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(54) **A PROPULSION ASSEMBLY FOR A MARINE VESSEL**

ANTRIEBSANORDNUNG FÜR EIN WASSERFAHRZEUG

ENSEMBLE DE PROPULSION POUR UN NAVIRE MARIN

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(56) References cited:
EP-B1- 0 306 642 DE-A1- 102011 055 998
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Description

Technical field

[0001] The present invention relates to a propulsion assembly for a marine vessel according to the preamble of claim 1.

Background art

[0002] Marine vessels use various propulsion systems or units. The main propulsion unit or units is/are normally arranged in the aft part of the ship. In addition to such main propulsion units a marine vessel usually requires separate steering thrusters for facilitating safe and efficient port manoeuvring. Steering thrusters are generally of fixed or azimuthing type. Fixed thruster is arranged to a thruster duct running transversely from one side of the vessel hull to the opposite side. Thus the fixed thruster is capable of producing sideways force to the ship. Steerable azimuthing thruster is supported vertically rotatable in respect to the hull and is therefore capable of steering the vessel towards any selected direction.

[0003] Publication EP0306642B1 discloses a transverse thruster which consists of a transverse-thrust passage, formed in the hull and consisting of a tunnel tube, and a transmission housing arranged in this transverse-thrust passage and having a propeller. EP0306642B1 teaches to provide air-discharge openings formed in or at the wall of the tunnel tube at its both ends. An aim of the solution is to reduce noise during start-up. The air-discharge openings are connected to an air compressor via at least one air-supply tube and are of appropriate size for forming a finely distributed air flow.

[0004] EP3009342A1 discloses an electric transverse tunnel thruster which is driven by motor arranged to rim of the propeller. The thruster comprises a cylindrical housing, which is open at both sides in its axial direction, a thruster body disposed inside the cylindrical housing and a pair of fairing ducts which are removably mounted to respective side surfaces of the thruster body inside the housing. The thruster body includes an annular stator, an annular rotor disposed inside the stator and a propeller blade provided on an inner peripheral surface of the rotor.

[0005] WO2018193149A1 discloses a thruster in which a nozzle duct is arranged around a propeller of the thruster. The nozzle duct is supported to hub of the thruster by means of vanes extending inwards in a duct. There is a rim drive electric motor used to drive the propeller. The rim drive electric motor comprises a rotor rim and a stator. The rotor rim is arranged on the outer perimeter of the propeller i.e. on the outer tips of the propeller blades. The rotor rim rotates in an annular groove extending radially outwards from an inner surface of the nozzle. Z Document DE 10 2011 055998 A1 and US 5 607 329 A also disclose a thruster in which a nozzle duct is arranged around a propeller of the thruster.

[0006] Although these may be advantageous as such,

there is still a need for improvements in operation of a propulsion assembly for a marine vessel. Particularly, it is an object of the invention to improve efficiency and reduce noise level of such assembly.

Disclosure of the Invention

[0007] Objects of the invention can be met substantially as is disclosed in the independent claims and in the other claims describing more details of different embodiments of the invention.

[0008] A propulsion assembly for a marine vessel according to an embodiment of the invention comprises

- a body comprising a duct having a longitudinal axis, and a first end and a second end,
- a support structure for a propeller comprising a propeller shaft at a centre line of the duct,
- a propeller, positioned into the duct and being attached to the propeller shaft, wherein the propeller comprising at least three blades and a boss which is supported to the shaft, and further a circular rim to which radial ends of the propeller blades are attached, wherein
- a circumferential slot is provided, opening inside the duct between the first end and the second end, into which slot the circular rim is arranged to extend radially, and further at least one gas inlet arranged to open into the slot.

[0009] By means of the gas inlet, gas, preferably air is introduced such that a layer of air is maintained between the duct and the circular rim in the slot. The layer of air provides advantageous effects such as minimizing frictional resistance of the outer wall of the rim as well as noise dampening.

[0010] According to an embodiment of the invention a space is arranged radially between a bottom of the slot and outer surface of the rim, and that the at least one gas inlet is arranged to open into the space.

[0011] According to an embodiment of the invention one gas inlet is arranged to open into the space at its lowermost position.

[0012] According to an embodiment of the invention the slot is formed to the body as an indent from the level of the inner wall of the duct.

[0013] According to an embodiment of the invention the slot is formed to the body as a radially inward extending circumferential projections provided with the circumferential slot.

[0014] According to an embodiment of the invention the projection comprises a first fairing at a first side of the propeller and a second fairing at a second side of the propeller having the slot between the fairings.

[0015] According to an embodiment of the invention the projection comprises a first axial end and a second axial end. The outer diameter of the projection at the first end and at the second end is substantially the same, and

equal to the inner diameter of the duct. The inner diameter of the projection is substantially equal to the inner diameter of the duct at the first axial end, and the inner diameter of the projection at its second axial end is less than outer diameter of the circular rim.

[0016] According to an embodiment of the invention the assembly comprises at least four gas inlets arranged to open into the slot.

[0017] According to an embodiment of the invention the assembly comprises 1 - 4 gas inlets arranged to open into the slot.

[0018] According to an embodiment of the invention the assembly comprises evenly distributed gas inlets, having an angle of 5 - 30 degrees between the gas inlets.

[0019] According to an embodiment of the invention the assembly comprises a circumferentially extending gas plenum in connection with the body provided with plurality of substantially evenly distributed gas inlets arranged to open into the slot.

[0020] According to an embodiment of the invention the gas plenum circumscribes the duct.

[0021] According to an embodiment of the invention the propeller shaft is a driven shaft. The propeller shaft may be driven by a bevel gear connection, or by an electric motor driving the shaft directly.

[0022] According to an embodiment of the invention the propeller shaft is a non-driven shaft.

[0023] According to an embodiment of the invention propeller is provided with a rim drive.

[0024] According to an embodiment of the invention propeller is provided with a mechanical rim drive.

[0025] According to an embodiment of the invention propeller is provided with an electric motor wherein the rim comprises a rotor part of the motor and the body of the duct is provided with a stator part of the motor.

[0026] According to an embodiment of the invention the propulsion assembly is a transverse tunnel thruster, wherein the duct of the propulsion assembly is a straight tube.

[0027] According to an embodiment of the invention the propulsion assembly is a shaft line propulsion system, wherein the body of the duct of the propulsion assembly is rigidly attached to a hull of a vessel and the shaft extends via a stern tube through the hull of the vessel.

[0028] According to an embodiment of the invention the propulsion assembly is a steerable azimuthing thruster wherein the body comprises a nozzle duct and the boss of the propeller is connected to the shaft in a support structure, the support structure extending radially from the boss for coupling the azimuthing thruster to a vessel in rotatably manner.

[0029] A transverse tunnel thruster for a marine vessel according to an embodiment of the invention comprises

- a body comprising a duct having a longitudinal axis, and a first end and a second end,
- a support structure for a propeller comprising a pro-

PELLER shaft at a centre line of the duct,

- a propeller, positioned into the duct and being attached to the propeller shaft, wherein the propeller comprising at least three blades and a boss which is supported to the shaft, and further a circular rim to which radial ends of the propeller blades are attached, wherein
- a circumferential slot is provided, opening inside the duct between the first end and the second end, into which slot the circular rim is arranged to extend radially, and further
- at least one gas inlet arranged to open into the slot, wherein the duct of the transverse tunnel thruster comprises a straight tube.

