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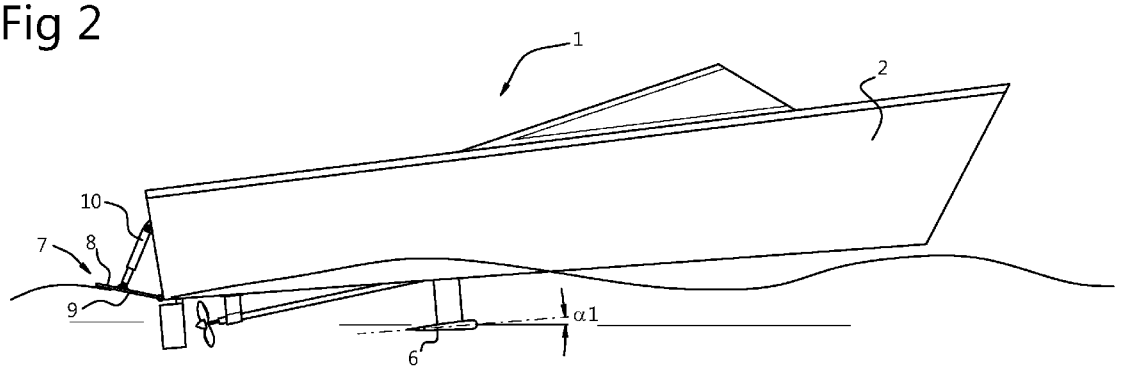
(54) Title: PLANING BOAT

Fig 2



(57) Abstract: The invention relates to a planing boat (1) with a single hull, comprising a supporting hydrofoil (6) arranged near the center of gravity (Z) thereof, below the vessel, and a stabilizer arranged near the rear end (11) of the vessel, characterized in that the stabilizer has a plate-shaped profile (7) with two opposite sides (8, 9), wherein the stabilizer is arranged such that during the intended sailing condition one side (9) is in contact with water for influencing the water flow and wherein the opposite side (8) substantially does not influence the water flow.

WO 2021/002744 A1

Title: Planing boat

Description

The present invention relates to a planing boat or planing vessel (i.e. planing during the intended sailing condition) with a single hull comprising a supporting hydrofoil arranged near the center of gravity thereof, below the vessel, and a stabilizer arranged near the rear end of the vessel.

PRIOR ART

Planing boats are known from the prior art. Planing refers to a condition in which the boat rises out of the water and glides over the water, as it were. The boat is carried by part hydrostatic force and part hydrodynamic lift, depending on the speed. When a boat planes, it reaches its highest speed. Whether and when a boat will plane depends on several factors. This could include thrust, speed, hull shape and weight.

A major disadvantage of such planing boats is that when encountering waves, uncomfortable behavior occurs and and/or drastic stabilization measures are necessary or speed must be reduced. Such measures must be taken so quickly that it is practically impossible to carry them out manually.

The resistance of a planing boat is dictated by the frictional resistance and the extent to which hydrodynamic lift can be generated from the hull shape.

Therefore, systems have been proposed in the prior art for use with hydrofoil boats involving a front and a rear hydrofoil, these systems predicting the arrival of waves at the underwater ship and adjusting the angle of the hydrofoil accordingly. An alternative is that the force on the wings is regulated by the extent to which they split the water surface.

Although such systems work, they are costly and are associated with a relatively large effort. In addition, circumstances exist under which such systems do not operate. In such cases, a particularly uncomfortable sailing behavior will be obtained. In particular, as mentioned, these systems also see application in hydrofoil boats, instead of planing boats. A hydrofoil boat is known from, for example, US 5,448,963. Two hydrofoils are known from this publication, one hydrofoil being located

near the center of gravity of the vessel and the other hydrofoil being arranged near the rear end of the vessel. The rear hydrofoil is located some distance below the hull and is fully immersed in the water under normal sailing conditions. With hydrofoil boats, the effect is achieved that when the sailing speed is increased, the vessel, with the exception of the hydrofoils, is completely lifted out of the water, as a result of which the hull surface that comes into contact with the water disappears above the water, which reduces friction. Both hydrofoils always remain completely under water. This makes it possible to achieve a higher speed with the same power.

Because a planing boat glides over the water, as it were, and is not intended to be lifted almost completely out of the water, such as a hydrofoil boat, such systems, as used in hydrofoil boats, are not applicable one-to-one to planing boats.

US 6,782,839 B1 furthermore discloses a hydrofoil boat with a hydrofoil arranged below the hull of the boat.

US 6,805,068 B1 moreover discloses a hydrofoil system for lifting a boat partially out of the water to reduce drag.

OBJECT OF THE INVENTION

An object of the present invention is to provide a planing vessel or planing boat, with a hydrofoil, with which on the one hand it is possible to reduce friction, experienced by displacement of the hull through the water, and on the other hand to provide a particularly stable sailing behavior.

SUMMARY OF THE INVENTION

This object is achieved in that a planing boat is provided comprising a supporting hydrofoil arranged near the center of gravity thereof, below the vessel, and a stabilizer arranged near the rear end of the vessel, wherein the stabilizer comprises a plate-shaped profile having two opposite sides, wherein the stabilizer is arranged in such a way, that during the intended sailing one side is in contact with water to influence the water flow and wherein the opposite side substantially does not influence the water flow.

