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(54) Benævnelse: **Fartøj omfattende en fremdrivningsenhed**

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WO-A1-98/30440
GB-A- 2 014 929
US-A- 5 397 255

DESCRIPTION

FIELD OF THE INVENTION

[0001] The present invention relates to a propulsion unit for being mounted on a submerged portion of the hull of a waterborne vessel, the propulsion unit comprising a propeller nozzle for being pivotally mounted to the hull, a propeller rotatably arranged inside the nozzle, a drive means for driving the propeller, and a deployment mechanism for controlling the orientation of the propeller nozzle. The present invention further a vessel comprising such propulsion unit.

BACKGROUND OF THE INVENTION

[0002] Waterborne vessels are often operated in both shallow and deeper waters, such as oceans, coastal waters and rivers. When vessels operate in relatively deep waters a propeller is most often used for providing thrust enabling the vessel to move. The size of the propeller is related to the obtainable thrust and large propellers may be needed to provide the necessary trust. Using large propellers may result in the propeller extending below the lowest point of the hull making the propeller the lowermost point of the vessel. The propeller thus determines the draught of the vessel making the propeller vulnerable to impact. This is usually not a problem when vessels are operated in sufficient water depth, but when a vessel is operated close to land, or across a shallow water area, a need may arises for minimizing the draught of the vessel.
In this regard, US 5,397, 255 disclosed a propeller mounted on a retractable rod. Other existing solutions involve changing the diameter of the propeller by folding the propeller as disclosed in US 4,565,531.

[0003] GB 2 014 929 discloses a propulsion unit including a propeller which can be pivoted out from a room arranged in the bottom of the hull.

[0004] The above mentioned solutions suffer from various drawbacks, especially when a propeller diameter is made larger to provide more thrust. A retractable propeller will need a heavy attachment so as to absorb forces from the propeller and ensure that the propeller stays in position during use. Hence, an improved propulsion unit for waterborne vessels would be advantageous.

OBJECT OF THE INVENTION

[0005] It is an object of the present invention to provide a propulsion unit for a waterborne vessel that allows a propeller of the propulsion unit to be moved to reduce the draught of the vessel.

SUMMARY OF THE INVENTION

[0006] Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a propulsion unit for being mounted on a submerged portion of the hull of a waterborne vessel, the propulsion unit comprising a propeller nozzle for being pivotally mounted to the hull, a propeller rotatably arranged inside the nozzle, a drive means for driving the propeller, and a deployment mechanism for controlling the orientation of the propeller nozzle, wherein the propeller nozzle is pivotally around a nozzle pivoting axis intersecting the propeller nozzle, between a deployed orientation wherein the propeller is arranged in a substantially upright position suitable for providing thrust for moving the vessel and a retracted orientation wherein the propeller is arranged in a tilted or substantially horizontal position to reduce a draught of the vessel.

[0007] Hereby an improved propulsion unit is provided, in particular a more efficient propulsion unit in which a relatively large propeller diameter may be utilized, while at the same time accommodating for low water depths. The propulsion unit is in particular suited for vessels operating in both deep as well as in shallow water. During normal operation, the propulsion unit is flipped down. This allows for much larger propeller diameter than for conventional propulsion unit.

[0008] The propeller and propeller nozzle may be turned to reduce the draught of the vessel and due to the particulars of the invention the turning radius of the propeller and propeller nozzle becomes as little as possible, helping to reduce the spaced needed to accommodate the propulsion unit.

[0009] Further, the nozzle pivoting axis may extending in a direction perpendicular to a direction of an axis of rotation of the propeller. Also, the nozzle pivoting axis may extends in a direction substantially transversal to a direction of sailing of the waterborne vessel.

[0010] In one embodiment of the above described propulsion unit, the nozzle pivoting axis may be offset from the axis of rotation of the propeller. By utilizing an offset pivoting axis attachment points for the propeller nozzle may be arranged closer to the hull of the vessel compared to a propulsion unit wherein the pivoting axis is coincident with an axis of rotation of the propeller. Having attachment points closer to the hull results in a better transmission of forces between the propulsion unit the hull. Hereby the dimensions of the supporting structures may be reduced, which may improve the hydrodynamic characteristics of the hull and reduces drag. Additionally, reducing the dimension of the supporting structure may reduce draught of the vessel when the propeller nozzle is in the retracted orientation. In all, the offset rotating axis enables the use of larger propellers, which may be advantageous.

