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- **Choi, Jung Eun**
Ulsan (KR)
- **Chung, Seok Ho**
Ulsan (KR)
- **Choi, Bong Jun**
Ulsan (KR)
- **Lee, Sang Bong**
Ulsan (KR)

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(71) Applicant: **Hyundai Heavy Industries Co., Ltd.**
Ulsan 682-792 (KR)

(74) Representative: **Betten & Resch**
Theatinerstrasse 8
80333 München (DE)

(72) Inventors:
• **Kim, Jung Hun**
Ulsan (KR)

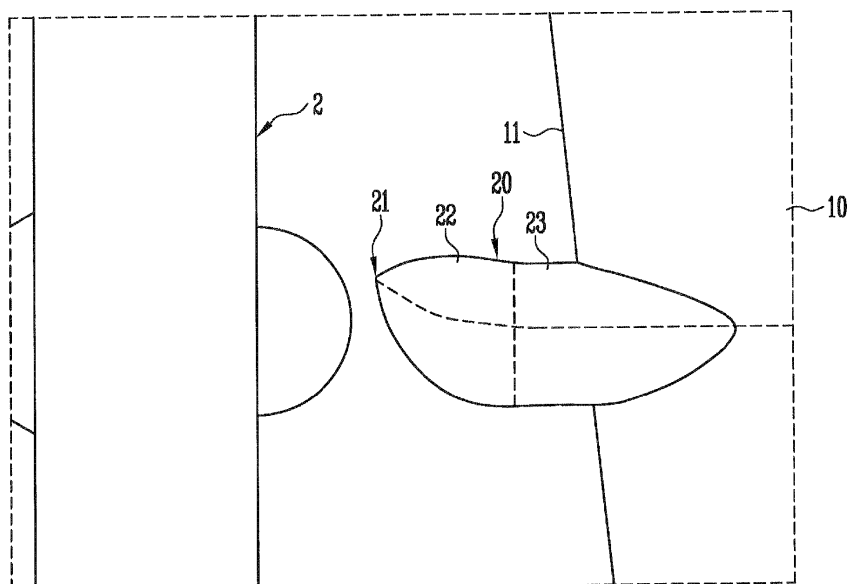
(54) **Rudder for ship**

(57) A rudder for a ship provided at a rear side of a propeller to control a direction in which the ship sails includes a rudder body, and a rudder bulb protruding from a front end of the rudder body, wherein the rudder bulb has a rear end arranged next to a propeller shaft and a

front end eccentric upwards on the basis of the propeller shaft, and the front end of the rudder bulb has a vertex shape, so that self-propulsion performance and steering performance may be significantly improved.

[FIG. 1]

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Korean patent application number 10-2013-0004432 filed on January 15, 2013, in the Korean Intellectual Property Office, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

[0002] The present invention relates generally to a rudder for a ship.

[0003] The present invention is contrived in a research carried out as a part of the industry convergence original technology development project for the Ministry of Knowledge Economy/Institute for Information and Technology Advancement (Republic of Korea) and the Korea Evaluation Institute Of Industrial Technology (Project No. 10040060, Project Name: Development and application of devices for resistance propulsion performance improvement and energy saving according to ship type).

[0004] In general, a large ship moves forward by using the flow of fluid generated when a propeller attached to the rear of the ship rotates. A rudder is attached to the rear of the propeller. As the rudder moves left or right, the direction in which the fluid flows may be controlled so that the direction in which the ship sails may change accordingly.

[0005] In order to achieve a predetermined speed by the rotation of the propeller, an engine needs to be driven using oil such as diesel. However, since a large amount of oil is consumed to drive the engine, greenhouse gases are emitted. As a result, the destruction of the environment may be caused.

[0006] Therefore, various efforts have been made to reduce fuel consumption by saving energy for the propulsion of ships. The International Maritime Organization (IMO) discussed measures to regulate and reduce emissions of greenhouse gases from shipping in 2010 and has been working on regulations and directions on energy efficiency for ships.

[0007] As shipping firms also join such moves, they started paying attention to energy saving ships to deal with high oil prices. In response to their needs, shipbuilders have performed continuous research and development of energy saving techniques for reducing energy consumption and greenhouse gas emissions.

