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 The application is published incomplete as filed (Rule 68(1) EPC).

(54) **Propulsion device for a floating vessel**

(57) The invention relates to a propulsion device (1) for a floating vessel (2) such as a ship. The propulsion device (1) comprise a hub (3) to be rotated by a drive means (4) about an central axis of the hub (3), first blades (6) arranged at the hub (3) and extending radially outwards from the hub (3) so as to be rotated together with the hub (3) about the central axis, wherein each first blade

(6) terminating in an outer tip (7), and an annular nozzle member (8) that at least partly surrounds the first blades (6) and that is arranged concentrically with the hub (3). The annular nozzle member (8) is attached to the outer tip (7) of at least one first blade (6) so as to be rotated together with the hub (3) and the first blades (6) about the central axis.

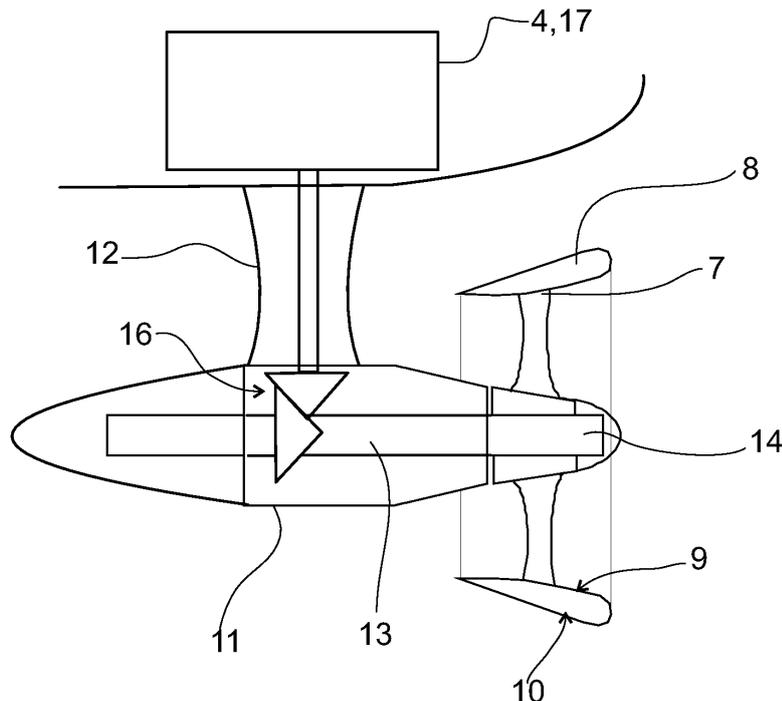


FIG 2

Description

Field of the invention

5 [0001] The invention relates to a propulsion device for a floating vessel such as a ship, said propulsion device comprising a hub to be rotated by a drive means about an central axis of the hub, first blades arranged at the hub and extending radially from the hub so as to be rotated together with the hub about the central axis of the hub, wherein each first blade terminating in an outer tip, and an annular nozzle member that surrounds the first blades and that is arranged concentrically with the hub as defined in the preamble of independent claim 1.

10 [0002] Two main types of propellers are used in propulsion devices: The first type is ducted propellers comprising a nozzle or Kort type shroud surrounding the propeller to increase thrust at low speeds. The second type is open propellers without a nozzle.

Objective of the invention

15 [0003] The object of the invention is to provide a new and inventive propulsion device.

Short description of the invention

20 [0004] The propulsion device for a floating vessel of the invention is characterized by the definitions of independent claim 1.

[0005] Preferred embodiments of the propulsion device are defined in the dependent claims.

[0006] The invention is based on attaching the annular nozzle member to the outer tip of at least one first blade so as to be rotated together with the hub and the first blades about the central axis of the hub.

25 [0007] In a preferred embodiment of the invention the annular nozzle member is attached to the outer tip of each first blade.

[0008] In a preferred embodiment of the propulsion device the annular nozzle member has an inner surface having an inner diameter that increases in one direction of the central rotation axis and an outer surface having an outer diameter that increases in the same direction of the central rotation axis as the inner diameter of the inner surface increases in.

