

(19)



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(11)

EP 1 013 544 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
27.10.2004 Bulletin 2004/44

(51) Int Cl.7: **B63H 25/42**, B63H 25/38,
B63H 5/16, B63B 23/24
// B63H21/17

(21) Application number: **99125210.7**

(22) Date of filing: **17.12.1999**

(54) **Azimuth propeller apparatus and ship equipped with the apparatus**

Azimet-Vortriebsvorrichtung und damit ausgerüstetes Schiff

Propulseur azimuthal et bateau équipé avec un tel propulseur

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**

(30) Priority: **21.12.1998 JP 36304798**
16.06.1999 JP 17000799

(43) Date of publication of application:
28.06.2000 Bulletin 2000/26

(73) Proprietor: **Mitsubishi Heavy Industries, Ltd.**
Tokyo (JP)

(72) Inventors:
• **Toki, Naoji, Nagasaki R&D Ct.**
5-chome, Nagasaki, Nagasaki-ken (JP)
• **Kobayashi, Eiichi. c/o Nagasaki R&D Center**
5-chome, Nagasaki, Nagasaki-ken (JP)
• **Yasukawa, Hironori, c/o Nagasaki R&D Center**
5-chome, Nagasaki, Nagasaki-ken (JP)

• **Manabe, Noriyuki, c/o Nagasaki R&D Center**
5-chome, Nagasaki, Nagasaki-ken (JP)
• **Hoshino, Tetsuji, c/o Nagasaki R&D Center**
5-chome, Nagasaki, Nagasaki-ken (JP)

(74) Representative: **Lins, Edgar, Dipl.-Phys. Dr.jur.**
Gramm, Lins & Partner GbR,
Theodor-Heuss-Strasse 1
38122 Braunschweig (DE)

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1995 (1995-10-17)

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Description

[0001] The present invention relates to an azimuth propeller apparatus and a ship equipped with the azimuth propeller apparatus.

[0002] Generally, ships are equipped with a propeller. The propeller is turned, propelling the ship in a direction that is controlled by a rudder.

[0003] FIG. 1 shows a typical conventional ship 80. FIG. 2 is a magnified view of a stern of the ship 80, illustrating a rudder 82 of the ship 80.

[0004] As shown in FIGS. 1 and 2, a propeller 81 is provided at the stern, along with the rudder 82. The propeller 81 is driven by the main engine 84 installed in a hull of the ship 80 at the same level. The main engine 84 has its shaft axially aligned with the propeller 81. The rudder 82 is attached to the stern by a rudder horn 83.

[0005] As the main engine 84 drives the propeller 81, the ship 80 is propelled. The direction in which the ship 80 is propelled is controlled by turning the rudder 82 on the rudder horn 83.

[0006] In recent years, ships have been proposed, each having an azimuth propeller at the stern. The azimuth propeller can be rotated around a vertical axis. The azimuth propeller propels the ship as it is driven around the horizontal, and steers the ship as it rotates around the vertical axis.

[0007] FIG. 3 depicts a ship 90 with a conventional azimuth propeller apparatus 91. FIG. 4 is a magnified view of the stern of the ship 90, showing the conventional azimuth propeller apparatus 91.

[0008] As shown in FIGS. 3 and 4, the azimuth propeller apparatus 91 comprises a strut 92, a pod 93 and a propeller 94. The strut 92 is connected to the stern of the ship 90 and can rotate around a vertical axis. The pod 93 is secured to the strut 92. The propeller 94 is attached to the pod 93.

[0009] In the stern there is provided a generator/engine (G/E), which is located above the strut 92. The generator/engine drives a generator (not shown), which generates electric power. The electric power is supplied to the motor provided in the pod 93. Driven with the electric power, the motor drives the propeller 94.

[0010] FIG. 5 is a graph representing the various relations between the rudder angle and the lateral force, which are observed with various ships. In FIG. 5, curve D indicates the angle-force relation observed when the propeller 81 and the rudder 82 (both shown in FIG. 2) are used, propelling and steering the ship 80 shown in FIG. 1 at low speed of 18 knots. Curve E shows the angle-force relation observed when the azimuth propeller apparatus 91 (shown in FIG. 4) is used, propelling and steering the ship 90 shown in FIG. 3 at low speed of 18 knots. Curve C indicates the angle-force relation observed when the ship 80 is propelled and steered at high speed of 25 knots.