[0008] For example, energy saving devices (ESD) that increase propulsion efficiency and reduce energy consumption by improving the shape of the rear of a ship, a propeller or a rudder, or attaching separate appendages have come to prominence. These energy saving devices (ESD) have already been used in a considerable number of ships.

[0009] Among these energy saving devices, a device which includes a bulb in a rudder to control the flow of

fluid has been widely used. However, since the existing bulb device has a hemispheric shape with the center thereof located on the shaft of the propeller, when the propeller slipstream has horizontal or vertical asymmetry, it may fail to properly control the fluid. As a result, high steering performance or propulsion efficiency may not be achieved.

SUMMARY OF THE INVENTION

[0010] Various embodiments relate to a rudder for a ship capable of obtaining high steering performance and propulsion performance that includes a rudder bulb in which a rear end of the rudder bulb is arranged next to a propeller shaft and a front end is eccentric upwards and has a vertex shape to optimize a flow of fluid.

[0011] A rudder for a ship provided at a rear side of a propeller to control a direction in which the ship sails according to an embodiment of the present invention may include a rudder body, and a rudder bulb protruding from a front end of the rudder body, wherein the rudder bulb has a rear end arranged next to a propeller shaft and a front end eccentric upwards on the basis of the propeller shaft.

[0012] A gradient in which the rudder bulb may be deflected upwards on the basis of the propeller shaft gradually increases toward the front end.

[0013] A central axis of the rudder bulb may be a multi-dimensional curve extended by a predetermined length along the propeller shaft from the rear end and subsequently inclined upwards toward the front end, as viewed laterally.

[0014] The gradient in which the rudder bulb is deflected upwards on the basis of the propeller shaft may have a constant value.

[0015] A central axis of the rudder bulb may be extended by a predetermined length along the propeller shaft from the rear end, be subsequently bent and be inclined toward the front end at a constant gradient, as viewed laterally.

[0016] A position where the rudder bulb has a maximum width may be extended in forward and backward directions at a constant cross-sectional area.

[0017] A vertex may be formed at the front end of the rudder bulb.

[0018] The front end of the rudder bulb may have a conical shape.

[0019] The rudder bulb may include a rear portion having vertical symmetry on the basis of the propeller shaft and a front portion having the front end inclined upwards on the basis of the propeller shaft.

[0020] A lateral cross-section of the front portion may have a closed curve shape including a vertex.

[0021] The rudder bulb may have a maximum width at a position protruding from a leading edge of the rudder body, and a cross-sectional area of the rudder bulb may decrease from the position where the rudder bulb has the maximum width toward the front end or the rear end.

[0022] The front end of the rear portion having the maximum width may be extended in a forward direction by a predetermined length and is subsequently connected to the front portion.

[0023] The front end of the rudder bulb may be inclined to a left side on the basis of the propeller shaft.

[0024] The rudder bulb may include a rear portion having vertical symmetry on the basis of the propeller shaft and a front portion having the front end inclined to the left side on the basis of the propeller shaft.

[0025] The rudder bulb may be eccentric to the left side in parallel on the basis of the propeller shaft.

[0026] The rudder bulb may be rotated around an axis perpendicular to the propeller shaft so that the front end of the rudder bulb is inclined toward the left side and the rear end is inclined toward a right side.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a side view illustrating a rudder for a ship according to an embodiment of the present invention;

FIG. 2 is a graph illustrating performance of a rudder for a ship according to an embodiment of the present invention; and

FIGs. 3 to 5 are plan views illustrating a rudder bulb in a rudder for a ship according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0028] Hereinafter, various embodiments will be described in detail with reference to the accompanying drawings. The figures are provided to allow those having ordinary skill in the art to understand the scope of the embodiments of the disclosure. The present invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art.

[0029] FIG. 1 is a side view illustrating a rudder for a ship according to an embodiment of the present invention.

[0030] As illustrated in FIG. 1, a rudder 1 for a ship according to an embodiment of the present invention may be provided at the rear of a propeller 2 and control the direction in which the ship sails. The rudder 1 may include a rudder body 10 and a rudder bulb 20.

[0031] The rudder body 10 may be connected to a horn or a skeg of a ship body. A rudder shaft (not illustrated) may be connected to the rudder body 10. The rudder shaft may be formed in a vertical direction. A leading edge 11 may be formed at a front end of the rudder body 10, and a trailing edge (not illustrated) may be formed at

a rear end thereof.