[0011] In another embodiment the pivoting axis may intersect the axis of rotation of the propeller.

[0012] Additionally, the propeller may be rim-driven and in this embodiment the drive means may be a permanent magnet motor. The principles of a rim driven propeller utilizing permanent magnets have previously been disclosed international application, publication number WO 2010/13480 A2 by the applicant.

[0013] In one embodiment, stationary permanent magnets may be provided in the propeller nozzle and the propeller may be mounted in a propeller housing provided with permanent magnets and rotatably arranged inside the propeller nozzle. Hereby a bearing for the propeller housing is provided. Further, an advantage of providing a rim-driven propeller is that the transmission for torque is optimized compared to traditional shaft mounted and centre driven propellers. The transmission of torque becomes even more important when large propellers are employed. In this regard, it has been shown that in a vessel having a propulsion unit according to the present invention the required power may be reduced by approximately 20%, while vessel's thrust is maintained. This provides great savings on space, material use, fuel consumption etc. Additionally, other advantages include reduced noise and vibration, and the ability to actively compensate for vessel undulations.

[0014] Still further, the propeller nozzle may be adapted to be attached to supporting structures extending from the submerged portion of the hull.

[0015] In another embodiment the propeller may be mounted on a rotatable propeller shaft supported by a supporting structure extending inside the propeller nozzle and the drive means may be a motor arranged to rotate the propeller shaft.

[0016] Furthermore, the propulsion unit may be adapted to be pivotally mounted to the submerged portion of the hull about a substantial vertical azimuth axis thereby providing an azimuth thruster functionality. Hereby a direction of thrust from the propulsion unit may be directed in other directions than otherwise provided by the propeller, which may be used for enhanced steering of the vessel.

[0017] The invention further relates to a waterborne vessel, such as an offshore supply vessel or an mobile offshore drilling unit, comprising one or more of the above described propulsion unit.

[0018] Different aspects of the present invention may each be combined with any of the other aspects. These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

[0019] The propulsion unit on a vessel according to the present invention will now be described in more detail with reference to the accompanying figures. The accompanying figures illustrates an example of embodiment of the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 shows two propulsion unit mounted on a vessel,

Figure 2a and 2b shows a vessel comprising a propulsion unit,

Figure 3a and 3b shows different orientations of a propulsion unit,

Figure 4a and 4b illustrates the relationship between a thrust axis and a pivoting axis of a propulsion unit according to one embodiment of the invention,

Figure 5a shows propulsion unit, and

Figure 5b and 5c shows a cross section of the propulsion unit of Fig. 5a along line AA' and B, respectively.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0020] Fig. 1 shows two propulsions unit mounted on a submerged portion of a hull 2 in an aft section of a vessel 1. Each propulsion unit comprises a pivotally mounted propeller nozzle 13 and a rotatable propeller 14 arranged inside the nozzle. A deployment mechanism 15 is provided for pivoting the propeller nozzle and the propeller about a nozzle pivoting axis 17 between a deployed orientation and a retracted orientation. Referring to Fig. 2a and 2b, in the deployed orientation shown in Fig. 2a the propeller is arranged in a substantially upright position suitable for providing thrust for moving the vessel as and in the retracted orientation shown in Fig. 2b the propeller is arranged in a tilted or substantially horizontal position to reduce a draught D of the vessel. The propulsion unit further comprises drive means 16 for driving the propeller as will be further described below.

[0021] As seen from Fig. 1, the propulsion units 10 are shown to be mounted between a central supporting structure 30 and side supporting structures 31 extending from the hull 2. However, the propulsion unit may also be mounted to on a hull in a number of other ways without departing from the scope of the invention. Nozzle protrusions 131 extends from the propeller nozzle 13 and provide attachment points for attachment with the supporting structures. As is readily understood by the skilled person, the propeller nozzle is mounted using the necessary bearings to provide the pivotal motion. The deployment mechanism 15 provided for moving the propeller nozzle is shown in further detail in Fig. 4b. The deployment mechanism shown comprises a pivoting arm 151 mounted on the nozzle protrusion 131 that in turn is connected to a linear actuator, such as a hydraulic cylinder 152. When a piston 153 of the hydraulic cylinder is moved forward or backwards, dependent on the operation of an associated hydraulic pump, the movement of the piston is transferred to the pivoting arm 151 that facilitates the movement of the propeller nozzle 13 and propeller 14. The propeller nozzle and the propeller is turned about the nozzle pivoting axis 17 that intersecting the propeller nozzle. As seen from Fig. 4a the pivoting axis extends in a direction perpendicular to a direction of an axis of rotation 142 of the propeller. Thus, when the propeller is moved between the deployed orientation and the retracted orientation, the direction of the axis of rotation of the propeller 142, which may also be denoted the thrust direction of the propeller, gradually shifts. Depending on how the propulsion unit is mounted on the vessel, the nozzle pivoting axis may also extends in a direction substantially transversal to a direction of sailing of the waterborne vessel.

