

Finned Rudder**10 Specification**

The invention relates to a finned rudder according to the preamble of claim 1.

15 Rudder for sea ships serve for the controlling of sea ships and are usually vertically attached to the stern and can be pivoted about approximately 60° towards each side. The traction current of sea ships causes a rudder pressure that is divided into a resistance component directed towards the driving direction and a transept-directed control force that causes the reaction of the sea ship. For increasing the transept-directed control force a high efficiency flap rudder for vessels having a main rudder is known from
20 EP 0 170 919 B1 which can be pivoted by means of a rudder stock that is supported in a seawater-tight duct through the ship hull, the so called rudder trunk (Koker). At the, with respect to the driving direction, rear edge of the main rudder blade a finned ruder blade is joined, that is adjustable via an adjusting device with respect to the main rudder blade, wherein the adjusting device contains an eccentric rigidly connected to the axis of the
25 finned rudder blade and an adjusting rod that is joined with one end to the eccentric and with the other end to a fixed point at the ship hull adjacent to the rudder stock.

A rotation of the main rudder blade thus causes an additional rotation in the same direction and of the same magnitude of the finned rudder blade at the rear edge of the main
30 rudder relative to the main rudder, whereby the transverse forces generated by the rudder are increased and the maneuverability of sea ships is improved therewith.

From EP 0 811 552 A1 a rudder for sea ships is known that consists of a main rudder and a fin joined thereto that is positively guided by the main rudder, which fin is provided
35 with a slide piston coupling out of a slide bearing formed at the fin for a pivoting piston that is connected to a coupling bolt that is supported in a slide bearing having a bearing housing attached to the ship hull. By means of an arrangement of a hinge bolt according

to the type of a cardan joint between the pivoting piston and the coupling bolt, compared to a pure slide bearing connection between the pivoting piston and the coupling piston, a movement between the pivoting piston and the coupling bolt is facilitated, by means of which bending moments caused by pressure onto the rudder and acting on the system
5 are compensated and the pivoting piston and the coupling bolt can be pulled out of their housings attached to the ship hull and the fin in the vertical and horizontal direction after unlocking the hinge connection.

In an arrangement of a hinge joint between the pivoting piston and the coupling bolt, the
10 danger of canting the hinge joint in case forces act on the fin, that not only cause a rotation of the fin and thereby of the pivoting piston about the longitudinal ship axis (X-axis), but also about the transverse ship axis (Z-axis), so that the hinge joint cants when a force acts on the fin that causes a combined pivoting of the fin or the pivoting piston, respectively, about the longitudinal ship axis (X-axis) and the transverse ship axis (Z-axis), is
15 disadvantageous. In such a case no rotation of the pivoting piston about the hinge joint is caused, but comprises a force component running perpendicular thereto that cants the bolt of the hinge joint or at least hinders a compensation movement. A compensation about the vertical ship axis (Y-axis) is not possible, since the latter is determined by the adjusted rudder throw.

20 Moreover, the hinge joint comprises only a small hinge area determined by the hinge bolt that necessitates a certain dimensioning of the hinge joint, in order to absorb the rudder forces. This however causes a corresponding large-volume construction, or as the case may be, requires an application of high-strength and correspondingly expensive materials.
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In addition, the design of the coupling bolt as a bolt formed in a slide bearing having a bearing housing for the piston that is attached to the ship hull and that is closed at its end facing the ship hull, is complex and accident-sensitive in case the cushion formed in the
30 interior of the bearing housing above the piston out of an gaseous or liquid medium is not sealed seawater-tightly.

The problem of the present invention is to specify a finned rudder of the afore-mentioned kind that assures, by means of an improved movability of the pivoting piston, a high stability of the connection between the pivoting piston and the shaft journal with low effort
35 concerning the production and assembly of the fin coupling.

According to the invention, this problem is solved with the features of claim 1.

5 The solution according to the invention assures by means of a movability of the pivoting piston in the direction of the longitudinal ship axis or X-axis and the transverse ship axis or Z-axis at an arbitrary deflection and therefore arbitrary rotation angle of the main rudder about the vertical ship axis or Y-axis an optimal stability of the connection between the pivoting piston connected to the fin and the shaft journal connected to the ship hull that is caused by the design of the joint bearing alone and is therefore associated to a low effort regarding production as well as assembly.

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Preferably, the pivoting piston is inserted into a horizontal borehole of the coupling housing that comprises a vertical borehole, into which the joint bearing housing the shaft journal is inserted.

15 By means of this construction, the free movability of the pivoting piston in the X-Z-plane is combined with a simple and safe connection between the pivoting piston and the shaft journal that assures, besides a simple assembly, also an easy disassembly for repair and service purposes.