In the context of this description, with respect to the hydrofoil, the term “supporting” is to be understood as providing a lift force or lifting force which is

sufficient for causing planing of the boat during the intended sailing condition, but a lift force or lifting force which, however, is not sufficient to lift the boat completely out of the water to provide a hydrofoil boat. The lifting force is preferably 35 - 65%, for example 40 - 60%, such as 45 - 55% of the total weight of the boat, at maximum speed.

According to the present invention, a plate-shaped profile is arranged near the rear side of the vessel, such that one side influences the water flow while the other side has no effect on the water flow. It has surprisingly been found that this results in particularly stable sailing behavior. The equilibrium described above resulting from the planing of the vessel's hull at higher speeds is no longer unstable but stable.

In contrast with the prior art, the stabilizer according to the present invention water forces are exerted on only one side. After all, the other side of the stabilizer has no effect on the water flow. It has been found that when passing a wave due to this unilateral influence, the unstable behavior as observed in the prior art does not arise. This is believed to be caused by the fact that, in case of a prior art vessel, such as described in US 5,448,963, for example, wherein temporarily less contact of the vessel with water is present (in the case of a wave) an unstable equilibrium arises, because in such a case less upward pressure is created on the hydrofoil.

Since the rear, submerged trim foil according to the prior art is influenced by movements of the water at the surface later, i.e. the same will result in a delay in the change in force, when the water level is lowered by, for example, a wave, the vessel will first pitch forward and dive into the water with the bow.

Subsequently, due to the deeper immersion in the water, the bow is pushed upwards and the stern is further submerged and experiences a greater upwardly pushing force from the water. If no adjustments are made, this movement can continue for a long time.

Preferably, the longitudinal distance between the stabilizer on the one hand and the supporting hydrofoil and the center of gravity on the other hand is about 30 – 60%, for instance 30 - 50%, such as about 40% of the length of the vessel.

According to the present invention, the stabilizer is flowed by the water on only one side and there is a stable equilibrium between the force pressing the vessel upwards at the rear and the more forwardly arranged supporting hydrofoil. In addition, a part of the planing hull may also be in the water to absorb the other,

preferably 65 - 35%, for example 60 - 40%, such as 55 - 45% of the force, so that the hull can more easily undergo such changes due to waves.

It should be understood that while the above theory is now believed to be correct, it is the measures of the present invention which provide the intended effect and for which specific rights are claimed.

It has been found that the position of the stabilizer has to be determined depending on the speed and the weight distribution. Therefore, the stabilizer is preferably adjustable. Such adjustability is to be distinguished from the adjustability of prior art stabilizers to absorb wave motion. As described above, such adjustment with a stabilizer according to the present invention is not necessary for stable sailing behavior in waves. Therefore, the adjustment used in the present invention can operate relatively slowly.

The stabilizer of the present invention may be arranged in various positions near the rear side of the vessel.

A first possibility is that it is arranged behind the transom of the vessel. A further possibility is that it is placed near the rear end or transom, below the hull of the vessel. A reception space or reception means may be provided at the transom or rear end for receiving the stabilizer.

The stabilizer can be designed in various ways. According to a first embodiment, it consists of a flap extending in the direction of sailing of the vessel, extending at a slight angle with respect to the water surface (i.e. when the vessel is motionless). Preferably, the flap is adjustable between an angle of -5 and 45°, such as 0 and 30°, for example 0 and 15°, with respect to the waterline.

According to a further advantageous embodiment of the invention, the stabilizer comprises a partition or plate which is lowered perpendicular to the water surface and protrudes below the bottom surface of the hull. In such a case, the upstream side of the stabilizer will be subjected to considerable water flow, while the downstream side will have no effect on the water flow. In the latter case, it should be understood that the stabilizer should only be moved or displaced slightly out of the hull (a few centimeters), such as a maximum of 3 percent, or a maximum of 2 percent or a maximum of 1 percent of the length of the vessel.

The planing boat may further comprise a propulsion system to which the stabilizer is attached, such as an outboard engine or an inboard engine.

Therein, the stabilizer may be configured for being rotated around an axis perpendicular to a mirror plane (S) of the vessel, to achieve an angle (β2) relative to a direction of movement (X) of the vessel of +10° to -60°.

As mentioned before, the propulsion system may be an inboard engine or an outboard engine.

The stabilizer may be rotatably fixed with respect to the propulsion system and the propulsion system therein may be configured for being rotated around a rotational axis perpendicular to a mirror plane (S) of the vessel at an angle (β3) relative to a direction of movement (X) of the vessel of +10° to -60°.

Alternatively, or additionally, the stabilizer may be rotatable with respect to the propulsion system around an axis perpendicular to a mirror plane (S) of the vessel.

The abovementioned embodiments of the stabilizers can be used both in an embodiment wherein the stabilizer is arranged behind the vessel, such as when attached to an aforementioned propulsion system, as well as when attached to the vessel as such, and in an embodiment wherein the stabilizer is arranged below the vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be explained in more detail below, with reference to illustrative embodiments shown in the drawing. Therein:

Fig. 1-3 shows a first embodiment of the invention;

Fig. 4 shows a second embodiment of the invention;

Fig. 5 shows a third embodiment of the invention;

Fig. 6 shows an embodiment related to the third embodiment of the invention, wherein the stabilizers are arranged at an angle;

Fig. 7 shows a fourth embodiment of the invention; and

Fig. 8 shows a fifth embodiment of the invention.

