder shaft

The present invention concerns an apparatus for attaching a ship rudder with a conical opening to a rudder shaft, a rudder shaft, a ship rudder with a conical opening in the rudder and a method for attaching a rudder shaft to a ship rudder.

During attachment of a ship rudder with a conical connection between the rudder and the rudder shaft, it has turned out that the current solutions result in limitations in optimisation of rudder design with respect to hydrodynamics, propulsion efficiency, installation processes and production costs.

Today, normally are rudders attached to the rudder shaft by means of a conical connection, where a hydraulic pressure is applied between the rudder and the rudder shaft in the conical surface and hydraulic pressure is applied to an assembly tool, normally designed as a nut with an internal hydraulic piston (hydraulic nut). The hydraulic nut is assembled to the lower part of the rudder shaft and pulls the rudder shaft down into the rudder. It is necessary with access to the nut through one or several openings in the rudder. When the assembly process has been performed, the assembly tool or nut is locked towards the rudder shaft and then acts as a safeguard against the rudder falling off if the conical connection should fail. The opening or openings in the rudder are thereafter closed with one or several covers. This solution is however unfavourable, in particular with large rudder shaft diameters, because the hydraulic nut becomes large and bulky, and is vulnerable to damages. Furthermore the opening or openings in the rudder for access to the hydraulic nut leads to unfavourable stress concentrations, and reduces the material cross section in this section of the rudder. This reduces the physical strength of the rudder, and this has to be compensated with a more bulky and heavy structure in the rudder. This again leads to increased production costs. Furthermore the rudder must physically include space for the hydraulic nut, and the thickness of the rudder may be dictated by this space. This poses further limitations for optimisation of the rudder design with respect to hydrodynamics and propulsion efficiency.

In JP 8-34397 it is shown a structure for assembly of a rudder and a rudder shaft with a conical portion and a system for hydraulic tightening.

With the assembly concept according to the present invention, it is used a conical connection corresponding to the one that already exists, as described above.

However the rudder shaft is designed toward the top of the rudder such that it is formed a chamber, that when a hydraulic pressure is applied substitute the assembly force that in the solution described above is provided by the hydraulic nut. When the assembly process has been performed, the chamber is tightened

with suitable units and this will then act as a safeguard to prevent the rudder from falling off if the conical connection should fail. With this solution it is achieved a lower number of and smaller components, and the requirement for an opening in the side of the rudder is eliminated. In this manner the structure of the rudder can be made more slender and lighter, and the production costs can be reduced. Of

the same reason may the rudder design to a greater extent be optimised with respect to hydrodynamics and propulsion efficiency. With a solution as defined in the present invention, it is in other words possible to achieve a connection

between the rudder and the rudder shaft with an assembly force from a hydraulic pressure in a chamber that is integrated in the rudder and the rudder shaft, and the assembly force can be applied in the conical connection between the rudder and the rudder shaft at the largest diameter of the cone. The conical connection between the rudder and the rudder shaft has accordingly an assembly process without any requirements of access to the smallest diameter of the cone. No

assembly tools or openings in the skin-plates of the rudder for access to the cone are required. Furthermore it is not required any threaded portion of the rudder shaft, a hydraulic nut, or a nut below the cone as a safeguard to prevent the rudder from falling off if the conical connection should fail.

Accordingly the present invention concerns an apparatus for attachment of a ship rudder with a conical opening to a rudder shaft with a corresponding conical part.

The rudder shaft includes, in a direction towards the rudder, a cylindrical portion followed by an expanded flange part with a cylindrical portion, followed by the conical portion of the rudder shaft. The rudder includes a rudder part and a flange

element or part for attachment in the rudder element. The flange element includes an inner cylindrical portion for mating, sliding and to sealingly surrounding the cylindrical portion of the rudder shaft. Furthermore it is provided channels for applying hydraulic pressure above the expanded flange part in the flange element.