[0011] As can be understood from curve C, the ship

80 can receive a sufficient lateral force while being propelled at a relatively high speed, as in off-shore navigation. The ship 80 can therefore be well steered in off-shore navigation. However, when the ship 80 is propelled at low speed as it is navigated in the harbor, as it is moored at the pier, or as it leaves the pier, its steerability greatly decreases as curve D reveals in FIG. 5.

[0012] As described above, the ship 90 shown in FIG. 3 has the azimuth propeller apparatus 91 shown in FIG. 4. As the strut 92 of the apparatus 91 is rotated, a lateral force is applied to the ship 90. The lateral force is smaller than the lateral force applied to the ship 80 (FIG. 1) as the rudder 82 is rotated. Therefore, the greater part of the lateral force, which is applied to the ship 90 when the ship 90 is propelled at low speed, is a lateral component of the propelling force that the propeller 94 applies to the ship 90.

[0013] The lateral component of the propelling force applied to the ship 90 at low speed of 18 knots is small as is indicated by curve E in FIG. 5. In other words, the steerability of the ship 90 equipped with the azimuth propeller apparatus 91 also become insufficient during the low-speed navigation.

[0014] To impart sufficient steerability to the ship 91, a sufficiently large lateral force must be applied to the ship 91, not only when the ship 91 is propelled at low speed, but also when the wind is strong or waves are high.

[0015] If tax is levied on carbon emission in order to prevent the global warming, ships will need to be navigated at low speed to save energy. When ships are navigated at low speed, however, the rudder force decreases. Hence, the steerability of a low-speed ship is particularly lowered.

[0016] It is therefore demanded not only that a ship with an azimuth propeller apparatus maintains sufficient steerability even while navigated at low speed, but also that the propelling efficiency of azimuth propeller apparatuses be enhanced.

[0017] GB 1 203 560 discloses a steering and propulsion gear for ships and relates to marine propulsion drive rather than to an azimuth propeller apparatus shape like flap and arranged at the back of a skeg protruding from the stern of a ship, and which therefor has a rudder that conforms to the skeg in shape.

[0018] The present invention has been made to solve the problems described above. An object of the invention is to provide an azimuth propeller apparatus which can increase the steerability of ships during low-speed navigation and which can propel ships with high efficiency. Another object of the invention is to provide a ship which is equipped with this azimuth propeller apparatus.

[0019] According to the invention, there is provided an azimuth propeller apparatus which comprises: a rotatable shaft connectable to a stern of a ship and comprising a skeg protruding from the stern of the ship and having a notch in an edge part to allow passage of the propeller being rotated around the shaft; a rudder plate

secured to the shaft configured control the course of the ship, a pod mounted on middle part of the rudder plate; a propeller having a propeller shaft connected to one end of the pod; and driver provided in the pod, for driving the propeller shaft. In a preferred embodiment, the rudder plate includes an upper rudder plate secured to upper part of the shaft which is located above the pod and configured to control the course of the ship and a lower rudder plate secured to under part of the shaft which is located below the pod and configured to control the course of the ship.

[0020] According to the present invention, there is also provided a ship which comprises the aforementioned azimuth propeller apparatus.

[0021] In another preferred embodiment, a reaction fin is connected to the pod and located at fore-flow of the propeller and swirl water in a direction opposite to a rotational direction of the propeller.

[0022] Further preferred embodiments are described in the subclaims.

[0023] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side view showing a ship having a conventional propeller and a conventional rudder;

FIG. 2 is a magnified view of the stern of the ship shown in FIG. 1;

FIG. 3 is a side view of a ship equipped with a conventional azimuth propeller apparatus;

FIG. 4 is a magnified view of the stern of the ship shown in FIG. 3;

FIG. 5 is a graph representing the various relations between the rudder angle and the lateral force, which are observed with various ships;

FIG. 6 is a graph illustrating the relation which the gap between the hull and rudder of a ship and the lateral force applied to the rudder have when the rudder angle is 35°;

FIG. 7 is a side view of the stern of a ship according to the invention, which is equipped with an azimuth propeller apparatus of a different type;

FIG. 8 is a side view for explaining the operation of the embodiment in FIG. 7;

FIG. 9 is a side view of the stern of a ship equipped with a modification of the azimuth propeller apparatus according to a preferred embodiment, which has a reaction fin at the fore-stream of the propeller;

[0024] The embodiments of the invention will be described, with reference to the accompanying drawings.

