(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 May 2024 (16.05.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/100275 A1

(51) International Patent Classification:
B63H 1/22 (2006.01) *B63H 21/17* (2006.01)
B63H 1/24 (2006.01)

(21) International Application Number:
PCT/EP2023/081489

(22) International Filing Date:
10 November 2023 (10.11.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20221209 11 November 2022 (11.11.2022) NO

(71) Applicant: **SEADRIVE AS** [NO/NO]; Bjellandveien 13, N-3172 VEAR (NO).

(72) Inventors: **LIMSETH, Finn**; Galeasveien 17, N-3138 SKALLESTAD (NO). **LIMSETH, Gina**; Granlyveien 12, N-3154 Tolvsrød (NO). **LIMSETH, Markus**; Galeasveien 17, N-3138 SKALLESTAD (NO).

(74) Agent: **ONSAGERS AS**; P.O. Box 1813 Vika, N-0123 Oslo (NO).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,

(54) Title: A SYSTEM FOR GENERATING ELECTRICITY ONBOARD A MOVING VESSEL

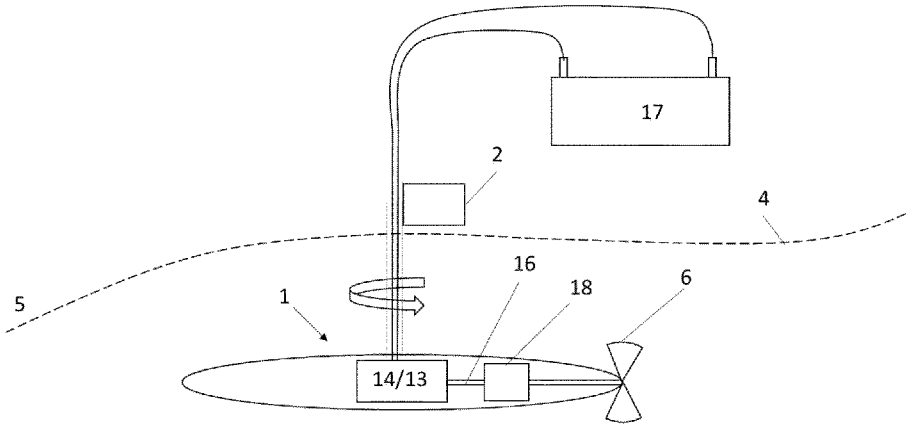

Fig. 8

(57) Abstract: The invention describes a system for generating electricity on a moving vessel. The system comprises a rotatable propeller unit (1) having a propeller with foldable propeller blades, wherein the propeller blades can move between a folded position with the propeller blades substantially aligned with a longitudinal direction of the propeller unit (1) and an unfolded position with the propeller blades (7) substantially directed perpendicular to the longitudinal direction of the propeller unit (1) and wherein the propeller blades are blocked against further movement past the perpendicular direction when in the unfolded position. Furthermore, the system comprises a generator (14) generating electricity from power provided by the propeller unit and power transfer means (16) for transferring rotational power between the propeller unit (1) and the generator (14). The rotatable propeller unit (1) is at least rotatable in a substantially horizontal plane between a forward pointing position and a rearward pointing position.

WO 2024/100275 A1

[Continued on next page]

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

Title: A system for generating electricity onboard a moving vessel

Technical field

The invention relates to generation of electricity onboard boats. In particular the invention relates to a combined propulsion and generator by a rotatable propeller unit with foldable propeller blades able to produce electricity in a more efficient manner when the propeller unit is turned 180 degrees around from the propulsion direction.

Background

Vessels at sea are in need of electricity. Electricity is generated by means of generators, solar panels, wind generators or hydrogenerators or stored on batteries. Almost all vessels also have a propulsion system using propellers to move the vessel forward. The excellent idea of combining use of the propeller both for propulsion and generation of electricity is available on the market. Different solutions have been sold in large numbers in particular to sailing boat owners. When using a folding propeller for the purpose of generating electricity, the currently available solutions must have software constantly balancing the charging level and keeping the folding propeller at a min. rpm. to prevent collapse. The balancing act refers to balancing the centripetal force generated when rotating the propeller against the force of the generator slowing the propeller down and the water pushing the propeller blade towards a closed position. This link describes this very well, https://oceanvolt.com/solutions/hydro-generator/. Also available is the Oceanvolts's "servoprop", which uses a variable pitch folding propeller where the software continuously optimizes the pitch by limiting the charging level relative to the boat sailing speed. The first solution mentioned gives a very limited charging possibility, and the second is both expensive and mechanically complicated and have problems with growth, damage etc.

Gori fixed pitch steps folding propeller is also available and may be used for generating electricity. The product is described on their website:
https://goripropeller.com/product/3-blade-folding-overdrive-propeller/
Normal functionality for propulsion, and for hydro charging in 180 degrees the overdrive function combined with higher pitch causes higher charging levels at lower speeds/lower rpm. of the propeller.