20 In this embodiment of the solution according to the invention the pivoting piston can be released from its connection to the flange and pulled out of the borehole of the flange in the horizontal direction, so that a simple installation or demounting of the shaft journal with or without the flange is possible afterwards.

25 Preferably, the joint bearing consists of a spherical bearing having an inner ring having a cylindrical borehole for housing the shaft journal and a sphere-layer shaped outer surface and an outer ring having a sphere-layer shaped inner surface adapted to the outer surface of the inner ring and a cylindrical outer surface adapted to the vertical borehole of the coupling housing.

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The design of the joint bearing as a spherical bearing does not only allow for an optimal movability of the pivoting piston with respect to the shaft journal connected to the ship hull, but also assures an optimal pressure distribution over a largest possible area, so that also under extreme loads a largest possible stability of the joint bearing is assured.

35 Alternatively, in case of predetermined load limits, the joint bearing may comprise smaller

dimensions as necessary for instance in case of hinge bearings or cardan joints due to the lower, force transmitting area.

5 The shaft journal and the inner ring of the joint bearing can be, by means of a force-fit press fit or an arbitrary form-fit connection, firmly connected or glidingly connected in the vertical direction with respect to each other. Particularly, in case of a gliding connection between the shaft journal and the inner ring of the joint bearing, an additional movability of the pivoting piston in the direction of the vertical ship axis or Y-axis is assured, so that also an unavoidable play of the coupling of the fin to the main rudder is compensated in
10 the Y-direction.

Preferably, the inner ring of the spherical bearing comprises an axial length that is larger than the axial length of the outer ring, that assures that the inner ring butts against the outer ring even in case of stronger pivoting movements of the pivoting piston with respect
15 to the shaft journal, so that a corresponding large-area load distribution is always guaranteed.

For fixation of the joint bearing inserted into the vertical borehole of the coupling housing and formed as a spherical bearing, the outer ring is axially fixed by securing rings that
20 butt against the front faces of the outer ring and are inserted into circular grooves in the vertical borehole of the coupling housing, wherein the securing rings are preferentially designed as snap rings.

In order to assure the movability of the spherical bearing and therewith of the pivoting
25 piston even in case of infiltrating, aggressive seawater, the inner ring and the outer ring of the spherical bearing comprise at least one circular lubricant groove that is connected to the outer surface of the spherical bearing via channels for servicing and adding a lubricant, wherein the channels are seawater-tightly closable at the outer surface of the coupling housing.

30 Preferably, the lubricant grooves are centrally aligned in the axial direction of the spherical bearing and are aligned with respect to each other with respect to the outer and inner ring of the spherical bearing.

35 The connection of the pivoting piston to the coupling housing can either be effected force-fittedly by means of a press fit or force- and form-fittedly by means of a locking

screw that is screwed through a borehole in the coupling housing into the end of the pivoting piston that is inserted into the horizontal borehole of the coupling housing or that force-fittedly butts against the outer surface of the portion of the pivoting piston that is inserted into the horizontal borehole of the coupling housing.

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The idea underlying the invention and further features and advantages of the invention shall be explained in more detail by means of an embodiment depicted in the Figure. It is shown in:

10 Fig. 1 a schematic side view of a finned rudder arranged in the stern section of a ship;

Fig. 2 a plan view of a coupling housing having a vertical borehole for housing a shaft journal and a horizontal borehole for housing a pivoting piston and

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Fig. 3 a longitudinal cut through the coupling housing according to Fig. 2.

Fig. 1 shows a schematic side view of a ship stern with a part of the ship hull 1, a propeller 2 and a finned rudder that consists of a main rudder 3 and a fin 4 joined to the main rudder 3 via a hinge-shaped connection 13. The main rudder 3 is firmly connected to a rudder stock 11 inserted into a recess of the main rudder 3, which rudder stock 11 is lead through the ship hull 1 through a rudder trunk 10 for leading through the rudder stock 11 in a seawater-tight manner and connected to a rudder engine 12. The rudder engine 12 causes via the rudder stock 11 a maximal deflection of the main rudder 3 of approximately 45° towards both sides with respect to a position of the main rudder 3 aligned with the longitudinal ship axis or X-axis.

The controlling of the fin 4 takes place positively-guided and coupled to the deflection of the main rudder 3 by means of an adjusting device 7 arranged at the top edge of the main rudder 3 and the fin 4, that contains a vertical shaft journal 5 that is connected to the rudder trunk 10 at the ship hull 1 or rather via a flange 15, a coupling housing 8 connected jointly to the shaft journal 5, a pivoting piston 6 aligned horizontally and a slide bearing 14 connected to the fin 4 in which the pivoting piston 6 is guided.