DETAILED DESCRIPTION

A vessel according to the present invention is indicated by 1 in the figures. In the illustrated example, a vessel with a length of about 5 m is shown, but it

will be understood that the length of the vessel can be shorter or significantly longer. Preferably, the length of the vessel is between 3 - 35 m.

The vessel 1 has a hull 2 and a superstructure 3. These can be designed in any way known in the prior art. The hull in particular is designed in the same way as in planing boats, i.e. it has a V-shaped appearance in cross section. Further/further transverse hull shapes are conceivable, depending on the desired speed regime of the vessel, such as hollow (concave), convex or straight. The longitudinal hull shape can also be concave, convex or straight, depending on the desired application. Spray rails (not shown) can also be used to prevent spray, create extra lift, reduce the wetted surface, prevent pitching and yawing movements, or to reduce water spray.

The vessel's center of gravity is indicated by Z. A supporting hydrofoil 6 is located directly below the vessel, below the center of gravity Z of the vessel, or at a small distance in front thereof. This hydrofoil 6 can be designed in any manner known in the art. Preferably, this hydrofoil is arranged (vertically) in the vessel in a displaceable way, in any manner known in the prior art, so that damage is prevented when sailing through shallow water, wherein the supporting hydrofoil 6 is configured at a vertical distance from the hull 2, when planing, of about 1 - 2 times, such as 1 - 1.5 times, the chord length of the supporting hydrofoil 6. Optionally, the angle of attack $\alpha 1$, $\alpha 2$ of this hydrofoil 6 (within limited and safe limits) is adjustable, such as between -5 and 10°. The hydrofoil 6 can also be non-adjustable (i.e. fixed).

The supporting hydrofoil 6 is preferably configured to provide a lift force of preferably 35 - 65%, for example 40 - 60%, such as 45 - 55% of the total weight of the vessel 1, at maximum speed.

Preferably, the longitudinal distance between the stabilizer 7 on the one hand and the supporting hydrofoil 6 (and the center of gravity Z) on the other hand is about 30 - 60%, for instance 30 - 50%, such as about 40% of the length of the vessel 1.

The propeller of vessel 1 is indicated by 4 while 5 indicates the rudder. The figures also show a fixed propeller shaft with propeller 4. However, other (propeller) configurations are also conceivable, such as, but not limited to, a Z-drive, a surface propeller, a waterjet, an outboard motor or a pulling propeller, with or without single or double screws.

According to an embodiment of the present invention, a stabilizer 7 is provided at the rear 11 side of the vessel as a trim flap. The bottom of this stabilizer is indicated with 9 while the top is indicated with 8. This stabilizer 7 is pivotable about a pivot axis 12 by means of a hydraulic or electric jack 10.

Fig. 1 shows the position in which the vessel is motionless. In this position, not being the intended sailing condition, the stabilizer 7 is under water.

However, as can be seen from figures 2 and 3, when the desired speed is reached, the stabilizer 7 will be exactly on the interface with the water. I.e. surface 9 affects the water flow while surface 8 of the stabilizer is not in contact with water. Depending on the desired resp. instantaneous speed, the angle of the stabilizer 7 relative to the vessel is controlled. The stabilizer 7 is preferably adjustable between an angle of -10 and 45°, such as 0 and 30°, for example 0 and 15°, with respect to the waterline.

In case the vessel 1 encounters a wave, the upward force on the stabilizer will change. This provides a stabilizing effect.

It has been found that a resistance reduction of 10 - 15% at a speed of 30 - 35 knots can be achieved, with a vessel length of, for example, 5 m.

In addition, it has been found that a particularly stable and comfortable sailing behavior is created.

Fig. 4 shows a variant of the present invention. The stabilizer is indicated there by 17 and is located below the hull 2 of the vessel. The side being flowed by the water is indicated by 19, while side 18 is not in contact with water. The hull 2 is provided with a reception space or reception means 16 for receiving the stabilizer 17, so that no problems can arise in shallow waters.

Positioning of the stabilizer is accomplished using a hydraulic piston cylinder 20.

A further variant is shown in fig. 5. In this variant, the stabilizer indicated by 27 is perpendicular to the water surface and can be moved downwards (a few centimeters) from the underwater ship, such as a maximum of 3 percent, a maximum of 2 percent or a maximum of 1 percent of the length of the vessel 1, such as up to 5 centimeters, 4 centimeters, 3 centimeters, 2 centimeters or even just 1 centimeter. The side flowed by the water is indicated with 29 while the side that does not affect the water flow is indicated with 28. This stabilizer is included in reception

space 26 of hull 2 and is movable with the aid of, for example, a hydraulic jack 30 in the direction of arrow 31.

Fig. 6 shows an embodiment related to the third embodiment of the invention, wherein a pair of stabilizers 27 is arranged at an angle β1 with respect to a plane H aligned with the longitudinal direction X of the vessel 1 and perpendicular to a longitudinal plane of symmetry S of the vessel 1. The angle β1 preferably lies in the range of 0 - 45°, more preferably lies in the range of 20 - 30° with respect to the plane H. Each of the (pair of) stabilizers 27 may be arranged at a distance from the mirror plane S, such as 50 – 200 cm, for instance 100 – 150 cm.