Also known in the literature is variable blades, that turn depending on rpm (this link describes both feathering and variopropeller:
https://www.youtube.com/watch?v=iYxq0AHRbkY)

When a charging unit is only intended for charging an optimized, larger diameter propeller with higher pitch, either fixed or folding propeller, is preferred.

An object of the invention is to find a solution to the problem of how to use foldable propellers mounted on a vessel for generating electricity in a robust and efficient manner when sailing.

Summary of the invention

The invention describes a system for generating electricity on a moving vessel, wherein the system comprises a rotatable propeller unit. The rotatable propeller unit comprises a propeller with a propeller base with at least two foldable propeller blades hinged attached, wherein the at least two propeller blades can move between a folded position with the at least two propeller blades substantially aligned with a longitudinal direction of the propeller unit and an unfolded position with the at least two propeller blades substantially directed perpendicular to the longitudinal direction of the propeller unit. The at least two propeller blades are fully open and blocked against further movement past the substantially perpendicular direction when in the unfolded position. The system further comprises a generator for generating electricity from power provided by the propeller unit and power transfer means for transferring rotational power between the propeller unit and the generator. The rotatable propeller unit is at least rotatable in a substantially horizontal plane between a rearward pointing position and a forward pointing position in which the foldable propeller blades are able to transfer motional energy from the passing water to rotational energy in the propeller because of the fully open unfolded position of the propeller blades. The generator is positioned in the rotatable propeller unit wherein the generator also functions as an electrical motor propelling the vessel forward and as a side thruster

In an embodiment of the system the propeller unit is rotatable 360 degrees.

In yet an embodiment of the system the foldable propeller blades have a pitch between an optimal pitch for charging and an optimal pitch for propulsion.

In yet an embodiment of the system the pitch of the foldable propeller blades has two steps: one step having a pitch optimized for charging and another step having a pitch optimized for propulsion.

In yet an embodiment of the system the pitch of the foldable propeller blades is continuously variable.

In yet an embodiment of the system, the system further comprising a motor and a gearbox for coupling the power transfer means to the motor and the generator.

In yet an embodiment of the system the system further comprises a battery for storing electric energy produced by the generator.

Brief description of the figures

The invention will now be described in more detail by reference to the accompanying figures. The same numeral on different drawings refer to the same feature.

Fig. 1 shows a perspective view of an embodiment of a propeller unit according to the invention in a folded state.

Fig 2 shows a perspective view of an embodiment of a propeller unit according to the invention in an unfolded state.

Fig. 3 shows an embodiment of a propeller unit turned in a forward pointing position for generating electricity.

Fig 4 shows an embodiment of a propeller unit turned in a rearward pointing position for propelling the vessel forward.

Fig. 5 shows an embodiment of a propeller unit turned in a sideways pointing position for thrusting the vessel sideways.

Fig. 6 shows an embodiment of the system for generating electricity on a moving vessel.

Fig. 7 shows an embodiment of the system including a motor and a gearbox.

Fig. 8 shows an embodiment of the system wherein the generator is positioned in the propeller unit.

Fig. 9 shows an embodiment of the propeller unit which is able to sweep a sector to find an optimal angle for charging.

Detailed description

The invention describes a system for generating electricity on a vessel moving in water. The system comprises a rotatable propulsions unit 1 able to function as a main propulsion unit, side thruster and hydrogenerator combined. By hydrogenerator we mean a propeller being rotated by water passing the propeller and transferring the rotational energy to a generator for production of electricity. The propeller unit 1 is rotatable in a horizontal plane by means of an electric servo 2, controlled by joystick/steering wheel, or manual lever 3 version integrated into the boat's existing steering system. An embodiment of such systems is shown in fig. 6 and 7. The rotatable propeller unit 1 comprises a propeller 6 and is under water, normally under the hull 4, behind the keel 5, well protected against ropes, plastic bags, wood branches, seaweed etc., which is a huge

problem to water surface hydrogenerators. We consider an extension arm 22 for extending the propeller unit 1 away from the hull 4 as part of the propeller unit 1.

The system further comprises a generator 14 and power transfer means 16 for transferring mechanical power between the generator 14 and the propeller 6. As shown in fig. 8 the generator 14 may be positioned in the rotatable propeller unit 1. Furthermore, the power transfer means 16 may in its simplest form (seen in fig. 8) be a shaft between the propeller and the generator. There may also be a gear box 18 between the propeller 6 and the generator 14 to enable improved adjustment of rpm. In another embodiment a gear box 18 is positioned between the propeller 6 and the generator to enable improved adjustment of rpm. The gear box 18 may also be able to direct power from a motor 13 separate from the generator 14 to the propeller (see fig. 7).