[0030] A steerable azimuthing thruster for a marine vessel according to an embodiment of the invention comprises

- a body comprising a duct having a longitudinal axis, and a first end and a second end,
- a support structure for a propeller comprising a propeller shaft at a centre line of the duct,
- a propeller, positioned into the duct and being attached to the propeller shaft, wherein the propeller comprising at least three blades and a boss which is supported to the shaft, and further a circular rim to which radial ends of the propeller blades are attached, wherein
- a circumferential slot is provided, opening inside the duct between the first end and the second end, into which slot the circular rim is arranged to extend radially, and further
- at least one gas inlet arranged to open into the slot, and wherein the body comprises a nozzle tube and the boss of the propeller is connected to the shaft in a support structure, the support structure extending radially from the shaft for coupling the azimuthing thruster to a vessel in rotatably manner.

[0031] By means of the invention the propeller can be designed to be highly loaded at tips of the blades, which improves efficiency of the propeller and can enable also smaller diameter of tunnel. This has positive impact on total cost and less vessel resistance, which in turn results in fuel savings.

[0032] The exemplary embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" is used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated. The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims.

Brief Description of Drawings

[0033] In the following, the invention will be described with reference to the accompanying exemplary, schematic drawings, in which

Figure 1 illustrates a propulsion assembly for a marine vessel according to an embodiment of the invention,

Figure 2 illustrates a sectional view II - II in the Figure 1,

Figure 3 illustrates a detail of a propulsion assembly for a marine vessel according to an embodiment of the invention,

Figure 4 illustrates a propulsion assembly for a marine vessel according to another embodiment of the invention,

Figure 5 illustrates a sectional view of the propulsion assembly according to an embodiment of the invention,

Figure 6 illustrates a sectional view of the propulsion assembly according to another embodiment of the invention,

Figure 7 illustrates a sectional view of the propulsion assembly according to still another embodiment of the invention, and

Figure 8 illustrates a propulsion assembly for a marine vessel according to another embodiment of the invention, and

Figure 9 illustrates a propulsion assembly for a marine vessel according to still another embodiment of the invention.

Detailed Description of Drawings

[0034] Figure 1 depicts schematically a water submersible propulsion assembly 10 for a marine vessel 1 according to an embodiment of the invention. The propulsion assembly is a thruster assembly and it comprises a body 12, which in turn comprises a duct 20 for water to flow through the body for generating thrust. The duct may be referred to as a tube or a tunnel. The duct 20 has a longitudinal axis L, and a first end 20.1 and a second end 20.2. More precisely, the thruster assembly in the figure 1 is a transverse tunnel thruster, in which case the duct 20 is a straight tube having a first diameter D1. The duct 20 may also be referred to as a tunnel. The transverse tunnel thruster is installed rigidly to a hull of the vessel, typically inside the hull, such the first end 20.1 and the second end 20.2 open into the surrounding water at opposite sides of

the hull, i.e. it is installed transversely to the longitudinal direction of the vessel. The thruster assembly 10 comprises a propeller 16 and a support structure 14 for the propeller 16. The support structure comprises a propeller shaft 18 arranged at a centre line L of the duct, to which propeller shaft 18 the propeller 16 is attached to. The propeller shaft may be driven or non-driven depending on the actual practical solution.

[0035] The propeller 16 comprises at least three blades 22 and a boss 24 which is supported to the shaft 18. The propeller further comprises a circular rim 26 attached the radial ends 22' of the propeller blades 22, and vice versa. The rim 26 is illustrated in the figure 1 as a cylindrical rim part having an axial length shorter than the propeller boss 24. The rim has a radially outer surface which has a second diameter D2. The second diameter is less than the first diameter D1 such that the propeller with the rim 26 can be easily assembled to and disassembled from the shaft 18. The rim is parallel to the boss 24 having equal radiuses at its axial ends. The rim reduces tip vortices created by the propeller, decreases noise generation and also improves efficiency of the thruster.

[0036] The assembly 10 is provided with a circumferential slot 28 at its inner surface such that the circular rim 26 extends at least partly into the slot 28 in radial direction. The circumferential slot 28 opens inside the duct 20 between the first 20.1 end and the second end 20.2 of the duct. The slot 28 has substantially radially extending side walls 28'. Respectively, the circular rim 26 has substantially radially extending side walls 26', the side walls of the slot and the rim being at least part radially overlapping. This way the radially extending side walls 26', 28' form a radial gap between the slot 28 and the circular rim 26.

[0037] There is at least one gas inlet 30 arranged to open into the slot 28. There is a space arranged radially between a bottom of the slot and outer surface of the rim, and that the at least one gas inlet is arranged to open into the space. By means of the gas inlet, gas, preferably air is introduced such that a layer of air is maintained between the duct 20 and the circular rim 26 in the slot 28. The layer of air provides advantageous effects such as noise dampening as well as minimizing frictional resistance of the outer wall of the rim 26.

[0038] There is a space arranged radially between a bottom of the slot 28 and radially outer surface of the rim 26, wherein the at least one gas inlet 30 is arranged to open into the thus formed space. The gas inlet may be arranged to a bottom wall of the slot 28.

[0039] In the embodiment shown in the figure 1 the slot 28 is formed to the duct 20 by means of two radially inward extending circumferential projections 32, which are arranged such that first one of the projections 32 is axially on a first side of the rim 26 and the second one of the projections 32 is arranged axially on a second side of the rim 26. The projections are ring-like parts, optionally formed of several segments. The projections 32 are releasably assembled to the duct 20 so that the propeller with the rim 26 can be easily assembled to and disas-

sembled from the shaft 18. The propeller and the projections are installed so that firstly the projection 32 behind (as seen from the first end 20.1. of the duct, or on the side of the support structure 14) the propeller is installed and attached to the duct 20, next the propeller is attached to the shaft 18 and after that the projection 32 in front of the propeller 16, seen from the first end 20.1 of the duct. The projection 32 is a circular part, or an assembly of circular segments having a cylindrical outer surface. Its radially inner surface provides smooth change of inner diameter between the first axial end and second axial end of the projection 32.

[0040] The projections are formed so as to provide a first fairing at a first side of the propeller 24 and a second fairing at a second side of the propeller 26. This way, even if the outer diameter, the second diameter D2, of the rim is smaller than the inner diameter of the duct 20, the first diameter D1, efficiency of the propeller is maintained at good level thanks to the radial projections 32 on both sides of the rim 26. When the slot is arranged between the projection parts having fairings on a side in contact with the water flow when in use, the hydrodynamical efficiency is improved. The fairing smoothly bridges the radial gap/step between the duct inner surface and the rim inner surface that has smaller diameter. The projection 32 has a first axial end and a second axial end. Its inner diameter is substantially equal to the first diameter D1 at the first axial end. The outer diameter of the projection 32 is substantially equal at its first and second ends. Inner diameter of the projection 32 at its second axial end is less than the second diameter D2.

[0041] The projections are made as a removable assembly of at least two parts to enable installation and removal of the propeller.

