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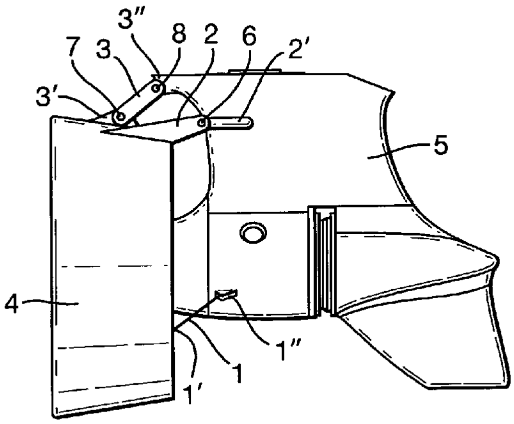
(54) **Title:** SYSTEM FOR FIXING A PROPELLER NOZZLE TO A STRUCTURE THAT FORMS A VESSEL OR A PART OF A VESSEL

Fig.1.



(57) **Abstract:** The present invention concerns a system for attaching a propeller nozzle (4) to a structure (5) including a vessel or a part of a vessel. The nozzle (4) surrounds a propeller that is supported in the structure (5). The system includes at least one first attachment point (2) for attaching the nozzle to the structure substantially for taking up pressure forces, at least one second attachment point (3') for attaching the nozzle (4) to the structure (5) for accommodating forces in tension, and at least one strut (1) attached in at least one strut attachment point (1') on the nozzle (4), for accommodating forces in tension, extending between nozzle (4) and the structure (5).

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System for fixing a propeller nozzle to a structure that forms a vessel or a part of a vessel

The present invention concerns a system for attaching a propeller nozzle to a structure forming a vessel or part of a vessel by means of a system including tensioned struts. Structures of this type typically include an azimuth propeller both of a pulling and pushing type, but the invention may also be used in relation to attachment of a nozzle to a hull with conventional shaft lines. Up until now it has been common to attach the propeller nozzles for azimuth propellers towards a gear housing with solid steel plates that are bolted and welded. This involves time-consuming processes, and in such processes there is a risk for imposing mechanical tensions that may result in permanent deformations and stress release. Furthermore these stresses may result in fatigue fracture and unwanted geometries. During production it is furthermore a risk in connection with exposing vital parts such as bearings and gears for sparks, which can contribute to reduce the life span of the system considerably.

These attachment methods may also represent hydrodynamic blocking effects as they prevent water flow. The ability of the water to pass the structure is an important condition to allow the nozzle to give the desired additional force that is the purpose with this type of extra equipment as compared to a propeller without a nozzle. With a nozzle attachment according to the previously known art, is an area that is important for generating the additional force removed. Furthermore the additional resistance becomes increased and there is a risk for separation of the flow (relief) in and around the nozzle.

In EP 0816221 A2 it is shown a propulsion device for a vessel adapted to run in ice, where a pulling azimuth propeller with a nozzle is shown.

In RU 2128126 it is shown a double azimuth propeller with nozzles attached to a gear housing.

None of these publications do however show an attachment system according to the present invention.

The present invention concerns an alternative solution to this where these disadvantages are reduced in that the area of the attachment elements in the propeller flow is reduced, and in that it is given simple and predictable mechanical stress conditions.

Thereby the invention concerns a system for attaching a propeller nozzle to a structure. The structure may be a vessel or a part of a vessel. Typical areas of use may be supply ship, tugs, icebreakers, dynamical positioning systems for platforms etc. where a nozzle surrounds a propeller that is supported in this structure. The system includes at least one first attachment point for attaching the nozzle to the structure substantially for accommodating pressure forces.

In this connection it is sought moment free connections apart from a moment in a vertical plane in a transversal direction of the ship. The system further includes at least one second attachment point for attaching the nozzle to the structure for accommodating pressure forces; and at least one strut attached in at least one strut attachment point on the nozzle, for accommodating forces in tension. The at least one strut extends between the nozzle and the structure. The at least one strut can typically include a turnbuckle for tensioning the strut. The strut is typically a steel wire or steel rod. Synthetic ropes may also be used as these in many conditions have better resistance against fatigue and improved resistance to stress corrosion. Alternatively may other methods for tensioning the struts be used. The strut may for instance be formed as a threaded rod that can be attached with a nut in a ordinary way. The attachment points for the struts may typically include ball joints to ensure that it is only transferred forces in tension to the struts. The tension in the struts may be adjusted such that it is ensured that it always is transferred tension in the struts. Sensors that measure tension or mechanical stresses for instance strain gauges can be used to monitor the stress conditions.