30 [0009] In a preferred embodiment of the invention the propulsion device comprises a pod housing for attachment to the floating vessel such as to a hull of a ship. In this preferred embodiment the propulsion device includes a shaft for the attachment of the propulsion device to the floating vessel and possible also a turning device for turning the pod housing with respect to the floating vessel for example for steering the floating vessel. In this preferred embodiment a propeller shaft extends from the inside of the pod housing so that the propeller shaft has a propeller shaft portion outside the pod housing. In this preferred embodiment the hub is attached to the propeller shaft portion outside the pod housing. In this preferred embodiment the annular nozzle member is arranged so that the inner diameter of the inner surface of the annular nozzle member increases in the direction away from the pod housing and so that the outer diameter of the outer surface of the annular nozzle member increases in the direction away from the pod housing. In this preferred embodiment the pod housing comprises drive means may include at least one of the following: an electrical motor within the pod housing for rotating the propeller shaft, or a gearing arrangement for rotating the propeller shaft with a motor arranged outside the pod housing such as within a hull of a ship.

35 [0010] An advantage with a propulsion device according to the invention is that the annular nozzle member increase thrust at low speeds (bollard pull thrust) with approximately 30% corresponding to open propeller (same thrust with lower energy consumption).

40 [0011] Another advantage with a propulsion device according to the invention is also reduced pressure pulses to vessel hull from propeller tips.

[0012] In a propulsion device according to the invention, because the annular nozzle member is fastened to the outer tip of at least one first blade so as to be rotated together with the hub and the first blades about the central axis of the hub, thrust and efficiency are increased.

45 [0013] Another advantage that is achieved with a propulsion device the according to the invention is that tip vortex cavitation is also reduced or eliminated.

[0014] Another advantage that is achieved with a propulsion device the according to the invention is that vessel hull vibration created by tip vortex cavitation is also reduced or eliminated.

50 [0015] Another advantage that is achieved with a propulsion device the according to the invention is that the construction is made strong by supporting outer tips of the first blades by the annular nozzle member.

55 [0016] First blade thickness may be reduced compared to an open propeller or to a propeller surrounded by an annular nozzle member that is not fastened to the propeller and by reducing first blade thickness to increase propeller efficiency further.

[0017] Because the annular nozzle member is fastened to the outer tip of at least one first blade so as to be rotated together with the hub and the first blades about the central axis of the hub also supports and protects first blade tips of ice impacts (ice breaking applications), grounding, wires/ropes etc.

[0018] By attaching annular nozzle member to at least one outer tip of at least one first blade so as to be rotated together with the hub and the first blades about the central axis of the hub, no separate nozzle supporting structures are needed as in conventional ducted propellers and due to that also reduce resistance created by such separate nozzle supporting structures are eliminated and costs are reduced. This also leads to simple product management; no need for special design when nozzle needed.

List of figures

[0019] In the following the invention will be described in more detail by referring to the figures of which

Figure 1 shows a floating vessel in the form of a ship having a propulsion device according to an embodiment of the invention,

Figure 2 shows a propulsion device according to a first embodiment of the invention,

Figure 3 shows a propulsion device according to a second embodiment of the invention,

Figure 4 the embodiment shown in figure 3 as seen from one end,

Figure 5 shows a propulsion device according to a third embodiment of the invention,

Figure 6 shows a propulsion device according to a fourth embodiment of the invention,

Figure 7 the embodiment shown in figure 6 as seen from one end,

Figure 8 shows a propulsion device according to a fifth embodiment of the invention,

Figure 9 shows a propulsion device according to a sixth embodiment of the invention,

Figure 10 the embodiment shown in figure 9 as seen from one end, and

Figure 11 shows a propulsion device according to a seventh embodiment of the invention.

Detailed description of the invention

[0020] The invention relates to a propulsion device 1 for a floating vessel 2 such as a ship as shown in figure 1.

[0021] The propulsion device 1 comprises a hub 3 to be rotated by a drive means 4 about a central rotation axis A of the hub 3. The drive means 4 may for example be an electric motor or a combustion engine.

[0022] The hub 3 may comprise attachment means 5 for attaching the hub 3 to a propeller shaft 13 that is rotated by the drive means 4.

[0023] The propulsion device 1 comprises first blades 6 arranged at the hub 3 and extending radially from the hub 3 so as to be rotated together with the hub 3 about the central rotation axis A of the hub 3. Each first blade 6 terminates in an outer tip 7. The first blades 6 are preferably identical and evenly disposed with respect to the hub 3.

[0024] The propulsion device 1 comprises an annular nozzle member 8 that at least partly, preferably completely, surrounds the first blades 6 and that is arranged concentrically with the hub 3. The annular nozzle member 8 is attached to the outer tip 7 of at least one first blade 6 so as to be rotated together with the hub 3 and the first blades 6 about the central axis of the hub 3. The annular nozzle member 8 is preferably, but not necessarily, attached to the outer tip 7 of each first blade 6.

[0025] In a preferred embodiment of the propulsion device 1 the annular nozzle member 8 has an inner surface 9 having an inner diameter that increases in direction of the central rotation axis.