[0032] As viewed from the side, the leading edge 11 of the rudder body 10 may be inclined backwards from top to bottom, and the trailing edge may be formed in the vertical direction and be perpendicular to the water plane. The leading edge 11 and the trailing edge of the present embodiment are not limited to those described above. On the other hand, the leading edge 11 may be perpendicular to the water plane, and the trailing edge may be inclined.

[0033] The rudder body 10 may have a planar cross-section in which the front end may be curved and the rear end may be pointed. More specifically, the rudder body 10 may have an airfoil shape. In addition, the planar cross-section of the rudder body 10 may be reduced in area from top to bottom. The planar cross-section of the rudder body 10 may be reduced at a constant ratio. When the trailing edge is formed in the vertical direction, a left-right width and a front-back width of the cross section may decrease from top to bottom on the basis of the trailing edge.

[0034] The rudder bulb 20 may protrude from the front end of the rudder body 10. The rudder bulb 20 may extend forward by a predetermined length on the basis of the leading edge 11 of the rudder body 10. In addition, the rudder bulb 20 may extend from the left and right of the rudder body 10 at the rear of the leading edge 11.

[0035] A vertex 21 of the rudder bulb 20 may be formed at a front end thereof. The front end of the rudder bulb 20 may be eccentric upwards on the basis of a propeller shaft 3. Hereinafter, a portion defined from a maximum width point of the rudder bulb 20 to the vertex 21 may be referred to as a front portion 22, and a portion defined from the maximum width point to the rear end may be referred to as a rear portion 23.

[0036] The front portion 22 of the rudder bulb 20 may include a front end having a conical shape. However, the front portion 22 of the rudder bulb 20 may have a conical shape so that a cross-sectional area may increase from the vertex 21 toward the rear at a constant ratio. The front portion 22 may also have various shapes in which the increase of the cross-sectional area may vary. For example, according to an embodiment of the present invention, the increase of the cross-sectional area of the front portion 22 of the rudder bulb 20 may gradually decrease from the front end toward the maximum width point, and a lateral cross section may have a shape of closed curve having a vertex, rather than a semicircle.

[0037] A degree to which the front portion 22 of the rudder bulb 20 is deflected upwards on the basis of the propeller shaft 3, i.e., a deflection gradient may gradually increase toward the front end. In other words, when viewed from the side, a central axis (indicated by a dotted line in FIG. 1 and passing through the center in each cross section) of the front portion 22 of the rudder bulb 20 may be a multi-dimensional curve which is inclined upwards toward the front end. The central axial line may be approximately a two-dimensional curve which is

smoothly inclined upward.

[0038] The central axis of the rudder bulb 20 may be a multi-dimensional curve which is extended along the propeller shaft 3 by a predetermined length and is substantially inclined upwards toward the front end. This is because the rear portion 23 of the rudder bulb 20 may not be inclined upwards or downwards, which will be described below.

[0039] In addition, though not illustrated in FIG. 1, the deflection gradient, i.e., the degree to which the front portion 22 is inclined upwards, may have a predetermined value. The central axis of the front portion 22 may be an oblique shape which is inclined with respect to the propeller shaft 3. The central axis of the rudder bulb 20 may be extended by a predetermined length along the propeller shaft 3 from the rear end of the rudder bulb 20 toward the front, be subsequently bent at a position where the front portion 22 and the rear portion 23 are connected, and be inclined upwards toward the front end at a constant ratio.

[0040] The rudder bulb 20 may have the maximum width at a position protruding from the leading edge 11 of the rudder body 10. The cross-sectional area of the rudder bulb 20 may decrease from the position where the rudder bulb 20 has the maximum width toward the front end or the rear end. In other words, a cross-section of each of the front portion 22 and the rear portion 23 of the rudder bulb 20 may decrease toward the end. Similarly to the front portion 22, the cross-sectional area of the rear portion 23 of the rudder bulb 20 may decrease from the maximum width point to the rear end at a constant ratio or the decrease of the cross-sectional area may increase. When the decrease of the cross-sectional area increases, the rear portion 23 of the rudder bulb 20 may have an airfoil shape.

