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(71) Applicant: **Adrio Abalo, Vicente**
36350 Nigran (Pontevedra) (ES)

(72) Inventor: **Adrio Abalo, Vicente**
36350 Nigran (Pontevedra) (ES)

(74) Representative: **Ungria López, Javier**
Avda. Ramón y Cajal, 78
28043 Madrid (ES)

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(54) **PROPELLER FOR SHIPS**

(57) Propulsion unit for vessels which facilitates pitch variation of propeller blades through a characteristic hydraulic actuation device which allows modifying the pitch of propeller blades adjusting it by varying the engine's revolutions. It is also worth highlighting the fact that it includes a position sensor in order to know the position of a yoke in real time and, therefore, the blade pitch. It is

even possible to reverse the blade pitch when the vessel goes backwards in order to stop it in a shorter period. The invention is also focused on enabling the replacement of a fixed-pitch propeller propulsion unit already included in a vessel by the propulsion unit of the invention comprising variable-pitch propeller blades.

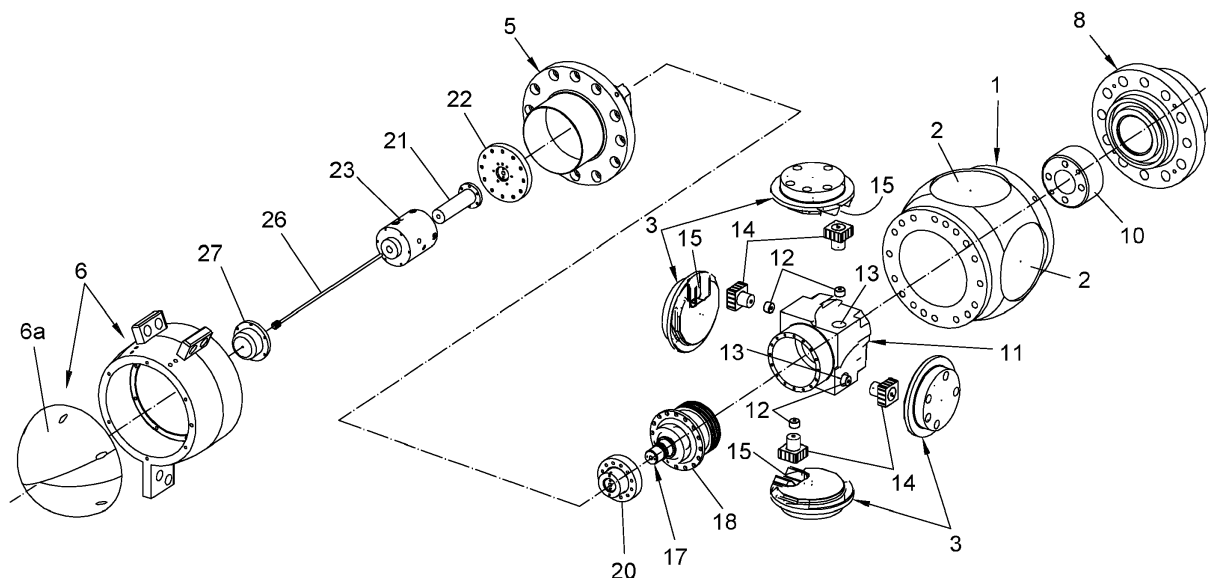


FIG. 1

Description

OBJECT OF THE INVENTION

[0001] The present invention, as expressed in the title of this descriptive report, refers to a propulsion unit for vessels that allows, in existing vessels, for dealing with the replacement of fixed-pitch propellers by controllable-pitch propellers without having to change the transmission shaft that transmits the rotation movement from the gear-box of the engine to the propeller, therefore the costs related to the replacement of the transmission shaft are eliminated, since one transmission shaft with greater diameter is not necessary, nor are increases of the diameter of the stern tube, of reversing hydraulic systems, etc. Replacement operation times are also reduced, with the subsequent economical benefit for the shipowners.

TECHNICAL PROBLEM TO ADDRESS AND BACKGROUND OF THE INVENTION

[0002] Currently, fixed-pitch propeller blade propulsion units in vessels are basically defined by four main elements, namely:

- Solid transmission shaft.
- A conical portion located in correspondance with the end section of the transmission shaft which ends in a peg or threaded portion in its tip.
- Several propulsion propeller blades which are jointly joined to the conical portion of the transmission shaft where they fit by means of a key.
- An axial retaining nut to immobilize the set of propeller blades.

[0003] By and large, as far as the most common systems are concerned, variable-pitch propeller blade systems are differentiated based on their way of operation, in mechanical systems and hydraulic systems.

[0004] In the mechanical system, the linear movement of linear displacement of a yoke to vary the pitch of the propeller blades is carried out by means of a push rod. On the other hand, in hydraulic systems, yoke displacement is carried out by means of a high-pressure hydraulic piston housed inside the propeller hub, to which it is jointly joined.