[0026] In a preferred embodiment of the propulsion device 1 the annular nozzle member 8 has an outer surface 10 having an outer diameter that increases in direction of the central rotation axis.

[0027] In a preferred embodiment of the propulsion device 1 the annular nozzle member 8 has an inner surface 9 having an inner diameter that increases in one direction of the central rotation axis and an outer surface 10 having an outer diameter that increases in the same direction of the central rotation axis as the inner diameter of the inner surface 9 increases in.

[0028] In a preferred embodiment of the propulsion device 1 the propulsion device 1 comprises a pod housing 11 for attachment to the floating vessel 2 such as to a hull of a ship. In this preferred embodiment the propulsion device 1 includes a shaft 12 for the attachment and possible also a turning device (not shown in the figures) for turning the pod housing 11 with respect to the floating vessel 2 for example for steering the floating vessel 2. In this preferred embodiment a propeller shaft 13 extends from the inside of the pod housing 11 so that the propeller shaft 13 has a propeller shaft portion 14 outside the pod housing 11. In this preferred embodiment the hub 3 is attached to the propeller shaft portion 14 outside the pod housing 11. In this preferred embodiment the annular nozzle member 8 is arranged so that the inner diameter of the inner surface 9 of the annular nozzle member 8 increases in the direction of the central rotation axis away from the pod housing 11 and so that the outer diameter of the outer surface 10 of the annular nozzle member 8

increases in the direction of the central rotation axis away from the pod housing 11. In this preferred embodiment the pod housing 11 comprises drive means 4 which may include at least one of the following: an electrical motor 15 within the pod housing 11 as shown in figures 5, 8, and 11 for rotating the propeller shaft 13, or a gearing arrangement 16 as shown in figure 2 for rotating the propeller shaft 13 with a motor 17 arranged outside the pod housing 11 such as within a hull of a ship.

[0029] The annular nozzle member 8 may have a cross-section configuration in the direction of the central rotation axis of the hub 3 of a NACA (National Advisory Committee for Aeronautics) Airfoil type such of NACA type 4415 or be a Kort Nozzle of 19A or of 37 of the MARIN series.

[0030] In an embodiment of the propulsion device the first blades 6 are arranged in the axial direction of the central rotation axis of the hub in a first series 18 of first blades 6 and in a second series 19 of first blades 6. In this embodiment the first series 18 of first blades 6 are arranged in the axial direction of the central rotation axis of the hub at a different location than the second series 19 of first blades 6. In this embodiment the first blades 6 in the first series 18 of first blades 6 are identical and are evenly disposed with respect to the hub. In this embodiment the first blades 6 in the second series 19 of first blades 6 are identical and are evenly disposed with respect to the hub. The first blades 6 in the first series 18 of first blades 6 have preferably, but not necessarily, a smaller pitch than the first blades 6 in the second series 19 of first blades 6.

[0031] In the embodiment of the propulsion device shown in figures 6 to 8 the number of first blades 6 in the first series 18 of first blades 6 is the same as the number of first blades 6 in the second series 19 of first blades 6, and the first blades 6 in the second series 19 of first blades 6 are phase shifted with respect to the first blades 6 in the first series 18 of first blades 6 with an angle of $\alpha/2$ about the central rotation axis of the hub, where

$$\alpha = 360 / \text{the number of first blades in the first series} \quad (1).$$

[0032] This means that if the number of first blades 6 in the first series 18 is 4 as is the situation in figures 6 to 8, α is $360/4$ i.e. 90. In this case the first blades 6 in the second series 19 of first blades 6 are phase shifted with respect to the first blades 6 in the first series 18 of first blades 6 with an angle of $90/2$, i.e. by 45 degrees.

[0033] In an embodiment of the propulsion device, such as in the embodiment shown in figures 9 to 11, second blades 20 are attached to the annular nozzle member 8 and extending radially inwards from the annular nozzle member 8 towards the central rotation axis of the hub so that each second blade has a free inner tip 21 that is unsupported by the hub. In this embodiment the second blades 20 are unsupported by the hub. In this embodiment of the propulsion device, the first blades 6 may be identical and be evenly disposed with respect to the hub, and the second blades 20 may be identical and may be evenly disposed with respect to the annular nozzle member.

[0034] In the embodiment of the propulsion device shown in figures 9 to 11, the first blades 6 and the second blades 20 are arranged in the axial direction of the central rotation axis of the hub in the same location. In the embodiment of the propulsion device shown in figures 8 and 9, the number of first blades 6 being the same as the number of second blades 20, and a space 22 is formed between two adjacent first blades 6, and a second blade is arranged in each space formed between two adjacent first blades 6.