In one embodiment of the invention, which is particularly relevant for sailing boats, the propeller is a standard folding propeller 6. Folding propellers 6 are fairly common in order to minimize drag, and increases speed substantially as compared to normal fixed propellers, when sailing. The rotatable propeller unit 1 is able to turn at least 0 - 180 degrees relative to the sailing direction of the vessel. A standard folding propeller will normally collapse if any resistance due to charging is added. When using the propeller unit 1 for propulsion/side-thruster the folding propeller 6 will be fully open and will collapse during sailing for minimum drag. A folding propeller have at least two propeller blades 7 which all are hinged attached to a propeller base 8 with a rotational axis 15 substantially perpendicular to the longitudinal axis of the propeller unit 1. When the foldable propeller is rotated by a motor 13 the foldable propeller 6 will unfold due to centripetal forces at first and, and as it unfolds, also because of the well-known shape of the propeller blades combined with the rotational force from the motor 13. The propeller blades 7 are configured to stop unfolding past a position substantially perpendicular to the longitudinal direction of the propeller unit.

Fig. 1 and 2 shows an embodiment of the foldable propeller 6. The propeller blades 7 rotates around a pin 11 attached to the propeller base 8 and reaches an optimal angle close to 90 degrees to the longitudinal axis of the propeller unit 1 a locking surface 9 on the base of the propeller blades 7 abuts a stopping surface 10 on the propeller base 8. Fig. 3, 4 and 5 shows different rotational positions of the propeller unit 1. Fig 3 shows the propeller unit 1 rotated 180 degrees relative to a centerline (CL) of the vessel in a position for charging. Fig. 4 shows the propeller unit in an unrotated position suitable for propulsion, while fig. 5 shows the propeller unit 1 in an intermediate angle suitable for a sideway thrust. When turned 180 degrees around and as long as the vessel moves in a forward direction, the folding propeller 6 will be kept fully open at all times due to the passing water pushing the propeller blades 7 towards an open unfolded position and rotating the propellers. In such a configuration the charging level will be set depending on water speed and battery charge level, and not by a collapsing balance, which is the issue with known systems without turning feature using a folding propeller for generating electricity. With the described invention the captain can control how much to charge vs. how much the charging drag slows down the sailing speed by direct manual control or by means of software controlling the generator.

It is possible to customize the folding propellers to optimize for charging or for propulsion. A user has to choose between a propeller designed for max. speed during drive, or maximum charging level when generating electricity. When comparing a given power (ie. 5kW), the propeller for propulsion needs to torque the motor lower compared to the propeller required to torque the generator to obtain charging power of 5kW. A higher pitch on the propeller blades is optimal when charging compared to the optimal pitch for propulsion. This can also be regulated by the diameter of the propeller. A simple and acceptable solution is to choose a propeller between these two optimal parameters to get a compromise between max. speed, and max. charging. A preferred solution is to have a propeller with variable pitch. The pitch can be continuously variable or, for lower cost and mechanical complexity, comprise two steps. One step having a pitch optimized for charging and another step having a pitch optimized for propulsion.

In an embodiment illustrated in fig. 9 the angle of the propeller unit 1 can be adjusted to allow for a waterflow to be slightly angled with respect to the longitudinal centerline 21 of the boat when the generator is functioning as a generator and not as an electric motor. This is most often the cased when sailing with a wind component pushing sideways on the sails. The centerline 20 of the propeller unit is sweeping a sector on each side of a line parallel with the longitudinal centerline 21 to find the optimal angle for charging. The output from the generator at the different angles is measured and then locked on to the angle where the output of the generator is the largest. This only works in stable condition without too much waves and gusts of wind. Preferably, the centerline 20 of the propeller unit is sweeping an angle α of 5 degrees on each side of the longitudinal centerline 21 of the boat, more preferably the propeller unit is sweeping an angle α of 10 degrees on each side of the longitudinal centerline 21 of the vessel as indicated by $-\alpha$ and $+\alpha$.

In order to avoid too high load on the folding propellers when opening up the propeller blades, the propeller unit 1 may be prohibited to be turned into a generator position when the speed is above a threshold. 10 or 15 knots may be a reasonable threshold.

Preferably the propeller unit can be lifted-up or out of the water or retracted into the hull. This is preferable to lower drag when sailing, especially if using a fixed propeller, but also for folding propellers.

References

1 Rotatable propeller unit
2 Electric servo
3 Manual lever
4 Hull
5 Keel
6 Propeller
7 Propeller blades
8 Propeller base
9 Locking surface
10 Stopping surface
11 Pin
12 Vessel
13 Motor
14 Generator
15 Rotational axis of propeller blade
16 Power transfer means
17 Battery
18 Gearbox
19 Rotational axis of propeller unit
20 Longitudinal direction of propeller unit
21 Longitudinal direction / Centerline of the vessel