[0042] As it becomes clear from the figure 2, which shows an embodiment of the sectional view II-II of the figure 1, the assembly comprises multiple gas inlets 30 in the wall of the duct 20 opening into the slot 28. The assembly 10 comprises evenly distributed gas inlets 30 in the duct 20, having an angle A of 5 - 30 degrees between two adjacent gas inlets 30. The assembly 10 comprises a circumferentially extending gas plenum 42 in connection with the body 12 which is provided with plurality of substantially evenly distributed gas inlets 30 arranged to open into the slot 28 inside the duct 20. As is depicted in the figure 2 the gas plenum advantageously circumscribes the body 12 outside the duct 20. The plenum 42 and the gas inlets 30 are connected to a source of pressurized air 38 by means of a pipe 40 and a control valve system 43 arranged between the source of pressurized air 38 and the plenum 42.

[0043] Depending on the case the propeller shaft maybe a driven shaft, which means that the shaft is attached to the propeller such that torque and axial thrust can be transmitted from the propeller to the shaft. Also, the shaft is also coupled to a prime mover, such as an electric or hydraulic motor.

[0044] The propeller shaft may be a non-driven, which

means that the shaft is attached to the propeller such that axial thrust can be transmitted from the propeller to the shaft. In such a case the propeller may be provided with a rim drive and be rim driven e.g. driven by an electric motor 31, having a rotor part arranged to the rim and a stator part to the body. This particular feature is depicted in the figure 3 which schematically shows a detail where the rotor part 34 is in connection with the rim 26 and the stator part 36 in connection with the body 12. The propeller may also be mechanically drive by suitable gear system or a belt or a chain drive. Also hydraulic or pneumatic force transmission via the rim of the propeller is feasible alternative to operate the thruster.

[0045] Figure 4 depicts schematically a water submersible thruster assembly 10 for a marine vessel according to an embodiment of the invention. The thruster assembly comprises a body 12, which in turn comprises a duct 20 for water to flow through the body for generating thrust. The duct 20 has a longitudinal axis, and a first end 20.1 and a second end 20.2. More precisely, the thruster assembly in the figure 4 is a steerable azimuthing thruster, in which case the duct 20 is a nozzle duct. The boss 24 of the propeller is connected to a support structure 14 extending radially from boss for coupling the steerable azimuthing thruster to a vessel 1 in manner rotatably around a vertical axis as depicted by the arrow A. The thruster assembly 10 comprises a propeller 16 and a support structure 14 for the propeller 16.

[0046] In the figure 4 the slot is formed to the body as an indent from the general level of the inner wall of the duct. In other words, in this embodiment the radially inner wall of the rim is substantially flush with the wall of the duct 20. The plenum 42 and the gas inlets 30 are connected to a source of pressurized air 38 by means of a pipe 40 and a control valve system 43 arranged between the source of pressurized air 38 and the plenum 42. Practically the functionalities of the introduction of gas in the embodiment of the figure 4 correspond to that of the figure 1 and at least their main features are totally interchangeable.

[0047] Figure 5 discloses an embodiment of the invention as a sectional view at the location of the section II-II in the figure 1. The assembly 10 comprises one gas inlet 30 in the duct 20, which is positioned to open into the slot 26 at its lowermost position. The gas inlet 30 is connected to a source of pressurized air 38 by means of a pipe 40 and a control valve system 43 arranged between the source of pressurized air 38 and the inlet 30. This is the most straightforward manner of realizing the introduction of the pressurized air into the slot.

[0048] Figure 6 discloses an embodiment of the invention as a sectional view at the location of the section II-II in the figure 1. The assembly 10 comprises three gas inlets 30 in the duct 20, one of which is positioned to open into the slot 26 at its lowermost position and to other equally distributed to the rim of the duct. The gas inlets 30 are each connected to a common source of pressurized air 38 by means of a pipe 40 and a control valve system 43 arranged between the source of pressurized air 38 and

inlet. This is the most straightforward manner of realizing the introduction of the pressurized air into the slot with improved distribution of gas introduction compared to the embodiment of the figure 5.

[0049] Figure 7 discloses an embodiment of the invention as a sectional view at the location of the section II-II in the figure 1. The assembly 10 comprises four gas inlets 30 in the duct 20, one of which is positioned to open into the slot 26 at its lowermost position and to other equally distributed to the rim of the duct. The gas inlets 30 are each connected to a common source of pressurized air 38 by means of a pipe 40 and a control valve system 43 arranged between the source of pressurized air 38 and inlet. This is the most straightforward manner of realizing the introduction of the pressurized air into the slot with improved distribution of gas introduction compared to the embodiment of the figure 6. Should the practical application need more than four gas inlets 30, the embodiment shown in the figure 2 is believed to be the most feasible way of obtaining the air distribution into the slot.

[0050] Figure 8 depicts schematically a water submersible thruster assembly 10 for a marine vessel 1 according to an embodiment of the invention. The thruster assembly comprises a duct 20 for water to flow through the body for generating thrust. The duct 20 has a longitudinal axis L, and a first end 20.1 and a second end 20.2. The duct 20 is a straight tube having a first diameter D1 at its second end 20.2, while the first end of the duct has smaller diameter than the first diameter. The rim 26 is illustrated in the figure 8 as a cylinder having an axial length shorter than the propeller boss 24. The rim has a radially outer surface which has a second diameter D2. The second diameter is less than the first diameter D1 such that the propeller with the rim 26 can be easily assembled to and disassembled from the shaft 18 via the second end of the duct 20.

[0051] In the embodiment shown in the figure 8 the slot 28 is formed to the duct 20 by means of two radially inward extending circumferential projections 32, which are arranged such that first one of the projections 32 is axially on a first side of the rim 26 and the second one of the projections 32 is arranged axially on a second side of the rim 26.

[0052] It is notable that due to decreasing of the diameter of the duct in front of the propeller 22 the projection 32 is flush with the inner wall of the duct, at the axial end of the projection farthest from the propeller. The projections are made as a removable assembly of at least two parts to enable installation and removal of the propeller. In other respect the embodiment of the figure 8 corresponds to the embodiment of the figure 1.

[0053] Figure 9 depicts schematically a propulsion assembly 10 for a marine vessel according to an embodiment of the invention. The propulsion assembly 10 is a shaft line propulsion system, wherein the body 12 of the duct 20 of the propulsion assembly is rigidly attached to a hull of a vessel 1 and the shaft 18 extends via a stern tube through the hull of the vessel 1. The operation and

features relating to the duct 20, the slot 28 and the gas inlets 30 may be adopted from anyone of the embodiments shown in the figures 1 to 8. There is a rudder 8 arranged in co-operation with the duct 20 and the propeller 16 for obtaining steering effect of propulsion for the vessel.

[0054] While the invention has been described herein by way of examples in connection with what are, at present, considered to be the most preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but is intended to cover various combinations or modifications of its features, and several other applications included within the scope of the invention, as defined in the appended claims. The details mentioned in connection with any embodiment above may be used in connection with another embodiment when such combination is technically feasible.