[0041] However, the position at which the rudder bulb 20 has the maximum width may be extended to the front and back at a constant cross-sectional area. In other words, as illustrated in FIG. 1, a front end of the rear portion 23 of the rudder bulb 20 may extend forward by a predetermined length to a size allowing the maximum width and be connected to the front portion 22 of the rudder bulb 20.

[0042] The rear portion 23 of the rudder bulb 20 may have vertical symmetry. For example, an outer contour of the rear portion 23 of the rudder bulb 20 may have a shape in which outwardly protruding two-dimensional curves are connected to the left and right of the rudder body 10.

[0043] In addition, the end of the rear portion 23 of the rudder bulb 20 may be located on the propeller shaft 3. In other words, as viewed from the side, the central axis (indicated by a dotted line in FIG. 1 and passing through the center in each cross section in substantially the same manner as the central axis of the front portion 22) of the rear portion 23 of the rudder bulb 20 may coincide with the propeller shaft 3.

[0044] In other words, the rear end of the rudder bulb

20 may be located on the propeller shaft 3, and the front end thereof may be located above the propeller shaft 3. In this case, as described above, the central axis of the rudder bulb 20 may be curved or bent at least once with the front end deflected upwards.

[0045] According to an embodiment of the present invention, the entire central axis of the rudder bulb 20 may not be arranged next to the propeller shaft 3 or may not have a linear shape inclined upward or downward as described above. Instead, the central axis of the rear portion 23 may coincide with the propeller shaft 3, and the central axis of the front portion 22 may be more inclined upwards than the propeller shaft so that the entire rudder bulb 20 may have a bent curve shape (or bent linear shape). Therefore, as compared to that in the related art, the present embodiment may significantly improve thrust. This will be described below in detail with reference to FIG. 2.

[0046] FIG. 2 is a graph illustrating performance of a rudder for a ship according to an embodiment of the present invention.

[0047] FIG. 2 illustrates improvement effects of delivered horse power (DHP) with respect to a case in which a rudder bulb is attached to a rudder, a case in which an inclined rudder bulb is attached to a ruder (see FIG. 10 of Korean Patent Application Publication No. 10-2011-0007721) and the present embodiment in which the central axis of the rudder bulb 20 is bent so that the rear end of the rudder bulb 20 may be formed on the propeller shaft 3 and the front end of the rudder bulb 20 may be inclined upwards on the propeller shaft 3 on the basis of a case in which only the rudder is included.

[0048] When only the rudder is provided, an improvement effect of 0% is obtained since this case is a reference one. When a rudder bulb is added to the rudder, an improvement effect of 0.4% was obtained. When the rudder bulb is inclined, an improve ratio of 1.0% was obtained.

[0049] However, in the present embodiment, since the central axis is bent, the rear end of the rudder bulb 20 may be located on the propeller shaft 3 and the front end thereof may be upwardly formed on the propeller shaft 3, so that a significant improvement effect of 3.5% was obtained.

[0050] As a result of analyzing the experiments, when the inclined rudder bulb is provided, the rear end of the rudder bulb may also be deflected downwards on the basis of the propeller shaft 3. As a result, there was an insignificant improvement effect of the DHP or a contrary effect was produced.

[0051] However, according to the present embodiment, since the rear end of the rudder bulb 20 is located on the propeller shaft 3 and the front end thereof is upwardly formed on the propeller shaft 3, the improvement effect of the DHP was maximized. In other words, in comparison to the conventional rudder bulb shapes, since the rudder bulb according to the present embodiment has a bent central axis, thrust may be significantly im-

proved and energy saving may be achieved.

[0052] In the present invention, the vertex 21 of the rudder bulb 20 may be eccentric upwards to the left. Self-propulsion performance may be improved by deflecting the front end of the rudder bulb 20 since a slipstream produced by the propeller 2 has vertical asymmetry, which will be described below with reference to FIGs. 3 to 5.

[0053] FIGs. 3 to 5 are plan views illustrating a rudder bulb in a rudder for a ship according to an embodiment of the present invention. The rudder body 10 is not illustrated in FIGs. 3 to 5 for illustrative purposes.

[0054] As illustrated in FIG. 3, the rear portion 23 of the rudder bulb 20 may have vertical symmetry on the basis of the propeller shaft 3. However, the vertex 21 of the front portion 22 of the rudder bulb 20 may be inclined upwards to the left on the basis of the propeller shaft 3.