Fig. 7 shows a fourth embodiment of the invention. The planing boat 1 as shown in figure 7 comprises a propulsion system 16 to which the stabilizer 13 is attached, such as an outboard engine 16 as shown (or an inboard engine – not shown). Therein, the stabilizer 13 may be configured for being rotated in a mirror plane S to achieve an angle β2 relative to a direction of movement X of the vessel of +10° to -60°, such as 0° to -30°. The unflowed side of the stabilizer 13 is indicated by reference numeral 14 and the flowed side of the stabilizer with reference numeral 15, although the skilled person will understand that strictly speaking essentially both sides 14, 15 of the stabilizer 13 in fact may be “flowed” (which also depends on the chosen angle). The stabilizer 13 may be rotatably fixed with respect to the propulsion system 12 and the propulsion system 12 therein may be configured for being rotated as a whole around a rotational axis 21 perpendicular to a mirror plane S of the vessel 1 at an angle β3 relative to a direction of movement X of the vessel of +10° to -60°, such as 0 to -30°, i.e. the so-called propulsion line (indicated by axis P) is effectively changed by rotating the propulsion system 12 as a whole leading to advantageous trim effects.

Alternatively, or additionally, the stabilizer 13 may be rotatable with respect to the propulsion system 12 around an axis perpendicular to a mirror plane S of the vessel 1.

Fig. 8 shows a fifth embodiment of the invention related to the fourth embodiment as shown in figure 7. The stabilizer 13 is again attached to a propulsion system 12, such as an outboard engine (16 in figure 7) as shown. Therein, the stabilizer 13 may again be configured for being rotated in a mirror plane S at an angle β2 relative to a direction of movement X of the vessel of +10° to -60°, such as 0 to -30°. The unflowed side of the stabilizer 13 is now indicated by reference numeral 14 and the flowed side of the stabilizer with reference numeral 15. The stabilizer 13 may

have a leading edge sweep of for instance 0° to 60°, such as 0° to 45°. When the stabilizer 13 is rotatably fixed with respect to the propulsion system 12, preferably at an angle of 0° to the propulsion line, i.e. parallel to the propulsion line P, a perpendicular distance d1 between the bottom side 14 of the stabilizer 13 and the propulsion line P is preferably 0 – 20 cm, such as 10 – 15 cm to achieve optimal trim performance. To further increase performance, the bottom side 14 of the stabilizer 13 may be provided with longitudinal ribs 22, such as 1 – 10 longitudinal ribs 22, 1-6 longitudinal ribs 22 or 1-4 longitudinal ribs 22, such as 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10 longitudinal ribs 22. The stabilizer 13 preferably has a width w1 of 10 – 50 cm, for instance 10 – 30 cm, such as 15 – 25 cm. Preferably, the (opposite) lateral ends 23 of the stabilizer 13 are swept downwards, much like winglets as used with aircraft wings.

The Applicant also foresees an embodiment, wherein the stabilizer 13 as such is omitted and the propulsion system 12 as such is used to alter trim conditions, by rotating the propulsion system 12 (and therefore the propulsion line P) with respect to the longitudinal direction X of the vessel 1.

Although the invention has been described above with reference to a preferred embodiment, variants within the scope of the present invention will readily occur to those skilled in the art after reading the above description. Such variants are within the scope of claim 1 and the dependent claims. In addition, it is to be understood that express rights are requested for variants as described in the dependent claims of independent of claim 1.

LIST OF REFERENCE NUMERALS

1. Planing boat
2. Hull
3. Superstructure
4. Propeller
5. Rudder
6. Hydrofoil
7. Stabilizer
8. Top of stabilizer
9. Bottom of stabilizer
10. Jack
11. Rear end of vessel
12. Pivot axis
13. Outboard engine stabilizer
14. Not-flowed side of outboard engine stabilizer
15. Flowed side of outboard engine stabilizer
16. Outboard engine
17. Stabilizer
18. Not-flowed side of stabilizer
19. Flowed side of stabilizer
20. Piston cylinder
21. Rotational axis of outboard engine
22. Longitudinal rib
23. Lateral end of outboard engine stabilizer
24. –
25. –
26. Reception space
27. Stabilizer
28. Not-flowed side of stabilizer
29. Flowed side of stabilizer
30. Jack

CLAIMS

1. Planing boat (1) with a single hull, comprising a supporting hydrofoil (6) arranged near the center of gravity (Z) thereof, below the vessel, and a stabilizer arranged near the rear end (11) of the vessel, characterized in that the stabilizer comprises a plate-shaped profile (7, 13, 17, 27) with two opposite sides (8, 14, 18, 28; 9, 15, 19, 29), wherein the stabilizer is arranged in such a way, that during the intended sailing condition one side (9, 15, 19, 29) is in contact with water for influencing the water flow and wherein the opposite side (8, 14, 18, 28) substantially does not influence the water flow.

2. Planing boat according to claim 1, wherein the opposite side (8, 14, 18, 28) extends above the water surface during the intended sailing condition.

3. Planing boat according to any one of the preceding claims, wherein the supporting hydrofoil (6) is arranged at or in front of the center of gravity of the boat, as viewed in the direction of movement of the vessel.

4. Planing boat according to any one of the preceding claims, wherein said stabilizer (7, 13, 17, 27) is adjustable relative to the vessel, in such a way, that the free end thereof is submerged more or less deeply into the water.

