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(54) MARINE VESSEL PROPULSION ARRANGEMENT AND METHOD OF OPERATING A MARINE VESSEL PROPULSION ARRANGEMENT

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JP-A- 9 142 391

- **PATENT ABSTRACTS OF JAPAN vol. 1997, no. 10 31 October 1997 & JP 09 142 391 A (MITSUBISHI HEAVY IND LTD) 03 June 1997**

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EP 1 513 724 B1

Description

[0001] The invention relates to marine vessel propulsion system according to the preamble of claim 1. The invention relates also to method of operating a marine vessel propulsion system according to the preamble of claim 8.

[0002] The general aims, just to mention a few, of designing propulsion system to a marine vessel are good efficiency, reliability, durability and good low speed manoeuvring capabilities. Emphasis of the features is depending on an application in question.

[0003] For example, in so called ROPAX (Roll On/Roll Off Passenger) vessels there is a need to provide a propulsion system, which is simultaneously efficient at cruise speeds, say over 25 knots, and which also provides for good harbour manoeuvring capabilities.

[0004] It has been suggested to use azimuthing propulsion drives, such as so called pod drives, instead of conventional mechanical shaft propulsion. A reference is made to a publication EP 590867, in which a propulsion arrangement is shown, which consists of a turnable drive unit, inside which there is an electrical motor acting as the ship's propulsion motor and being connected to a propeller at the end of the drive unit. The pod drives are favourable in a sense that they are flexible having azimuthing control possibility, and they also provide freedom in location of main engines. However, the pod drives are of high cost and the electric power transmission cause considerable transmission losses.

[0005] Mechanical propeller drive as such has clear advantages being of low cost, simple and having substantially low power transmission losses. However, mechanical propeller has disadvantages as well. Propulsion efficiency is not as good as desired and particularly at low speed conditions there is a risk for pressure side cavitation when controllable pitch propeller is used. This occurrence is caused when driving the propeller at low pitch, high rotational speed conditions resulting in decreasing of local pressure at the surface of the propeller blade. Also manoeuvrability is substantially poor.

[0006] A combination of pod drives and mechanical propeller drive in general level as such has been suggested in a paper "Hydrodynamics of fast ropax vessel" by Raimo Hämäläinen. The suggested combination has been considered to have several benefits. However, it has been found that the solution does not result in optimum solution as such, particularly at low speed / manoeuvring operation. Although the proposal in general seems to be promising, there are still practical issues to be solved.

[0007] In Japanese patent publication JP 914 2391 there is shown a marine vessel propulsion system comprising steerable azimuthing propellers arranged on both sides of main propeller at stern section of the vessel. This kind of system has a negative effect on the propulsion efficiency particularly in low speed / manoeuvring operation.

[0008] It is an object of the invention to provide marine vessel propulsion system and method of operating a marine vessel propulsion system in which the shortcomings of the prior art have been minimised. Particularly it is an object of the invention to provide a marine vessel hybrid propulsion system and method of operating a marine vessel propulsion system, which result in good overall and particularly low speed / manoeuvring operation efficiency and operation, and also reduced propulsion vibration and noise level.

[0009] Objects of the invention are met substantially as is disclosed in the claim 1, 8 and as is more clearly disclosed in the other claims.

[0010] The objects of the invention are met by marine vessel propulsion system, which comprises engine system for producing propulsion power and several propulsion means including at least two propulsion arrangements capable of steering action and at least one shaft driven propeller drive, at its stern section, The invention is characterised by a feature that the at least one shaft driven propeller drive is provided with a controllable pitch propeller being adjustable to substantially feathering conditions. According to the invention the at least one shaft driven propeller drive is provided with a controllable pitch propeller being adjustable to substantially feathering conditions.

[0011] According to a preferred embodiment of the invention the at least two propulsion arrangements capable of steering are azimuthing propulsion arrangements, which may be provided with either variable or constant pitch propeller systems. The azimuthing propulsion arrangements are preferably powered by electric motor, the power to which being supplied by piston engine generator set. The shaft driven propeller drive is mechanically connected to a piston engine by means of a gear system or alike. In some cases also water jet propulsion systems may be used as propulsion arrangements capable of steering.