[0035] In one preferred embodiment of the propulsion device 1 the hub 3, the first blades 6 and the annular nozzle member 8 is a one-piece part manufactured by casting. If the propulsion device 1 is provided with second blades 20, a such one-piece part may additionally comprise second blades 20.

[0036] In another preferred embodiment of the propulsion device 1 the annular nozzle member 8 is releasably attached to the outer tip 7 of at least one first blade 6 preferably so that the annular nozzle member 8 is releasably attached to the outer tip 7 of each first blade 6.

[0037] In another preferred embodiment of the propulsion device 1 at least one second blade is releasably attached to the annular nozzle member 8.

[0038] In still another preferred embodiment of the propulsion device 1 the annular nozzle member 8 is fixedly attached for example by welding to the outer tip 7 of at least one first blade 6 preferably so that the annular nozzle member 8 is fixedly attached to the outer tip of each first blade 6.

[0039] In another preferred embodiment of the propulsion device 1 at least one second blade is fixedly attached for example by welding to the annular nozzle member 8.

[0040] It is apparent to a person skilled in the art that as technology advances, the basic idea of the invention can be implemented in various ways. The invention and its embodiments are therefore not restricted to the above examples, but they may vary within the scope of the claims.

Claims

1. A propulsion device (1) for a floating vessel (2) such as a ship, said propulsion device (1) comprising a hub (3) to be rotated by a drive means (4) about a central axis of the hub (3),
5 first blades (6) arranged at the hub (3) and extending radially outwards from the hub (3) so as to be rotated together with the hub (3) about the central axis of the hub (3), wherein each first blade (6) terminating in an outer tip (7), and an annular nozzle member (8) that at least partly surrounds the first blades (6) and that is arranged concentrically with the hub (3),
10 **characterized**
by the annular nozzle member (8) being attached to the outer tip (7) of at least one first blade (6) so as to be rotated together with the hub (3) and the first blades (6) about the central axis of the hub (3).
2. The propulsion device (1) according to claim 1, **characterized by** the annular nozzle member (8) being attached to the outer tip (7) of each first blade (6).
15
3. The propulsion device (1) according to claim 1 or 2, **characterized by** the first blades (6) being identical and being evenly disposed with respect to the hub (3).
4. The propulsion device (1) according to any of the claims 1 to 3, **characterized by** the annular nozzle member (8) having an inner surface (9) having an inner diameter that increases in one direction of the central axis of the hub (3).
20
5. The propulsion device (1) according to any of the claims 1 to 4, **characterized by** the annular nozzle member (8) having an outer surface (10) having an outer diameter that increases in one direction of the central axis of the hub (3).
25
6. The propulsion device (1) according to any of the claims 1 to 5, **characterized**
by the propulsion device (1) comprising a pod housing (11) and a shaft (12) for attaching the pod housing (11) to the floating vessel (2),
30 by a propeller shaft (13) extending from the pod housing (11) so that the propeller shaft (13) has a shaft portion (14) outside the pod housing (11),
by the hub (3) being attached to the shaft portion (14) outside the pod housing (11), and by the pod housing (11) comprises drive means (4) for rotating the hub (3) so that the first blades (6) attached to the hub (3) and the annular nozzle member (8) attached to the outer tip (7) of at least one first blade (6) rotates together with the hub (3) about the central axis of the hub (3).
35
7. The propulsion device (1) according to claim 6, **characterized by** the inner diameter of the inner surface (9) of the annular nozzle member (8) increases in the direction of the central axis of the hub (3) away from the pod housing (11).
8. The propulsion device (1) according to claim 6 or 7, **characterized by** the outer diameter of the outer surface (10) of the annular nozzle member (8) increases in the direction of the central axis of the hub (3) away from the pod housing (11).
40
10. The propulsion device (1) according to any of the claims 7 to 9, **characterized by** the pod housing (11) comprising drive means (4) including at least one of the following: an electrical motor (15) within the pod housing (11) for rotating the propeller shaft (13), or a gearing arrangement (16) for rotating the propeller shaft (13) with a motor (17) arranged outside the pod housing (11) such as within a hull of a ship.
45
11. The propulsion device (1) according to any of the claims 1 to 10, **characterized**
50 **by** the first blades (6) being arranged in the axial direction of the central rotation axis of the hub in a first series (18) of first blades (6) and in a second series (19) of first blades (6),
by the first series (18) of first blades (6) being arranged in the axial direction of the central rotation axis of the hub at a different location than the second series (19) of first blades (6),
by the first blades (6) in the first series (18) of first blades (6) being identical and being evenly disposed with respect to the hub, and
55 by the first blades (6) in the second series (19) of first blades (6) being identical and being evenly disposed with respect to the hub.