5. Planing boat according to any one of the preceding claims, wherein the stabilizer (7) comprises a plate arranged at the rear side (11) of the vessel.

6. Planing boat according to claim 5, wherein the plate is pivotably connected to the rear end of the vessel and the pivot axis (12) is below the waterline in a non-sailing condition.

7. Planing boat according to any one of the preceding claims, wherein the stabilizer (17, 27) comprises a plate movable from the underwater ship.

8. Planing boat according to claim 7, wherein the underwater ship is provided with a reception space (16, 26) for the plate.

9. Planing boat according to claim 7 or 8, wherein the plate is substantially vertically movable out of the underwater ship.

10. Planing boat according to claim 9, wherein the plate can be moved downwards from the underwater ship up to 3 percent of the length of the vessel (1), such as up to 2 percent, for example up to 1 percent of the length of the vessel (1).

11. Planing boat according to claim 9 or 10, wherein the plate can be moved downwards from the underwater ship by a maximum of 5 centimeters, 4 centimeters, 3 centimeters, 2 centimeters or even only 1 centimeter.

12. Planing boat according to any one of the preceding claims, comprising a propulsion system (16) to which the stabilizer (13) is attached, such as an outboard engine (16) or an inboard engine.

13. Planing boat according to claim 12, wherein the stabilizer (13) is configured for being rotated around an axis perpendicular to a mirror plane (S) of the vessel, at an angle (β2) relative to a direction of movement (X) of the vessel of +10° to -60°.

14. Planing boat according to claim 12 or 13, wherein the propulsion system (16) is an inboard engine or an outboard engine (16).

15. Planing boat according to any one of the claims 12 – 14, wherein the stabilizer (13) is rotatably fixed with respect to the propulsion system (16) and the propulsion system (16) is configured for being rotated around a rotational axis (21) perpendicular to a mirror plane (S) of the vessel at an angle (β3) relative to a direction of movement (X) of the vessel of +10° to -60°.

16. Planing boat according to any one of the claims 12 – 14, wherein the stabilizer (13) is rotatable with respect to the propulsion system (16) around an axis perpendicular to a mirror plane (S) of the vessel.

17. Planing boat according to any one of the preceding claims, comprising hydraulic or electric displacement means (10, 20, 30) for operating the plate-shaped profile.

18. Planing boat according to any of the preceding claims, wherein the supporting hydrofoil (6) is arranged vertically adjustable.

19. Planing boat according to any of the preceding claims, wherein the angle of attack (α1, α2) of the supporting hydrofoil (6) is adjustable between 0 and 15°, preferably between 0 and 10°, such as between 0 and 5°.

20. Planing boat according to any of the preceding claims, wherein the longitudinal distance between the stabilizer (7, 17, 27) on the one hand and the supporting hydrofoil (6) and the center of gravity (Z) on the other hand is about 30 – 60%, for instance 30 - 50%, such as about 40% of the length of the vessel (1).

21. Planing boat according to any of the preceding claims, wherein the supporting hydrofoil (6) is configured to provide a lift force of 35 - 65%, for instance 40 - 60%, such as 45 - 55% of the total weight of the boat, at maximum speed.