5 The flange element can be tightened to the rudder element by means of means for tightening, typically bolts or a threaded ring/collar on the flange and the rudder part. The flange element also includes an inner cylindrical portion for sliding, mating arrangement around the cylindrical portion of the flange part of the rudder shaft.

10 The cylindrical portions ensure that it is formed a sealed chamber between the parts of the rudder shaft and the flange that can be exposed to hydraulic pressure to press the rudder shaft downwards in relation to the flange and the rudder part. Channels are provided for applying the hydraulic pressure between the rudder shaft and the flange part in an area between the cylindrical portion of the rudder shaft and the cylindrical portion of the expanded flange part. It is formed a chamber between the flange and the rudder shaft that is expanded when the hydraulic pressure presses these parts apart.

20 In the case bolts are used, these may extend between the rudder part and the flange part. The bolts are typically placed in a ring around the flange part.

In the case threaded rings are used to tighten the flange part to the rudder part, may this include external threads on the flange part and internal threads on the rudder part. In this case may the flange part include milled out sections for contact with a suitable tool for tightening purposes.

25 Furthermore may the apparatus include channels for applying hydraulic pressure between the conical opening in the rudder part and the conical portion of the rudder shaft for expanding the conical opening in the rudder part during assembly. The channels may typically be sealed with suitable sealing bolts or plugs when these not are in use.

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Sealing rings may be provided for sealing between the cylindrical portion of the rudder shaft and the inner cylindrical portion of the flange part and between the cylindrical portion of the expanded flange part of the rudder shaft and the inner cylindrical portion in the flange part to prevent leakage of hydraulic fluid during assembly and to prevent ingress of seawater between these elements. These sealing rings will during assembly act as piston rings between the cylindrical faces. The sealing rings will typically be made of an elastomeric material.

The conical opening in the rudder may extend into a bottom portion, and the rudder shaft includes an end portion. The bottom portion and the end portion may form a sealed chamber with a sealable supply channel for bleeding during assembly and for application of hydraulic pressure for disassembly. The bleeding ensures that no pressure undesirably is build up in the chamber during assembly.

It may be placed sealing rings between the conical portion of the rudder shaft and the conical opening at the upper part of the cone, near the flange, and at the lower part of the cone, near the end portion of the rudder shaft. The purpose of the sealing rings is to prevent ingress of seawater, and to reduce leakage of hydraulic fluid, such that a sufficient pressure is achieved during assembly.

The end portion of the rudder shaft may be substantially plane, as no attachment of a nut at the lower end of the rudder shaft is required.

Furthermore the invention concerns a rudder shaft for a ship rudder with a portion for attachment to a rudder adapted for being fixed to the rudder with an apparatus as described above. The portion includes, in a direction toward the rudder, a cylindrical portion followed by an expanded part with a cylindrical portion, followed by a conical portion.

The conical portion may further transfer into a plane end portion.

The rudder shaft may further include a step after the cylindrical part of the expanded portion.

Furthermore the invention concerns a ship rudder with a conical opening in the rudder adapted for attachment of a rudder shaft with an apparatus as described above. The rudder includes a rudder part, a flange part, and means for tightening
5 the flange part to the rudder part. The flange part includes at least one inner cylindrical portion, with a first diameter, for sealing, sliding contact with a rudder shaft, and at least one further cylindrical portion with a second diameter that is greater than the diameter of the first diameter, on the flange part.

10 The conical opening of the rudder part may end in a closed bottom portion of the lower end of the conical portion.

The rudder may further include a channel for applying a hydraulic pressure to the closed bottom portion.

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A method for attaching a rudder shaft to a ship rudder may include leading a conical portion of the rudder shaft into a conical opening in the rudder. A flange part is led over the rudder shaft all the way to an expanded flange part with a cylindrical portion on the rudder shaft. The flange part may then be tightened
20 towards the rudder part with means for tightening of these components towards each other. A hydraulic pressure is applied between the flange part and the expanded flange part of the rudder shaft such that the conical portion of the rudder shaft is pressed down into the conical opening of the rudder part. The hydraulic pressure may then be unloaded and the flange part can furthermore be tightened
25 towards the rudder part with the means for tightening.