[0005] In both ways of handling the blades' angle, and also as far as construction is concerned, these systems are defined by the presence of the following elements:

- A hollow transmission shaft through the inner side of which an actuation system for the movement of the yoke passes. Both for the mechanical and hydraulic systems, the mechanism is actuated from the engine rooms and introduced in the shaft from its stern end.
- Coupling of the shaft and hub. The hub and shaft joining system may be of two totally different forms;

on the one hand by means of a cone and spike, as in fixed-pitch propeller blades and, on the other hand, by means of a forged shaft in the outer end of which presents a clamp where the hub is coupled.

- Hub. This element comprises a hollow structure where the yoke and displacement mechanisms are housed inside, with the propeller blades being housed outside.
- Yoke. This is an element that is displaced longitudinally in the direction of the transmission shaft housing some dice-like elements, one for each blade, in a channel arranged in the direction perpendicular to that of its movement.
- Dices. Each of these pieces shows a rectangular external section, with a circular housing inside, which joins the yoke to the rotation disc of the blade shaft.
- Blade rotation disc. This is a circular piece positioned inside the hub of the propeller blades to which the blade is fixed by means of bolts, and the inner part of which has a pivot that is introduced in the housing of the dice provided for it. The system formed by the blade, dice, pivot and rotation disc is what makes the position angle of the blades vary jointly.

[0006] The German invention patent with Publication Number in Germany DE 10 2006 045076 consists in a variable-pitch blade propeller unit, whose hub supports rotation discs to which both propellers are fixed, while the regulation of the propellers' pitch (blades) is carried out by the combination of connecting rods associated through several ends to the above-mentioned rotation discs and through the opposing ends they are related to a frontal plate connected through its centre to the stem of a hydraulic cylinder, whose controlled axial displacement causes said disks to be retained to locate them in the expected stable positions to achieve the desired pitch in the blades.

[0007] Feeding the hydraulic fluid to feed said cylinder is carried out through the free end of the propeller unit assembly by means of a static piece acting as a bracket, which is not dragged during the rotation of the propeller unit assembly.

[0008] On the other hand, in order to change the speed of the vessel in fixed-pitch propellers, what is changed are the revolutions of the vessel's engine, whereas in the case of controllable-and variable-pitch propellers, the engine always works at constant revolutions and what varies for the propulsion and manoeuvres of the vessel is the pitch of the propeller blades.

DESCRIPTION OF THE INVENTION

[0009] In order to meet the objectives and avoid the drawbacks mentioned in the previous sections, the invention proposes a propulsion unit for vessels which comprises:

- a hub of tubular structure the wall of which wall com-

prises several radial openings, in correspondence with which rotation discs are mounted which are in turn joined to propeller blades; wherein the hub has two opposing mouths: front and rear;

- a yoke with axial displacement that is guided within an inner space of the hub;
- intermediate devices that relate the yoke with the rotation discs, said discs rotating by means of the axial displacement of the yoke associated to a hydraulic actuation device to conduct the axial displacement of the yoke and thus vary the pitch of the propeller blades;
- a stern clamp fixed to the rear mouth of the hub;
- a bracket through which several continuous hoses pass to feed the hydraulic actuation device with oil fluid to move the yoke;

[0010] Said bracket is coupled around part of the stern clamp interposing a displacement bushing, thus always maintaining the bracket in a static position where it will not be dragged by the rotation of the propulsion unit. The bracket incorporates an end lid for the access to the feeding head which is coupled around the axial shaft.

[0011] The hydraulic actuation device comprises a front chamber and a rear chamber both separated by a plunger jointly fixed to a stem, these two elements forming a static head; wherein said chambers are made up within a cylindrical hole of the yoke; where said cylindrical hole is closed by its ends by means of front walls: a front wall related to the front mouth of the hub and a rear front wall related to the rear mouth of the hub.

[0012] The stem of the static head extends outwards by means of an orifice in the rear front wall of the yoke, composed of a frontal lid fixed to an annular seat of the yoke. In an embodiment of the invention, the fore front wall closing the front end of the cylindrical hole of the yoke is a body that is part of the yoke itself.

[0013] The stem of the static head is fixed to the stern clamp by means of an annular element; wherein in one embodiment said annular element comprises an annular extension that is part of the stem itself.

[0014] On the other hand, an end of the stem of the static head is joined to an axial shaft by means of a front clamp fixed to the stern clamp; wherein said front clamp is arranged facing the annular element that fixes the stem to the stern clamp.

[0015] A feeding head housed within the bracket is coupled around the axial shaft; the oil fluid feeding hoses being connected to said feeding head.

[0016] The static head and axial shaft have a first duct which ends in the front chamber, and a second duct which ends in the rear chamber; both chambers being formed in the yoke whereas the opposing ends of said ducts end in several nozzles of the feeding head where the hoses through which the oil fluid circulates are connected.