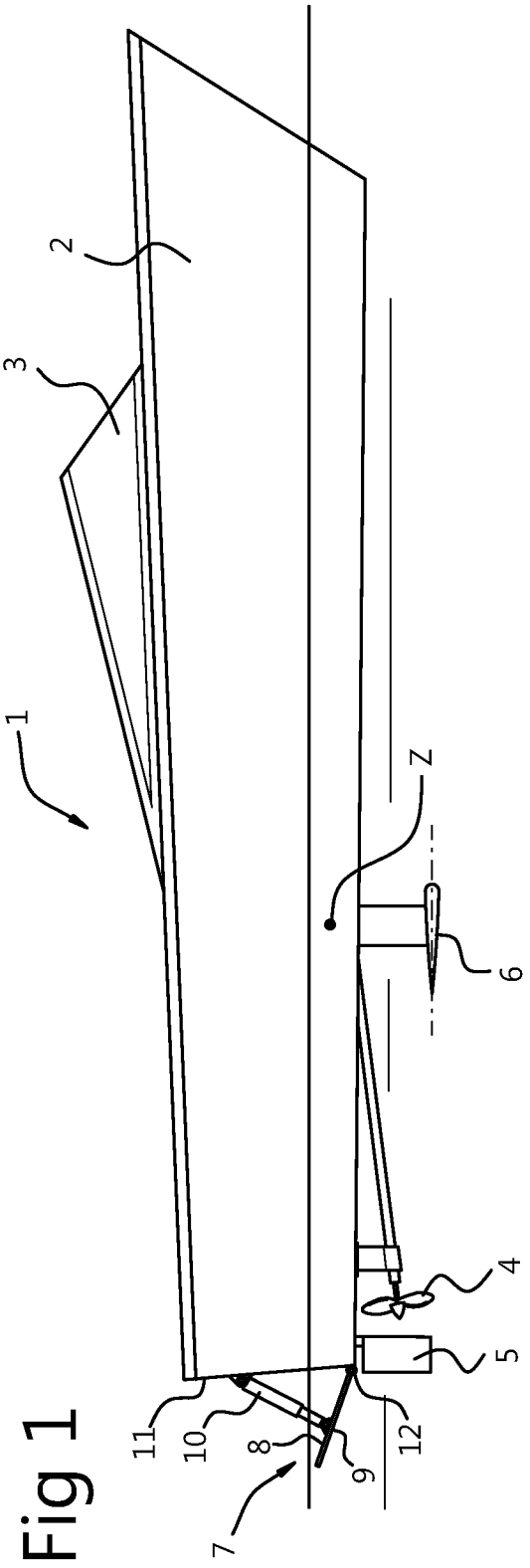


Fig 1

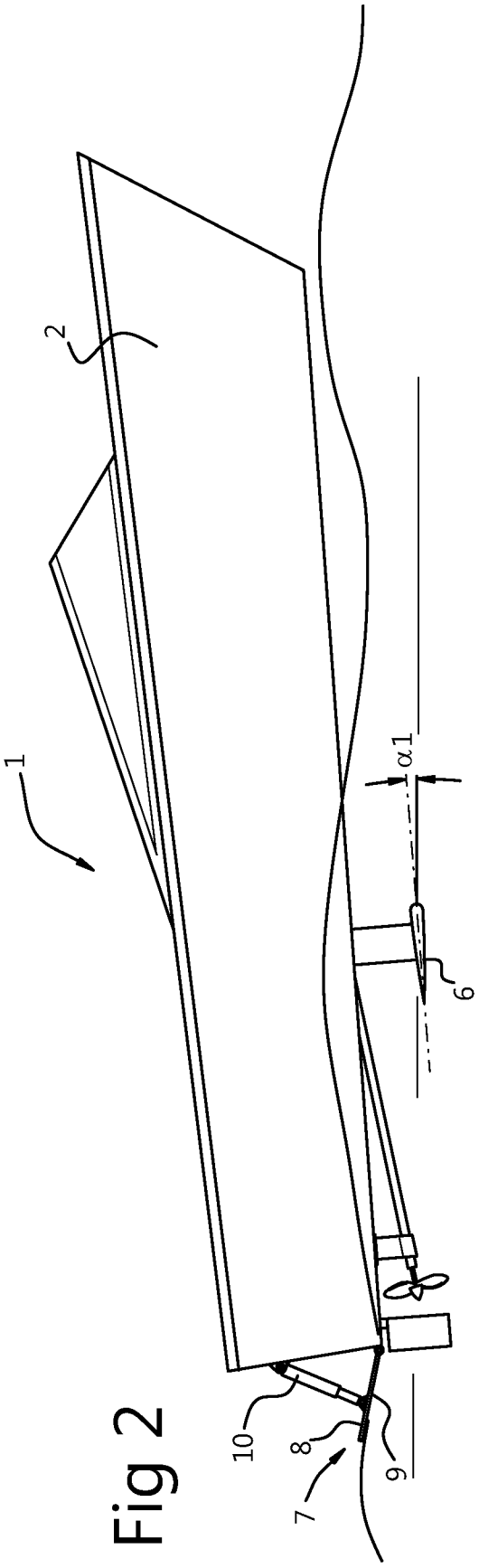


Fig 2

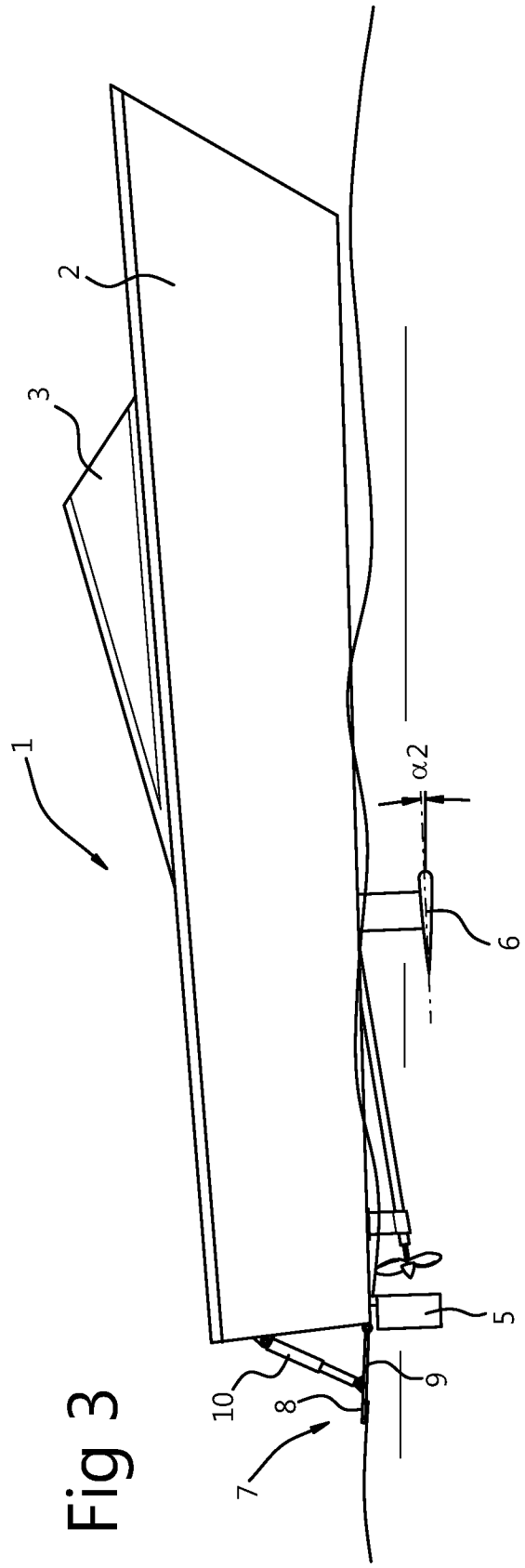


Fig 3

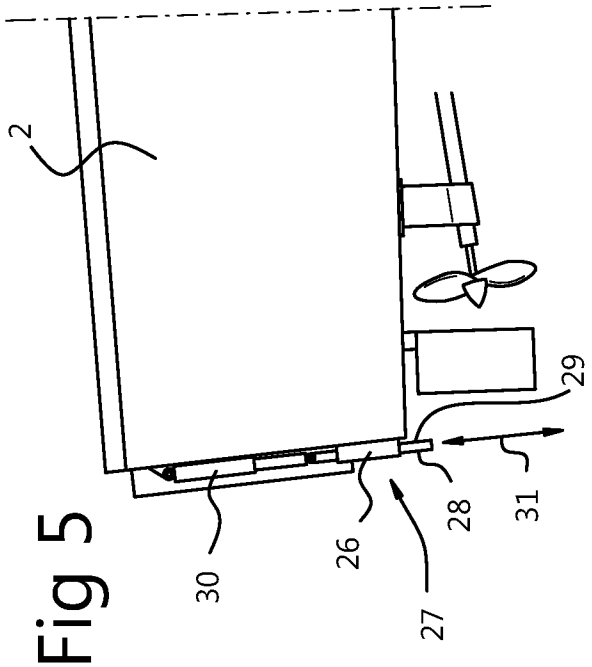


Fig 5

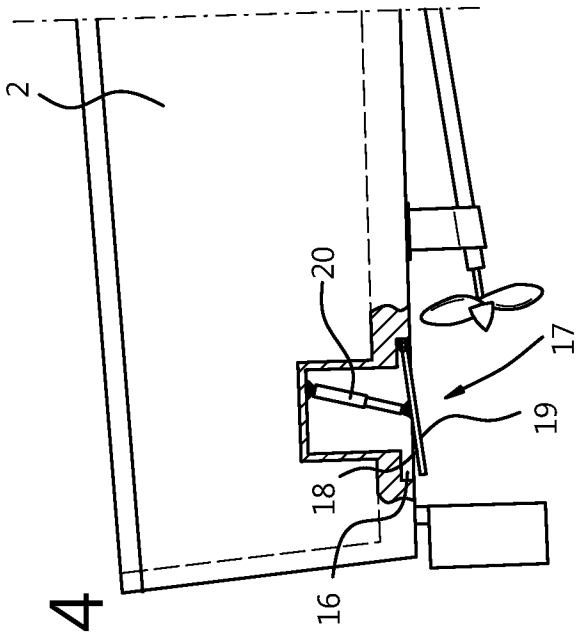


Fig 4

Fig. 6

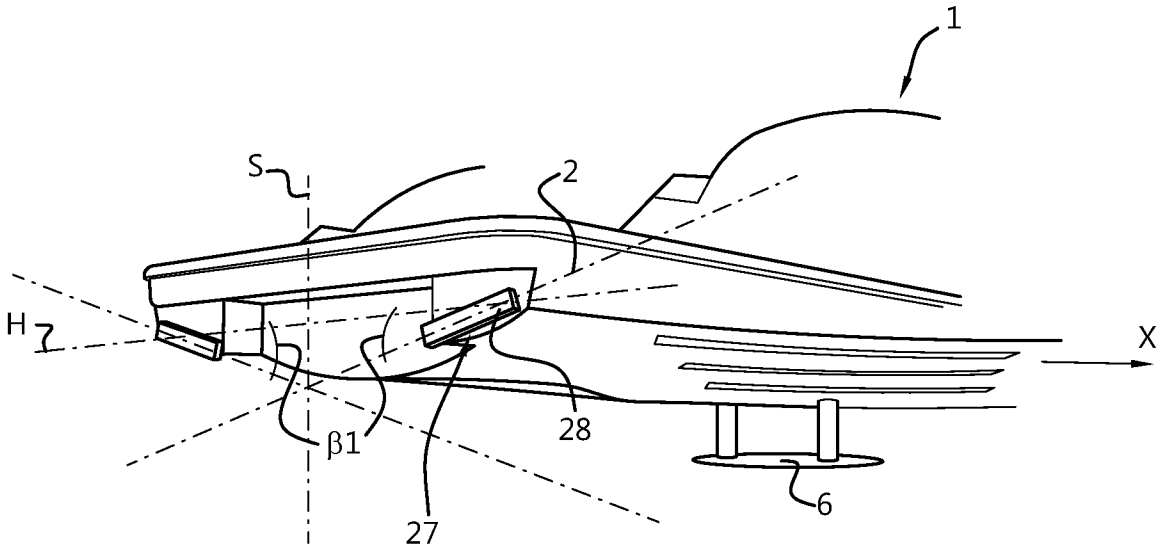


Fig. 7

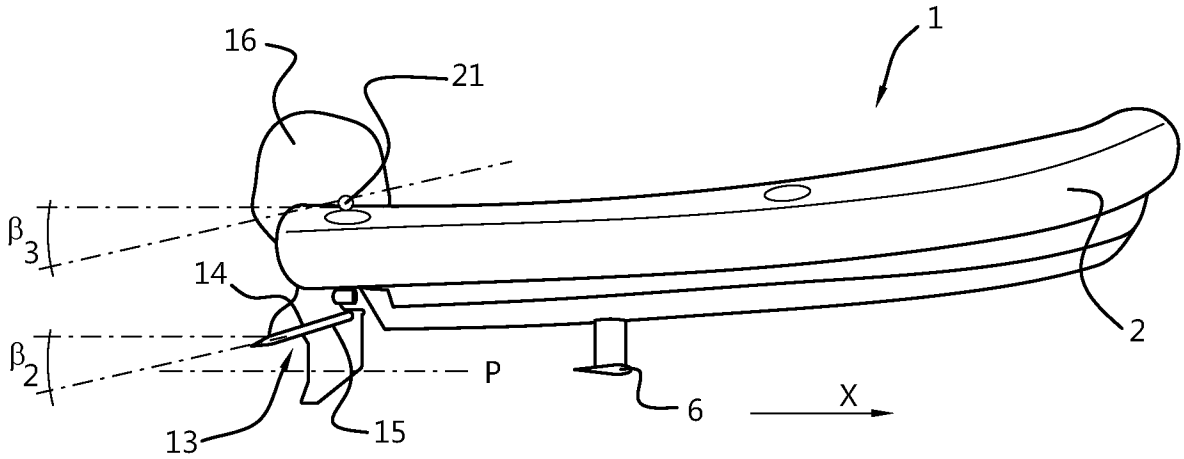
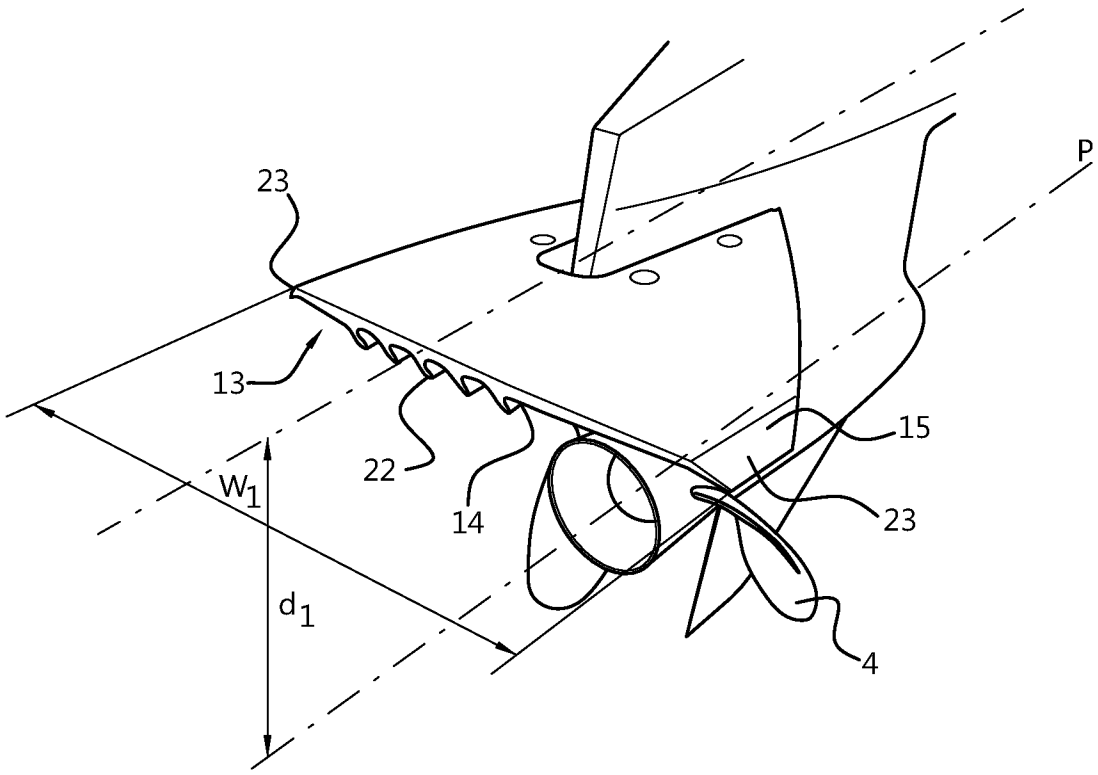


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2020/050427

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63B1/30 B63B39/06 B63B1/34 B63B1/18 B63H20/10 B63H20/34
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B63B B63H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 6 782 839 B1 (NOZAKI TAKEAKI [JP]) 31 August 2004 (2004-08-31) column 10, line 65 - column 11, line 28; figures 1, 12-15	1-6, 17-21 7-16
Y	KR 2018 0108053 A (MOKPO NATIONAL MARITIME UNIV INDUSTRY ACADEMIC COOPERATION FOUNDATION) 4 October 2018 (2018-10-04) paragraph [0030]; figure 4	7,8
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Y	US 2007/221113 A1 (DETWILER TIMOTHY P [US] ET AL) 27 September 2007 (2007-09-27) abstract; figures	12-14,16

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 September 2020	14/09/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schmitter, Thierry

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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