[0012] The propulsion system according to invention is arranged to be driven differently at different operation modes, namely specifically at normal/cruise speed operation mode and at low speed / harbour manoeuvring operation mode. At normal/cruise speed operation mode both the at least two azimuthing propulsion arrangements and the at least one shaft driven propeller drive are adapted to at least cause thrust in order to move the vessel. At low speed /harbour manoeuvring operation mode only the at least two azimuthing propulsion arrangements are adapted to cause thrust in order to move the vessel. This way the manoeuvring behaviour is more advantageous. The steering of the vessel is accomplished always by means of the at least two propulsion arrangements capable of steering action i.e. the azimuthing propulsion arrangements.

[0013] The pitch angle of blades in the propeller of shaft driven propeller drive is adjustable to be at angle $\pm$ 80° - 100° in respect of the normal of the shaft of the shaft driven propeller drive. This means in practise that the

blades of the propeller are rotated to either direction until they are substantially parallel to longitudinal axis of the vessel. The direction of rotation may be selected according to the shape of the blades so that the flow resistance is minimised. Preferably the engine system comprises a gear and a coupling means connecting the propeller drive shaft to an engine and being shiftable to disengaged position. This result in a benefit of stopping the transmission of power to the drive shaft before and while the propeller is at feathering conditions. Providing the propeller drive with coupling means also results in a possibility of keeping the engine running while the power transmission is disengaged. However, it is advantageous to stop the engine e.g. in order to reduce unnecessary emissions.

[0014] According to the method of operating a marine vessel propulsion system comprising at its stern section at least two propulsion arrangements capable of steering action and at least one shaft driven propeller drive, at normal/cruise speed the propulsion thrust is provided by the shaft driven propeller drive and the propulsion arrangements capable of steering action. Steering thrust is provided by the propulsion arrangements capable of steering action. The propulsion system further comprising at least one shaft driven propeller drive having a controllable pitch propeller, and at normal/cruise speeds the thrust of the shaft driven propeller drive is mainly adjusted by adjusting pitch angle of propeller. Further at low speed and/or harbour manoeuvring operation the shaft driven propeller drive is adjusted to be feathering and that power transmission to the propeller is stopped. This is accomplished by adjusting the pitch angle of the shaft driven propeller.

[0015] While the power supply to the propeller drive is stopped from the engine system, the at least two propulsion arrangements capable of steering action are maintained in operation. Power transmission to the shaft driven propeller drive is stopped by disengaging the engine from the shaft of the shaft driven propeller drive, or in case of single engine without a gear system, by stopping the engine before adjusting the propeller to be feathering.

[0016] The pitch angle of propeller of the shaft driven propeller drive is adjusted to be advantageously either + 80-100° or - 80-100°. The at least two propulsion arrangements capable of steering action are preferably powered by electric motors, the power to which being supplied by one or more piston engine generator sets. During low speed and/or harbour manoeuvring operation piston engines of the piston engine generator sets are operated at greater speed than idle speed, substantially at their most efficient constant speed, and preferably substantially independently from the power consumption of said propulsion arrangements. This manner the engines may run at optimum circumstances regardless of the power demand and prevailing speed of the vessel.

[0017] The invention provides several advantages over prior art. First of all the propulsion system causes lower investment costs compared to conventional diesel-electric propulsion system. It also provides excellent manoeuvring characteristics as well as excellent propulsion efficiency for high speed ships. With the present invention, at the low speed / manoeuvring operation the engines may operate at optimum conditions and there is no risk of cavitation of the shaft driven propeller drive. Also one of the advantage of the present invention is that the number of diesel generator sets connected to the network can be varied according to the load demand i.e. the engines may be started and stopped. This way the load of the engine may be kept doser to the optimum.

[0018] In the following the invention will be described by the way of example, with the reference to the appending drawings in which

- Figure 1 shows schematically an embodiment of the propulsion system according to the invention at normal operation, and
- Figure 2 shows the propulsion system according to figure 1 in low speed / manoeuvring operation.