5 12. The propulsion device (1) according to claims 11, **characterized**
by the number of first blades (6) in the first series (18) of first blades (6) being the same as the number of first blades
(6) in the second series (19) of first blades (6), and
by the first blades (6) in the second series (19) of first blades (6) being phase shifted with respect to the first blades
(6) in the first series (18) of first blades (6) with an angle of $\alpha/2$ about the central rotation axis of the hub, where

$$\alpha = 360 / \text{the number of first blades in the first series} \quad (1).$$

10 13. The propulsion device (1) according to any of the claims 1 to 10, **characterized**
by second blades (20) attached to the annular nozzle member (8) and extending radially inwards from the annular
nozzle member (8) towards the central rotation axis of the hub so that each second blade has an free inner tip (21)
that is unsupported by the hub (3), and
15 by the second blades (20) being unsupported by the hub.

14. The propulsion device (1) according to claim 13, **characterized**
by the first blades (6) being identical and being evenly disposed with respect to the hub, and
by the second blades (20) being identical and being evenly disposed with respect to the annular nozzle member.

20 15. The propulsion device (1) according to claim 13 or 14, **characterized**
by the first blades (6) and the second blades (20) being arranged in the axial direction of the central rotation axis
of the hub in the same location,
by the number of first blades (6) being the same as the number of second blades (20), by a space being formed
between two adjacent first blades (6), and
25 by a second blade being arranged in each space formed between two adjacent first blades (6).