CLAIMS

1. A system for generating electricity on a moving vessel (12) comprising:

a rotatable propeller unit (1) comprising:

a propeller (6) with a propeller base (8) with at least two foldable propeller blades (7) hinged attached, wherein the at least two propeller blades (7) can move between a folded position with the at least two propeller blades substantially aligned with a longitudinal direction of the propeller unit (1) and an unfolded position with the at least two propeller blades (7) substantially directed perpendicular to the longitudinal direction (20) of the propeller unit (1) and wherein the at least two propeller blades (7) are fully open and blocked against further movement past the substantially perpendicular direction when in the unfolded position,

a generator (14) for generating electricity of power provided by the propeller unit (1),

power transfer means (16) for transferring rotational power between the propeller unit (1) and the generator (14),

wherein the rotatable propeller unit (1) is at least rotatable in a substantially horizontal plane between a rearward pointing position and a forward pointing position in which the foldable propeller blades (7) are able to transfer motional energy from the passing water to rotational energy in the propeller (6) because the at least two propeller blades (7) are fully open and blocked against further movement past the substantially perpendicular direction,

characterized in that the generator is positioned in the rotatable propeller unit (1) wherein the generator (14) also functions as an electrical motor (13) propelling the vessel (12) forward and as a side thruster.

2. System according to claim 1 wherein the propeller unit (1) is rotatable 360 degrees.

3. System according to any of the preceding claims, wherein the folding propeller blades (7) has a pitch between an optimal pitch for charging and an optimal pitch for propulsion.

4. System according to any of the preceding claims, wherein the pitch of the foldable propeller blades (7) have two steps: one step having a pitch optimized for charging and another step having a pitch optimized for propulsion.

5. System according to any of the preceding claims, wherein the pitch of the foldable propeller blades (7) is continuously variable.

6. System according to any of the preceding claims, further comprising a motor (13) and a gearbox (18) for coupling the power transfer means (16) between the motor (13) and the generator (14).

7. System according to any of the preceding claims, wherein the system further comprises a battery (17) for storing electric energy produced by the generator (14).