[0019] In the figures with the reference number 1 it is referred to a hull of the vessel, only the stern section of which is shown. The vessel is provided with engine system 2 having a number of piston engine generator sets 2.1 and number of piston engines 2.2 mechanically connected to a shaft driven mechanical propeller drive 3. The shaft driven propeller drive 3 comprises a gear and a clutch 4 through which the engines 2.2 are connected to a drive shaft 5 of the propeller drive 3. At the outer end of the drive shaft 5 there is a propeller 6 connected thereto. The shaft driven propeller system drive 3 comprises a controllable pitch propeller 6 and an arrangement 7 for adjusting its pitch angle A, which is shown herein very schematically. The arrangement 7 for adjusting the pitch angle may be hydraulic or mechanically operated commercially available system known as such. However, the pitch angle adjusting arrangement 7 is such that the pitch of the propeller is adjustable to substantially feathering conditions. In practise this means that the mechanism for turning the propeller blades allows the blades to turn over to greater angle than in normal pitch adjusting. This will be described later in more detailed manner with the reference to figure 2.

[0020] The piston engine generator sets 2.1 produce electric power and supply it to a network 8, through which power may be transmitted to the propulsion arrangements capable of steering action, such as pod drive units 9. The pod drive unit 9 is turnable about its vertical axis as depicted by the arrows in the figures. This feature is utilised in the present invention so that the pod units 9 operate as steering devices and the shaft driven propeller drive 3 is without any rudder system.

[0021] The shaft driven propeller drive 3 is positioned at centre line of the hull. In case there would be several shaft driven propeller drives it is desired to position them symmetrically in respect of the centre line of the hull 1. In the figures the two propulsion arrangements capable

of steering action i.e. the pod drives 9 are positioned at both sides of the shaft driven propeller drive 3 and substantially same longitudinal position as the propeller 6 of the shaft driven propeller drive 3.

[0022] At normal cruise speed conditions the shaft driven propeller drive 3 and the pod drives 9 are used for producing thrust force for moving the vessel. The pod drives 9 are provided with variable speed propeller systems and the thrust force of the pod drives 9 is adjusted by controlling the rotational speed of their propellers. The thrust force may also be controlled by controlling propeller pitch angle, in the case they are provided with controllable pitch propellers. The thrust force of the shaft driven propeller drive 3 is mainly adjusted by adjusting propeller pitch angle. Naturally, it is possible to adjust rotational speed by adjusting the engine speed.

[0023] In such operation in which better manoeuvrability is desired and the speed is lower, only the pod drives 9 are used for propulsion. At this mode of operation the pitch angle of the shaft driven propeller drive is adjusted such that its flow resistance is substantially decreased. This situation is shown in figure 2. This way the overall efficiency may be increased. Preferably the pitch angle (A) of the shaft driven propeller drive 3 is adjusted such that the propeller is feathering. By the term feathering or feathering conditions it is meant here that the angle (A) of the blades is positioned so that the chords, straight line between the leading and the trailing edge of a blade, become approximately parallel to the water streamline or longitudinal axis of the vessel. The blade angle (A) means an angle between normal of the drive shaft axis and a mean direction of straight line joining the leading and trailing edges of a blade.

[0024] When changing over to the low speed / harbour manoeuvring operation first the power supply to the shaft driven propeller drive 3 is stopped, which may be accomplished by shifting the clutch 4 to disengaged position. After stopping the power transmission, the propeller of the drive 3 is adjusted to feathering conditions. In this manner it is possible to obtain advantageous properties to the propulsion system for low speed / manoeuvring operation. The pod drives 9 are maintained in operation in such a manner that the piston engines of the piston engine generator sets 2.1 are operated at greater speed than idle speed, substantially at their most efficient constant speed substantially independently from the power consumption of said propulsion arrangements 9. This means that the total power production may be greater than actual demand of the pod drives 9. It is also advantageous to shut down the engine system 2.2. According to the invention, in this operation mode the engine system 2 is operated in most advantageous manner resulting in low emissions and vibrations to the vessels hull constructions.

[0025] The invention is not limited to the embodiments shown but several modifications of the invention are reasonable within the scope of the attached claims.

Claims

1. Marine vessel propulsion system comprising engine system (2) for producing propulsion power and several propulsion means (3, 9) including at least two propulsion arrangements (9) capable of steering action and at least one shaft driven propeller drive (3) at its stern section, **characterised in that** the at least one shaft driven propeller drive (3) is provided with a controllable pitch propeller (6) being adjustable to substantially feathering conditions.

2. Marine vessel propulsion system according to claim 1, **characterised in that** the at least two propulsion (9) arrangements capable of steering are azimuthing propulsion arrangements.

3. Marine vessel propulsion system according to claim 2, **characterised in that** the azimuthing propulsion arrangements (9) are provided with constant pitch propeller systems and/or variable pitch propeller systems.