Claims

1. A propulsion assembly (10) for a marine vessel (1) comprising
 - a body (12) comprising a duct (20) having a longitudinal axis (L), and a first end (20.1) and a second end (20.2),
 - a support structure (14) for a propeller (16) comprising a propeller shaft (18) at a centre line of the duct (20),
 - a propeller (16), positioned into the duct (20) and being attached to the propeller shaft (18), wherein the propeller (16) comprising at least three blades (22) and a boss (24) which is supported to the shaft (18), and further a circular rim (26) to which radial ends (22') of the propeller blades are attached, **characterized in that**
 - a circumferential slot (28) is provided, opening inside the duct between the first end (20.1) and the second end (20.2), into which slot the circular rim (26) is arranged to extend radially, and **in that** the assembly further comprising
 - at least one gas inlet (30) arranged to open into the slot (28).
2. A propulsion assembly according to claim 1, **characterized in that** a space is arranged radially between a bottom of the slot (28) and outer surface of the rim (26), and that the at least one gas inlet (30) is arranged to open into the space.
3. A propulsion assembly according to claim 2, **characterized in that** one gas inlet (30) is arranged to open into the space at its lowermost position.
4. A propulsion assembly according to anyone of the preceding claims, **characterized in that** the slot (28)

- is formed to the body by radially inwardly extending circumferential projection (32) forming the side walls of the circumferential slot (28).
5. A propulsion assembly according to claim 4, **characterized in that** the projection (32) comprises a first fairing at a first side of the propeller (16) and a second fairing at a second side of the propeller having the slot (28) between the fairings.
 6. A propulsion assembly according to claim 4, **characterized in that** the projection (32) comprises a first axial end and a second axial end, and inner diameter of the projection (32) is substantially equal to inner diameter of the duct (20) at the first axial end, and outer diameter of the projection (32) is substantially equal to inner diameter of the duct (20) at its first and second ends, and that inner diameter of the projection (32) at its second axial end is less than outer diameter of the circular rim (26).
 7. A propulsion assembly according to anyone of the preceding claims, **characterized in that** 1 - 4 gas inlets (30) are arranged to open into the slot (28).
 8. A propulsion assembly according to according to anyone of the preceding claims 1 - 6, **characterized in that** the assembly comprises more than four gas inlets (30) arranged to open into the slot (26).
 9. A propulsion assembly according to anyone of the preceding claims, **characterized in that** the assembly comprises a circumferentially extending gas plenum (42) in connection with the body (12) provided with plurality of substantially evenly distributed gas inlets (30) arranged to open into the slot (28).
 10. A propulsion assembly according to anyone of the preceding claims 1-6, **characterized in that** the assembly comprises evenly distributed gas inlets (30), having an angle (A) of 5 - 30 degrees between the gas inlets (30).
 11. A propulsion assembly according to claim 9, **characterized in that** the gas plenum (42) circumscribes the duct (20).
 12. A propulsion assembly according to anyone of the preceding claims, **characterized in that** the propeller is provided with a rim drive.
 13. A propulsion assembly according to claim 12, **characterized in that** the propeller is provided with an electric motor (31) wherein the rim (26) comprises a rotor part (34) of the motor and the body (12) of the duct is provided with a stator part (36) of the motor (31).
 14. A propulsion assembly according to claims 12, **characterized in that** the propeller is provided with a mechanical rim drive.
 15. A propulsion assembly according to anyone of the preceding claims, **characterized in that** the propeller shaft (18) is a driven shaft.
 16. A propulsion assembly according to claim 12 **characterized in that** the propeller shaft is a non-driven shaft.
 17. A propulsion assembly according to claim 1, **characterized in that** the slot (28) is formed to the duct (20) as an indent from the level of the inner wall of the duct (20).
 18. A propulsion assembly according to anyone of the preceding claims, **characterized in that** propulsion assembly is a transverse tunnel thruster, wherein the duct (20) of the propulsion assembly is a straight tube (20).
 19. A propulsion assembly according to anyone of the preceding claims 1 - 17, **characterized in that** propulsion assembly is a shaft line propulsion system, wherein the body (12) of the duct (20) of the propulsion assembly is rigidly attached to a hull of a vessel (1) and the shaft (18) extends via a stern tube through the hull of the vessel (1).
 20. A propulsion assembly according to anyone of the preceding claims 1 - 17, **characterized in that** propulsion assembly is a steerable azimuthing thruster wherein the body (12) comprises a nozzle duct (20) and the boss of the propeller is connected to the shaft (18) in a support structure (14), the support structure (14) extending radially from shaft (18) for coupling the azimuthing thruster to a vessel (1) in rotatably manner.

Patentansprüche

1. Antriebsanordnung (10) für ein Schiff (1), umfassend
 - einen Körper (12), der einen Kanal (20) mit einer Längsachse (L) und einem ersten Ende (20.1) und einem zweiten Ende (20.2) umfasst,
 - eine Tragstruktur (14) für eine Schiffsschraube (16), die eine Schiffsschraubenwelle (18) an einer Mittellinie des Kanals (20) umfasst,
 - eine Schiffsschraube (16), die in dem Kanal (20) positioniert ist und an der Schiffsschraubenwelle (18) angebracht ist, wobei die Schiffsschraube (16) mindestens drei Blätter (22) und eine an der Welle (18) getragene Nabe (24) und ferner einen kreisförmigen Kranz (26) umfasst,