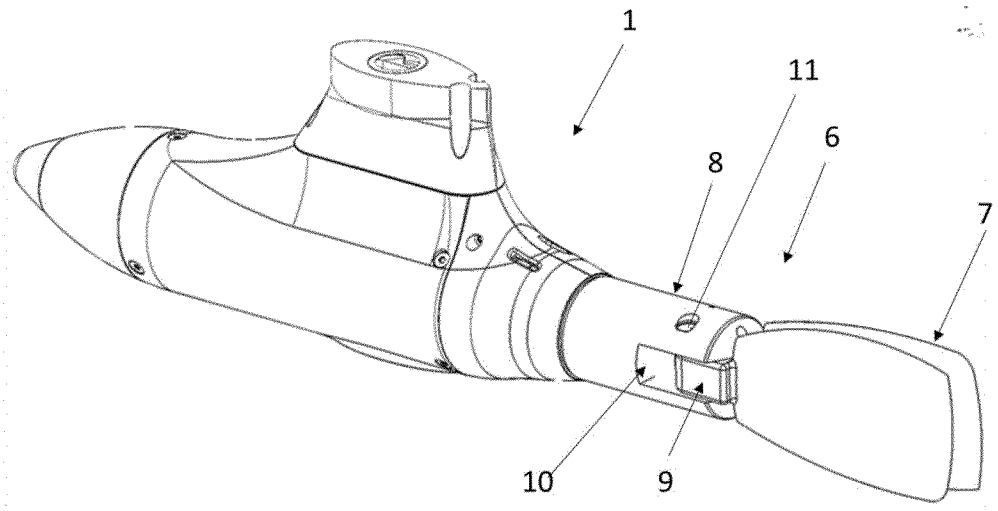

Fig. 1

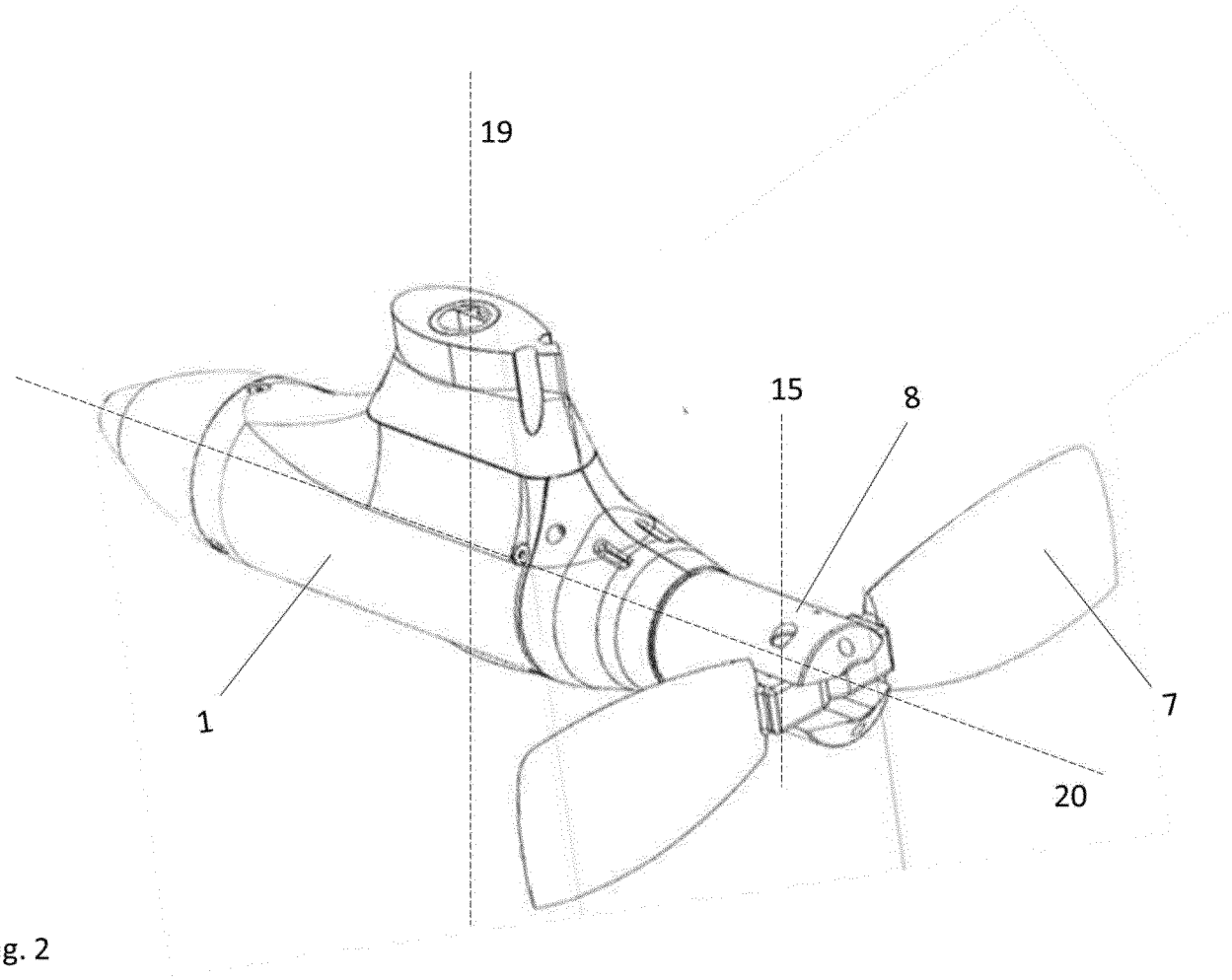

Fig. 2

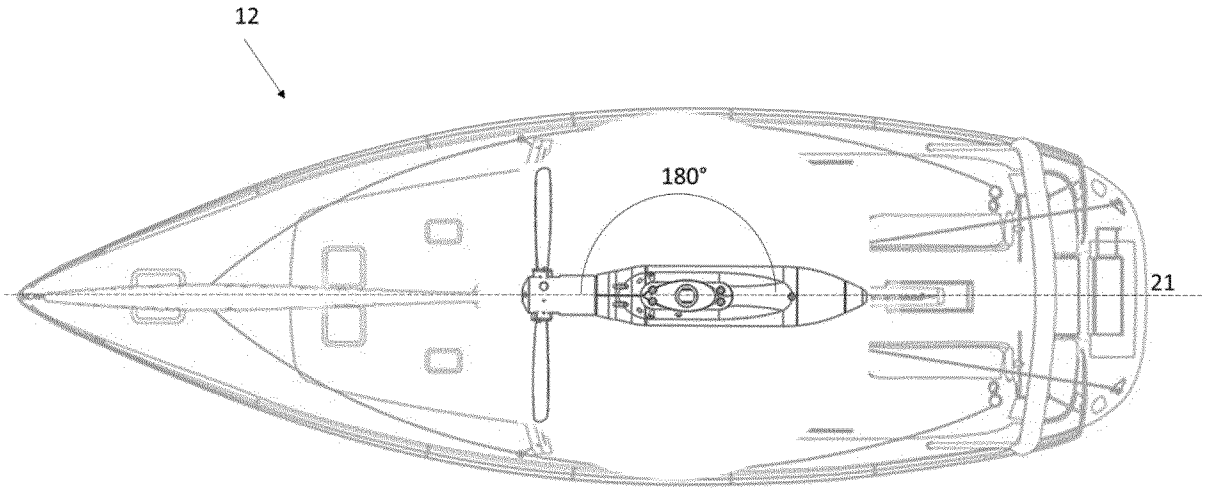

Fig. 3

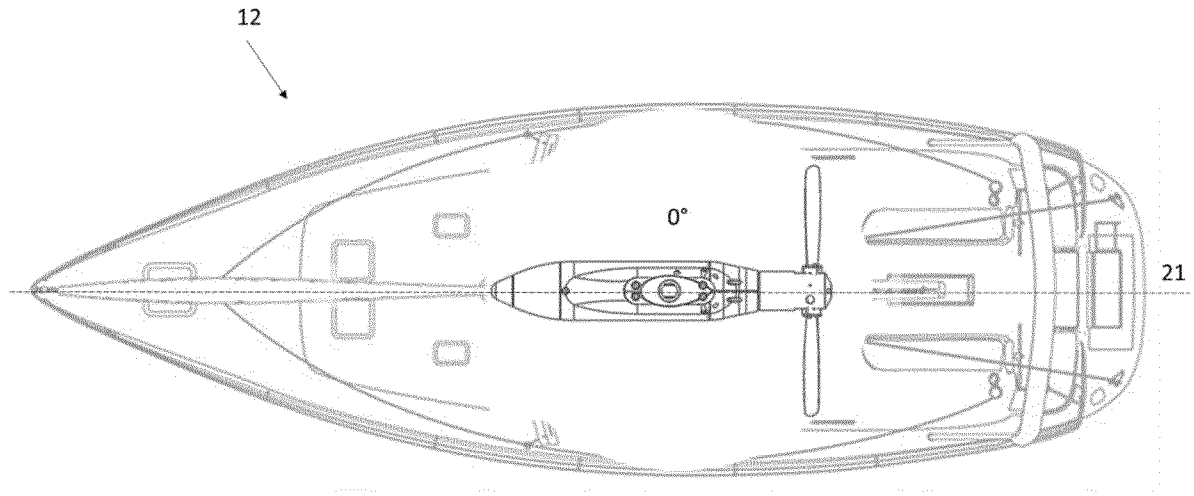

Fig. 4

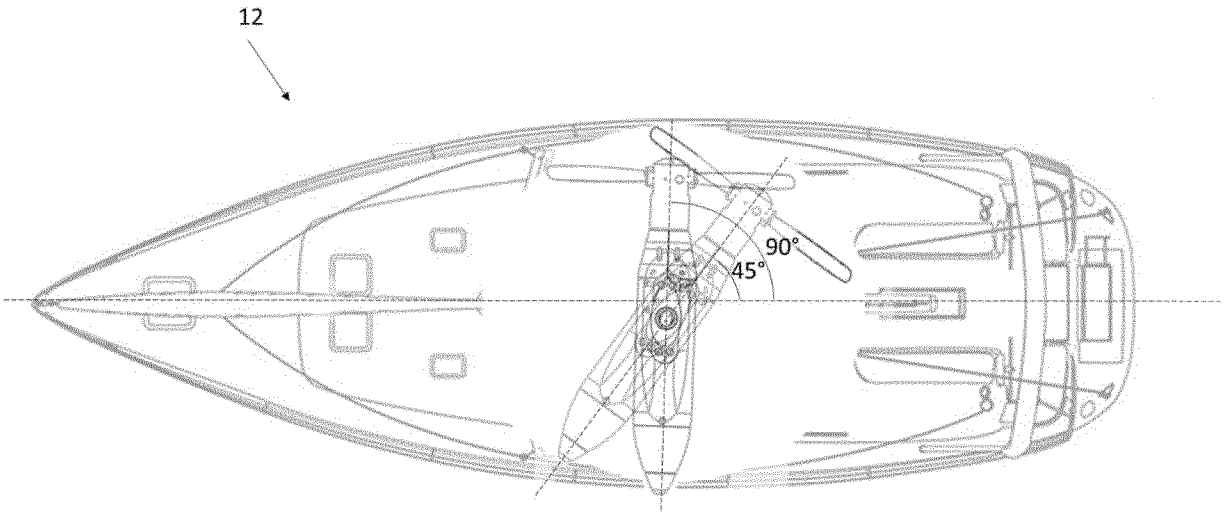

Fig. 5

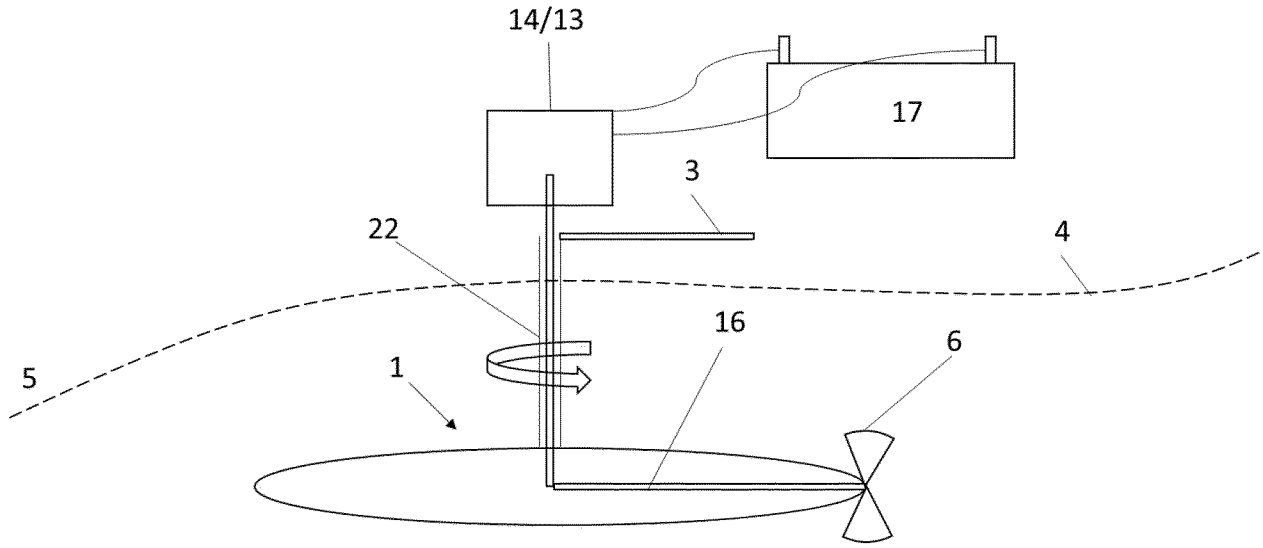

Fig. 6

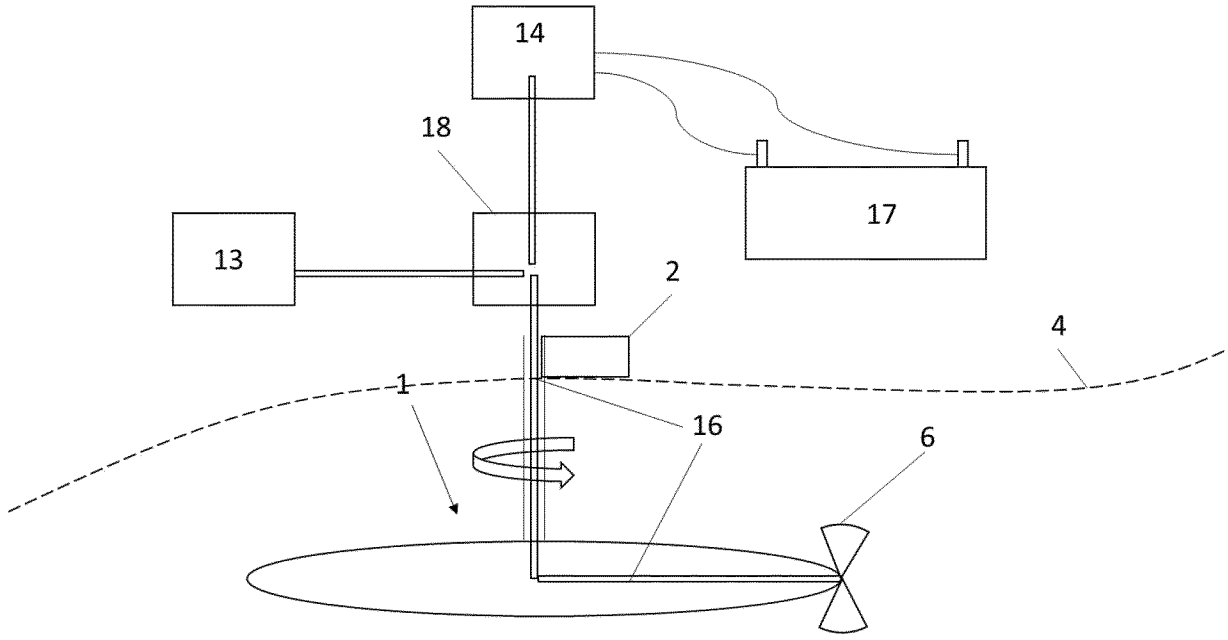

Fig. 7

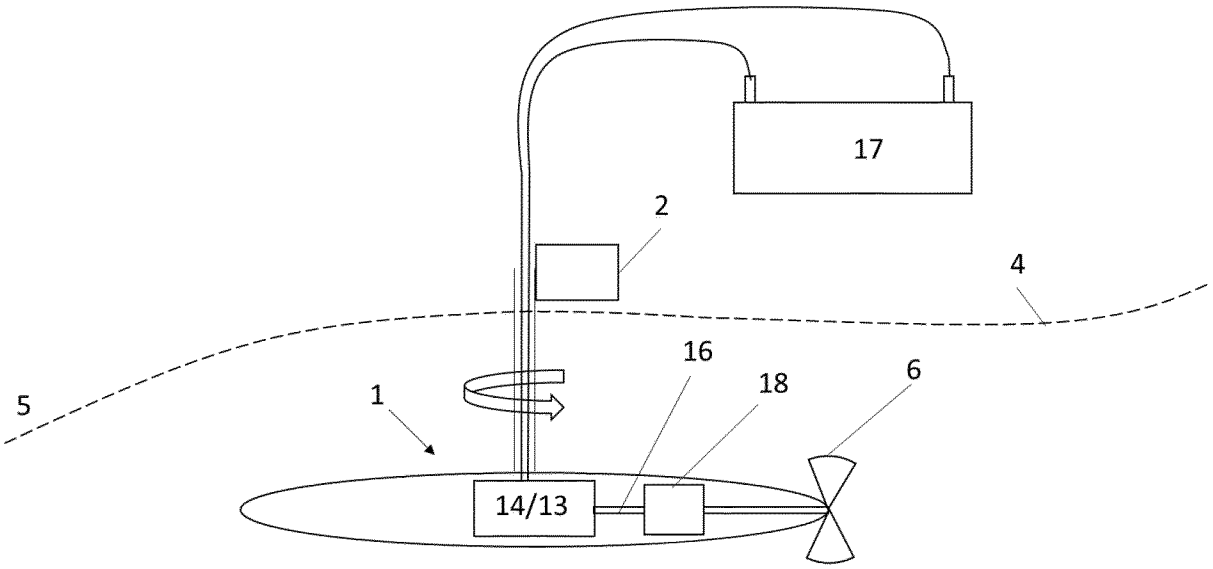

Fig. 8

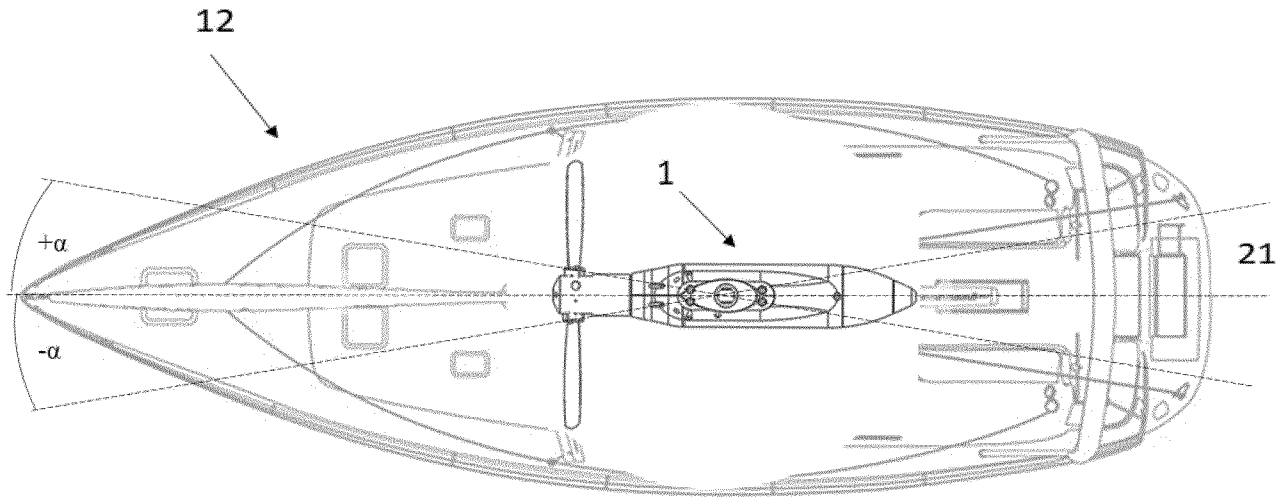

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/081489

A. CLASSIFICATION OF SUBJECT MATTER
INV. B63H1/22 B63H1/24 B63H21/17