4. Marine vessel propulsion system according to anyone of claims 2-3, **characterised in that** the azimuthing propulsion arrangements (9) are powered by electric motor, the power to which being supplied by piston engine generator set (2.1) and that the shaft driven propeller drive is mechanically connected to a piston engine (2.2)

5. Marine vessel propulsion system according to claim 2, **characterised in that** the propulsion system is arranged to be driven at different operation modes, when at normal/cruise speed operation mode both the at least two azimuthing propulsion arrangements (9) and the at the least one shaft driven propeller drive (3) are adapted to at least cause thrust in order to move the vessel, and at low speed / manoeuvring operation mode only the at least two azimuthing propulsion arrangements (9) are adapted to cause thrust in order to move the vessel.

6. Marine vessel propulsion system according to claim 1, **characterised in that** pitch angle (A) of blades in the propeller (6) of the shaft driven propeller drive is adjustable to be either + 80° - 100° or -80° - 100°.

7. Marine vessel propulsion system according to any one of the preceding claims, **characterised in that** the engine system (2) comprises a coupling means (4) connecting the propeller drive (3) shaft (5) to an engine (2.2) and being shiftable to disengaged position.

8. Method of operating a marine vessel propulsion system comprising at its stern section at least two propulsion arrangements (9) capable of steering action

and at least one shaft driven propeller drive (3), wherein at normal/cruise speed

- the propulsion thrust is provided by the shaft driven propeller drive (3) and said propulsion arrangements (9) capable of steering action and
- steering thrust is provided by the propulsion arrangements (9) capable of steering action, and

characterised in that the propulsion system further comprising at least one shaft driven propeller drive (3) having a controllable pitch propeller (6) and at normal/cruise speed the thrust of the shaft driven propeller drive is mainly adjusted by adjusting pitch angle of propeller (6), and
at low speed and/or harbour manoeuvring operation the shaft driven propeller drive (3) is adjusted to be feathering and that power transmission to the propeller (6) is stopped.

9. Method of operating a marine vessel propulsion system according to claim 8, **characterised in that** power transmission to the shaft driven propeller drive (3) is stopped by disengaging the engine (2.2) from the shaft (5) of the shaft driven propeller drive (3).

10. Method of operating a marine vessel propulsion system according to claim 8 or 9, **characterised in that** power transmission to the shaft driven propeller drive (3) is stopped by stopping the engine (2.2).

11. Method of operating a marine vessel propulsion system according to claim 8, **characterised in that** while the power supply to the propeller drive (3) is stopped from the engine (2.2) system, the at least two propulsion arrangements (9) capable of steering action are maintained in operation.

12. Method of operating a marine vessel propulsion system according to claim 8, **characterised in that** at low speed and/or manoeuvring operation the pitch angle (A) of propeller of the shaft driven propeller means (3) is adjusted to be advantageously either + 80-100° or - 80-100°.

13. Method of operating a marine vessel propulsion system according to any one of preceding claims 8-12 wherein the at least two propulsion arrangements (9) capable of steering action are powered by electric motors, the power to which being supplied by one or more piston engine generator sets (2.1), **characterised in that** at low speed and/or harbour manoeuvring operation piston engines of the piston engine generator sets (2.1) are operated at greater speed than idle speed, substantially at their most efficient constant speed substantially independently from the power consumption of said propulsion arrangements (9).

Patentansprüche

1. Marineschiff-Antriebssystem aufweisend ein Maschinensystem (2) zur Erzeugung einer Antriebsleistung und mehrere Antriebsmittel (3, 9) mit mindestens zwei, eine Steuerungsaktion ausführbare Antriebs-Anordnungen (9), und mindestens einem wellenangetriebenen Schrauben-Antrieb (3) am Heck-Abschnitt,
dadurch gekennzeichnet, dass der mindestens eine wellenangetriebene Schrauben-Antrieb (3) mit einer steuerbaren Schraubenneigungs-Schiffsschraube (6) versehen ist, die auf im wesentlichen flachgedrehte Zustände einstellbar ist.

2. Marineschiff-Antriebssystem nach Anspruch 1,
dadurch gekennzeichnet, dass die eine Steuerung ausführbaren mindestens zwei Antriebs-Anordnungen (9) azimutale Antriebs-Anordnungen sind.