[0022] Figure 2a and 2b shows how movement of the propeller nozzle from the deployed orientation in Fig. 2a to the retracted orientation in Fig. 2b reduces the draught, D of a vessel comprising one or more propulsion units according to the invention. In fig. 2a the lower most point of the propeller nozzle is decisive to the draught of the vessel, where as in Fig. 2b the previous lower most point of the propeller nozzle is now above the lover most point of the vessel and the draught, D is hereby reduced.

[0023] Fig. 4a and 4b illustrates how the pivoting axis 17 may be offset from the axis of rotation 142 of the propeller by an offset-distance, r. The closer the pivoting axis is arranged to the axis of rotation, the lower a dimensioning moment of the propulsion unit may be. Compared to traditional retractable azimuth thrusters that are often supported at a single point high above the propeller, the dimensioning moment of the present propulsion unit may be no more than 1/10.
The offset-distance, r may be less than or equal to half the maximum diameter of said propeller. For example, the offset-distance, r may be in the range of 0 to 1.5 meter. The support arrangement for the propulsion unit must be dimensioned with respect to the moment of the propeller nozzle and propeller about the pivoting axis and a small offset-distance, r ensures that the moment is correspondingly low. Further, as the pivoting axis 17 is located relatively close to the hull the forces required to pivot the propeller nozzle and propeller is relatively low compared to traditional retractable azimuth thrusters and by being attached to the hull at two points the propulsion unit provides a stiff and strong structure. In addition, the arrangement of the attachment points of the propeller nozzle and the direction of the pivoting axis 17 enables the propeller nozzle and propeller to be substantially flush with the shape and angels of the hull in the retracted orientation.

[0024] Various drive means and configurations for driving the propeller may be used while remaining within the scope of the invention. Referring to Fig. 5a-5c, according to one aspect the propeller may be rim-driven by a permanent magnet motor. The propulsion unit 10 is shown to comprise stationary permanent magnets 163 arranged along an inner circumference of the propeller nozzle and the propeller 14 is mounted in a propeller housing 161 rotatable arranged inside the propeller nozzle. An

outer circumference of the propeller housing is provided with rotating permanent magnets 162, and together the stationary and the rotating permanent magnets provide a bearing for the propeller housing able to absorb both axial and radial loads.

[0025] Further, the propeller nozzle constitutes a stator 164 comprising windings for providing a rotating magnetic field adapted to rotate the propeller housing comprising permanent magnets thereby constituting a rotor. By controlling the current running through the windings, the propeller housing may be rotated and a permanent magnet motor for driving the propeller is provided.

[0026] In another embodiment (not shown), a structure for supporting a propeller shaft is provided inside the propeller nozzle. The propeller shaft is arranged in a centre of the nozzle and the supporting structure extends from the circumference of the propeller nozzle towards the centre to support the propeller shaft. The propeller shaft may be supported at several points along the propeller shaft. The propeller is mounted on the propeller shaft and the drive means is a motor arranged to rotate the propeller shaft.

[0027] Figure 3a and 3b show how power lines 165 for supplying power to the drive means 16, such as a permanent magnet motor. The power lines are routed from the interior of the hull to the propulsion unit via attachment point of the propeller nozzle protrusions. As envisaged by the skulled person the power for driving the propeller must be supplied in manner adapted to allow pivoting of the propeller nozzle. Several options are available such as hydraulic, pneumatic as well as electrical drives, where hoses or wiring may be adapted to allow pivoting of the propulsion unit.

[0028] In the drawings, propulsion units according to embodiments of the invention are shown to be arranged in the rear part of a vessel as a main source of propulsion. However, propulsion units according to the invention may also be used for providing thrust elsewhere, such as a bow thruster to reduce turning radius or ease berth by providing a transversal trust force.

[0029] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. Also, the mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

10 propulsion unit

11 rudder element

13 Nozzle

131 Nozzle protrusions

14 Propeller

141 Propeller blades

142 axis of rotation of the propeller.