The method may further include applying hydraulic pressure between the conical portion of the rudder shaft and the conical opening in the rudder part through channels for expanding the conical opening when the rudder shaft is pressed
30 down into the rudder part.

The ship rudder may be disassembled from the rudder shaft by loosening the means for tightening between the flange part and the rudder part and apply

pressure to the chamber between the end portion of the rudder shaft and the bottom portion of the conical opening through the sealable supply channel such that the rudder shaft is pressed out of the rudder part.

5 Short description of the enclosed figures:

Figure 1 shows a cross section of a rudder and a rudder shaft according to the invention; and

Figure 2 shows a detail of figure 1.

10 Detailed description of the invention with reference to the enclosed figures:

In figure 1 it is shown a section through a rudder attached to a rudder shaft 1 according to the invention. The rudder includes a rudder part 6 and a flange part 8. The rudder part 6 is shown attached to the rudder shaft 1, that furthermore is supported in a vessel 20.

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The flange part 8 is shown attached to the rudder part 6 and is placed around the rudder shaft 1.

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As shown in figure 1, there are no openings in the rudder 6, and this is advantageous as previously described.

In figure 2 is the rudder element 6, the rudder shaft 1, the flange part 8 and the vessel 20 shown in greater detail.

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In figure 2 it is shown how the rudder shaft 1 includes a cylindrical portion 2 followed by an expanded flange part 3. The expanded flange part 3 also includes a cylindrical portion 4 with a greater diameter than the cylindrical portion 2. The cylindrical portion 2 and the cylindrical portion 4 of the expanded flange part 3 is in sealing and sliding contact with the flange element 8 placed around the rudder shaft 1. Seals or sealing rings 12, 13 are placed for sealing between the flange element 8 and the rudder shaft 1 on the cylindrical areas.

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5 The rudder shaft 1 or the flange element 8 includes one or several channels (not shown) for applying a hydraulic pressure between the sealing ring 12 and the sealing ring 13. When pressure is applied to the channel, it will thereby be created a pressure that will force the rudder shaft 1 downwards in relation to the flange part 8.

The rudder shaft 1 also includes a conical portion 5 that goes into a corresponding conical element or opening 21 in the rudder part or element 6.

10 The flange part or element 8 is bolted to the rudder element 6 with bolts 10 placed in a perimeter around the flange element 8.

15 The conical portion 5 of the rudder shaft 1 includes a sealing ring 19 at the upper portion of the conical portion 5, below the expanded flange part 3, and a sealing ring 18 at the end portion 15 of the rudder shaft 1. These sealing rings 18, 19 seals between the conical portion 5 of the rudder shaft 1 and the conical opening 21 in the rudder element 6. Hydraulic pressure can be applied to the channels 11, and this pressure can expand the conical opening 21 during assembly, to be able to press the conical portion 5 of the rudder shaft 1 further down into the conical opening 21 of the rudder element 6. The sealing rings 18 and 19 reduce the leakages during this application of pressure.

25 The rudder shaft 1 has a lower end portion 15, and the conical opening 21 has a sealed bottom portion 14, and together these portions form a sealed chamber 16 with the sealable supply channel 17. The supply channel 17 ensures that no pressure is build up in the chamber 16 during assembly. Furthermore may pressure be applied to the supply channel 17 and the cavity or chamber 16 during a possible disassembly of the rudder from the rudder shaft to press the rudder shaft 1 out of the rudder element 6.