3. Marineschiff-Antriebssystem nach Anspruch 2,
dadurch gekennzeichnet, dass die azimutalen Antriebs-Anordnungen (9) mit konstanten Schraubenneigungs-Schiffsschrauben-Systemen und/ oder variablen Neigungs-Schiffsschrauben-Systemen versehen sind.

4. Marineschiff-Antriebssystem nach einem der vorangehenden Ansprüche 2-3,
dadurch gekennzeichnet, dass die azimutalen Antriebs-Anordnungen (9) aus elektrischer Motorleistung gespeist werden, die aus einem Kolbenmaschinen-Generatorsatz (2.1) stammt, und dass der wellenangetriebene Schrauben-Antrieb mechanisch an eine Kolbenmaschine (2.2) angeschlossen ist.

5. Marineschiff-Antriebssystem gemäß Anspruch 2,
dadurch gekennzeichnet, dass das Antriebssystem dazu bestimmt ist, in verschiedenen Betriebsmodi angetrieben zu werden, wobei im Normal-/ Fahrgeschwindigkeits-Betrieb sowohl die mindestens zwei azimutalen Antriebs-Anordnungen (9) und der mindestens eine wellenangetriebene Schrauben-Antrieb (3) dazu bestimmt sind, zumindest die Beschleunigungskraft aufzubringen, um das Schiff zu bewegen, und wobei im Niedergeschwindigkeits-/Manöverbetrieb nur die mindestens zwei azimutalen Antriebs-Anordnungen (9) dazu bestimmt sind, die Beschleunigungskraft aufzubringen, um das Schiff zu bewegen.

6. Marineschiff-Antriebssystem gemäß Anspruch 1,
dadurch gekennzeichnet, dass der Neigungswin-

kel (A) der Blätter in der Schiffsschraube (6) des wellenangetriebenen Schrauben-Antriebs auf entweder +80°-100° oder -80°-100° einstellbar ist.

7. Marineschiff-Antriebssystem gemäß einem der vorangehenden Ansprüche,
dadurch gekennzeichnet, dass das Maschinensystem (2) eine Kupplungsvorrichtung (4) aufweist, mit der die Welle (5) des Schrauben-Antriebs (3) an eine Maschine (2.2) angeschlossen ist, und die in eine entkoppelte Position gebracht werden kann.

8. Verfahren zum Betreiben eines Marineschiff-Antriebssystems, das am Heckabschnitt mindestens zwei eine Steuerungsaktion ausführbare Antriebs-Anordnungen (9) und mindestens einen wellenangetriebenen Schrauben-Antrieb (3) aufweist, wobei bei einer Normalgeschwindigkeit/Fahrt

- die Antriebs-Beschleunigungsleistung durch den wellenangetriebenen Schrauben-Antrieb (3) und die die Steuerungsaktion ausführbaren Antriebs-Anordnungen (9) vorgesehen wird, und
- die Steuerungs-Beschleunigungskraft mittels der die Steuerungsaktion ausführbaren Antriebs-Anordnungen (9) vorgesehen wird, und

dadurch gekennzeichnet, dass das Antriebssystem überdies mindestens einen wellenangetriebenen Schrauben-Antrieb (3) mit einer steuerbaren Blattneigung der Schraube (6) aufweist, und bei Normal-/Fahrtgeschwindigkeit die Beschleunigungskraft des wellenangetriebenen Schrauben-Antriebs hauptsächlich durch Einstellen des Neigungswinkels der Schiffsschraube (6) eingestellt wird, und im Niedergeschwindigkeitsbetrieb und/oder einem Hafenmanöver der wellenangetriebene Schrauben-Antrieb (3) flachgedreht eingestellt wird und die Kraftübertragung auf die Schiffsschraube (6) unterbrochen wird.

9. Verfahren zum Betreiben eines Marineschiff-Antriebssystems gemäß Anspruch 8,
dadurch gekennzeichnet, dass die Kraftübertragung auf den wellenangetriebenen Schrauben-Antrieb (3) unterbrochen wird, indem die Maschine (2.2) von der Welle (5) des wellenangetriebenen Schrauben-Antriebs (3) entkoppelt wird.

10. Verfahren zum Betreiben eines Marineschiff-Antriebssystems gemäß Anspruch 8 oder 9,
dadurch gekennzeichnet, dass die Kraftübertragung auf den wellenangetriebenen Schrauben-Antrieb (3) durch Anhalten der Maschine (2.2) unterbrochen wird.