[0025] FIG. 5 is a graph representing the various relations between the rudder angle and the lateral force, which are observed with various ships. Curve D indicates the angle-force relation observed when the propeller 81 and the rudder 82 (both shown in FIG. 2) are used, propelling and steering the ship 80 shown in FIG. 1 at low speed of 18 knots. Curve E shows the angle-

force relation observed when the azimuth propeller apparatus 91 (shown in FIG. 4) is used, propelling and steering the ship 90 shown in FIG. 3 at low speed of 18 knots. Curve A indicates the angle-force relation observed when the azimuth propeller apparatus 1 (shown in FIG. 4) is used, propelling and steering a ship at low speed of 18 knots.

[0026] As seen from curve A, the lateral force is almost equal to the sum of the lateral force applied to the hull when the propeller 81 and the rudder 82 (FIG. 2) are used and the lateral force applied to the hull when the azimuth propeller apparatus 91 (FIG. 4) is used. Obviously, the ship with the azimuth propeller apparatus 91 according to the invention (Embodiment 4) can acquire a larger lateral force than the ship 80 with the propeller 81 and rudder 82 and the ship 90 with the conventional azimuth propeller apparatus 91.

[0027] Curve B in FIG. 5 indicates the relation between the rudder angle and the lateral force, angle-force relation observed when the ship according to the second embodiment is propelled and steered at low speed of 18 knots. As can be evidenced by comparing curve B with curve A, the lateral force is larger than the lateral force applied to the ship according to the first embodiment.

[0028] Moreover, curve C in FIG. 5 indicates the angle-force relation observed when the ship 80 is propelled and steered at high speed of 25 knots. As can be seen from comparison between curve C and curve B, a lateral force, which is comparable with the lateral force applied to the ship 80 navigated at 25 knots, can be applied to the ship, according to the second embodiment, though the ship is navigated at low speed of 18 knots.

[0029] The azimuth propeller apparatus according to this invention is characterized in two respects. First, the gap between the rudder plate and the hull is narrow, increasing the steerability of the ship. Second, the azimuth propeller apparatus is rotated by 180° from the normal position to propel the ship backward.

[0030] FIG. 7 is a side view of the stern of the ship according to the embodiment. With reference to FIG. 7 the azimuth propeller apparatus 4 and skeg 51 of the embodiment will be described.

[0031] The azimuth propeller apparatus 4 has a rudder plate 53. The rudder plate 53 is a modification of the rudder plate 23 shown in FIGS. 5 and 9. The rudder plate 53 has a projection 531 on the front edge and can rotate through 360°. The rudder plate 53 is identical to the rudder plate 23 of the azimuth propeller apparatuses 1 and 2 in the shape of its cross section, as is indicated by the two-dot, dashed lines 531 in FIG. 7.

[0032] The skeg 51 has a U-notch 511 in the rear edge. It is in the notch 511 in which the projection 531 of the rudder plate 53 is placed as long as the rudder plate 53 remains in the normal position. Thus, the gap between the plate 53 and the hull is much narrower than in the case of the conventional ships.

[0033] To propel the ship backward, it suffices to rotate the shaft 20 by 180°, thereby setting the rudder plate 53 in the position shown in FIG. 8. The propeller 21 is then located in the notch 511 of the skeg 51. As the propeller 21 is rotated in the notch 511, it applies a backward propelling force to the hull.

[0034] FIG. 9 shows a modification of the azimuth propeller apparatus 4 which has a reaction fin 50 at the fore-stream of the propeller 21.

[0035] The use of the reaction fin 50 can help to increase the ship-propelling efficiency.

