

Rudder for ships

This invention relates to a rudder for ships according to the preamble of claim 1.

It is known that the rudder trunk of a rudder system is made of wrought steel so that such rudder systems have high weights.

The aim of this invention is to find for the component rudder post an alternative material for the wrought steel. However, a sole material substitution for the component rudder post can lead to difficulties in the whole system, for example to an exceeding of maximally admissible bearing openings due to too great differences in the stiffness of the components rudder post and rudder trunk. For this reason, a material substitution is also provided for the rudder trunk in creating a rudder trunk with a low weight which has, in spite of a low weight, a high flexural strength and rigidity against torsion.

This aim is achieved for a rudder according to the type described in the introduction with the characteristics indicated in claim 1.

Accordingly, the invention consists in that the rudder trunk of the rudder system consisting of the rudder blade, the rudder post and the rudder trunk is made of a fibre composite material and after inserting and aligning is cast or bonded in an outer nautical trunk tube prepared by the shipyard and extending to the lower edge of the head box.

The integration of the rudder trunk in fibre composite construction into the nautical steel structure takes place similarly as for a stern tube. The rudder trunk is inserted and

aligned in an outer nautical trunk tube prepared by the shipyard which extends to the lower edge of the head box and then cast or bonded. Detail solutions (for example inserting of tapered rings made of flexible materials) are to be found for the lower edge of the nautical trunk tube in order to reduce here local tension concentrations in the trunk tube made of fibre composite material.

The following advantages are achieved with the configuration of the rudder trunk according to this invention. The main arguments for an alternative material for the wrought steel are the difficult procurement situation and the high costs for big cast parts. The use of fibre composite materials in relation with an effective method of production brings advantages as to the costs. The use of a rudder post made of fibre composite material also requires the substitution of the material for the rudder trunk. With fibre composite materials, clear weight advantages are to be achieved compared with wrought steel components. The inserting of the rudder trunk into the nautical structure prepared by the shipyard by an adhesive method brings technological advantages such as better alignment possibilities, the suppression of welded connections and welding delay.

Further advantageous configurations are the subject of the subclaims.

Besides the configuration of the rudder trunk of a fibre composite material, according to a further embodiment of the invention, the rudder post of the rudder system is also made of a fibre composite material.

The fibre composite material is a carbon fibre composite material or of carbon fibres with an epoxy resin matrix or a glass fibre composite material with polyester resin matrix.

According to a further embodiment, the rudder post and/or the rudder trunk are manufactured according to the filament winding method.

The use of a rudder trunk and/or of a rudder post made of a fibre composite material is particularly advantageous for a rudder, the rudder trunk of which is provided as a projecting support with a central inner longitudinal bore for receiving the rudder post for the rudder blade and is configured reaching into the rudder blade connected with the rudder post end, whereby a bearing is placed in the inner longitudinal bore of the rudder trunk for bearing the rudder post, bearing which penetrates with its free end in a recess, taper or the like into the rudder blade, whereby the rudder post projects in its end area with a section out of the rudder trunk and is connected with the end of this section with the rudder blade, whereby the connection of the rudder post with the rudder blade is situated above the propeller shaft centre and whereby the inner bearing for the bearing of the rudder post is placed in the rudder trunk in the end area of the rudder trunk.

The high stability and flexural strength of the rudder trunk made of a fibre composite material allows to place the bearing for the rudder post in the end area of the rudder trunk, even if the rudder post should have a bigger length. Only this bearing arrangement for the rudder post allows that the pressure forces acting onto the rudder blade of the rudder can be absorbed.

Furthermore, the rudder post can have end sections made of a non metallic material, in particular of wrought iron, and a central section made of a non metallic material connected with the end sections.

According to a further embodiment, the central section of the rudder post consisting of a non metallic material is made of a carbon fibre composite material or of carbon fibres, preferably of graphite fibres.

Both end sections of the rudder post made of wrought iron have, on their front sides turned to each other, neck-type reduced peg-shaped sections, the peripheral surfaces of which are provided with structures as adhesive surfaces for the central section made of carbon fibres which surround the peg-shaped sections as windings, whereby the carbon fibres are sheathed and lined with a cast resin in the whole winding area extending over the length of the central section.

Such a configuration of the rudder post brings the advantage that rudder posts with a big length, a big diameter and a high weight can be produced for rudders for water vehicles without a manufacturing of the whole rudder post of wrought iron being necessary since only the end sections of the rudder post are produced of wrought iron, while the central section of the rudder post situated between the end sections is made of a non metallic material and in particular of a carbon fibre material or of carbon fibres, preferably of graphite fibres which form in form of windings the central post section of the rudder post, whereby the windings of the carbon fibre composite material or the carbon fibres extend into the opposite ends of the end sections of the rudder post and are fixedly connected with them. In this manner, a rudder post is created, the end sections are made of

wrought iron and can be subject to the highest loads. Moreover, the end sections of the rudder post made of wrought iron take up the bearings for the bearing of the rudder post in a rudder trunk bearing.