[0017] In a first embodiment of the invention, such as that described so far, the pitch of the propellers may be varied as the vessel moves forward, and, in principle, it

is not necessary to know the pitch position of the propeller blades, since the vessel only moves in the forward direction when the propeller turns in one rotation direction. In this case for the vessel to move backwards, it is necessary to incorporate a reverse-reduction gear to change the direction of rotation of the transmission shaft and, therefore, of the propeller.

[0018] Meanwhile, in a second embodiment of the invention, the propulsion unit is capable of varying the pitch of the propeller blades so that the vessel moves both forward (positive pitch of the blades) and backwards (negative pitch of the blades).

[0019] For such purpose, the unit of the invention includes a real-time control device of the positioning of the yoke and of the propeller pitch; wherein said control device comprises a position sensor composed of a rod adjusted within an axial bore located along the static head and axial shaft.

[0020] Said position sensor is fixed at a widened rear end section to the feeding head by means of an end body; in such a way that said position sensor is not movable, thus always remaining in a static position.

[0021] A front end section of the position sensor opposite its rear end section is housed inside a blind bore located in a closing lid fixed to the yoke; wherein said closing lid constitutes the front wall closing the front end of the cylindrical hole of the yoke where the plunger of the static head is housed. The closing lid incorporates an extension adjusted and guided inside a blind orifice of the static head.

[0022] Referring to what was mentioned in the previous paragraph, the annular element fixing the stem of the static head to the stern clamp is an annular junction that is coupled to said stem.

[0023] The intermediate devices that relate the yoke with the rotation discs comprise cylindrical bodies coupled in blind bores of the yoke contained in a plane perpendicular to the axial displacement of the yoke, such plane being also perpendicular to the plane of the rotation discs.

[0024] Protruding ends of the cylindrical bodies are adjusted within orifices of dices which are fitted in radial channels provided in internal sides of the rotation discs, opposite the external sides of the rotation discs, onto which the propeller blades are fixed.

[0025] In correspondence with the front mouth of the hub a bow clamp is fixed, through which the propulsion unit assembly is coupled to a tapered portion of a transmission shaft; wherein the axial fixing of the propulsion unit comprises a nut coupled to an end section of the transmission shaft and wherein the rotating immobilisation of said propulsion unit comprises a key that is interspersed in the coupling between the transmission shaft and the tapered portion of said transmission shaft.

[0026] In the propulsion unit of the invention, two variables may be applied to control the speed of the vessel: on the one hand, the pitch of the propeller blades and, on the other hand, the engine's revolutions may also be

varied, thus obtaining a high performance and, as a result, substantial fuel savings, specifically between 10% and 35%.

[0027] To control the hydraulic actuation device, a PLC configured to obtain the maximum performance of the propeller throughout the range of revolution is installed. Using data obtained in sea trials, the propeller pitch may be configured automatically to achieve the maximum speed of the vessel with the lowest fuel consumption. Apart from this automatic control, there is a manual control mode (PITCH/RPM) and a third fixed-pitch option of the propeller blades. The pitch control of the propeller blades is carried out from the bridge of the vessel, by means of a control placed therein for such purpose and connected to the hydraulic actuation device located in the servo room (rudder) of the vessel.

[0028] By means of the control system, without knowing the position of the propeller blade pitch, said pitch varies based on two parameters of the engine: the engine's revolutions and, the "accelerator" degree (the rack degree of the fuel injector). Every engine injects an amount of fuel based on the revolutions, such that the hydraulic actuation device varies the pitch angle depending on the engine load, that is, the propeller would adapt to the amount of power provided by the engine of the vessel at each moment. Regardless of the pitch in which the blades are located, it is the engine itself what regulates this pitch in each situation and as deemed necessary.

[0029] The main advantages provided by the propulsion unit of the invention are the following:

- Reducing installation times. With the unit of the invention, installing a controllable-pitch propeller may be completed in only one week, since the only civil work to be conducted is opening holes to make the hydraulic pipes pass from the servo room to the propeller. In addition, in a ship with a conventional line of shafting, it is not feasible to transform it into a "classic" controllable-pitch system (the cost is too high since, apart from the equipment, the stern tube and the line of shafting need to be modified).
- Reducing fuel consumption. In empirical calculations and trials conducted, a fuel saving between 15% and 35% at the same speed has been achieved. This entails that with a variable-pitch propeller, the propeller performance is increased and consumption is reduced.
- Reducing vibration levels of the propeller. If the propeller of the unit of the invention is compared with a conventional solid propeller, the vibration level is much better because the propeller of the unit of the invention is supported on both ends, unlike the classic propeller, which is placed in a projecting shaft and, therefore, the vibrations are greater.
- Increasing maximum speed. The propeller of the unit of the invention allows for varying the propeller pitch

as desired by the captain. Therefore, it is possible to achieve 100% or even 110% of the vessel's engine power in order to gain higher speed than that gained with a classic propeller.