- an dem radiale Enden (22') der Schiffsschraubenblätter angebracht sind, **dadurch gekennzeichnet, dass**
- ein Umfangsschlitz (28) vorgesehen ist, der sich innerhalb des Kanals zwischen dem ersten Ende (20.1) und dem zweiten Ende (20.2) öffnet, wobei der kreisförmige Kranz (26) in diesen Schlitz derart angeordnet ist, dass er sich radial erstreckt,
 - und dadurch, dass die Anordnung ferner umfasst
 - mindestens einen Gaseinlass (30), der derart angeordnet ist, dass er sich in den Schlitz (28) öffnet.
2. Antriebsanordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** ein Raum zwischen einer Unterseite des Schlitzes (28) und einer äußeren Fläche des Kranzes (26) radial angeordnet ist und dass der mindestens eine Gaseinlass (30) derart angeordnet ist, dass er sich in den Raum öffnet.
 3. Antriebsanordnung nach Anspruch 2, **dadurch gekennzeichnet, dass** ein Gaseinlass (30) derart angeordnet ist, dass er sich an der untersten Position des Raums in diesen öffnet.
 4. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** der Schlitz (28) durch einen sich radial nach innen erstreckenden umlaufenden Vorsprung (32), der die Seitenwände des umlaufenden Schlitzes (28) bildet, an dem Körper gebildet ist.
 5. Antriebsanordnung nach Anspruch 4, **dadurch gekennzeichnet, dass** der Vorsprung (32) eine erste Verkleidung an einer ersten Seite der Schiffsschraube (16) und eine zweite Verkleidung an einer zweiten Seite der Schiffsschraube umfasst, wobei sich der Schlitz (28) zwischen den Verkleidungen befindet.
 6. Antriebsanordnung nach Anspruch 4, **dadurch gekennzeichnet, dass** der Vorsprung (32) ein erstes axiales Ende und ein zweites axiales Ende umfasst und der Innendurchmesser des Vorsprungs (32) im Wesentlichen gleich dem Innendurchmesser des Kanals (20) am ersten axialen Ende ist und der Außendurchmesser des Vorsprungs (32) im Wesentlichen gleich dem Innendurchmesser des Kanals (20) an seinem ersten und zweiten Ende ist, und dass der Innendurchmesser des Vorsprungs (32) an seinem zweiten axialen Ende kleiner ist als der Außendurchmesser des kreisförmigen Kranzes (26).
 7. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** 1 bis 4 Gaseinlässe (30) derart angeordnet sind, dass sie sich in den Schlitz (28) öffnen.
 8. Antriebsanordnung nach einem der vorstehenden Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Anordnung mehr als vier Gaseinlässe (30) umfasst, die derart angeordnet sind, dass sie sich in den Schlitz (26) öffnen.
 9. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Anordnung eine sich in Umfangsrichtung erstreckende Gassammelkammer (42) in Verbindung mit dem Körper (12) umfasst, die mit mehreren im Wesentlichen gleichmäßig verteilten Gaseinlässen (30) versehen ist, die derart angeordnet sind, dass sie sich in den Schlitz (28) öffnen.
 10. Antriebsanordnung nach einem der vorstehenden Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Anordnung gleichmäßig verteilte Gaseinlässe (30) umfasst, die einen Winkel (A) von 5 bis 30 Grad zwischen den Gaseinlässen (30) aufweisen.
 11. Antriebsanordnung nach Anspruch 9, **dadurch gekennzeichnet, dass** die Gassammelkammer (42) den Kanal (20) umgibt.
 12. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schiffsschraube mit einem Kranztrieb versehen ist.
 13. Antriebsanordnung nach Anspruch 12, **dadurch gekennzeichnet, dass** die Schiffsschraube mit einem Elektromotor (31) versehen ist, wobei der Kranz (26) einen Rotorteil (34) des Motors umfasst und der Körper (12) des Kanals mit einem Statorteil (36) des Motors (31) versehen ist.
 14. Antriebsanordnung nach Anspruch 12, **dadurch gekennzeichnet, dass** die Schiffsschraube mit einem mechanischen Kranztrieb versehen ist.
 15. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schiffsschraubenwelle (18) eine angetriebene Welle ist.
 16. Antriebsanordnung nach Anspruch 12, **dadurch gekennzeichnet, dass** die Schiffsschraubenwelle eine nicht angetriebene Welle ist.
 17. Antriebsanordnung nach Anspruch 1, **dadurch gekennzeichnet, dass** der Schlitz (28) als eine Vertiefung von der Ebene der Innenwand des Kanals (20) an dem Kanal (20) gebildet ist.
 18. Antriebsanordnung nach einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Antriebsanordnung ein Quertunnelstrahlruder ist,

wobei der Kanal (20) der Antriebsanordnung ein gerades Rohr (20) ist.

19. Antriebsanordnung nach einem der vorstehenden Ansprüche 1 bis 17, **dadurch gekennzeichnet, dass** die Antriebsanordnung ein Wellenstrangantriebssystem ist, wobei der Körper (12) des Kanals (20) der Antriebsanordnung an einem Rumpf eines Schiffs (1) starr angebracht ist und sich die Welle (18) über ein Stevenrohr durch den Rumpf des Schiffs (1) erstreckt.
20. Antriebsanordnung nach einem der vorstehenden Ansprüche 1 bis 17, **dadurch gekennzeichnet, dass** die Antriebsanordnung ein steuerbares Azimutstrahlruder ist, wobei der Körper (12) einen Düsenkanal (20) umfasst und die Nabe der Schiffschraube mit der Welle (18) in einer Tragstruktur (14) verbunden ist und sich die Tragstruktur (14) radial von der Welle (18) erstreckt, um das Azimutstrahlruder mit einem Schiff (1) drehbar zu verbinden.

Revendications

1. Ensemble de propulsion (10) pour un navire (1) comprenant
- un corps (12) comprenant un conduit (20) présentant un axe longitudinal (L), et une première extrémité (20.1) et une deuxième extrémité (20.2),
 - une structure de support (14) pour une hélice (16) comprenant un arbre d'hélice (18) au niveau d'une ligne centrale du conduit (20),
 - une hélice (16) positionnée dans le conduit (20) et fixée à l'arbre d'hélice (18), dans lequel l'hélice (16) comprend au moins trois pales (22) et un moyeu (24) supporté sur l'arbre (18), et en outre une bride circulaire (26) à laquelle sont fixées des extrémités radiales (22') des pales d'hélice, **caractérisé en ce que**
 - il est prévu une fente circumférentielle (28) s'ouvrant vers l'intérieur du conduit entre la première extrémité (20.1) et la deuxième extrémité (20.2), la bride circulaire (26) étant conçue pour s'étendre radialement dans ladite fente, **et en ce que** l'ensemble comprend en outre
 - au moins une entrée de gaz (30) conçue pour s'ouvrir vers la fente (28).
2. Ensemble de propulsion selon la revendication 1, **caractérisé en ce qu'**un espace est arrangé radialement entre une partie inférieure de la fente (28) et une surface extérieure de la bride (26), **et en ce qu'**au moins une entrée de gaz (30) est conçue pour s'ouvrir vers l'espace.
3. Ensemble de propulsion selon la revendication 2, **caractérisé en ce qu'**une entrée de gaz (30) est conçue pour s'ouvrir vers l'espace au niveau de sa position la plus basse.
4. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la fente (28) est formée sur le corps par une saillie circumférentielle (32) s'étendant radialement vers l'intérieur, formant les parois latérales de la fente circumférentielle (28).
5. Ensemble de propulsion selon la revendication 4, **caractérisé en ce que** la saillie (32) comprend un premier profilage sur un premier côté de l'hélice (16) et un deuxième profilage sur un deuxième côté de l'hélice comportant la fente (28) entre les deux profilages.
6. Ensemble de propulsion selon la revendication 4, **caractérisé en ce que** la saillie (32) comprend une première extrémité axiale et une deuxième extrémité axiale, et un diamètre intérieur de la saillie (32) est substantiellement égal à un diamètre intérieur du conduit (20) à la première extrémité axiale, et un diamètre extérieur de la saillie (32) est substantiellement égal au diamètre intérieur du conduit (20) à ses première et deuxième extrémités, et ce diamètre intérieur de la saillie (32) à sa deuxième extrémité axiale est inférieur à un diamètre extérieur de la bride circulaire (26).
7. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** 1 à 4 entrées de gaz (30) sont conçues pour s'ouvrir vers la fente (28).
8. Ensemble de propulsion selon l'une quelconque des revendications précédentes 1 à 6, **caractérisé en ce que** l'ensemble comprend plus de quatre entrées de gaz (30) conçues pour s'ouvrir vers la fente (26).
9. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'ensemble comprend une chambre de gaz (42) s'étendant circumférentiellement en liaison avec le corps (12), laquelle est dotée d'une pluralité d'entrées de gaz (30) réparties de façon substantiellement homogène, conçues pour s'ouvrir vers la fente (28).
10. Ensemble de propulsion selon l'une quelconque des revendications précédentes 1 à 6, **caractérisé en ce que** l'ensemble comprend des entrées de gaz (30) réparties uniformément, lesquelles présentent un angle (A) de 5 à 30 degrés entre les entrées de gaz (30).