The second attachment point for attaching the nozzle may include an attachment part extending between the nozzle and the structure. This attachment part may for instance be a rigid element with a throughgoing opening for a bolt. The attachment of the attachment part at each end may be made such that the attachment may be calculated as a hinge point. The attachment part shall primarily take up forces in tension, but can also be designed to take up some pressure, for instance as a redundant system if the struts should fracture. The part may also be designed such that this can take up moment imposed on the nozzle in relation to the structure. Such moment will substantially form a load sideways on the part.

It may typically be at least two first attachment points for taking up pressure forces, and these will typically be placed at each side of the second attachment point described above. Alternatively it may be at least two attachment points for taking up the pressure forces, and these may be placed at each side of the point for taking up pressure forces.

The nozzle may have a substantially circular cross section in a plane substantially parallel to a plane defined by the propeller. This plane will typically be parallel to the plane that is defined by the openings through the nozzle. The circular cross section has a center substantially adjoining with an axis of revolution for the propeller. The placement of the attachment point can be defined in radial directions and at a distance in relation to the axis of revolution of the propeller, such that it is formed angles between the radii extending between the attachment points and the axis of revolution for the propeller. The radii between the at least two first attachment points for taking up pressure forces and the axis of revolution may be placed at each side of the radius between the axis of revolution and the second attachment point.

It may typically be two or several struts for accommodating forces in tension. These are attached in the strut attachment points in the nozzle. The radii between these strut attachment points and the axis of revolution may typically form an angle in an order of magnitude of 120°. The number of struts and their mutual placement may however be varied as needed. If several struts are used, will the angle between the struts therein between or struts and the other attachment points be smaller. In many conditions will the struts be placed in the third and fourth quadrant if one considers a coordinate system with origo at the axis of revolution of the propeller. The struts may also be used to ensure that no unwanted elements get into the propeller. The attachment point or points for accommodating pressure forces, do in some cases strictly speaking not need to take up anything else than pressure, and made be formed by two opposing surfaces that are pressed towards each other. These do not need to be attached to each other as such. The angles between the radii for the strut attachment points and the second attachment point may be approximately 120°. Tests have however shown that exactly 120° not is what gives the best stress conditions in all situations, and the struts may therefore be somewhat adjusted in relation to this.

Short description of the enclosed figures:
Figure 1 shows an azimuth propeller assembled with a nozzle, attached in relation to the invention, seen from the side;
Figure 2 corresponds to figure 1, in a perspective view;
Figure 3 shows the solution of figure 1 at a plane perpendicular to figure 1;
Figure 4 shows an azimuth propeller with a nozzle attached thereto, secured in relation to an alternative embodiment of the invention, in a perspective view;
Figure 5 shows the azimuth propeller of figure 4, from the front;
Figure 6 shows an azimuth propeller assembled with a nozzle, attached according to yet another alternative embodiment of the invention, in a perspective view; and
Figure 7 shows the azimuth propeller of figure 6, seen from the front.

Detailed description of an embodiment of the invention with reference to the enclosed figures:
Figure 1 shows a typical azimuth unit with a structure 5 including a gear housing and a portion for attachment to a vessel, typically a boat or a ship. A nozzle 4 is attached in the structure 5 and is placed around a propeller (not shown) with an attachment system according to the invention. The attachment system includes

tension strut/tie rod 1 between the nozzle 4 and the structure 5, extending from a strut attachment point 1' on the nozzle 4 and to one strut attachment point 1" on the structure 5. A bracket 2 that forms a first attachment 2' for accommodating pressure forces, or forces in an opposite direction in relation to the forces that are imposed by the struts 1 and the attachment point 3, attaches the nozzle 4 to the structure 5 via a bolt 6, or another mechanism that prevents that the attachment takes up substantial moment about the bolt 6. A second tension attachment point 3' on the nozzle 4 attaches an attachment part 3 in the nozzles 4 via a bolt 7, and to the structure 5 via a bolt 8 in another tension attachment point 3" of the structure. The attachment part 3 between the nozzle 4 and the structure 5 ensures simple mechanical conditions in relation to tension in the tension attachment point 3'. Alternatively could the attachment point 3' on the nozzle be attached directly in the attachment point 3". However this would require more accurate production tolerances and could lead to more complicated conditions in relation to tension.