Claims

1. An azimuth propeller apparatus (4) **characterized by** comprising:

a rotatable shaft (13, 19) connectable to the stern of a ship and comprising a skeg (51) protruding from the stern of the ship and having a notch (511) in an edge part to allow passage of the propeller (21) being rotated around the shaft (13);

a rudder plate (53) secured to the shaft (13) configured to control the course of the ship;

a pod (15) mounted on a middle part of the rudder plate (53);

a propeller (21) having a propeller shaft (19) connected to one end of the pod (15); and driver provided in the pod (15), for driving the propeller shaft (19).

2. An azimuth propeller apparatus (4) according to claim 1, **characterized in that**:

the rudder plate (53) includes:

an upper rudder plate (53) secured to upper part of the shaft (19) which is located above to pod (15) and configured to control the course of the ship and a lower rudder plate (53) secured to under part of the pod (15) and configured to control the course of the ship.

3. An azimuth propeller apparatus (4) according to claim 1 or 2 **characterized by** further comprising:

a reaction fin which is connected to the pod (15) and located at fore-flow of the propeller (21) and swirl water in a direction opposite to a rotational direction of the propeller (21).

4. An azimuth propeller apparatus (4) according to claims 1 to 3 **characterized by** comprising:

a stator fin which is connected to the pod (15)

and located at aft-flow of the propeller (21) and swirl water in a direction opposite to a rotational direction of the propeller (21).

5. A ship **characterized by** comprising the azimuth propeller apparatus (4) according to claims 1 to 4.

6. A ship according to claim 5 **characterized in that** the skeg (51) located in front of the azimuth propeller apparatus (4).

7. A ship according to claim 5 or 6, **characterized in that** the skeg (51) has support means supporting the shaft (13).

Patentansprüche

1. Azimuth-Propellervorrichtung (4), **gekennzeichnet durch**:

eine rotierbare Welle (13, 19), die mit dem Heck eines Schiffes verbindbar ist und eine von dem Heck des Schiffes hervorstehende Ruderhake (51) mit einer Ausklinkung (511) in einem Randbereich, um den Durchgang des um die Welle (13) rotierten Propellers zu ermöglichen;

einem mit der Welle (13) verbundenen Ruderblatt (53), das zur Steuerung des Schiffskurses ausgebildet ist;

einem an einem Mittelteil des Ruderblatts (53) angebrachten Aggregat (15);

einem Propeller (21) mit einer an einem Ende des Aggregates (15) verbundenen Propellerwelle (19); und

einem Antrieb in dem Aggregat (15) zum Antreiben der Propellerwelle (19).

2. Azimuth-Propellervorrichtung (4) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Ruderblatt (53) hat:

ein mit dem oberen Teil der Welle (19) verbundenes oberes Ruderblatt (53), das oberhalb des Aggregates (15) angeordnet und zur Steuerung des Schiffskurses ausgebildet ist, und ein mit dem unteren Teil des Aggregates (15) verbundenes und zur Steuerung des Schiffskurses ausgebildetes unteres Ruderblatt (53).

3. Azimuth-Propellervorrichtung (4) nach Anspruch 1 oder 2, gekennzeichnet weiterhin mit:

einer Reaktionsflosse, die mit dem Aggregat (15) verbunden und am Bugstrom des Propellers (21) angeordnet ist und Wasser in eine Richtung entgegengesetzt zu einer Rotationsrichtung des Propellers (21) verwirbelt.

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4. Azimuth-Propellervorrichtung (4) nach einem der Ansprüche 1 bis 3, **gekennzeichnet durch**:

eine Leitflosse, die mit dem Aggregat (15) verbunden und am Heckstrom des Propellers (21) angeordnet ist und Wasser in eine Richtung entgegengesetzt zu einer Rotationsrichtung des Propellers (21) verwirbelt.

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5. Schiff, **gekennzeichnet durch** die Azimuth-Propellervorrichtung (4) nach einem der Ansprüche 1 bis 4.

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6. Schiff nach Anspruch 5, **dadurch gekennzeichnet, dass** die Ruderhacke (51) vor der Azimuth-Propellervorrichtung (4) angeordnet ist.

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7. Schiff nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** die Ruderhacke (51) Tragmittel zum Tragen der Welle (13) hat.