- Reducing braking time of the vessel. By allowing for varying the pitch up to the reverse position by turning the engine in the same direction, this operation is much faster than having to reverse the rotation direction of the engine to "brake" the ship.
- Reducing noise levels. Since it is possible to work with the engine at a revolution rate much lower than the one used with a classic propeller, noise pollution in the vessel is significantly lower.
- Reducing CO₂ emissions. As a result of the considerable consumption reduction achieved with this system, it is obvious that the CO₂ reduction achieved is also highly significant.

[0030] Hereinafter, in order to give a better understanding of the description, the object of the invention has been detailed in a series of drawings that are an integral part of the report and are for illustration purposes and without limitation.

25 BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Figure 1 shows an exploded perspective view of the propulsion unit for vessels, which is the object of the invention.

Figure 2 shows a cross-sectional view of the unit of the invention according to a first embodiment.

Figure 3 shows another cross-sectional view of the unit of the invention according to a second embodiment of the invention.

40 DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0032] Considering the numbering adopted in the figures, the propulsion unit for vessels comprises a hub (1) of tubular structure containing several radial openings (2), in correspondence with which rotation discs (3) are mounted where both blades (4) of the propeller are fixed. The rotation discs (3) are coupled in several staggered annular recesses of the hub (1) which prevent them from being removed outwardly.

[0033] The hub (1) has two opposing mouths: a front mouth and a rear mouth, through which the mounting and dismounting of rotation disks (3) is carried out. In correspondance with said rear mouth a stern clamp (5) is fixed, wherein a bracket (6) is in turn coupled interposing a displacement bushing (7), such that during the rotation of the propulsion unit the bracket (6) remains static.

[0034] Meanwhile, a bow clamp (8) is fixed in corre-

spondance with the front mouth of the hub (4), through the bow clamp (8) the propulsion unit assembly is coupled to a tapered portion (9a) of a transmission shaft (9), ensuring the axial fixing of the propulsion unit by means of a nut (10) coupled to an end section (9b) of the transmission shaft (9), whereas the rotating immobilisation of said propulsion unit is ensured by means of a key that is not represented in the figures.

[0035] Within the inner space of the hub (1) a yoke (11) is housed with axial, but not radial, displacement, such that the axial displacement of said yoke (11) causes the simultaneous rotation of the propeller blades (4) to vary the pitch thereof by means of intermediate devices that relate the yoke (11) with each of the rotation discs (3).

[0036] For such purpose, the rotation discs (3) are mounted in correspondence with cylindrical bodies (12) freely coupled in blind bores (13) of the yoke (11) contained in a plane perpendicular to the axial displacement of the yoke (11), such plane being also perpendicular to the plane of the rotation discs (3).

[0037] Protruding ends of the cylindrical bodies (12) are adjusted within orifices of dices (14) which are fitted in radial channels (15) provided in internal sides of the rotation discs (3), opposite the external sides of said rotation discs (3), onto which the propeller blades (4) are fixed.

[0038] The rotation discs (3) are supported through their inner sides onto lateral areas of the yoke (11), by means of which said yoke (11) is fitted and guided inside the hub (1), which, for such purpose, includes smooth surfaces that are in contact with said lateral areas of the yoke (11). The axial displacement of the yoke (11) is carried out by means of a hydraulic actuation device that manages to maintain a desired stable position of the pitch of the propeller blades (4), both in the forward and backward direction of the vessel.

[0039] The hydraulic actuation device comprises a front chamber (16a) and a rear chamber (16b), divided by a plunger (17a) jointly fixed to a stem (17b), these two elements making-up a static head (17); wherein said chambers (16a), (16b) are constituted within a blind cylindrical hole formed in the yoke (11), such that the mouth of said blind cylindrical hole is closed by means of a front lid (18) fixed to said mouth by means of screws.

[0040] The stem (17b) of the static head (17) extends outwards through an orifice of the front lid (18), such that during the rotation movement of the hub (1) that drags the blades (4), the static head (17) remains immovable. In turn, the stem (17b) is also fixed to the stern clamp (5) by means of an annular element that may be an annular extension (19) in an embodiment or by means of an annular junction (20) in a second embodiment.

[0041] An axial shaft is fixed as a projection of an end of the stem (17b) by means of a front clamp (22) fitted within a cavity of the stern clamp (5), which is in turn fixed by means of screws, such that said front clamp (22) is arranged opposite the annular element (19, 20) that fixes the stem to the stern clamp (5).

[0042] A feeding head (23) housed within the bracket (6) is coupled around the axial shaft (21), two oil fluid feeding hoses (24a, 24b) being connected to said feeding head (23) through which the oil fuel circulates to feed the hydraulic actuation device. Said bracket (6) includes an end lid (6a) to be able to access said feeding head (23).