End sections of wrought iron can be omitted when the whole rudder post is made for example of a carbon fibre composite material and is manufactured according to the filament winding method. For this configuration, neither the flexural strength nor the resistance to torsion are reduced.

The subject of the invention is represented as an example in the drawings.

Fig. 1 shows a side view of a rudder arrangement provide in the after body area with a rudder post placed in a rudder trunk.

Fig. 2 shows partly in view and partly in a vertical section a rudder system with the rudder trunk, the rudder post and the rudder blade.

Fig. 3 shows an enlarged cutout A according to fig., 2 with the rudder trunk reaching to the lower edge of the head box and inserted as well as cast or bonded in an outer trunk tube.

Fig. 4 shows partly in view and partly in a vertical section the rudder system with the rudder post supported on one end side in the trunk tube and fixed on the rudder post.

Fig. 5 shows a view of the rudder post with end-sided sections made of wrought iron and with a central rudder shaft section made of a non metallic material.

Fig. 6 shows a view of a rudder post with end sections made of wrought iron and a central section made of wound carbon fibres connected with the end sections.

For the embodiment of a rudder system for ships showed in fig. 1 and 4, 10 designates a hull, 20 a rudder trunk with its both ends 20a, 20b, 30 a rudder blade and 40 a rudder post.

The tube-type rudder trunk 20 configured as a projecting support is fixedly connected with its upper end 20a with the hull 10 and has an inner bore 25 which receives the rudder post 40. The rudder trunk 20 is guided into the rudder blade 30 which is fixedly connected with the free lower end 20b of the rudder post 40 which traverses the inner bore 25 of the rudder trunk bearing 20. The preferably cylindrical recess 35 which is configured in the rudder blade 30 for receiving the free end 20b of the rudder trunk 20 is limited by a lateral planking 36, 37 (fig. 4).

The rudder trunk 20 is provided with a central inner longitudinal bore 25 for receiving the rudder post 40 for the rudder blade 30 and is configured reaching into the rudder blade 40 connected with the rudder post end, whereby at least one bearing 70 is placed in the inner longitudinal bore 25 for bearing the rudder post, this bearing reaching with its free end 40a into a recess, taper or the like into the rudder blade 30, whereby the rudder post 40 is guided in its end area 40a with a section 40b from the rudder trunk 20 and which is connected with the end of this section 40b with the rudder blade, whereby the connection of the rudder post 40 with the rudder blade 30 is situated above the propeller spindle middle PM. The inner bearing 70 for the bearing of the rudder post 40 is placed in the rudder trunk in the end area of the rudder trunk 20 (fig. 4).

For the bearing of the rudder post 40, the rudder trunk 20 has at least one bearing. For the embodiment shown in fig. 4, two bearings 70, 71 are provided, namely an inner bearing 70 and an outer bearing 71, whereby the bearing 70 is configured on the inner wall surface of the rudder trunk bearing 20 and the other bearing 71 on the outer wall surface of the rudder trunk or on the inner wall surface of the bearing provided on the rudder blade 30.

The rudder post 40 supported in the rudder trunk 20 is made of wrought iron or is preferably configured in such a manner that both its end sections 41, 42 are made of wrought iron, whereby the central post section 45 is made of a non metallic material, in particular of a carbon fibre composite material or of carbon fibres, preferably of graphite fibres with or without an epoxy resin matrix (fig. 5). By wrought iron, we understand an iron with a carbon content situated under 0,8 %. Advantageously, the rudder post 40 is produced according to the known filament winding system.

For the fixing of the central post section 45 of the rudder post 40, different construction configurations can be provided. As the embodiment according to fig. 5 shows, the opposite front sides of both end sections 41, 42 have peg-shaped sections 51, 52 which are preferably with an outer wall structure 51a, 52a in order to guarantee the the grip and the hold of the central post section 45 made of carbon fibres. Preferably, the carbon fibres or the carbon fibre composite material are fixed according to the filament winding system on the pegs 51, 52 of the end sections 41, 42, whereby the windings extend across the periphery of both pegs 51, 52 and over the whole length of the central post section 45. The carbon fibres are sheathed or cast with a cast resin for increasing the strength.

The configuration of the rudder post 20 is particularly preferred in so far as very big lengths of rudder posts can be produced for a lowest weight. For a rudder post having for example a length of 10 m, the weight is reduced by more than 50 % with respect to a rudder post which is completely made of wrought iron.