35 In case of a rotation of the rudder stock 11 by means of the rudder engine 12 along one or the other rotation direction, the main rudder 3 is deflected in the respective rotation

direction by a corresponding angle about the vertical ship axis or Y-axis. Due to the joining of the fin 4 to the rear edge of the main rudder 3 and the connection of the fin 4 to the ship hull 1 via the adjusting device 7, an additional rotation of the fin 4 in the same direction and approximately of the same magnitude is caused relative to the main rudder 3, i.e., the fin 4 is absolutely deflected approximately by the double-angle of the deflection of the main rudder 3 and correspondingly increases the transverse forces effective for the controlling of the ship that are generated by the finned rudder.

Due to the longitudinal and transverse forces acting on the main rudder 3 and the fin 4, bending moments act on the adjusting device 7, that can lead, in case of correspondingly designed slide bearings and fits among the individual function elements of the adjusting device 7, to tensions and therewith to an early abrasion to the point of a destruction of the adjusting device 7 or parts thereof.

In order to avoid such tensions and cants of the function parts of the adjusting device 7 appearing in case of a rigid design of the adjusting device 7, a hinge bolt for connecting the shaft journal 5 to the pivoting piston 6 is provided in known systems, that allows for movements in an angle range of $\pm 90^\circ$ with respect to the vertical ship axis or Y-axis, that however is canted in case of transverse forces appearing in addition that are directed in the direction of the transverse ship axis or Z-axis or are composed of components of a force that acts in the direction of the longitudinal ship axis or X-axis and the transverse ship axis or Z-axis, since a compensation movement is not possible due to the fixedly adjusted rudder throw about the Y-axis.

More over, the hinge joint comprises only a small bearing area determined by a hinge bolt that necessitates a corresponding dimensioning of the hinge joint, in order to be able to absorb the rudder forces. This requires however a corresponding large-volume construction, or as the case may be, requires the application of high-strength und correspondingly expensive materials.

According to the present invention, instead of a hinge joint or a similar joint between a vertical shaft journal 5 and the horizontally aligned pivoting piston 6, a joint bearing is employed that allows for, independent of the deflection of the main rudder 3, a pivoting of the pivoting piston 6 about the longitudinal ship axis or X-axis as well as the transverse ship axis or Z-axis. This free movability of the pivoting piston 6 in the plane spanned by the X- and Z-axis assures that the adjusting device 7 compensates all forces in the X-

and Z-axis acting on the fin 4, so that no cants or additional tensions can appear in the adjusting device 7.

Fig. 2 shows a in a plan view and Fig. 3 shows in a longitudinal cut the coupling housing 8 of the adjusting device 7 depicted schematically in Fig. 1 for connecting the vertical shaft journal 5 to the horizontal pivoting piston 6. The coupling housing 8 comprises a horizontal borehole 81 for housing the pivoting piston 6 according to Fig. 1 as well as a vertical borehole 82 for housing a spherical bearing 9. A locking screw 18 serves for securing the pivoting piston 6 inserted into the horizontal borehole 81 of the coupling housing 8, which locking screw 18 connects the pivoting piston 6 form- and/or force-fittedly to the coupling housing 8.

The spherical bearing 9 comprises an inner ring 91 having a cylindrical borehole and a spherical or sphere-layer shaped outer surface as well as an outer ring 92 having a spherical or sphere-layer shaped inner surface adapted to the outer surface of the inner ring 91 and a cylindrical outer surface adapted to the vertical borehole 82 of the coupling housing 8. The cylindrical borehole of the inner ring 91 serves for housing the vertically, i.e., in the direction of the Y-axis aligned shaft journal 5 according to Fig. 1, that is preferably glidingly arranged in the cylindrical borehole of the inner ring 91 of the spherical bearing 9, so that the shaft journal 5 can accomplish compensation movements in the Y-direction.

For fixing and securing the spherical bearing 9, securing rings 16, 17 formed as snap rings are preferably provided at the axial ends of the outer ring 92 of the spherical bearing 9.

Due to a larger axial width of the inner ring 91 with respect to the outer ring 92 it is assured that the inner ring 91 butts against the outer ring 92 even in case of stronger pivoting movements of the pivoting piston 6 with respect to the shaft journal 5, so that a corresponding large-area load distribution is assured.

For decreasing the friction in case of a movement of the coupling housing 8 in the vertical direction or in the direction of the Y-axis, a lubricant film is provided in the cylindrical borehole of the inner ring 9, so that no friction forces hinder the axial movability of the coupling housing 8 with respect to the shaft journal 5. For generating and maintaining the lubricant film a circular lubricant groove is provided, centrally formed in the inner ring 91,

that aligns with a corresponding lubricant groove 94 in the outer ring in case of a horizontally aligned coupling housing 8. The outer lubricant groove 94 in the outer ring 92 is connected to openings at the outer side of the coupling housing 8 via lubricant channels 20 that are seawater-tightly closable by means of lock screws 19.