Use of the bolts 6, 7 and 8 ensure that the attachment points 2', 2", 3', 3" between the nozzle 4 and the structure 5 not transfer essential moment in a direction about the bolts and that these attachments can be considered as hinged. Thereby, this attachment results in simple, clear and predictable stress conditions between the attachment points for the nozzle 4 and the structure 5. The tension struts 1 are biased or tensioned between the nozzle 4 and the structure 5 between the strut attachment points 1' and 1" to ensure simple stress conditions and to prevent vibrations or other unwanted motion between the structure 5 and the nozzle 4. The biasing of the tension struts 1 ensure that the attachment part 3 only accommodate forces in tension.

Moment that is imposed on the nozzle 4 by the propeller and due to other conditions are primarily taken up by the brackets 2 with the attachment points 2', 2". The attachment points 2', 2", accommodate stresses in pressure, and are placed at each side of the attachment point 3' that takes up stresses in tension. The attachment point 3' for stresses in tension that is placed between the attachment point 2 for stresses in pressure, is attached in the attachment part 3 that furthermore is attached to the nozzle 4 via the bolt 7 and is attached in the other bolt 7 attached in the attachment point 3" of the structure 5. In that the attachment part 3 is attached with bolts 7, 8 at each side, it is ensured that the part 3 substantally only transfers pure tension.

The tension struts 1 also ensure that only tension is transferred between the attachment point 1' of the nozzle 4 and 1" of the structure 5.

In figure 2 the placement of the brackets 2 with the attachment points 2', 2" for accommodating pressure forces in relation to the attachment point 3' for the attachment part 3 for forces in tension is clearly shown. From the figure it is furthermore shown how the attachment brackets 2, attached with bolts 6 to the structure 5 substantially will be the only elements that take up moment imposed on the nozzle 4 in relation to the structure 5.

In figure 2 are bolt 7 for attaching the attachment point 3' to the nozzle 4 and bolt 8 for attaching the attachment part 3 to the attachment point 3" of the structure 5 clearly shown.

In figure 3 is furthermore the attachment of the nozzle 4 to the structure 5 shown. In figure 3 it is shown dashed lines that indicate the angle between the attachment elements 1, 2, 3 in relation to an axis represented by an axis of revolution for a propeller (not shown). In figure 3 it is shown an angle a between two struts 1 at one end attached in the nozzle 4 in attachment point 1', and at its other end attached in the attachment point 1" of the structure 5. An angle b between a line extending between the axis of revolution for the propeller and the attachment point 1' and a line extending between the axis of revolution of the propeller and the other attachment point 3' is placed at an angle c that is approximately 120°.

These angles may however be varied as needed and according to the stress conditions.

In figure 4 it is shown an alternative embodiment to the invention where a nozzle 4 is attached in a structure 5 via strut 1 with an attachment point 1" in the nozzle and 1" in the structure. Bolts 6 form along with the brackets 2 with attachment points 2' and 2", a hinged connection for the upper part of the nozzle. The bracket 2 takes up pressure. The attachment part 3 is shown as a fixed element between the nozzle 4 and the structure 5, and accommodate forces in an opposite direction in relation to the struts 1. Figure 5 shows the same embodiment as figure 4, seen from the front. The attachment part 3 is shown as a plate shaped body rigidly attached tohe structure 5 and the nozzle 4. The angle between the attachments 1', 1", 2', 2", 3', 3" and the struts 1 and the placement of the elements are clearly shown.