[0055] On the other hand, as illustrated in FIG. 4, according to an embodiment of the present invention, the rudder bulb 20 may be eccentric to the left in parallel on the basis of the propeller shaft 3. In other words, a rudder bulb central axis 24, which is a line passing through the front end and the rear end of the rudder bulb 20, may be separated from the propeller shaft 3 by a predetermined distance and be parallel to each other.

[0056] In this example, both the front portion 22 and the rear portion 23 of the rudder bulb 20 may have vertical symmetry on the basis of the rudder bulb central axis 24. However, both the front portion 22 and the rear portion 23 of the rudder bulb 20 may have vertical asymmetry on the basis of the propeller shaft 3. More specifically, each of the front portion 22 and the rear portion 23 of the rudder bulb 20 may have a larger area in the left than in the right on the basis of the propeller shaft 3.

[0057] In addition, according to the present embodiment, as illustrated in FIG. 5, the rudder bulb 20 may be rotated around an axis perpendicular to the propeller shaft 3 so that the vertex 21 at the front end of the rudder bulb 20 may be inclined toward the left. At the same time, contrary to the front end, the rear end of the rudder bulb 20 may be inclined toward the right. The axis (indicated by an intersecting point between the propeller shaft 3 and the rudder bulb central axis 24) perpendicular to the propeller shaft 3 may be in parallel with the rudder axis.

[0058] In this example, as described above with reference to FIG. 4, the front portion 22 and the rear portion 23 of the rudder bulb 20 may have vertical symmetry on the basis of the rudder bulb central axis 24. However, the front portion 22 and the rear portion 23 of the rudder bulb 20 may have asymmetry on the basis of the propeller shaft 3.

[0059] More specifically, the front portion 22 of the rudder bulb 20 may have a larger area in the left than in the right on the basis of the propeller shaft 3, while the rear portion 23 of the rudder bulb 20 may have a smaller area in the left of the propeller 3 shaft than in the right thereof.

[0060] As described above, according to the present invention, when the vertex 21 is formed at the front end

of the rudder bulb 20, the vertex 21 may be eccentric upwards, and the central axis of the rudder bulb 20 may be arranged next to the propeller shaft at the rear end and be eccentric upwards at the front end, so that a slipstream of the propeller 2 may be optimized to improve self-propulsion performance and steering performance may be improved by increasing a surface area by the rudder bulb 20.

[0061] According to an embodiment of the present invention, a rudder for a ship provided at a rear side of a propeller to control a direction in which the ship sails includes a rudder body, and a rudder bulb protruding from a front end of the rudder body, wherein the rudder bulb has a rear end arranged next to a propeller shaft and a front end eccentric upwards on the basis of the propeller shaft.

[0062] A rudder for a ship according to an embodiment of the present invention includes a rudder bulb, a front end of the rudder bulb is eccentric upwards, and the front end of the rudder bulb has a vertex shape, so that self-propulsion performance and steering performance may be significantly improved.

[0063] According to an embodiment of the present invention, a rudder for a ship may include a rudder bulb, a rear end of the rudder bulb may coincide with a propeller shaft and a front end thereof may be eccentric upwards, and the front end of the rudder bulb may form a vertex shape, so that self-propulsion performance and steering performance may be significantly improved.