11. Verfahren zum Betreiben eines Marineschiff-Antriebssystems gemäß Anspruch 8,
dadurch gekennzeichnet, dass die mindestens zwei die Steuerungsaktion ausführbaren Antriebs-Anordnungen (9) in Betrieb bleiben, während die Kraftübertragung auf den Schrauben-Antrieb (3) von dem Maschinensystem (2.2) unterbrochen ist.

12. Verfahren zum Betreiben eines Marineschiff-Antriebssystems gemäß Anspruch 8,
dadurch gekennzeichnet, dass bei niedriger Geschwindigkeit und/oder einem Manöverbetrieb der Neigungswinkel (A) der Schiffsschraube der wellenangetriebenen Schraubeneinrichtung (3) vorteilhafterweise auf entweder +80-100° oder -80-100° eingestellt wird.

13. Verfahren zum Betreiben eines Marineschiff-Antriebssystems gemäß einem der vorangehenden Ansprüche 8 bis 12, wobei die mindestens zwei die Steuerungsaktion ausführbaren Antriebs-Anordnungen (9) von Elektromotoren gespeist werden, deren Leistung durch einen oder mehrere Kolbenmaschinen-Generatorsätze (2.1) bereitgestellt wird,
dadurch gekennzeichnet, dass bei niedrigen Geschwindigkeiten und/oder einem Hafenmanöver die Kolbenmaschinen der Kolbenmaschinen-Generatorsätze 2.1 mit einer höheren Geschwindigkeit als im ungenutzten Geschwindigkeitsbetrieb betrieben werden, im wesentlichen zu ihrer effizientesten konstanten Geschwindigkeit, im wesentlichen unabhängig von der Leistungsanforderung der Antriebs-Anordnungen (9).

Revendications

1. Système de propulsion de navire comprenant un système (2) de moteur destiné à produire une puissance de propulsion et plusieurs moyens de propulsion (3, 9) comprenant au moins deux agencements de propulsion (9) capables d'une action de pilotage et au moins un dispositif d'entraînement d'hélice (3) entraîné par un arbre au niveau de sa section de coupe, **caractérisé en ce que** l'au moins un dispositif d'entraînement d'hélice (3) entraîné par un arbre est prévu avec une hélice à pas réglable (6) pouvant être ajusté sur des conditions sensiblement de mise en drapeau.

2. Système de propulsion de navire selon la revendication 1, **caractérisé en ce que** les au moins deux agencements de propulsion (9) capables d'une action de pilotage sont des agencements de propulsion d'azimutage.

3. Système de propulsion de navire selon la revendication 2, **caractérisé en ce que** les agencements de propulsion d'azimutage (9) sont prévus avec des

systèmes d'hélice à pas constant et/ou des systèmes d'hélice à pas variables.

4. Système de propulsion de navire selon l'une quelconque des revendications 2 à 3, **caractérisé en ce que** les agencements de propulsion d'azimutage (9) sont alimentés en puissance par un moteur électrique, dont la puissance est délivrée par un groupe électrogène (2.1) à moteur à piston et **en ce que** le dispositif d'entraînement d'hélice entraîné par un arbre est mécaniquement relié à un moteur à piston (2.2).

5. Système de propulsion de navire selon la revendication 2, **caractérisé en ce que** le système de propulsion est agencé de façon à être entraîné selon différents modes de fonctionnement, lorsqu'il se trouve en mode de fonctionnement à vitesse normale/de croisière, tant les au moins deux agencements de propulsion d'azimutage (9) que l'au moins un dispositif d'entraînement d'hélice (3) entraîné par un arbre sont adaptés pour provoquer au moins une poussée afin de déplacer le navire, et dans un mode de fonctionnement à faible vitesse/de manoeuvre, seuls les au moins deux agencements de propulsion d'azimutage (9) sont adaptés pour provoquer une poussée afin de déplacer le navire.

6. Système de propulsion de navire selon la revendication 1, **caractérisé en ce que** l'angle de pas (A) des pales dans l'hélice (6) du dispositif d'entraînement d'hélice entraîné par un arbre peut être ajusté de façon à être compris dans une plage soit de + 80° à 100° soit de - 80° à 100°.