[0043] Thus, the oil fluid is introduced within the chambers (16a, 16b) of the yoke (11) to displace it in one axial direction or the other and thus change the pitch of the propeller blades (4). For such purpose, the static head (17) and the axial shaft (21) have a first duct (25a) that ends in the front chamber (16a), and a second duct (25b) that ends in the rear chamber (16b), both chambers being formed in the yoke (11). The opposing ends of said ducts (25a, 25b) are linked to nozzles of the feeding head (23), where the hoses (24a, 24b) through which the oil fluid circulates are connected.

[0044] As it was mentioned above, it is possible to change the pitch of propeller blades (4) to adjust the forward speed of the vessel according to a first main embodiment, as well as to change the forward direction of the vessel according to a second embodiment, wherein in this second embodiment it is possible to brake the vessel in a more effective manner when it moves forward and it is necessary to prevent the vessel from moving forward.

[0045] Considering said second option, the propulsion unit includes a position sensor (26) in order to know, at all times, whether the vessel is to move forward or backward. Said position sensor indicates in a control panel of the vessel the pitch position of the propeller blades (4) at every moment, so that, through this indication as well as with the revolutions of the vessel's engine, it is possible to adjust the propeller and the pitch of its blades (4) to the best possible performance at every moment.

[0046] The position sensor (26) comprises a rod fitted within an axial bore (32) located along the static head (17) and axial shaft (21), the position sensor (26) being fixed by a widened rear end section (26a) to the feeding head (23) by means of an end body (27), so that said position sensor (26) cannot move and always remains in a static position.

[0047] A front end section of the position sensor (26) facing its rear end section (26a) is housed within a blind bore (29) located in a closing lid (28) fixed to the yoke (11) and which faces the front lid (18) crossed by the stem (17b) of the static head (17). In this second embodiment of the invention when the position sensor is added, an additional piece (30) is included, located in a cavity of the yoke (11) against which said closing lid (28) which includes the blind bore (29) abuts. Said closing lid (28) includes an extension (28a) adjusted and guided within a blind orifice (31) of the static head (17), the axial bore (32) ending in said blind orifice (31).

[0048] With the arrangement described in the second embodiment of the invention where the position sensor (26) is included, as mentioned above, when the yoke (11) moves axially, said position sensor (26) indicates in a

control panel of the vessel the pitch position of the propeller blades (4) at every moment, so that through this indication as well as through the revolutions of the vessel's engine, it is possible to adjust the propeller and the pitch of its blades (4) to the best possible performance at every moment.

Claims

1. A propulsion unit for vessels comprising:

- a hub (1) of tubular structure the wall of which integers several radial openings (2), in correspondence with which rotation discs (3) are mounted, which are in turn joined to propeller blades (4); wherein the hub (1) has two opposing mouths: front and rear;
- a yoke (11) with axial displacement that is guided within an inner space of the hub (1);
- intermediate devices that relate the yoke (11) with the rotation discs (3), said rotation discs (3) rotating by means of the axial displacement of the yoke (11) associated to a hydraulic actuation device to conduct the axial displacement of the yoke (11) and thus vary the pitch of the propeller blades (4).
- a stern clamp (5) fixed to the rear mouth of the hub (1);
- a bracket (6) through which several continuous hoses (24a, 24b) pass to feed the hydraulic actuation device with oil fluid to move the yoke (11);

characterized in that:

- the hydraulic actuation device comprises a front chamber (16a) and a rear chamber (16b) separated by a plunger (17a) fixed to a stem (17b), these two elements forming a static head (17); wherein said chambers (16a), (16b) are constituted within a cylindrical hole of the yoke (11); where said cylindrical hole is closed at its ends by means of front walls: a front wall related to the front mouth of the hub (1) and a rear front wall related to the rear mouth of the hub (1);
- the stem (17b) of the static head (17) extends outwards through an orifice of the rear front wall of the yoke (11);
- the stem (17b) of the static head (17) is fixed to the stern clamp (5) by means of an annular element;
- an end of the stem (17b) of the static head (17) is joined to an axial shaft (21) by means of a front clamp (22) fixed to the stern clamp (5); wherein said front clamp (22) is arranged opposite to the annular element that fixes the stem (17b) to the stern clamp (5);
- a feeding head (23) housed within the bracket

(6) is coupled around the axial shaft (21); the oil fluid feeding hoses (24a, 24b) being connected to said feeding head (23).

2. A propulsion unit for vessels, according to claim 1, characterized in that:

- the static head (17) and the axial shaft (21) have a first duct (25a) that ends in the front chamber (16a), and a second duct (25b) that ends in the rear chamber (16b), both chambers being formed in the yoke (11)
- the opposing ends of said ducts (25a, 25b) are linked to nozzles of the feeding head (23), to which the hoses (24a, 24b) through which the oil fluid circulates are connected.

3. A propulsion unit for vessels, according to claim 1, characterized in that the rear front wall that closes the rear end of the cylindrical hole of the yoke (11) comprises a front lid (18) fixed against an annular seat of the yoke (11).

4. A propulsion unit for vessels, according to claim 1, characterized in that the fore front wall that closes the front end of the cylindrical hole of the yoke (11) is a body composing a part of the yoke (11) itself.