Claims

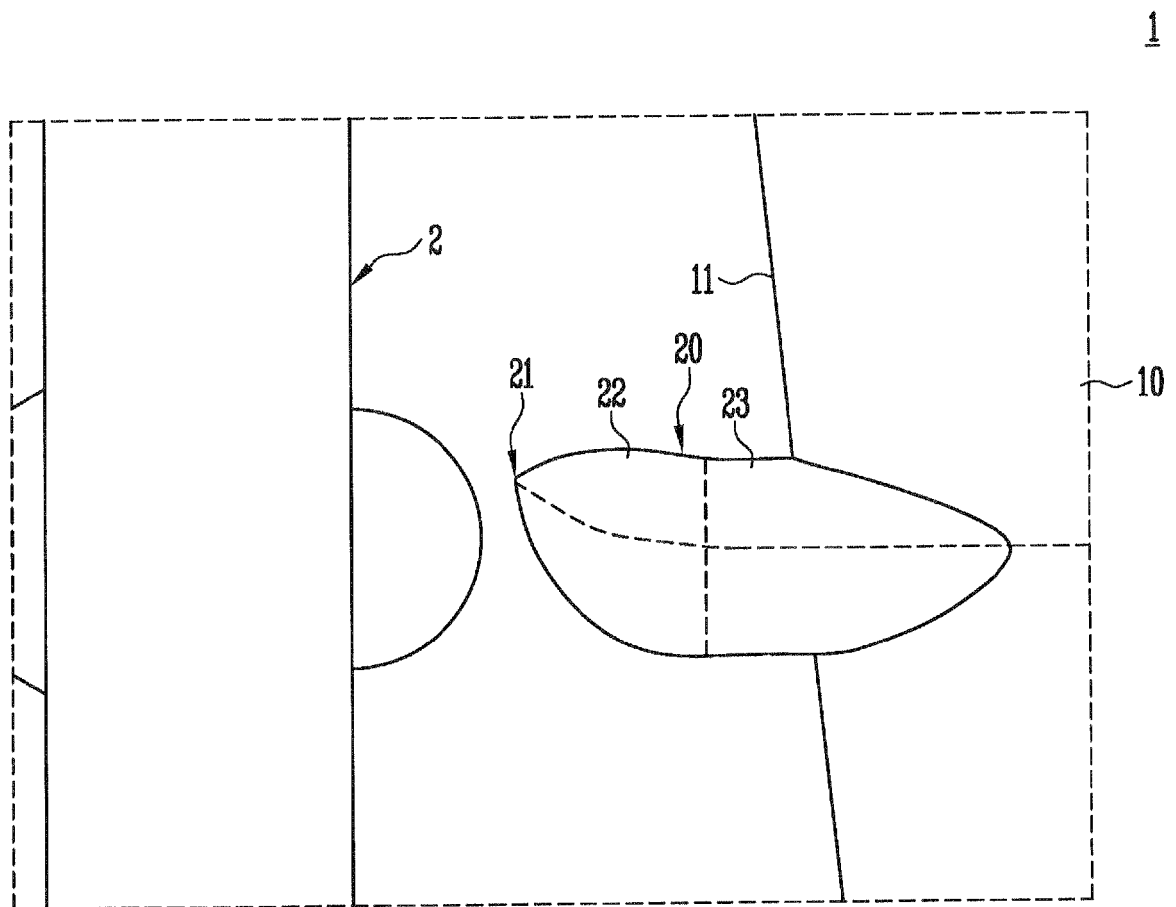
1. A rudder for a ship provided at a rear side of a propeller to control a direction in which the ship sails, the rudder comprising:
 - a rudder body; and
 - a rudder bulb protruding from a front end of the rudder body, wherein the rudder bulb has a rear end arranged next to a propeller shaft and a front end eccentric upwards on the basis of the propeller shaft.
2. The rudder of claim 1, wherein a gradient in which the rudder bulb is deflected upwards on the basis of the propeller shaft gradually increases toward the front end.
3. The rudder of claim 2, wherein a central axis of the rudder bulb is a multi-dimensional curve extended by a predetermined length along the propeller shaft from the rear end and subsequently inclined upwards toward the front end, as viewed laterally.
4. The rudder of one of claims 1 to 3, wherein the gradient in which the rudder bulb is deflected upwards on the basis of the propeller shaft has a constant

value.