A further embodiment provides that the rudder post 40 placed in the rudder trunk 20 has material reinforcements 80 in the area of the bearings 70, 71 placed in the rudder trunk 20, whereby preferably the material reinforcements 80 are provided in the area of the rudder trunk end 20b. These material reinforcements 80 are configured on the rudder post 40 preferably on the end section 42 of the rudder post 40 in the area of the inner bearing 70 provided on the rudder trunk 20 (fig. 4).

For the embodiment shown in fig. 2 and 3, the rudder trunk 20 is made of a fibre composite material 100 and is inserted into a nautical outer trunk tube 90 made of steel or of another appropriate material prepared by the shipyard, reaching into the lower edge 11a of the head box 11 and inserted into the rudder blade, whereby, after alignment of the rudder trunk 20 in the nautical trunk tube 90 the intermediate space formed between both components 20, 90 is cast with a cast resin, or both components 20, 90 are bonded together.

Due to the fact that the rudder trunk 20 is connected with the trunk tube 90 because of the bonding or the use of cast resins, a firm compound is obtained between both components so that thin-walled materials can be used for the tube-type rudder trunk and the trunk tube which moreover results in a saving of weight

which is particularly important when the matter is of bigger rudder installations.

The integration of the rudder trunk 20 in fibre composite material into the nautical steel structure, i.e. into the rudder blade 30, takes place similarly as for the stern tube of a ship. The rudder trunk 20 is inserted into an outer nautical trunk tube 90 of steel or of another appropriate material, prepared by the shipyard, which reaches to the lower edge 11a of the head box 11. This nautical trunk tube 90 is inserted and fixed in the rudder blade 30. The rudder trunk 20 made of the fibre composite material is then aligned in the nautical trunk tube 90. The intermediate space between the nautical trunk tube 90 and the rudder trunk 20 is then cast for example with a cast resin 95 or both components are bonded together so that a firm connection is created between the nautical trunk tube 90 and the rudder trunk 20 (fig. 3). The rudder post 40 is then inserted into the system configured in this manner into the rudder trunk 20 and is supported in the rudder blade 30 and fixed at the ends with the rudder blade. Detail solutions, for example placing of tapered rings made of flexible materials, are possible for the lower edge of the nautical trunk tube in order to reduce here local tension concentrations in the trunk tube 20 made of fibre composite material.

The fibre composite material for producing the rudder trunk 20 and/or of the rudder post 40 is a carbon fibre composite material or of carbon fibres of an epoxy resin matrix or a glass fibre composite material with polyester resin matrix.

The rudder post 40 as well as the rudder trunk 20 are produced according to the filament winding system.

Fibre composite materials have essential advantages compared with wrought steel since the carbon fibre materials with epoxy resin matrix compared with glass fibre materials with polyester resin matrix have the better material properties with respect to rigidity, resistance and firmness and however result in higher material costs. However, the selection of materials for the rudder trunk should take place only in connection with the dimensioning of the rudder post in order to achieve an adaptation of the structure rigidity of both components rudder trunk and rudder post.

The main argument for an alternative material such as a fibre composite material for the wrought steel are the difficult procurement situation and the high costs for big cast parts. The use of fibre composite materials in relation with an effective method of production brings advantages as to the costs.

With fibre composite materials, clear weight advantages are to be achieved compared with wrought steel components.

The inserting of the rudder trunk 20 by a bonding method or casting method into the nautical structure prepared by the shipyard brings technological advantages such as better alignment possibilities, suppression of welded connections and welding delay.

If fibre composite materials with the properties of wrought iron are used for the rudder trunk 20, a rudder trunk 20 configured in such a manner can also be used without intercalating a trunk tube 90 of steel.

Furthermore, the invention comprises a method for manufacturing a rudder trunk 20 which receives the rudder post

40 and which is inserted in a rudder blade 30 of the rudder for ships, whereby a nautical outer trunk tube 90 of steel or of another appropriate material is used and fixed in the rudder blade 30, a rudder trunk 20 made of a fibre composite material is then inserted into the nautical trunk tube 90 and is aligned in the trunk tube 90, after which the intermediate space between the rudder trunk 20 and the trunk tube 90 is filled with a cast resin 95 or both components 20, 90 are bonded together. The nautical trunk tube 90 is preferably inserted by reaching to the lower edge 11a of the head box 11 of the rudder blade 30.