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Revendications

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1. Propulseur azimuthal (4) **caractérisé par le fait qu'il** comprend :

un arbre rotatif (13, 19) pouvant être relié à la poupe d'un navire et comprenant un talon de quille (51) en saillie depuis la poupe du navire et présentant une encoche (511) dans une partie de bord afin de permettre le passage de l'hélice (21) étant en rotation autour de l'arbre (13) ;
un safran (53) fixé à l'arbre (13) configuré pour commander la route du navire ;
une nacelle (15) montée sur une partie médiane du safran (53) ;
une hélice (21) présentant un arbre d'hélice (19) relié à une extrémité de la nacelle (15) ; et
un moteur d'entraînement prévu dans la nacelle (15) destiné à entraîner l'arbre d'hélice (19).

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2. Propulseur azimuthal (4) selon la revendication 1, **caractérisé en ce que** le safran (53) comprend :

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un safran supérieur (53) fixé à la partie supérieure de l'arbre (19) qui est situé au-dessus de la nacelle (15) et configuré pour commander la route du navire et un safran inférieur (53) fixé à la partie inférieure de la nacelle (15) et configuré pour commander la route du navire.

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3. Propulseur azimuthal (4) selon la revendication 1 ou 2, **caractérisé en ce qu'il** comprend en outre :

une ailette à réaction qui est reliée à la nacelle (15) et située au flux avant de l'hélice (21) et de l'eau de remous dans une direction opposée à une direction de rotation de l'hélice (21).

4. Propulseur azimuthal (4) selon les revendications 1 à 3, **caractérisé en ce qu'il** comprend :

une ailette de stator qui est reliée à la nacelle (15) et située au flux arrière de l'hélice (21) et de l'eau de remous dans une direction opposée à une direction de rotation de l'hélice (21).

5. Navire **caractérisé en ce qu'il** comprend le propulseur azimuthal (4) selon les revendications 1 à 4.

6. Navire selon la revendication 5, **caractérisé en ce que** le talon de quille (51) est située à l'avant du propulseur azimuthal (4).

7. Navire selon la revendication 5 ou 6, **caractérisé en ce que** le talon de quille (51) présente des moyens de support destinés à supporter l'arbre (13).