5. A propulsion unit for vessels, according to claim 1, characterized in that the annular element fixing the stem (17b) of the static head (17) to the stern clamp (5) is an annular extension (19) that is part of the stem (17b) itself.

6. A propulsion unit for vessels, according to claim 1, characterized in that the bracket (6) includes an end lid (6a) to access the feeding head (23) which is coupled around the axial shaft (21).

7. A propulsion unit for vessels, according to claim 1, characterized in that:

- it includes a real-time control device of the positioning of the yoke (11) and of the pitch of the propeller blades; wherein said control device comprises a position sensor (26) composed of a rod adjusted within an axial bore (32) located along the static head (17) and the axial shaft (21);
- the position sensor (26) is fixed at a widened rear end section (26a) to the feeding head (23) by means of an end body (27); in such a way that said position sensor (26) is not movable, and always remains in a static position;
- a front end section of the position sensor (26) opposite its rear end section (26a), said front end section being housed inside a blind bore (29) located in a closing lid (28) fixed to the yoke

(11); wherein said closing lid (28) constitutes the front wall closing the front end of the cylindrical hole of the yoke (11) where the plunger (17a) of the static head (17) is housed.

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8. A propulsion unit for vessels, according to claim 7, **characterised in that** the closing lid (28) includes an extension (28a) adjusted and guided within a blind orifice (31) of the static head (17); where the axial bore (32) ends in said blind orifice (31). 10
9. A propulsion unit for vessels, according to claim 7, **characterised in that** the annular element fixing the stem (17b) of the static head (17) to the stern clamp (5) is an annular junction (20) which is coupled to said stem (17b). 15
10. A propulsion unit for vessels, according to claim 1, **characterized in that:** 20
 - the intermediate devices that relate the yoke (11) with the rotation discs (3) comprise cylindrical bodies (12) coupled to blind bores (13) of the yoke (11) contained in a plane perpendicular to the axial displacement of the yoke (11), such plane being also perpendicular to the plane of the rotation discs (3); 25
 - protruding ends of the cylindrical bodies (12) are adjusted within orifices of dices (14) which are fitted in radial channels (15) provided in internal sides of the rotation discs (3), opposite the external sides of the rotation discs (3), onto which the propeller blades (4) are fixed. 30
11. A propulsion unit for vessels, according to claim 1, **characterized in that** a bow clamp (8) is fixed in correspondence with the front mouth of the hub (1), through which the propulsion unit assembly is coupled to a tapered portion (9a) of a transmission shaft (9); wherein the axial fixing of the propulsion unit comprises a nut (10) coupled to an end section (9b) of the transmission shaft (9) and wherein the rotating immobilisation of said propulsion unit comprises a key (3). 35 40 45
12. A propulsion unit for vessels, according to claim 1, **characterised in that** the bracket (6) is coupled around part of the stern clamp (5) by means of a displacement bushing (7). 50

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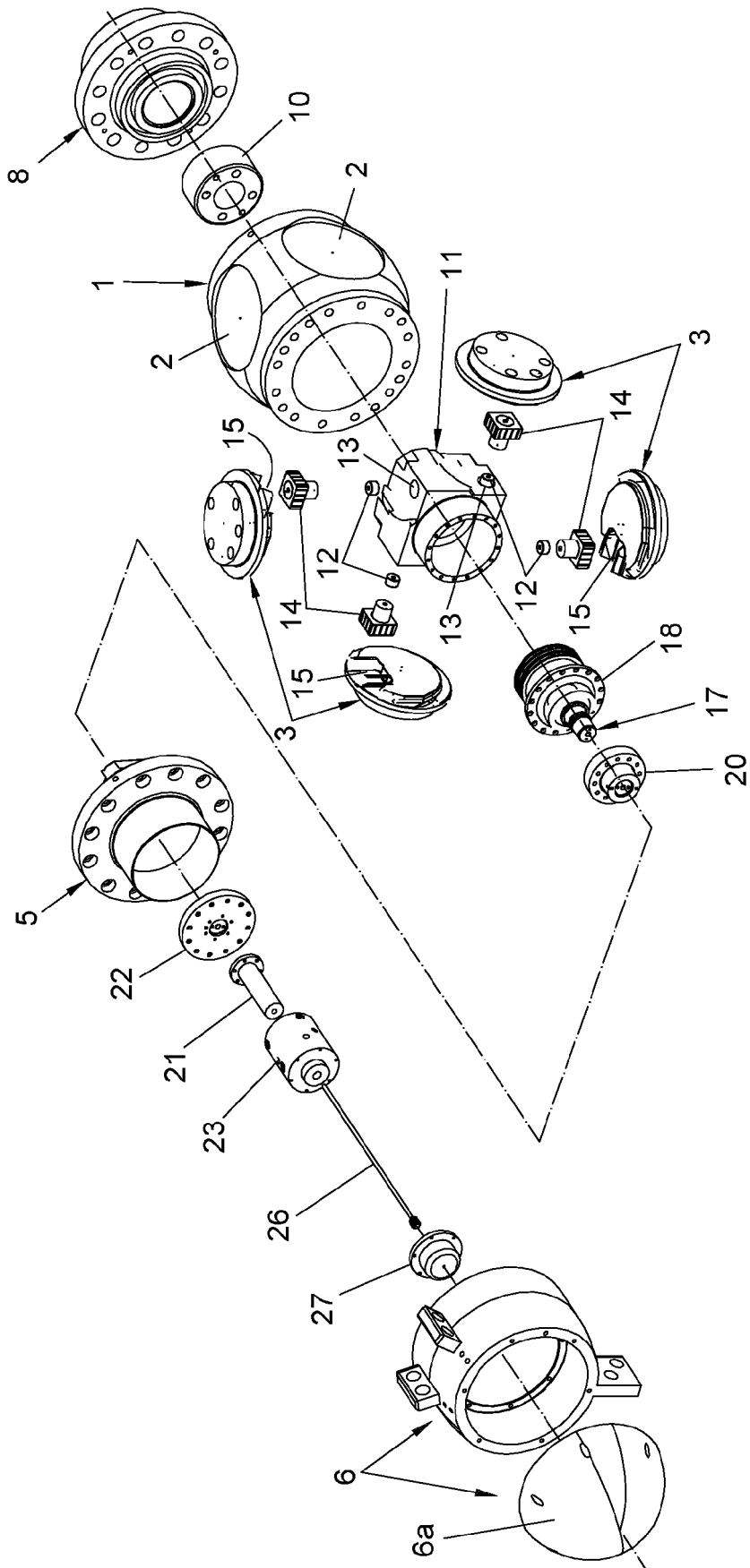