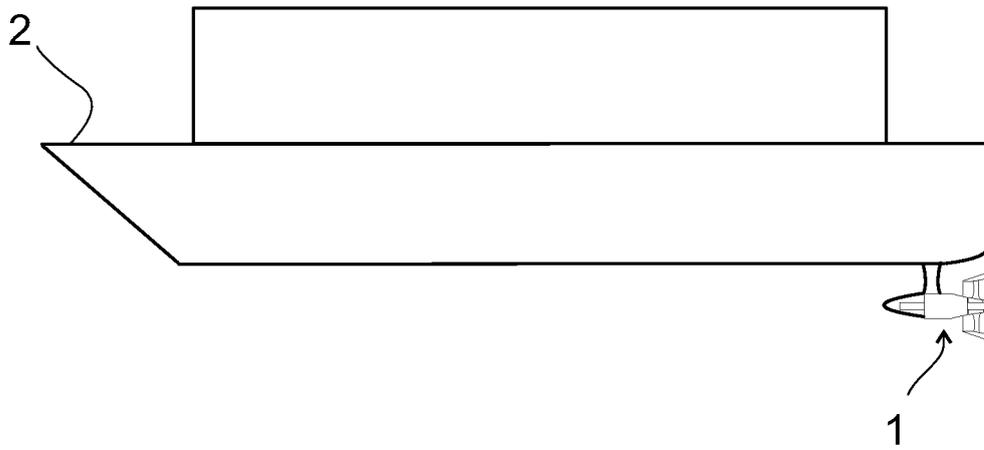


FIG 1

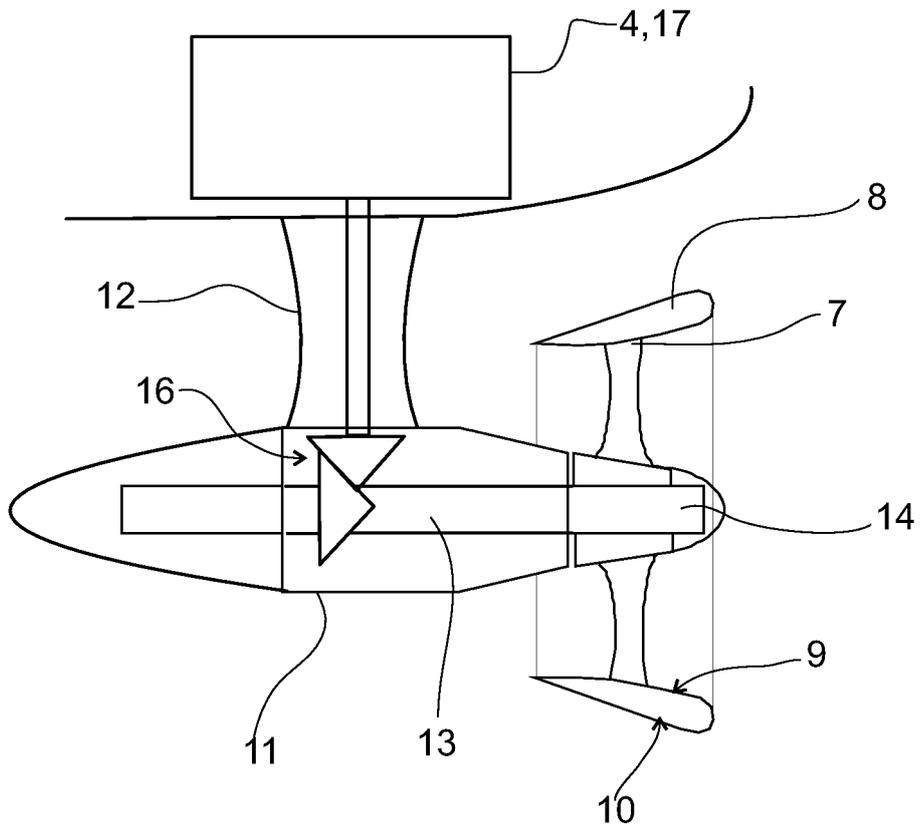


FIG 2

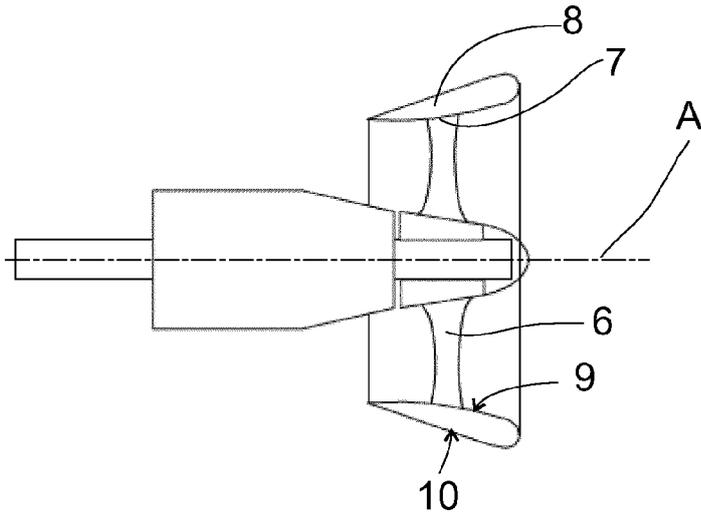


FIG 3

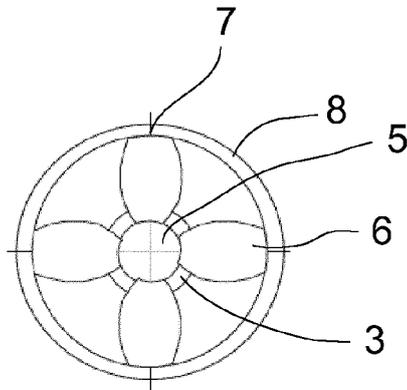


FIG 4

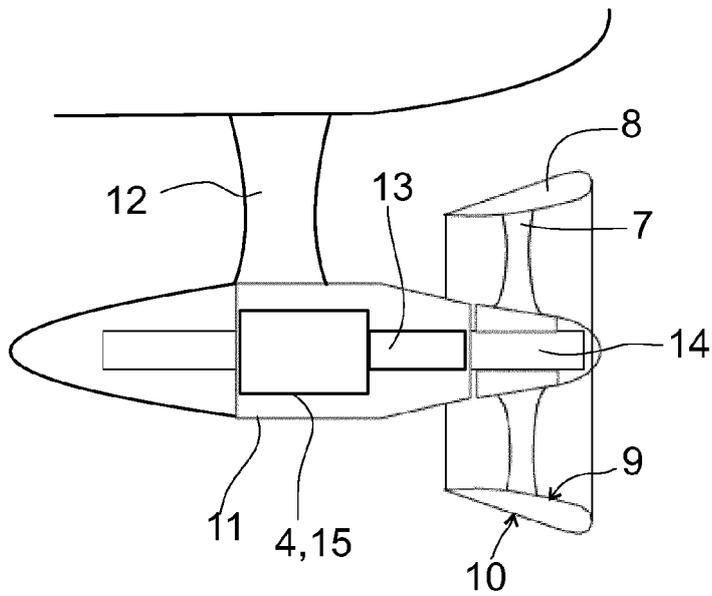


FIG 5

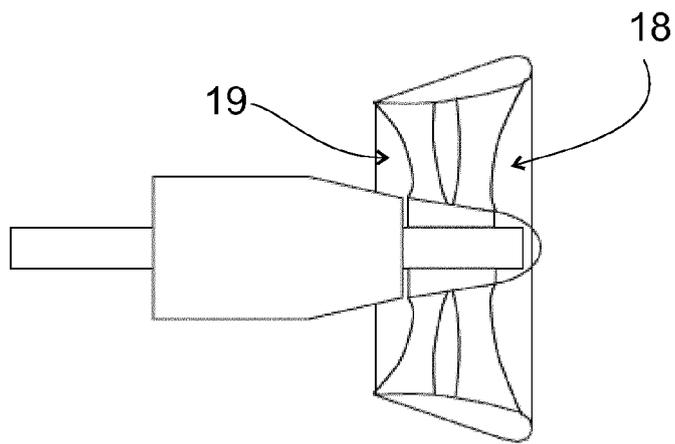


FIG 6

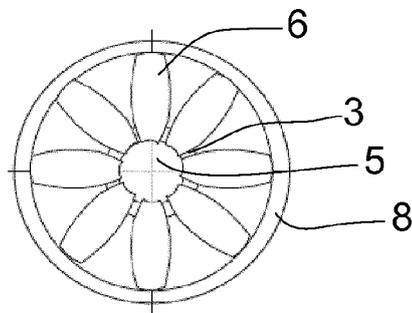


FIG 7

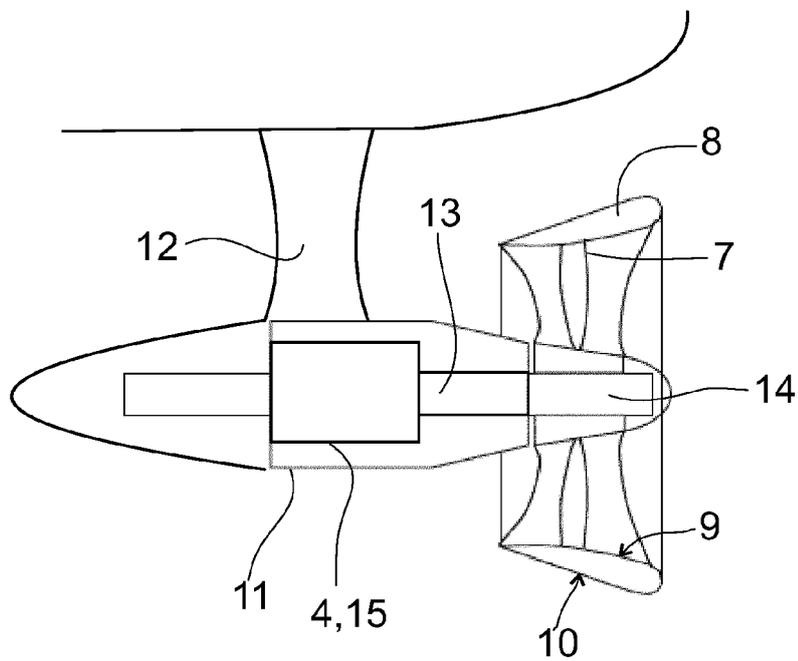


FIG 8

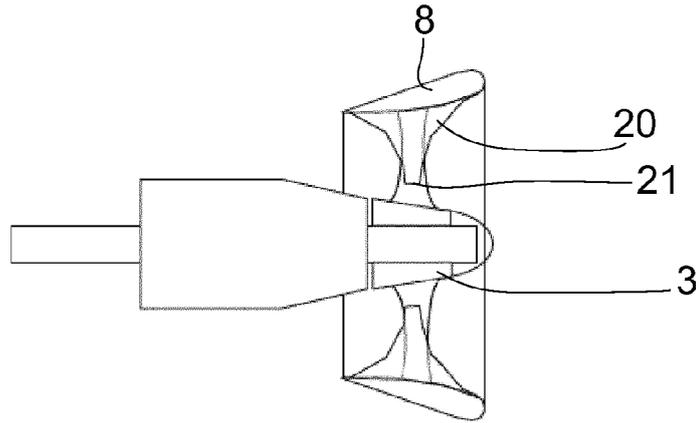


FIG 9

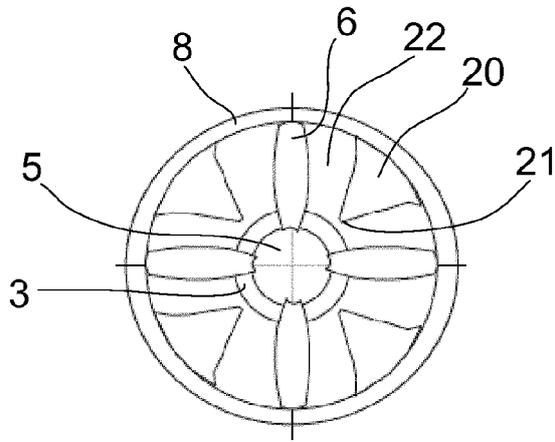


FIG 10

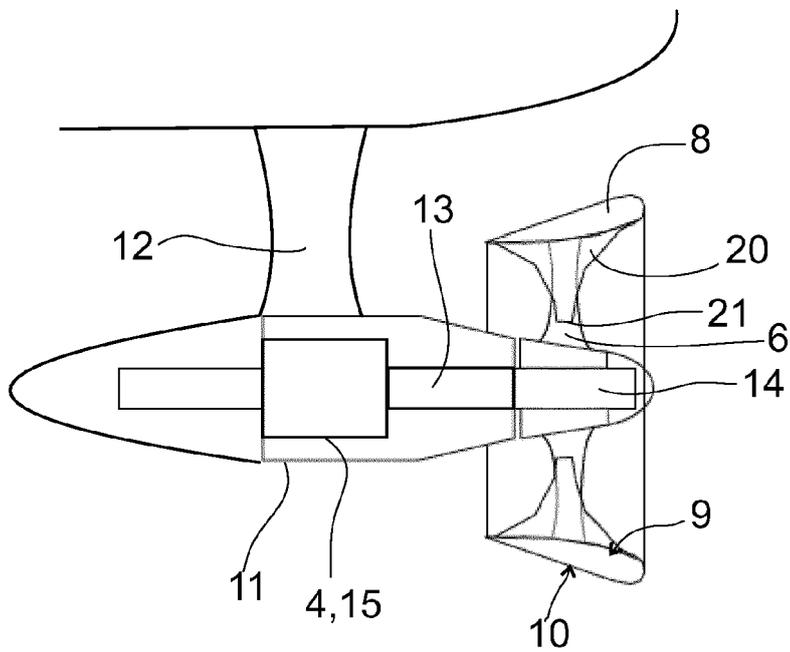


FIG 11



EUROPEAN SEARCH REPORT

Application Number
EP 12 18 4446

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 931 085 A (CAV LTD) 10 July 1963 (1963-07-10) * page 1, lines 37-43; figures *	1-4,6	INV. B63H1/16
X	US 3 826 591 A (WILSON E) 30 July 1974 (1974-07-30) * abstract; figures 1-5 *	1-8,10	
X	GB 2 440 400 A (ROLLS ROYCE PLC [GB]) 30 January 2008 (2008-01-30) * page 8, line 17 - page 9, line 21; figures 1-4 *	1-3,6,10	
A	WO 02/102659 A1 (ABB OY [FI]; YLITALO JARI [FI]) 27 December 2002 (2002-12-27) * abstract; figures *	6,10	