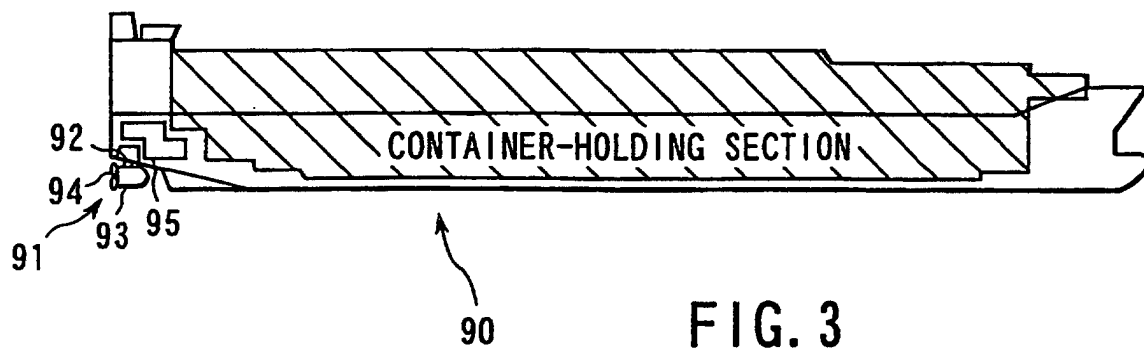
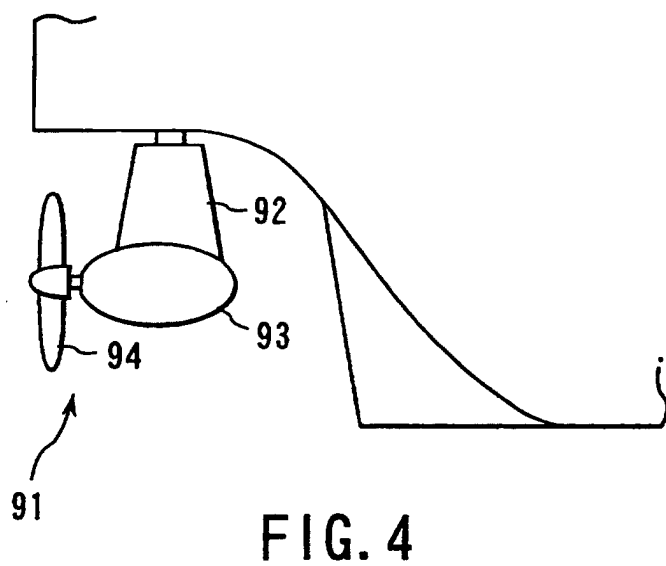
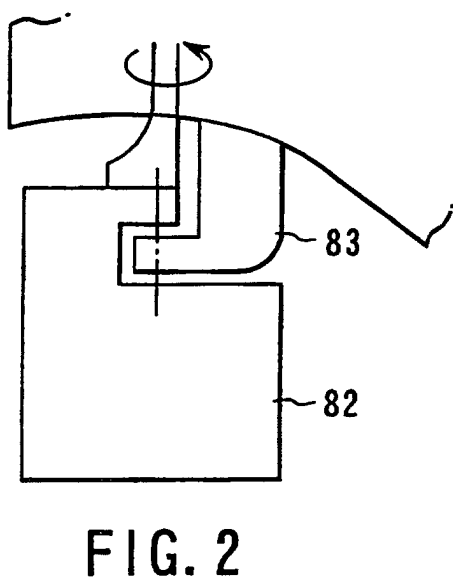
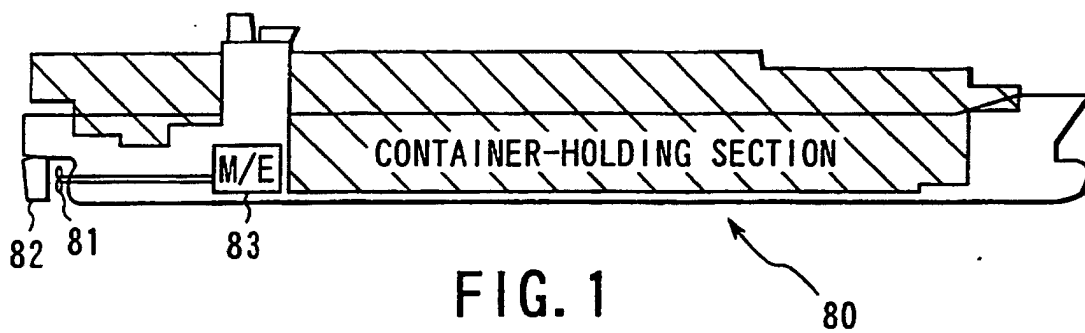