7. Système de propulsion de navire selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le système (2) de moteur comprend un moyen de couplage (4) reliant l'arbre (5) du dispositif d'entraînement d'hélice (3) à un moteur (2.2) et pouvant être placé en position désenclenchée.

8. Procédé destiné à faire fonctionner un système de propulsion de navire comprenant au niveau de sa section de coupe au moins deux agencements de propulsion (9) capables d'une action de pilotage et au moins un dispositif d'entraînement d'hélice (3) entraîné par un arbre, dans lequel
à vitesse normale/de croisière

- la poussée de propulsion est fournie par le dispositif d'entraînement d'hélice (3) entraîné par un arbre et lesdits agencements de propulsion (9) capables d'une action de pilotage et
- une poussée de pilotage est fournie par les agencements de propulsion (9) capables d'une action de pilotage, et

caractérisé en ce que le système de propulsion comprend au moins un dispositif d'entraînement d'hélice (3) entraîné par un arbre ayant une hélice à pas réglable (6) et à vitesse normale/de croisière, la poussée du dispositif d'entraînement d'hélice entraîné par un arbre est principalement ajustée par ajustement de l'angle de pas de l'hélice (6) ;
dans un mode de fonctionnement à faible vitesse et/ou de manoeuvre au port, le dispositif d'entraînement d'hélice (3) entraîné par un arbre est ajusté pour être mis en drapeau et **en ce que** la transmission de puissance à l'hélice (6) est arrêtée.

9. Procédé destiné à faire fonctionner un système de propulsion de navire selon la revendication 8, **caractérisé en ce que** la transmission de puissance au dispositif d'entraînement d'hélice (3) entraîné par un arbre est arrêtée par désenclenchement du moteur (2.2) d'avec l'arbre (5) du dispositif d'entraînement d'hélice (3) entraîné par un arbre.

10. Procédé destiné à faire fonctionner un système de propulsion de navire selon la revendication 8 ou 9, **caractérisé en ce que** la transmission de puissance au dispositif d'entraînement d'hélice (3) entraîné par un arbre est arrêtée par arrêt du moteur (2.2).

11. Procédé destiné à faire fonctionner un système de propulsion de navire selon la revendication 8, **caractérisé en ce que** pendant que l'alimentation en puissance du dispositif d'entraînement d'hélice (3) est arrêtée à partir du système de moteur (2.2), les au moins deux agencements de propulsion (9) capables d'une action de pilotage sont maintenus en fonctionnement.

12. Procédé destiné à faire fonctionner un système de propulsion de navire selon la revendication (8), **caractérisé en ce que** dans un mode de fonctionnement à faible vitesse et/ou de manoeuvre, l'angle de pas (A) de l'hélice du dispositif d'entraînement d'hélice (3) entraîné par un arbre est ajusté de façon à être compris avantageusement soit dans une plage de + 80° à 100° soit dans une plage de - 80° à 100 °.

13. Procédé destiné à faire fonctionner un système de propulsion de navire selon l'une quelconque des revendications 8 à 12 précédentes, dans lequel les au moins deux agencements de propulsion (9) capables d'une action de pilotage sont alimentés en puissance par des moteurs électriques, dont la puissance est délivrée par un ou plusieurs groupes électrogènes (2.1) à moteur à piston, **caractérisé en ce que** dans un mode de fonctionnement à faible vitesse et/ou de manoeuvre au port, les moteurs à piston des groupes électrogènes (2.1) à moteur à piston sont mis en fonctionnement à une vitesse supérieure à une vitesse de ralenti, sensiblement à leur vitesse

constante la plus efficace sensiblement indépendamment de la consommation de puissance desdits agencements de propulsion (9).