-----			TECHNICAL FIELDS SEARCHED (IPC)
			B63H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 February 2013	Examiner Vermeulen, Tom
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	

1
EPO FORM 1503 03/82 (P04/C01)



Application Number

EP 12 18 4446

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

- Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):
- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:
- 1-10
- The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 12 18 4446

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-10

A propulsion device comprising a propeller having an annular nozzle member attached to the tip of the blades for rotation therewith. The aim is to arrange the nozzle member in a specific manner with respect to the drive pod of the propulsion device for improved fluid flow.

2. claims: 1, 11, 12

A propulsion device comprising a propeller having an annular nozzle member attached to the tip of the blades for rotation therewith, wherein a second series of blades is provided at a different axial location. Aim is to increase the efficiency of the propeller.

3. claims: 1, 13-15

A propulsion device comprising a propeller having an annular nozzle member attached to the tip of the blades for rotation therewith, wherein second blades with a free inner tip extend radially inwards from the nozzle member towards the hub. Aim is to increase the efficiency of the propeller.

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

EP 12 18 4446

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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28-02-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 931085	A	10-07-1963	NONE

US 3826591	A	30-07-1974	NONE

GB 2440400	A	30-01-2008	NONE

WO 02102659	A1	27-12-2002	AT 354514 T 15-03-2007
		CN 1543414 A	03-11-2004
		DE 60126839 T2	25-10-2007
		DK 1395486 T3	04-06-2007
		EP 1395486 A1	10-03-2004
		ES 2278756 T3	16-08-2007
		JP 4656837 B2	23-03-2011
		JP 2004532159 A	21-10-2004
		US 2004214484 A1	28-10-2004
		WO 02102659 A1	27-12-2002