Patent claims:

1. An apparatus for attaching a ship rudder with a conical opening to a rudder shaft with a corresponding conical part,
5 characterized in that the rudder shaft (1) in a direction toward the rudder, includes a cylindrical portion (2) followed by an expanded flange part (3) with a cylindrical portion (4), followed by the conical portion (5) of the rudder shaft (1); the rudder includes a rudder element (6) and a flange element (8) for attachment
10 to the rudder element (6), wherein said flange element (8) includes an internal cylindrical portion (9) for mating, sliding and sealingly surrounding the cylindrical portion (2) of the rudder shaft (1) and an inner cylindrical portion (7) for sliding mating arrangement around the cylindrical portion (4) of the flange part (3) of the rudder shaft;
15 channels for applying a hydraulic pressure between the rudder shaft (1) and the flange element (8) in an area between the cylindrical portion (2) of the rudder shaft (1) and the cylindrical portion of the expanded flange part (3); and means (10) for tightening the flange element (8) to the rudder element (6).
- 20 2. The apparatus according to claim 1, wherein the means for tightening the flange element (8) to the rudder element (6) include bolts (10) extending between the rudder element (6) and the flange element (8).
- 25 3. The apparatus according to claim 1, wherein the means for tightening the flange element (8) to the rudder element (6) include external threads on the flange element (8) and internal threads on the rudder element (6).
- 30 4. The apparatus according to claim 1, further including channels (11) for applying hydraulic pressure between the conical openings (21) in the rudder element (6) and the conical portion (5) of the rudder shaft (1) for expanding the conical opening (21) in the rudder element (6) during assembly.

5. The apparatus according to claim 1, further including sealing rings (12, 13) for sealing between the cylindrical portion (2) of the rudder shaft (1) and the inner cylindrical portion (9) of the flange element (8) and between the cylindrical portion of the expanded flange part (3) of the rudder shaft (1) and the internal cylindrical portion (7) of the flange element (8).

6. The apparatus according to claim 1, wherein the conical opening (21) in the rudder element (6) extends into a bottom portion (14), wherein said rudder shaft (1) includes an end portion (15), wherein said bottom portion (14) and the end portion (15) forms a sealed chamber (16) with a sealable supply channel (17) for bleeding during assembly and for application of hydraulic pressure during disassembly.

7. The apparatus according to claim 1, wherein sealing rings (18, 19) are placed between the conical portion (5) of the rudder shaft (1) and the conical opening (21) by the upper portion of the cone, near the flange (8), and by the lower portion of the cone near the end portion (15) of the rudder shaft.

8. The apparatus according to claim 7, wherein the end portion (15) of the rudder shaft is substantially flat.

9. A rudder shaft (1) for attachment to a ship rudder with an apparatus as defined in claim 1, with a portion for attachment to the rudder, characterized in that the portion includes, in a direction towards the rudder, a cylindrical portion (2) followed by an expanded part (3) with a cylindrical portion (4) followed by a conical portion (5).

10. The rudder shaft according to claim 9, further including that the conical portion (5) terminates in a substantially flat end portion (15).

11. The rudder shaft according to claim 9, further including a step (20) after the cylindrical portion (4) of the expanded part (3).

12. A ship rudder with a rudder element (6) with a conical opening (21) for attachment to a rudder shaft through an apparatus as defined in claim 1,

c h a r a c t e r i z e d i n that it further includes:

a flange element (8), and means (10) for tightening the flange element (8) to the rudder element (6), wherein said flange element (8) includes at least one internally cylindrical portion (9), with a first diameter, for sealing, sliding contact with a rudder shaft (1); and

at least one further cylindrical portion (7) with a second diameter that is greater than the diameter of the internally cylindrical portion (9).

13. The ship rudder according to claim 12, further including a closed bottom portion (14) in the conical opening (21) of the rudder element (6) at the lower end of the conical portion (5).

14. The ship rudder according to claim 11, further including a channel (17) for applying hydraulic pressure to the closed bottom portion (14).

15. A method for disassembly of a ship rudder from a rudder shaft (1) attached with an apparatus as defined in claim 6,

c h a r a c t e r i z e d i n that it include the following steps:

releasing the means (10) for tightening between the flange element (8) and the rudder element (6); and

applying pressure to the chamber (16) between the end portion (15) of the rudder shaft and the bottom portion (14) of the conical opening (21) through the sealable supply channel (17) such that the rudder shaft (1) is pressed out of the rudder element (6).