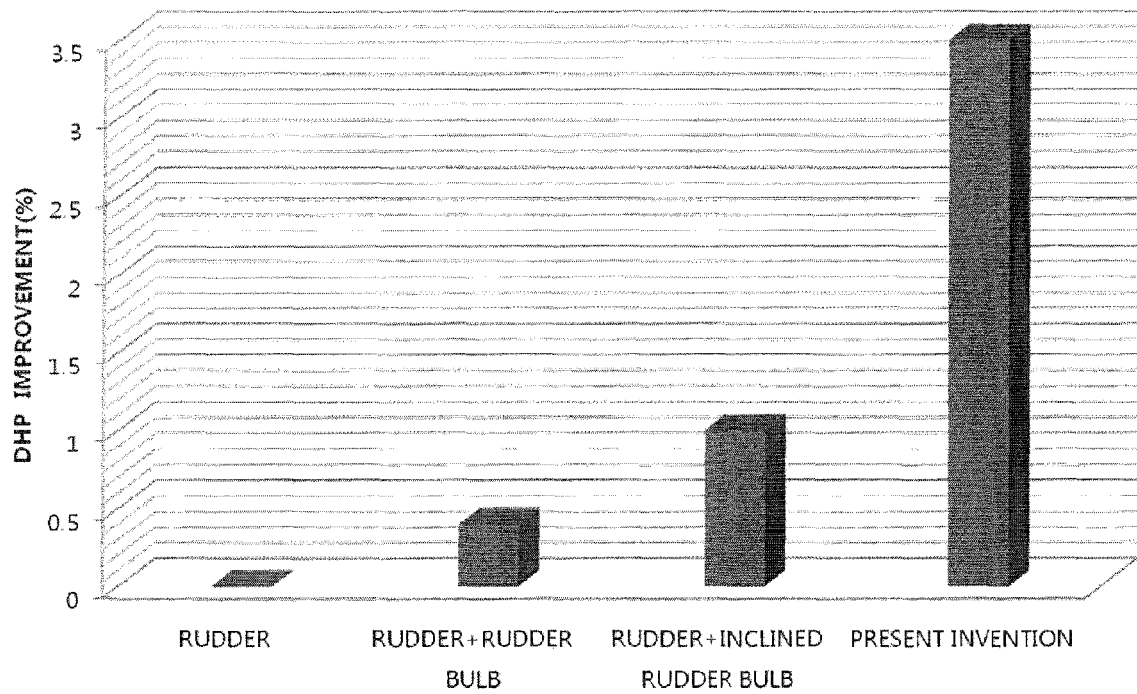
clined toward the left side and the rear end is inclined toward a right side.

5. The rudder of claim 4, wherein a central axis of the rudder bulb is extended by a predetermined length along the propeller shaft from the rear end, is subsequently bent and is inclined toward the front end at a constant gradient, as viewed laterally. 5
6. The rudder of claim 3 or 5, wherein a position where the rudder bulb has a maximum width is extended in forward and backward directions at a constant cross-sectional area. 10
7. The rudder of one of claims 1 to 6, wherein a vertex is formed at the front end of the rudder bulb. 15
8. The rudder of claim 7, wherein the front end of the rudder bulb has a conical shape.
9. The rudder of one of claims 1 to 8, wherein the rudder bulb includes a rear portion having vertical symmetry on the basis of the propeller shaft and a front portion having the front end inclined upwards on the basis of the propeller shaft. 20
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10. The rudder of claim 9, wherein a lateral cross-section of the front portion has a closed curve shape including a vertex.
11. The rudder of claim 9, wherein the rudder bulb has a maximum width at a position protruding from a leading edge of the rudder body, and a cross-sectional area of the rudder bulb decreases from the position where the rudder bulb has the maximum width toward the front end or the rear end. 30
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12. The rudder of claim 11, wherein the front end of the rear portion having the maximum width is extended in a forward direction by a predetermined length and is subsequently connected to the front portion. 40
13. The rudder of one of claims 1 to 12, wherein the front end of the rudder bulb is inclined to a left side on the basis of the propeller shaft. 45
14. The rudder of claim 13, wherein the rudder bulb includes a rear portion having vertical symmetry on the basis of the propeller shaft and a front portion having the front end inclined to the left side on the basis of the propeller shaft. 50
15. The rudder of claim 13, wherein the rudder bulb is eccentric to the left side in parallel on the basis of the propeller shaft. 55
16. The rudder of claim 13, wherein the rudder bulb is rotated around an axis perpendicular to the propeller shaft so that the front end of the rudder bulb is in-