FIG. 5

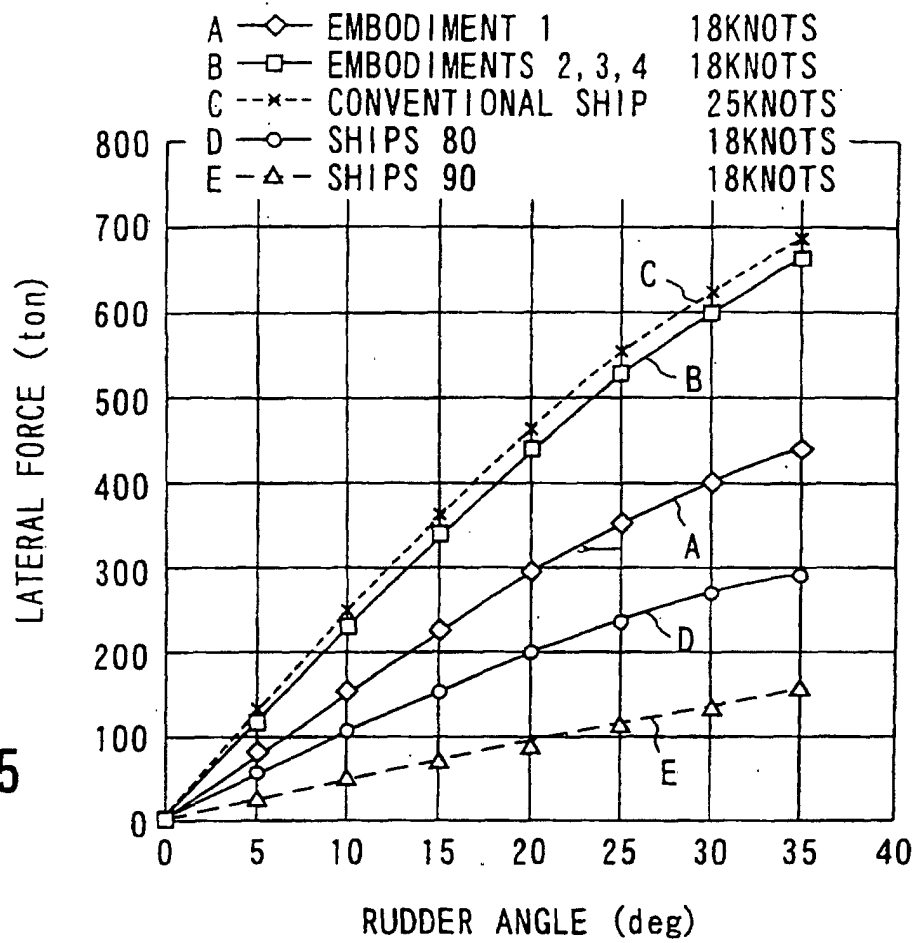


FIG. 6

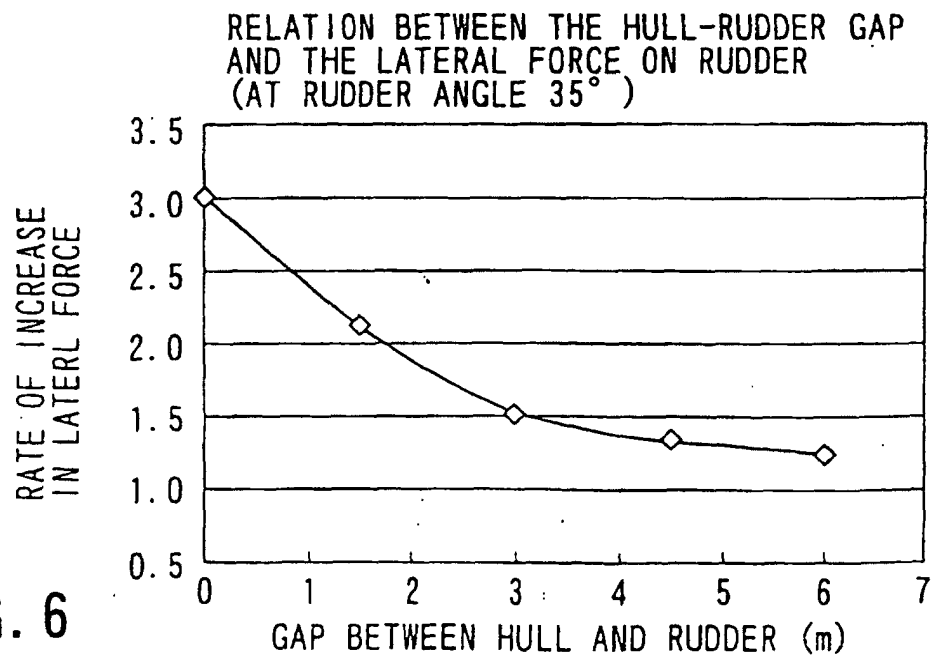


FIG. 7