List of reference numerals

- 10 Hull
- 11 Head box
- 11a Lower edge

- 20 Rudder trunk
- 20a Upper rudder trunk bearing end
- 20b Lower rudder trunk bearing end
- 25 Inner longitudinal bore

- 30 Rudder blade
- 31 Recess
- 35 Cylindrical recess
- 36 Lateral planking
- 37 Lateral planking

- 40 Rudder post
- 40a Lower rudder post end
- 40b End
- 41 End area
- 42 End section
- 45 Central post section

- 51 Peg
- 51a Surface structure
- 52 Peg
- 52a Surface structure

- 60 Carbon fibre windings

- 70 Inner bearing

- 71 Outer bearing
- 80 Material reinforcements
- 90 Trunk tube
- 95 Cast resin
- 100 Fibre composite material
- PM Propeller shaft centre

Claims

1. Rudder for ships made of a rudder blade (30) with a rudder post (40) held and supported in a rudder trunk (20), characterized in
that the rudder trunk (20) is made of a fibre composite material (100) and is inserted into a nautical outer trunk tube (90) made of steel or of another appropriate material prepared by the shipyard, reaching into the lower edge (11a) of the head box (11) and inserted in the rudder blade (30), whereby, after alignment of the rudder trunk (20) in the nautical trunk tube (90) the intermediate space formed between both components (20, 90) is cast with a cast resin (95) or both components (20, 90) are bonded together.
2. Rudder according to claim 1, characterized in
that the rudder post (40) is made of a fibre composite material (100).
3. Rudder according to any of the claims 1 or 2, characterized in
that the fibre composite material (100) is a carbon fibre composite material or is made of carbon fibres with an epoxy resin matrix.
4. Rudder according to any of the claims 1 or 2, characterized in
that the fibre composite material is a glass fibre composite material with polyester resin matrix.
5. Rudder according to any of the preceding claims 1 to 4, characterized in

the rudder post (40) and/or the rudder trunk (20) are manufactured according to the filament winding method.

6. Rudder according to claim 1,
characterized in
that the rudder post (40) has end sections (41, 42) made of a non metallic material, in particular of wrought iron, and a central post section (45) made of a non metallic material connected with the end sections (41, 42).
7. Rudder according to claim 1,
characterized in
the central post section (45) of the rudder post (40) consisting of a non metallic material is made of a carbon fibre composite material or of carbon fibres, preferably of graphite fibres.
8. Rudder according to any of the preceding claims 6 and 7,
characterized in
that both end sections (41, 42) of the rudder post (40) made of wrought iron have, on their front sides turned to each other, neck-type reduced peg-shaped sections (51, 52), the peripheral surfaces of which are provided with structures (51a, 52a) as adhesive surfaces for the central section (45) made of carbon fibres which surround the peg-shaped sections (51, 52) as windings (60), whereby the carbon fibres are sheathed and lined with a cast resin in the whole winding area extending over the length of the central section (45).
9. Rudder according to any of the preceding claims 6 to 8,
characterized in
that the ratio of the length of the end sections (41, 42) and of the central post section (45) of the rudder post (40) is $1/6$ to $2/3$ to $1/6$.

10. Rudder according to any of the preceding claims 1 to 9,
characterized in
that the rudder post (40) has material reinforcements in the
area of the bearings (70, 71) placed in the rudder trunk bearing
(20).
11. Rudder according to claim 10,
characterized in
that the material reinforcements (80) are provided in the area of
the rudder trunk bearing end (20b).
12. Rudder post according to claim 10 or 11,
characterized in
that the material reinforcements (80) are configured in the area
of the inner bearing (70) provided on the rudder trunk bearing
(20).
13. Rudder according to any of the preceding claims 1 to 12,
characterized in
that the rudder trunk (20) as a projecting support is provided
with a central inner longitudinal bore (25) for receiving the
rudder post (40) for the rudder blade (30) and is configured
reaching into the rudder blade (30) connected with the rudder
post end, whereby at least one bearing (70) is placed in the
inner longitudinal bore (25) of the rudder trunk (20) for bearing
the rudder post (40), bearing which penetrates with its free end
(40a) in a recess, taper or the like (31) into the rudder blade
(30), whereby the rudder post (40) projects in its end area (40a)
with a section (40b) out of the rudder trunk (20) and is
connected with the end of this section (40b) with the rudder
blade (30), whereby the connection of the rudder post (40) with
the rudder blade (30) is preferably situated above the propeller
shaft centre (PM) and whereby the inner bearing (70) for the

bearing of the rudder post (40) is placed in the rudder trunk (20) in the end area of the rudder trunk (20).

14. Method for manufacturing a rudder trunk (20) which receives the rudder post (40) and which is placed in a rudder blade (30) of the rudder for ships, characterized in
that a nautical outer trunk tube (90) of steel or of another appropriate material is used and fixed in the rudder blade (30), a rudder trunk (20) made of a fibre composite material is then inserted into the nautical trunk tube (90) and is aligned in the trunk tube (90), after which the intermediate space between the rudder trunk (20) and the trunk tube (90) is filled with a cast resin (95), or both components (20, 90) are bonded together.
15. Method according to claim 14, characterized in
that the nautical trunk tube (90) is inserted reaching to the lower edge (11a) of the head box (11) of the rudder blade (30).