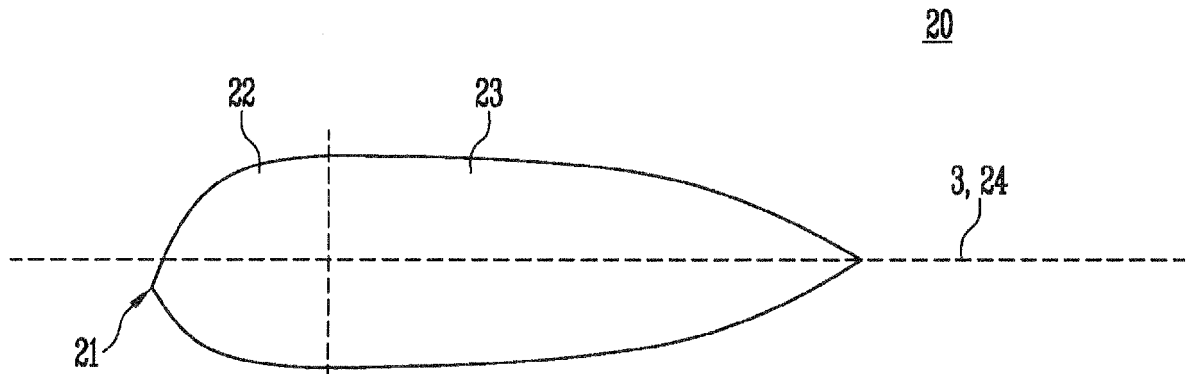
[FIG. 1]



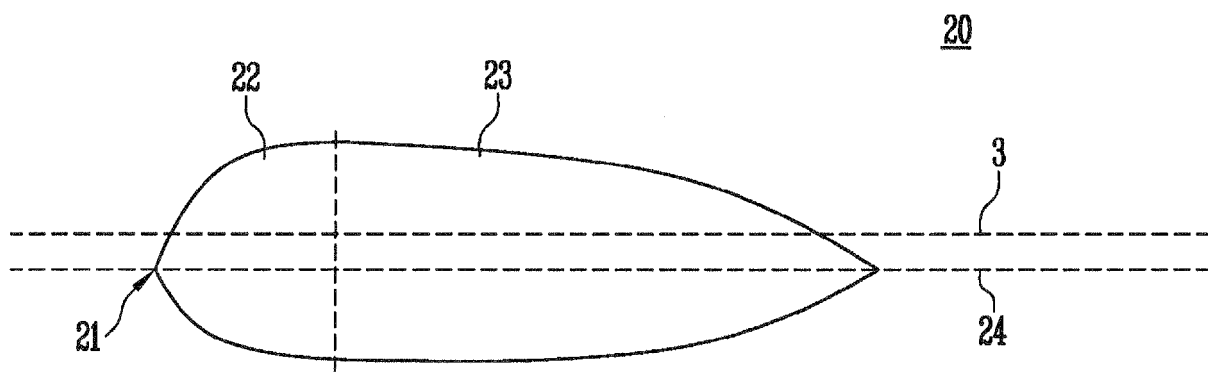
[FIG. 2]



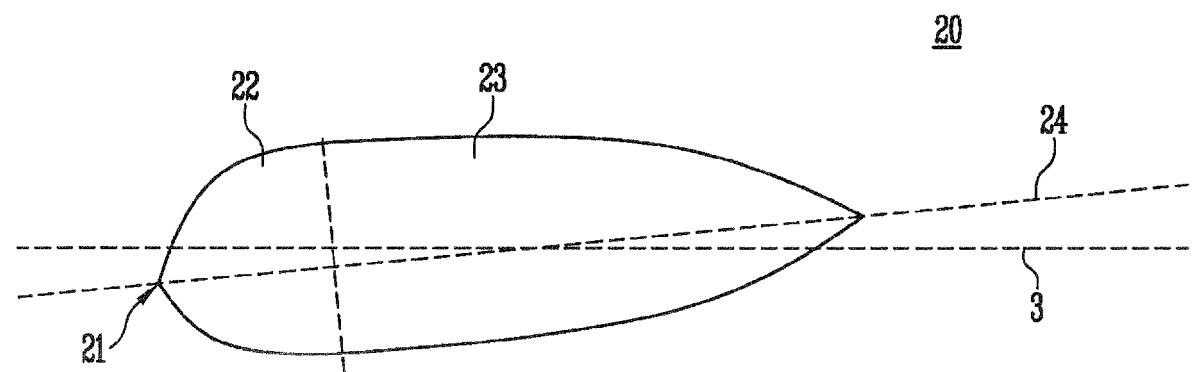
[FIG. 3]



[FIG. 4]



[FIG. 5]





EUROPEAN SEARCH REPORT

Application Number
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Place of search Munich		Date of completion of the search 14 April 2014	Examiner Brumer, Alexandre
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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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