15 Deployment mechanism

151 pivoting arm

152 hydraulic cylinder

153 piston

16 drive means

161 rotatable propeller housing

162 rotating permanent magnets

163 stationary permanent magnets

164 stator

165 power lines

17 pivoting axis

18 pivot drive mechanism

30 central supporting structure

31 side supporting structures

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US5397255A [0002]
- US4565531A [0002]
- GB2014929A [0003]
- WO2010134880A2 [0012]

Patentkrav

1. Fremdrivningsenhed (10) til at blive monteret på en nedsænket del af skroget (2) af et vandbåret fartøj (1), idet fremdrivningsenheden omfatter:

- en propeldyse (13) til at blive drejeligt monteret til skroget,
- en propel (14) roterbart anbragt inde i dysen (13),
- et drivorgan (16) til at drive propellen, og
- en indsatsmekanisme (15) til at styre orienteringen af propeldysen,

hvor propeldysen er drejelig rundt om en dysedrejeakse (17) mellem en indsat orientering hvor propellen er anbragt i en i det væsentlige opretstående position der er egnet til at tilvejebringe fremdrift til bevægelse af fartøjet og en tilbagetrukket orientering hvor propellen er anbragt i en skrånende eller i det væsentlige horisontal position for at reducere et træk (draught) (D) af fartøjet, **kendetegnet ved at** dysedrejeaksen (17) gennemskærer propeldysen (13).

2. Fremdrivningsenhed (10) ifølge krav 1, hvor dysedrejeaksen strækker sig en retning vinkelret på en retning af propellens rotationsakse (142).

3. Fremdrivningsenhed (10) ifølge krav 1 eller 2, hvor dysedrejeaksen strækker sig i en retning i det væsentlige på tværs af det vandbårne fartøjs sejlretning.

4. Fremdrivningsenhed (10) ifølge et hvilket som helst af de foregående krav, hvor dysedrejeaksen er forskudt fra propellens rotationsakse.

5. Fremdrivningsenhed (10) ifølge et hvilket som helst af kravene 1-3, hvor drejeaksen gennemskærer propellens rotationsakse.

6. Fremdrivningsenhed (10) ifølge et hvilket som helst af de foregående krav hvor propellen er remdrevet og drivorganet er en permanentmagnetmotor.

7. Fremdrivningsenhed (10) ifølge krav 6, hvor stationære permanentmagneter (163) er tilvejebragt i propeldysen og propellen er monteret i et propelhus (161)

tilvejebragt med roterbare permanentmagneter (162) og roterbart indrettet inde i propeldysen.

8. Fremdrivningsenhed (10) ifølge et hvilket som helst af de foregående krav, hvor propeldysen er tilpasset til at blive fastgjort til bærestrukturer der strækker sig fra den nedsænkede del af skroget.

9. Fremdrivningsenhed (10) ifølge et hvilket som helst af kravene 1-5, hvor propellen er monteret på en roterbar propelaksel båret af en bærestruktur der strækker sig inde i propeldysen og hvor drivorganet er en motor anbragt til at rotere propelakselen.

10. Fremdrivningsenhed (10) ifølge et hvilket som helst af de foregående krav tilpasset til at blive drejeligt monteret til skroget omkring en i det væsentlige lodret azimuth akse derved tilvejebringe en azimuth thruster-funktionalitet.

11. Vandbåren fartøj, såsom et offshore-forsyningsfartøj eller en mobil offshore-boreenhed, omfattende én eller flere fremdrivningsenheder ifølge et hvilket som helst af kravene 1-10.