In figure 6 it is shown yet another alternative embodiment of the invention where a nozzle 4 is attached in a structure 5 via strut 1 with attachment point 1' in the nozzles 4 and 1" in the structure 5. Bolts 8 form along with two attachment parts 3 a hinged attachment of the upper part of the nozzle to the structure 5. Attachment point 2' is in this embodiment shown between a fixed element between the nozzle 4 and the structure 5, that takes up forces in pressure. In this case the bracket 2 only includes elements in the structure 5 and the nozzle 4 with opposing faces that can take up the pressure. The expression attachment point 2' can in this connection be a point that only is capable of taking up forces in pressure.

Figure 7 shows the same embodiment as figure 6, seen form the front. The attachment parts 3 are shown as bodies adapted to take up tension, rigidly attached in the structure 5 and the nozzle 4. The angle between the attachments 1', 1", 3', 3", the bracket 2 and the struts 1 and the placement of the elements are clearly shown.

In this discussion it has been used expressions such as pressure forces, pressure and the tension, to describe the main direction of the forces that are present during normal conditions of operation. This is meant to indicate conditions of the operation where the biasing is sufficient such that it is tension in the attachment part 3. This is what has been considered as normal conditions of operation. During unfavourable conditions of operation may of course the load on the nozzle 4 exceed the pretensioning force such that the load conditions are changed and such that for instance the bracket 2 is exposed to tension and the attachment part is exposed to pressure. However may also these directions deviate somewhat in relation to a pure tension and pure pressure. It is of course also imposed forces do to hydrodynamic conditions, gravitation, mechanical conditions etc. that must be taken up by the attachments.

Patent claims:

1. A system for attaching a propeller nozzle (4) to a structure (5) including a vessel or a part of a vessel, where the nozzle (4) surrounds a propeller that is supported in the structure (5), with at least one first attachment point (2') and at least one second attachment point (3') for attaching the nozzle to the structure, characterized in that:
the at least one first attachment point (2') is substantially adapted for accommodating pressure forces during normal operational conditions and are hinged to the structure (5);
the at least one second attachment point (3') is adapted for accommodating forces in tension when the first attachment point (2') takes up pressure forces and is hinged to the structure (5); and
at least one strut (1) for pretensioning is attached in at least one strut attachment point (1') on the nozzle (4), to take up forces in tension, extending between the nozzles (4) and the structure (5), such that when the strut is pretensioned, the first attachment point (2') takes up pressure forces and the second attachment point (3') takes up forces in tension.

2. The system according to claim 1, wherein the second attachment point (3') for attaching the nozzle includes an attachment part (3) extending between the nozzle (4) and the structure (5).

3. The system according to claim 1, wherein there are at least two first attachment points (2', 2") for taking up the pressure forces.

4. The system according to claim 3, wherein the nozzle (4) has a substantially circular cross section in a plane substantially parallel to a plane defined by the propeller, wherein the circular cross section has a center substantially coinciding with an axis of revolution for the propeller and such that the attachment points (1', 1", 2', 2", 3') can be placed in radial directions in relation to the axis of revolution of the propeller, and such that is formed angles (a, b, c) between the radii extending between the attachment points (1', 1", 2', 2", 3') and the axis

of revolution, wherein said radii between the at least two first attachment points (2', 2") for accommodating pressure forces and the axis of revolution is placed at each side of the radius between the axis of revolution and the second attachment point (3').

5. The system according to claim 4, wherein the are at least two struts (1) for taking up forces in tension, and these are attached to the nozzles (4) in two strut attachment points (1'), wherein the radii between these strut attachment points (1') and the axis of revolution forms an angle of approximately 120°.

6. The system according to claim 5, wherein the angles (b, c) between the radii for the strut attachment points (1') and the second attachment point (3') is approximately 120°C.

Fig.1.