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The combination of a coupling housing 8 connecting the horizontal pivoting piston 6 to the vertical shaft journal 5 and a spherical bearing 9, assures not only a movability of the adjusting device 7 that avoids tensions and cants, but also additionally allows for a simple assembly and disassembly due to the arrangement of the horizontal borehole 81 for housing the pivoting piston 6 and the vertical borehole 82 for housing the spherical bearing 9 having the vertically aligned cylindrical borehole of the inner ring 91 for housing the vertical shaft journal 5.

By releasing the lock screw 18 the horizontal pivoting piston 6 guided in the slide bearing 14 can be separated from the coupling housing 8, so that the fin 4 for instance can be separated from the main rudder 3 for repair or service purposes. For exchanging, or as the case may be, repairing the adjusting device 7, the shaft journal 5 is to be released from its connection to the ship hull 1, so that the spherical bearing 9 can be pulled off together with the coupling housing 8 from the vertical shaft journal 5.

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In the same way, a simple assembly of the adjusting device 7 is guaranteed.

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Bezugszeichenliste

1	Ship hull
2	Propeller
3	Main rudder
4	Fin
5	Shaft journal
6	Pivoting piston
7	Adjusting device
8	Coupling housing
9	Spherical bearing
10	Rudder trunk
11	Rudder stock
12	Rudder engine
13	Hinge-shaped connection
14	Slide bearing
15	Flange
16, 17	Securing rings
18	Locking screw
19	Closure screws
20	Lubricant channels
81	Horizontal borehole
82	vertical borehole
91	Inner ring
92	Outer ring

Claims

1. Finned rudder having a main rudder (3) pivotable about a vertical ship axis or normal ship axis (Y-axis) and a fin (4) joined to the rear edge of the main rudder (3) and positively guided by the main rudder (3), which fin (4) is connected to a pivoting piston (6) joined via a joint bearing (9) to a vertical shaft journal (5) connected to the ship hull (1) and is pivotable independently of the deflection of the main rudder (3) about a horizontal axis (X-axis) and an axis (Z-axis) running perpendicular with respect to the horizontal axis (X-axis) and the vertical ship axis (Y-axis),

characterized in that,

the pivoting piston (6) is inserted into a horizontal borehole (81) of a coupling housing (8) that comprises a vertical borehole (82) into which the joint bearing (9) housing the shaft journal (5) is inserted.

2. Finned rudder according to claim 1, **characterized in that** the joint bearing consists of a spherical bearing (9) having an inner ring (91) having a cylindrical borehole for housing the shaft journal (5) and a sphere-layer shaped outer surface and an outer ring (92) having a sphere-layer shaped inner surface adapted to the outer surface of the inner ring (91) and a cylindrical outer surface adapted to the vertical borehole (82) of the coupling housing (8).
3. Finned rudder according to claim 2, **characterized in that** the inner ring (91) of the spherical bearing (9) comprises an axial length that is larger than that of the outer ring (92).
4. Finned rudder according to claim 2 or 3, **characterized in that** the shaft journal (5) and the inner ring (91) of the spherical bearing (9) are glidingly connected in the vertical direction.

5. Finned rudder according to at least one of the claims 2 to 4, **characterized in that** the outer ring (92) of the spherical bearing (9) is axially fixed by means of securing rings (16, 17) that butt against the front faces of the outer ring (92) and are inserted into circular grooves in the vertical borehole (82) of the coupling housing (8).
6. Finned rudder according to claim 5, **characterized in that** the securing rings consist of snap rings (16, 17).
7. Finned rudder according to one of the preceding claims 2 to 6, **characterized in that** the inner ring (91) and the outer ring (92) of the spherical bearing (9) comprise at least one circular lubricant groove (93, 94).
8. Finned rudder according to claim 7, **characterized in that** the at least one lubricant groove (93, 94) is connected to the outer surface of the coupling housing (8) via a channel (20).
9. Finned rudder according to claim 8, **characterized in that** the channel (20) is seawater-tightly closable at the outer surface of the coupling housing (8).
10. Finned rudder according to at least one of the preceding claims 7 to 9, **characterized by** lubricant grooves (93, 94) in the outer and inner ring (91, 92) of the spherical bearing (9), which lubricant grooves (93, 94) are central with respect to the axial direction of the spherical bearing (9) and are aligned with respect to each other.
11. Finned rudder according to at least one of the preceding claims, **characterized in that** the pivoting piston (6) is fixable in the horizontal borehole (81) of the coupling housing (8) by means of a locking screw (18).