DRAWINGS

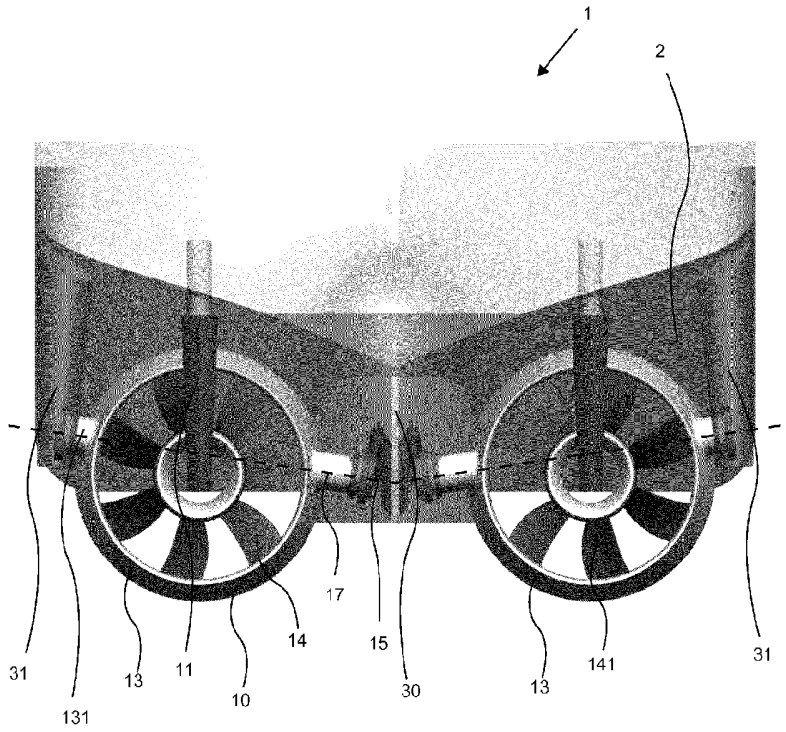


Fig. 1

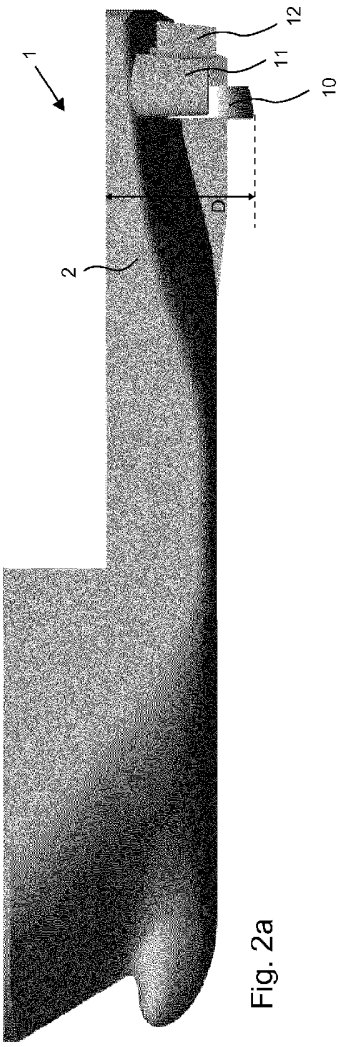


Fig. 2a

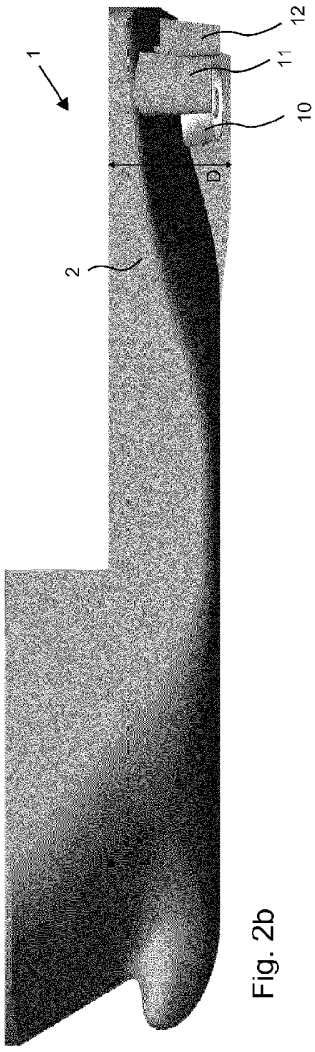


Fig. 2b

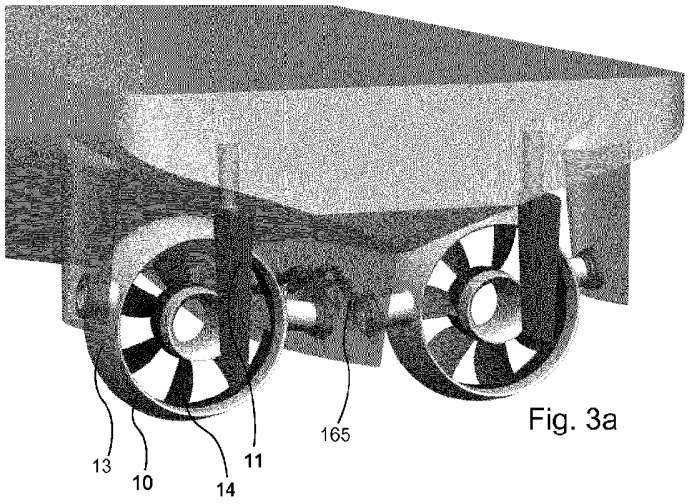


Fig. 3a

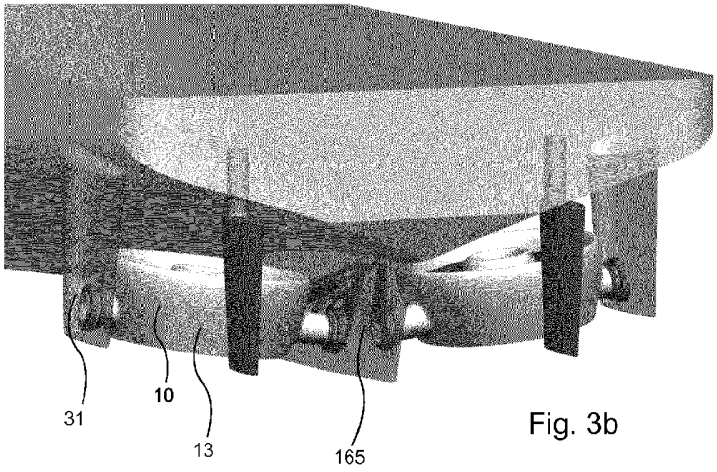