11. Ensemble de propulsion selon la revendication 9, **caractérisé en ce que** la chambre de gaz (42) encercle le conduit (20).
12. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'hélice est dotée d'un entraînement de bride. 5
13. Ensemble de propulsion selon la revendication 12, **caractérisé en ce que** l'hélice est dotée d'un moteur électrique (31), dans lequel la bride (26) comprend une partie de rotor (34) du moteur et le corps (12) du conduit est doté d'une partie de stator (36) du moteur (31). 10
15
14. Ensemble de propulsion selon la revendication 12, **caractérisé en ce que** l'hélice est dotée d'un entraînement de bride mécanique.
15. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'arbre d'hélice (18) est un arbre mené. 20
16. Ensemble de propulsion selon la revendication 12, **caractérisé en ce que** l'arbre d'hélice est un arbre non-mené. 25
17. Ensemble de propulsion selon la revendication 1, **caractérisé en ce que** la fente (28) est formée sur le conduit (20) comme une indentation dans la paroi intérieure du conduit (20). 30
18. Ensemble de propulsion selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'ensemble de propulsion est un propulseur de tunnel transversal, dans lequel le conduit (20) de l'ensemble de propulsion est un tube rectiligne (20). 35
19. Ensemble de propulsion selon l'une quelconque des revendications 1 à 17, **caractérisé en ce que** l'ensemble de propulsion est un système de propulsion de ligne d'arbre, dans lequel le corps (12) du conduit (20) de l'ensemble de propulsion est fixé de façon rigide à une coque d'un navire (1) et l'arbre (18) s'étend à travers la coque du navire (1) par le biais d'un tube d'étambot. 40
45
20. Ensemble de propulsion selon l'une quelconque des revendications précédentes 1 à 17, **caractérisé en ce que** l'ensemble de propulsion est un propulseur orientable en azimuth dirigeable, dans lequel le corps (12) comprend un conduit de buse (20) et le moyeu de l'hélice est relié à l'arbre (18) dans une structure de support (14), la structure de support (14) s'étendant radialement à partir de l'arbre (18) pour accoupler le propulseur orientable en azimuth à un navire (1) de façon rotative. 50
55

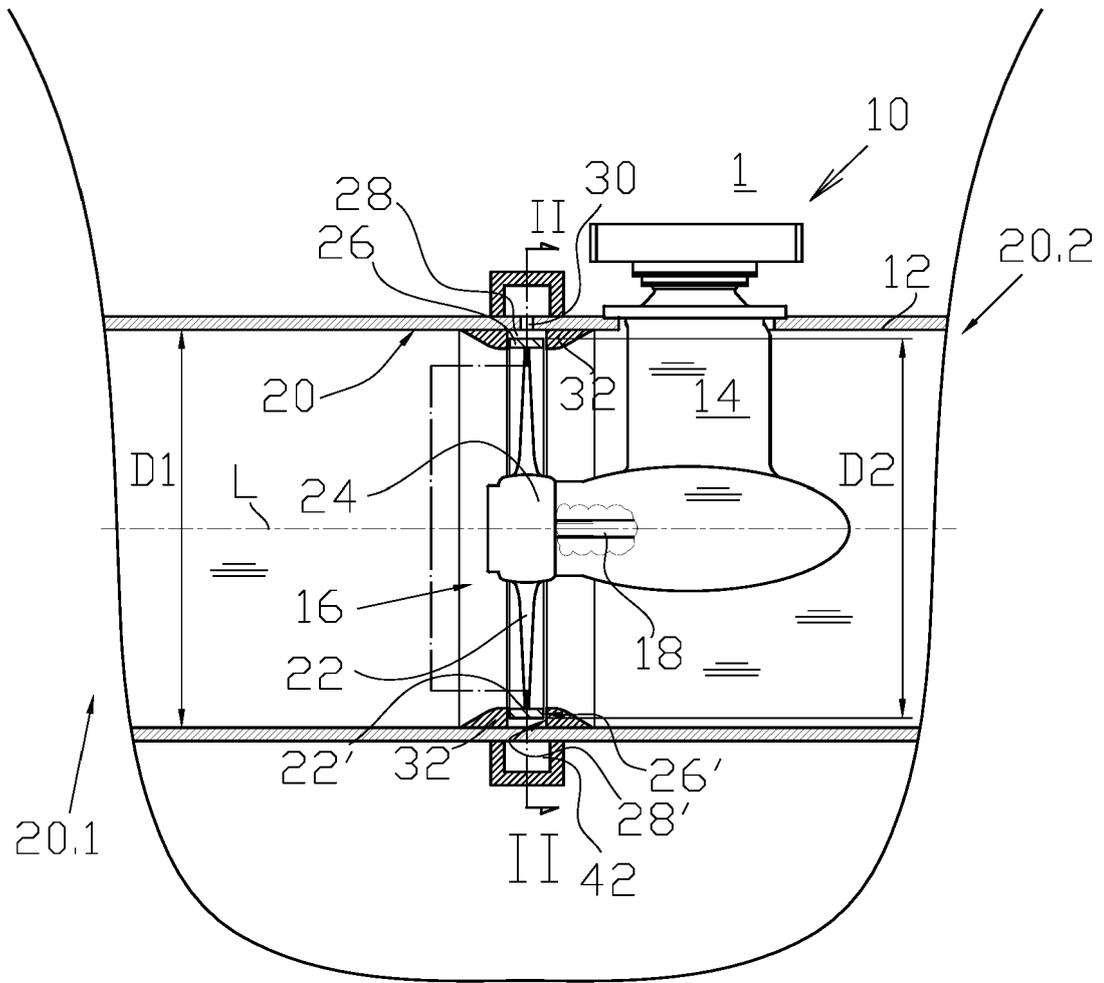
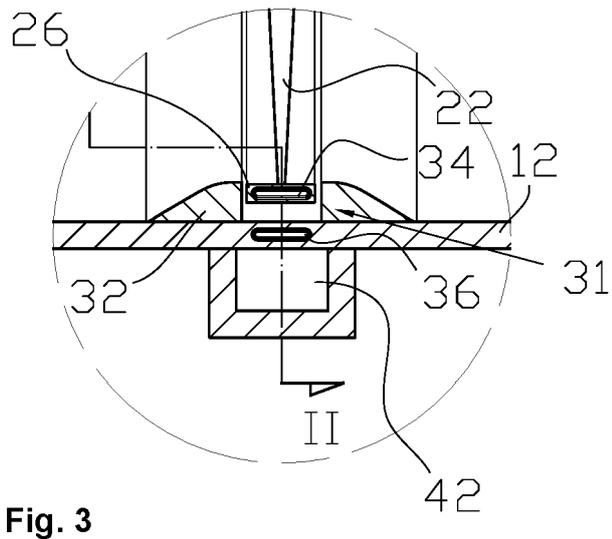
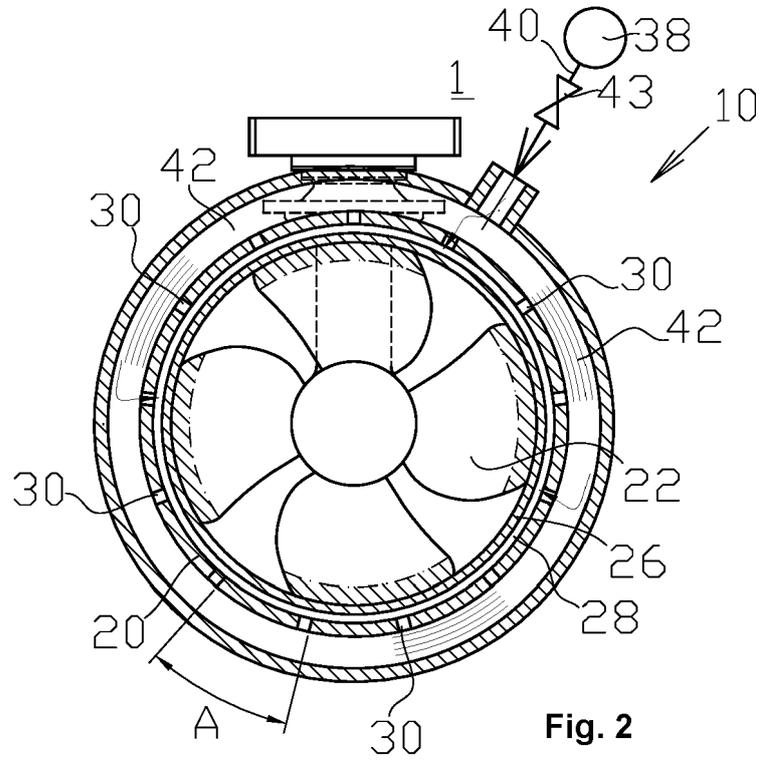