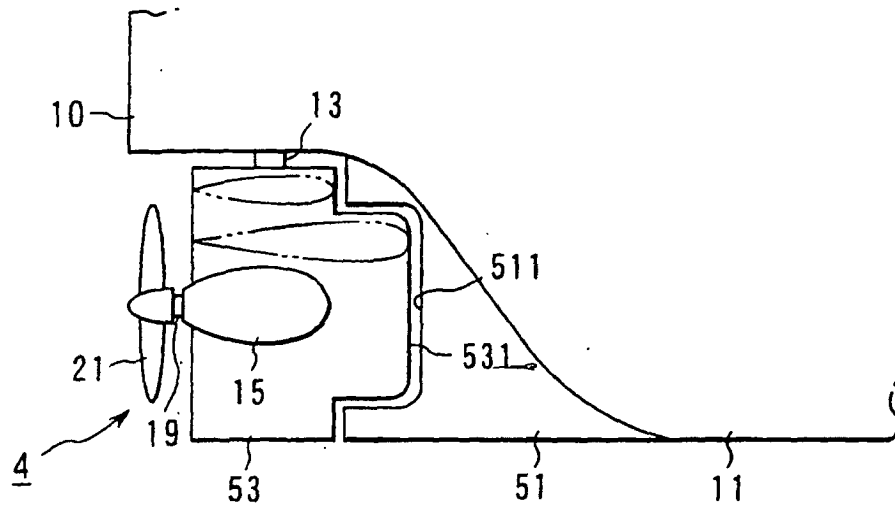
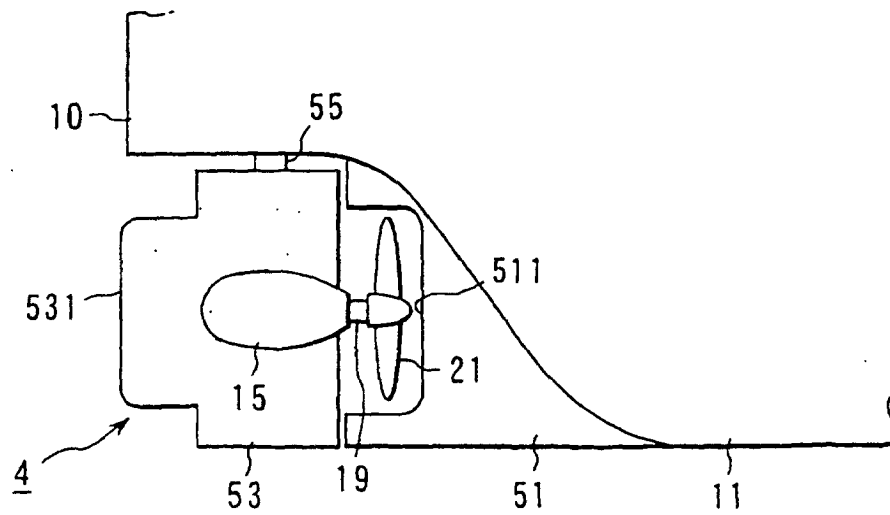


FIG. 8



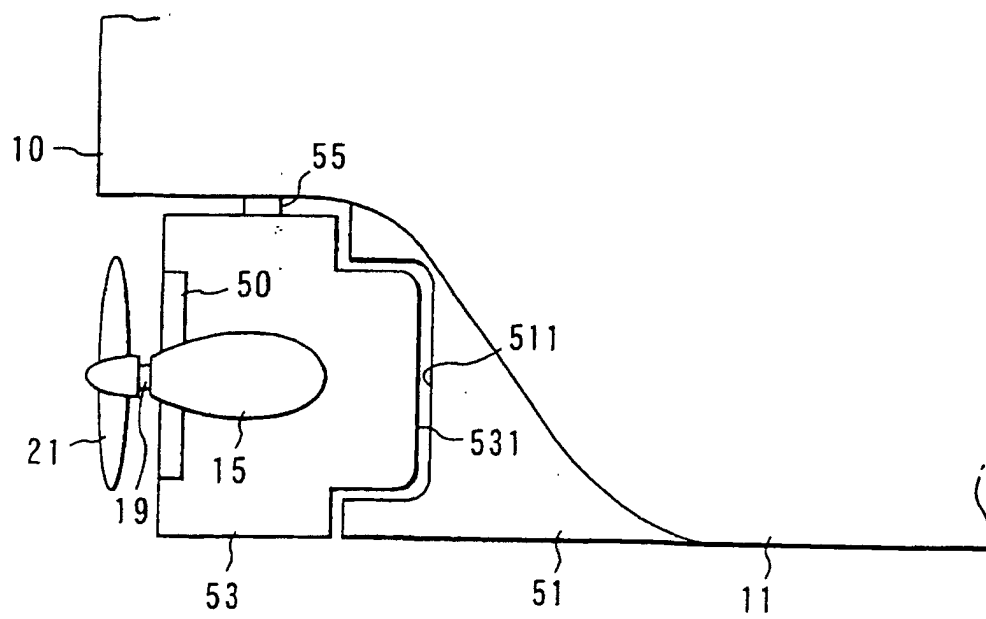


FIG. 9