FIG. 1

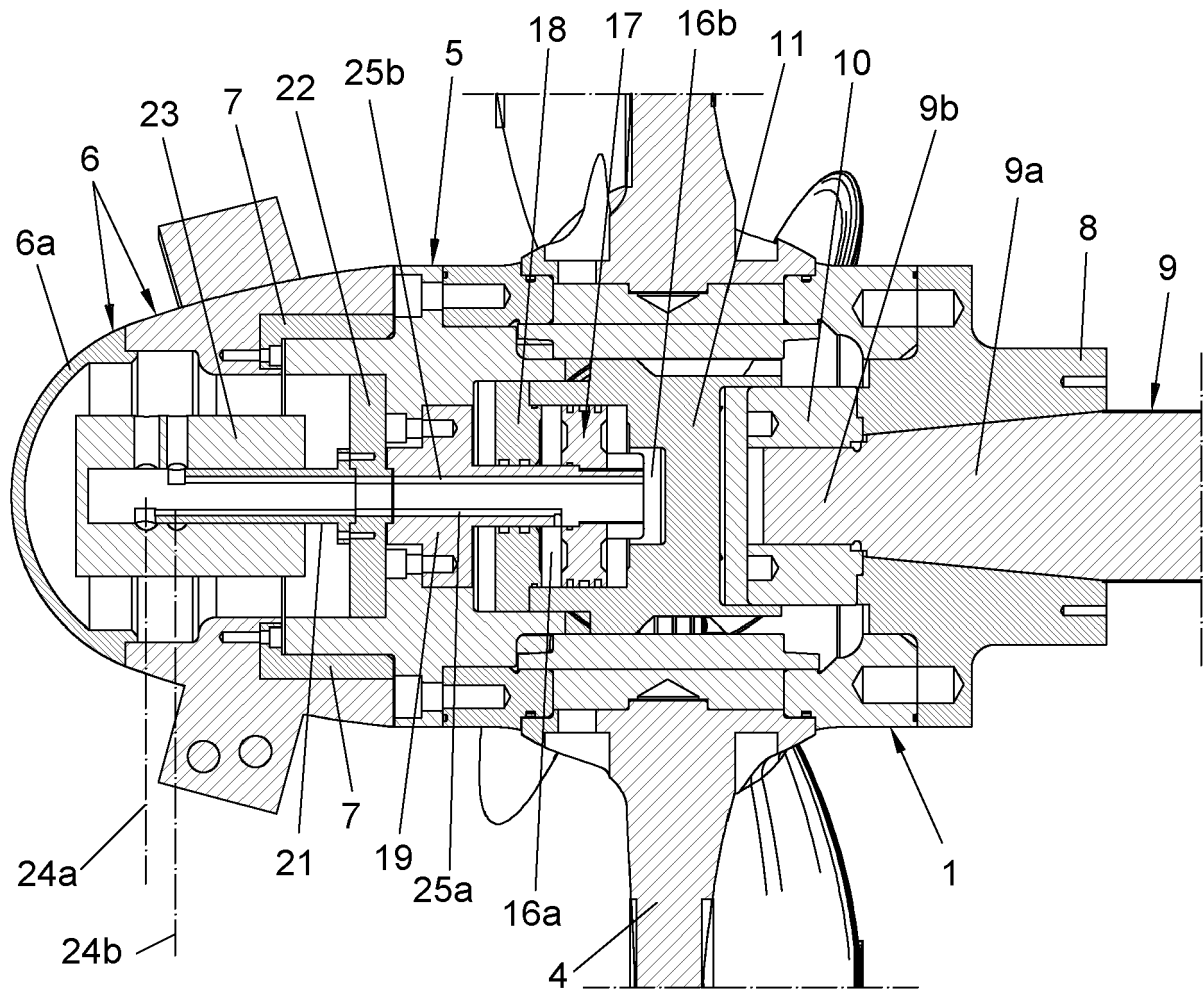
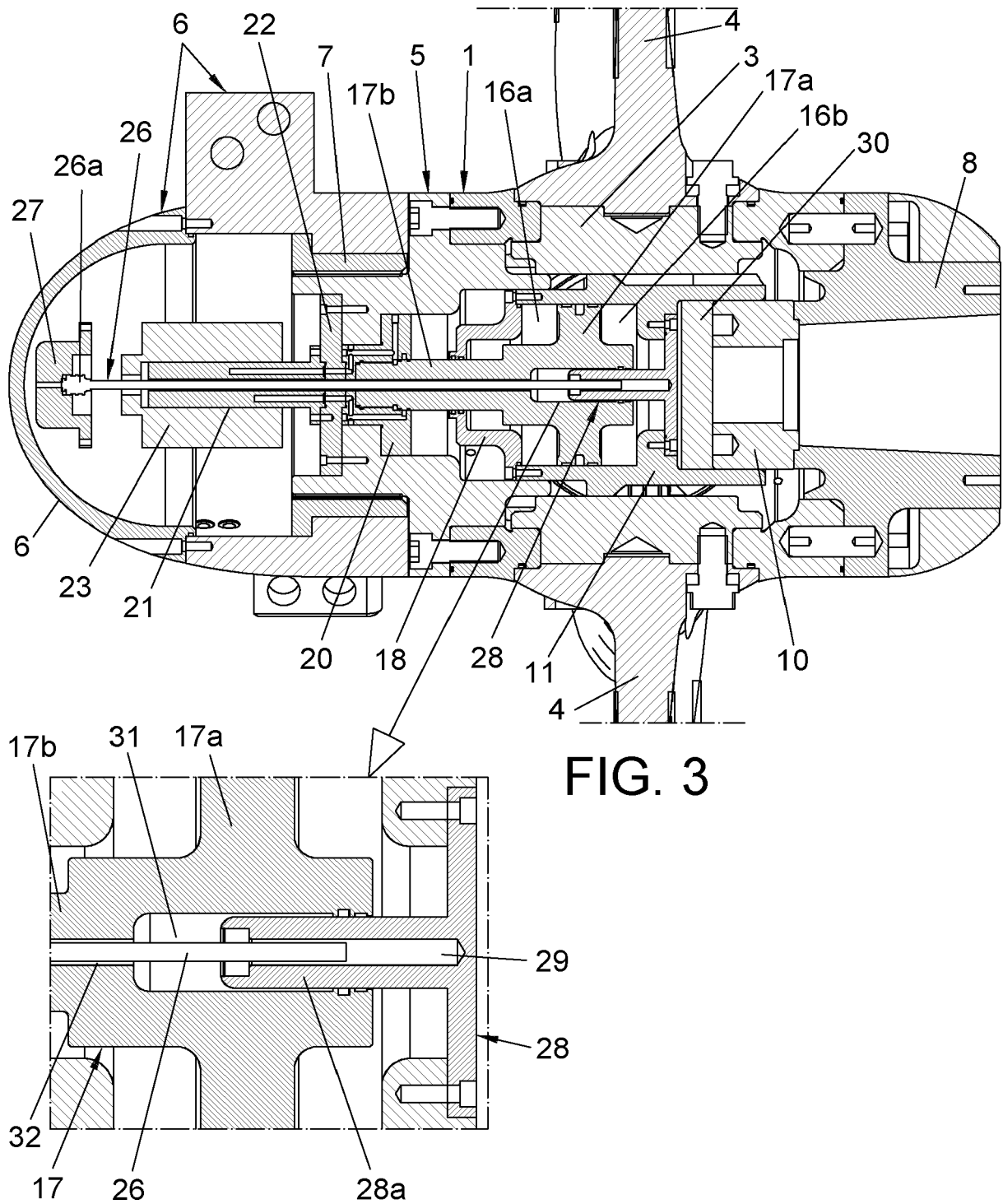


FIG. 2





EUROPEAN SEARCH REPORT

Application Number
EP 16 19 5962

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			B63H
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 10 March 2017	Examiner Barré, Vincent
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/02 (P04C01)

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

EP 16 19 5962

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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