Fig. 1



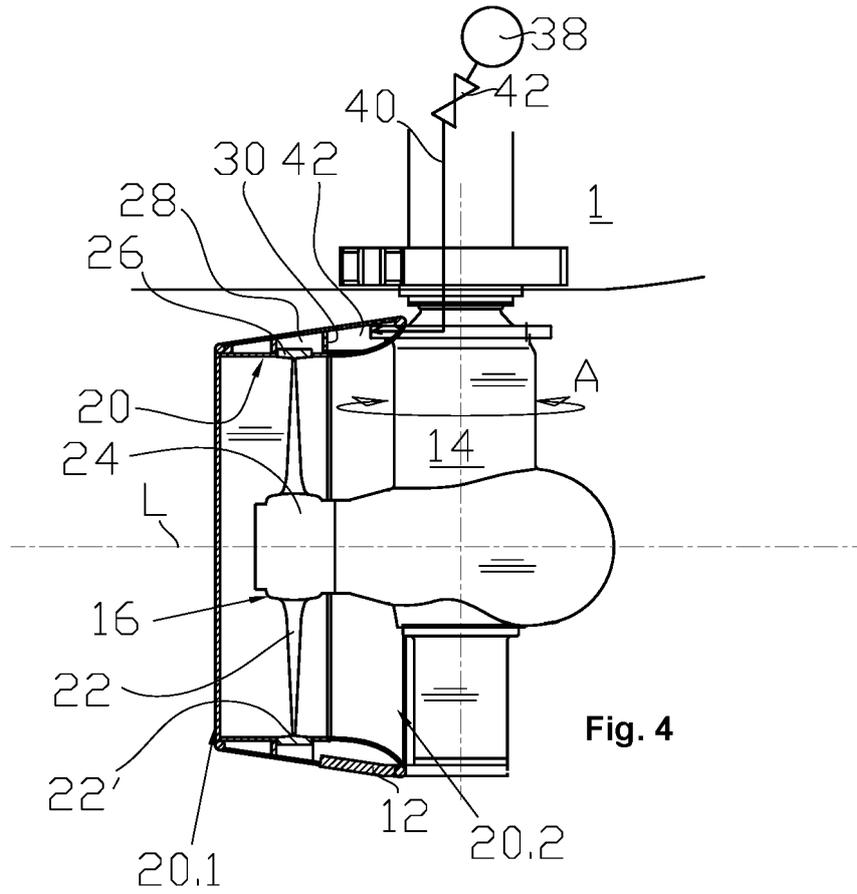


Fig. 4

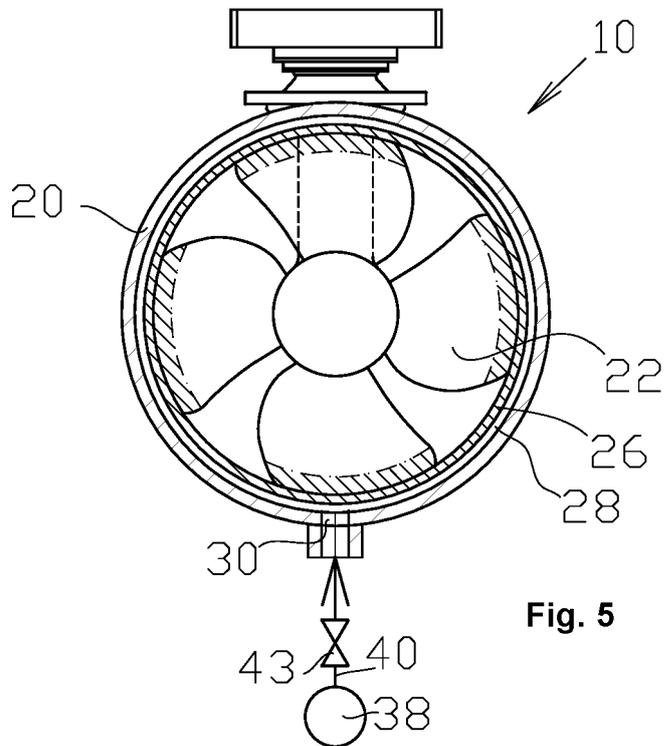


Fig. 5

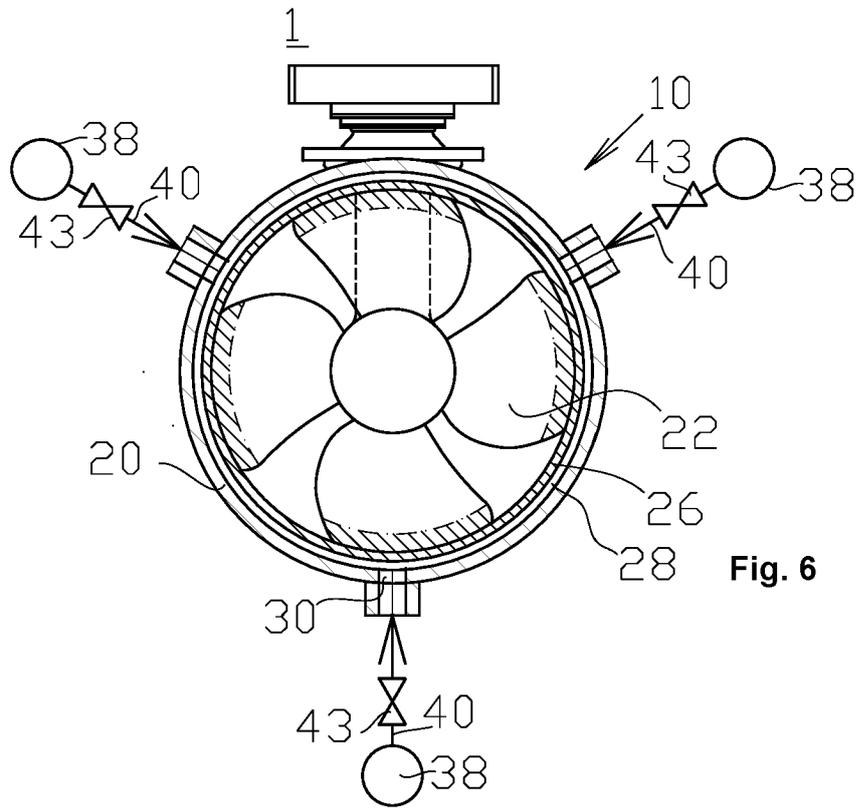


Fig. 6

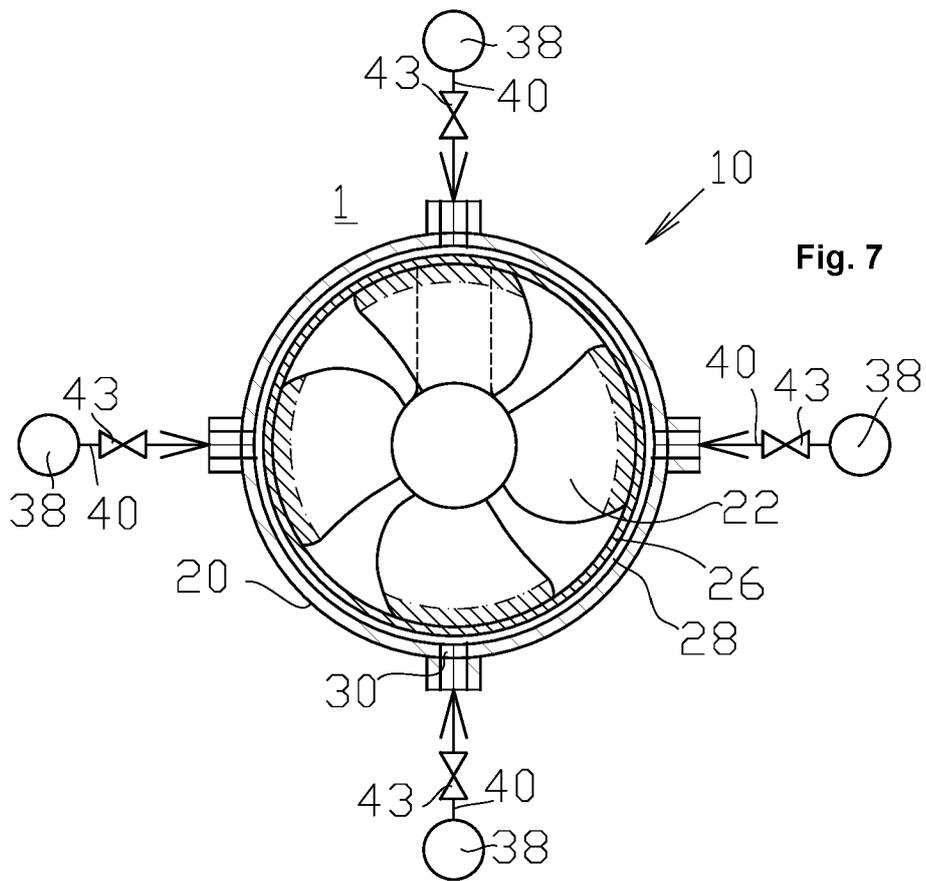


Fig. 7