Fig. 3b

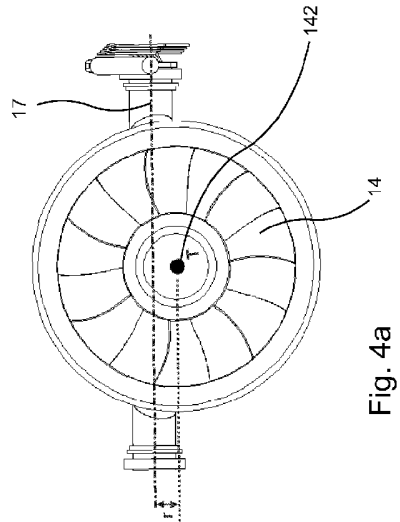


Fig. 4a

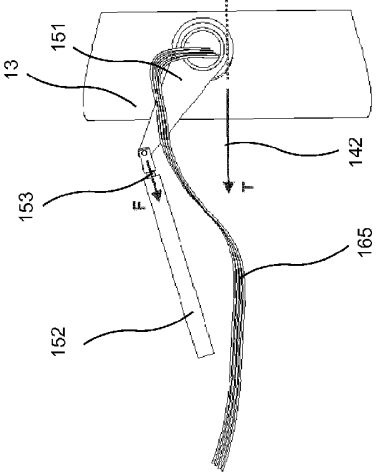


Fig. 4b

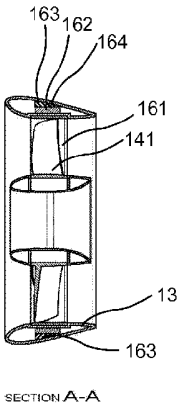


Fig. 5b

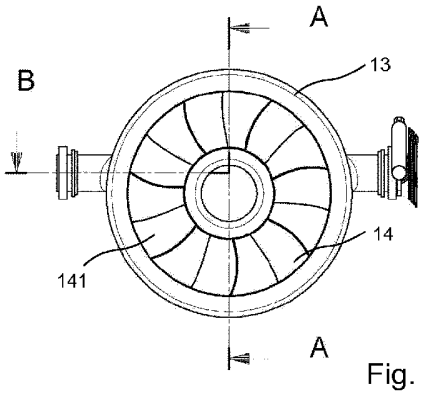


Fig. 5a

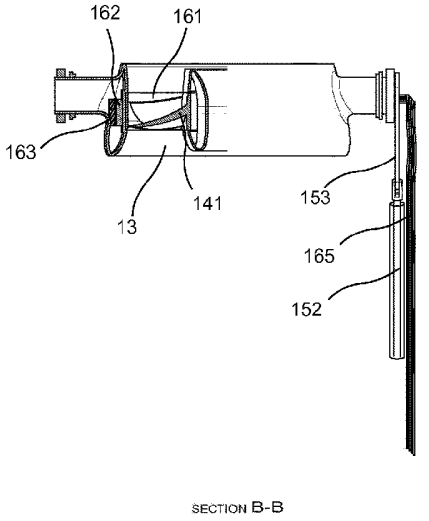


Fig. 5c