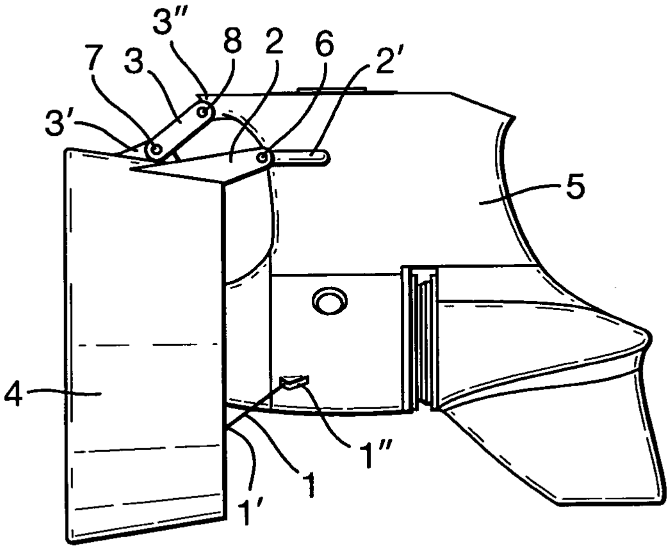


Fig.2.

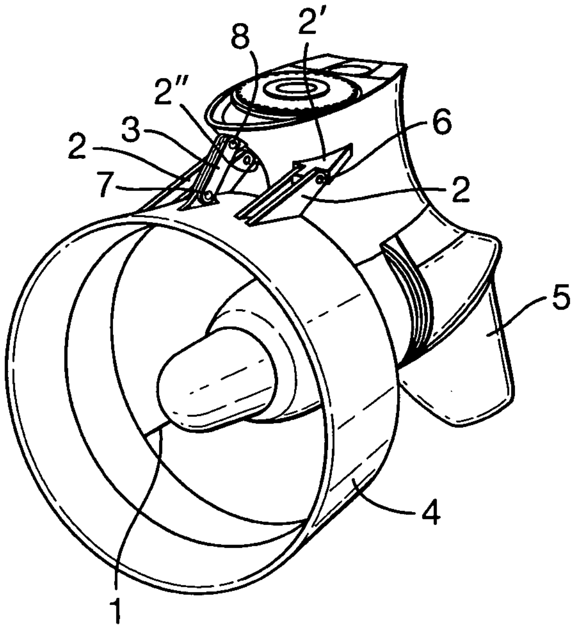


Fig.3.

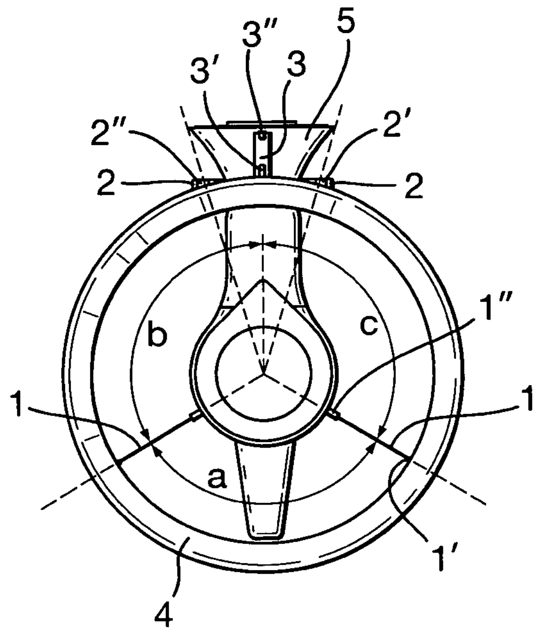


Fig.4.