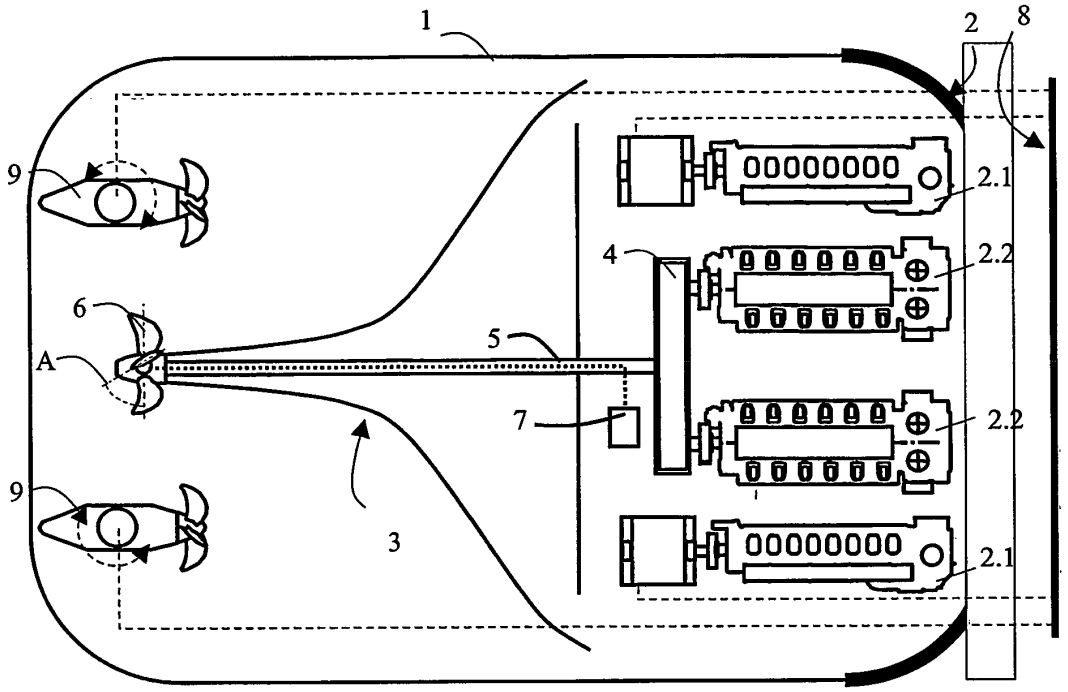


Fig. 1

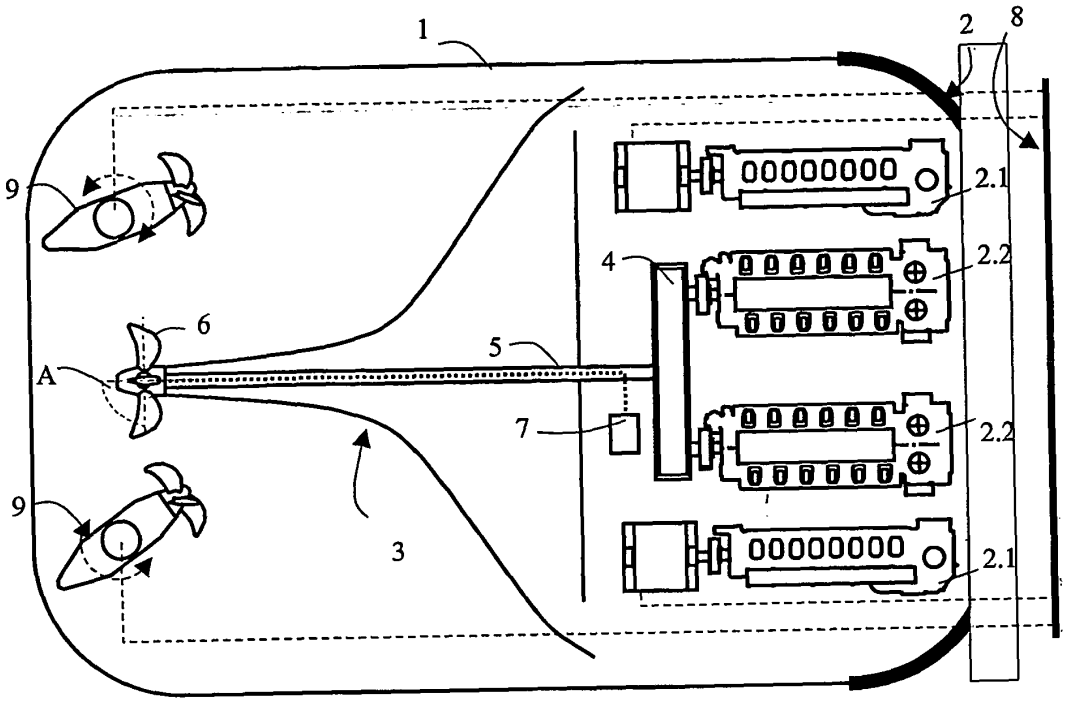


Fig. 2