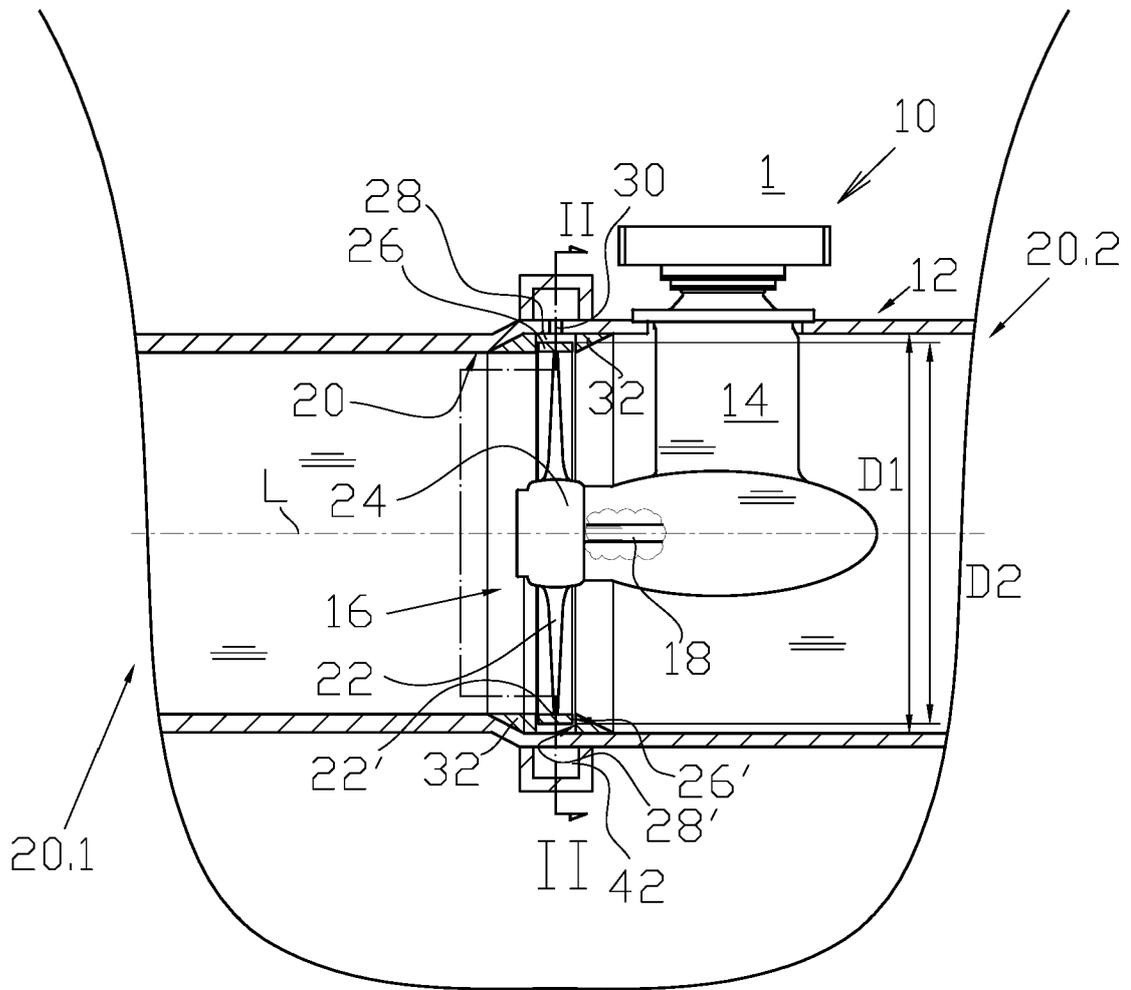


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0306642 B1 [0003]
- EP 3009342 A1 [0004]
- WO 2018193149 A1 [0005]
- DE 102011055998 A1 [0005]
- US 5607329 A [0005]