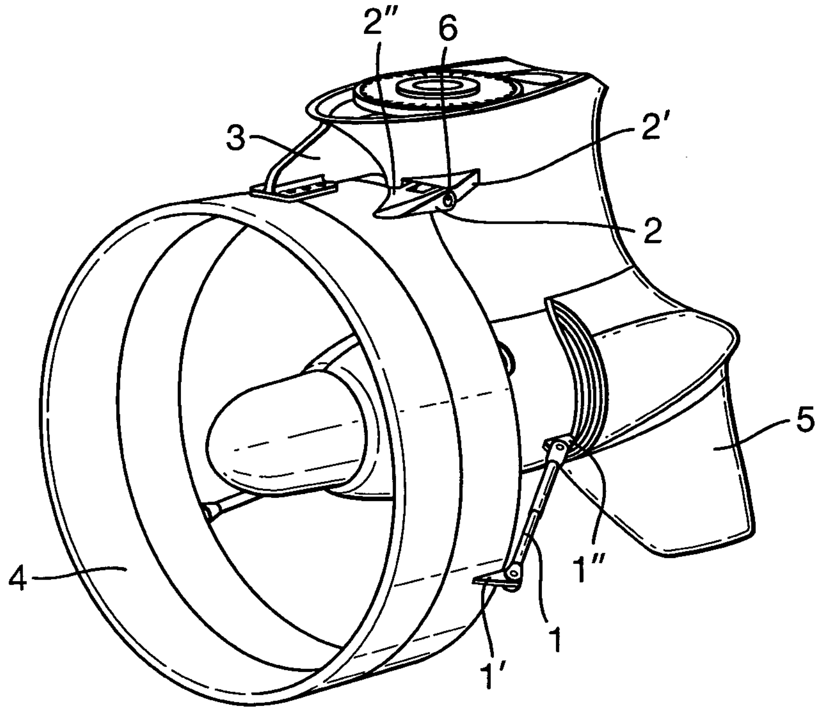


Fig.5.

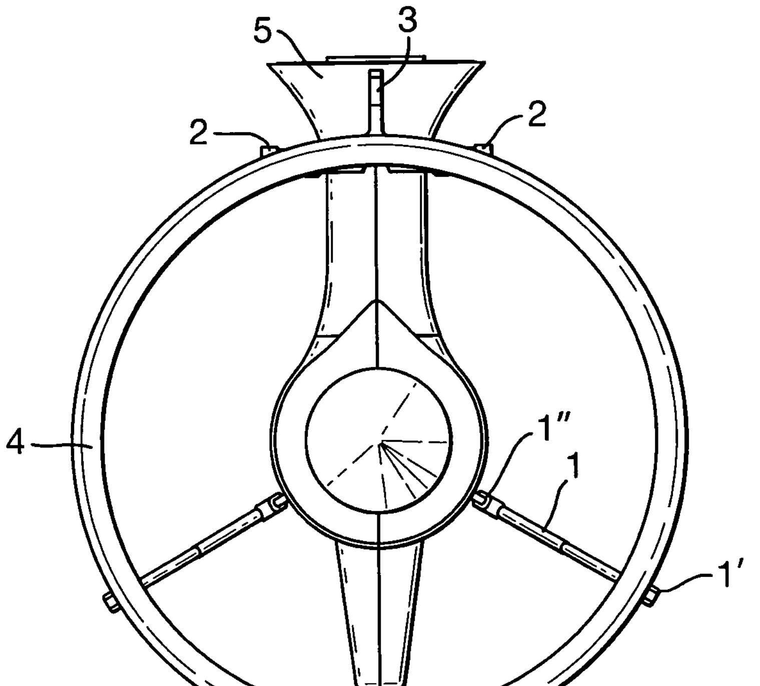


Fig.6.