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)
B63H B63J

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	US 2011/049882 A1 (LARSSON STEFAN [SE]) 3 March 2011 (2011-03-03)	1,2,6,7
Y	figure 6 paragraphs [0002], [0015], [0026], [0031], [0032], [0033]	3-5
Y	US 4 371 346 A (VIDAL JEAN-PIERRE [FR]) 1 February 1983 (1983-02-01) figure 10 column 3, lines 47-51 column 10, lines 3-8, 48, 49	1-7
Y	EP 2 722 272 A1 (AGATOS GREEN POWER SRL [IT]; MORISCO FEDERICO [IT]) 23 April 2014 (2014-04-23) figures 4a-4c paragraphs [0023] - [0025]	1-7

-/--

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

[x] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 February 2024	26/02/2024

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	Freire Gomez, Jon

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/081489

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 41 05 318 A1 (FICHT GMBH [DE]) 27 August 1992 (1992-08-27) figure 1 columns 2-3, lines 58-1 -----	1-7
A	US 2018/134162 A1 (BIEBACH JENS [DE]) 17 May 2018 (2018-05-17) figure 1 paragraphs [0002], [0018], [0056] -----	1-7

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2023/081489

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011049882 A1	03-03-2011	EP 1378045 A1	07-01-2004
		US 2011049882 A1	03-03-2011
		WO 02078148 A1	03-10-2002
US 4371346 A	01-02-1983	EP 0024998 A1	11-03-1981
		FR 2464186 A1	06-03-1981
		US 4371346 A	01-02-1983
EP 2722272 A1	23-04-2014	NONE	
DE 4105318 A1	27-08-1992	NONE	
US 2018134162 A1	17-05-2018	AU 2017258986 A1	31-05-2018
		CN 108069011 A	25-05-2018
		DE 102016121800 A1	17-05-2018
		DK 3321172 T3	02-03-2020
		EP 3321172 A1	16-05-2018
		JP 6554520 B2	31-07-2019
		JP 2018095244 A	21-06-2018
		US 2018134162 A1	17-05-2018