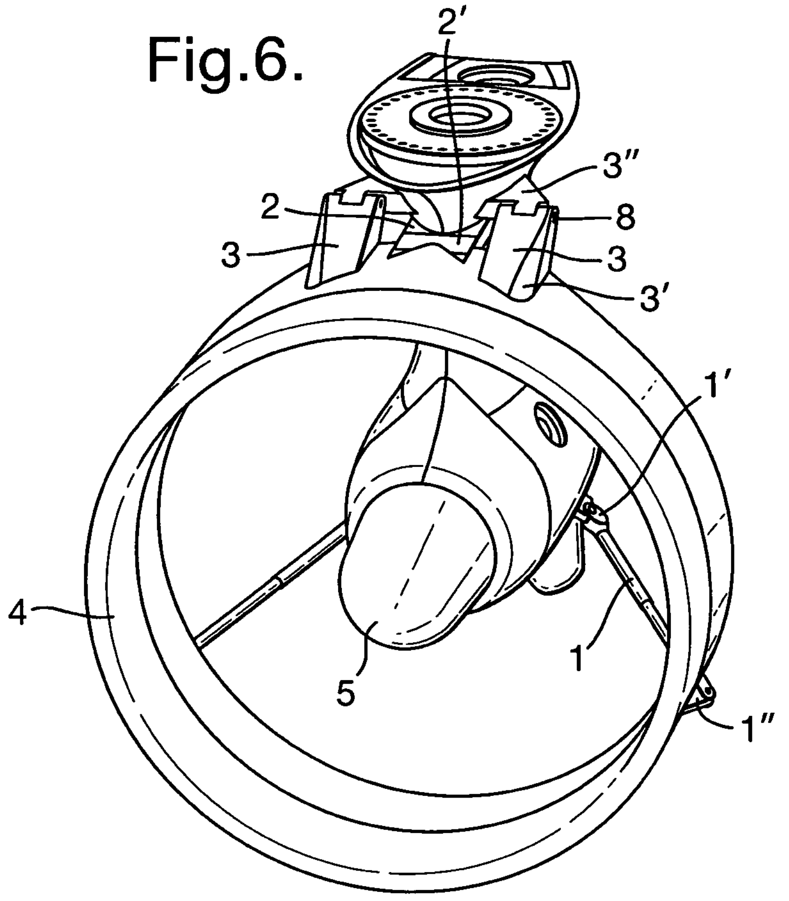
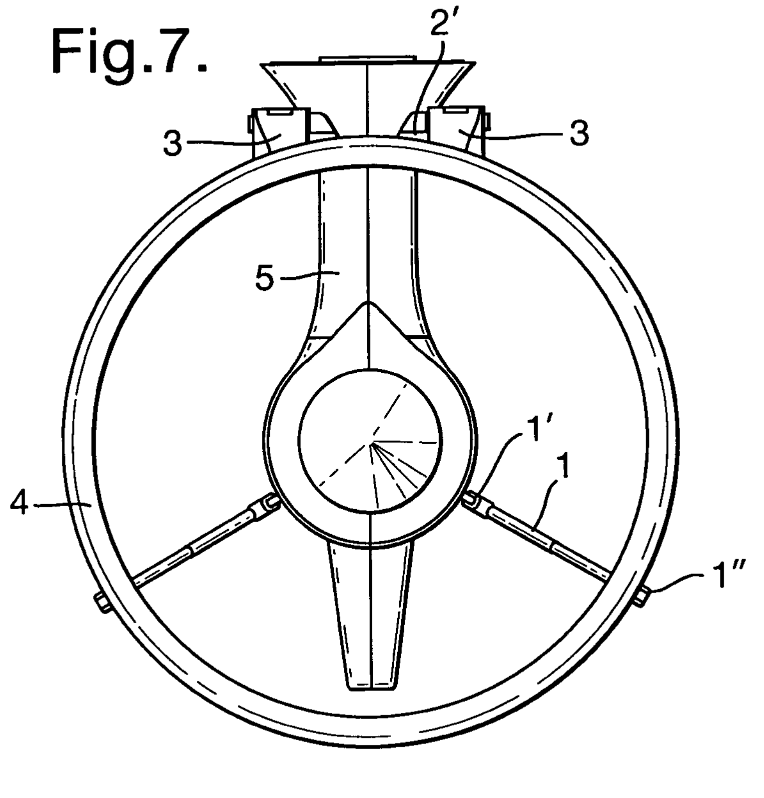


Fig.7.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2008/000180

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B63H

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5906522 A (HOOPER), 25 May 1999 (25.05.1999), figures 1-3, abstract --	1-6
A	US 20060166571 A1 (NORMAN ET AL), 27 July 2006 (27.07.2006), figure 8, paragraphs (0051),(0052) --	1-6
A	WO 02076822 A1 (ALLEN, ROBERT), 3 October 2002 (03.10.2002), page 4, line 22 - line 29, figure 2 -- --------	1-6

☐ Further documents are listed in the continuation of Box C. ☒ 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
15 Sept 2008	16 -09- 2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Erik Dahlblom / JA A Telephone No. +46 8 782 25 00

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Cited literature, if any, will be enclosed in paper form.

US	5906522	A	25/05/1999	NONE			
US	20060166571	A1	27/07/2006	AU	2006206204	A	27/07/2006
				CA	2595853	A	27/07/2006
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				NZ	529127	A	31/05/2007