Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention.)
Description

[0001] The invention relates to a propulsion and steering unit for a vessel comprising an integrated propeller/torpedo/rudder arrangement, wherein the torpedo is a part of a rudder horn fixedly mounted in a ship, and where the maximum diameter of the torpedo is greater than the diameter of a propeller hub.

[0002] Fuel savings, reduction of emissions and improved manoeuvrability are important conditions in the development of ships and ship equipment. The main objective of the present invention, which relates to an integrated system consisting of rudder, torpedo and propeller, is to improve propulsion efficiency and manoeuvring characteristics in relation to ships having conventional systems with separate rudder and propeller.

[0003] British Patent Application No. 762,445 makes known different types of the traditional Costa bulb, which have greater maximum diameter than the propeller hub, and which are arranged on the rudder behind the propeller. In the case of the structures taught here, the water flow between the hub and the front edge of the bulb will take place in such manner that the resistance of the bulb will increase. The solutions described are designed according to the principle that contraction of the propeller slip stream is wholly or partly eliminated by locating the front edge of the bulb close to the after end of the propeller blades.

[0004] In particular, GB 762,445 discloses a propulsion and steering unit for a vessel comprising an integrated propeller/torpedo/rudder arrangement, wherein the torpedo is a part of a rudder horn fixedly mounted in the ship, and where the maximum diameter of the torpedo is greater than the diameter of the propeller hub.

[0005] British Patent Publication No. 385607 makes known bodies mounted behind the propeller hub in such manner that in the case of fixed propellers they represent an extension of the propeller hub. Forward of these propeller hub extensions are openings to receive the nut at the rear of the fixed propeller. The diameter of these propeller hub extensions is not greater than that of the hub and therefore they will not reduce the contraction of the propeller slip stream. The main objective of this known solution is to avoid energy loss caused by cavitation behind the hub.

[0006] The transition between hub and extension is designed in such a way, though, that the desired effect is not achieved. However, a more streamlined transition between hub and extension is achieved by increasing the diameter of the propeller hub. An increased hub diameter causes, however, a reduction in the efficiency of the propeller.

[0007] Norwegian Patent Publication No. 154,262 also makes known the use of bulbs behind the propeller, which bulbs have a maximum diameter that is greater than the propeller hub. The bulbs are mounted on the moveable rudder blade and have a front edge extending to or ahead of the after end of the propeller hub, and are also combined with reaction fins. In the case of the bulbs taught in the Norwegian patent publication, the water flow between the hub and the front edge of the bulb will take place in such manner that the resistance of the bulb increases.

[0008] It is an object of the present invention to solve or at least alleviate the problems with the prior art.

[0009] Therefore, the present invention provides a propulsion and steering unit for a vessel comprising an integrated propeller/torpedo/rudder arrangement, wherein the torpedo is a part of a rudder horn fixedly mounted in the ship, and where the maximum diameter of the torpedo is greater than the diameter of the propeller hub, characterised in that the propeller hub, together with the torpedo, forms a continuous streamlined body, broken only by a narrow rotation gap, said propeller hub being designed to have a diameter that increases aftward.

[0010] The rudder may be a semi-balanced horn rudder with a horn needle bearing built into an aft end portion of the torpedo.

[0011] Preferably, the rudder blade has a notch substantially adapted to the outer contour of the torpedo profile, so that the rudder can swing freely without coming into contact with the torpedo.

[0012] Conveniently, the rotation gap between the propeller hub and the torpedo is designed to be conical with the greatest diameter aftward.

[0013] It is preferred that the rotation gap between the propeller hub and the torpedo is covered with a tear-proof material on one of the sides thereof.

[0014] Preferably, the upper edge of the torpedo is equipped with a coupling flange (screw connection) which fits against a corresponding coupling flange in a lower end of the horn, so that a torpedo and horn bearing bracket can be dismounted relatively easily for propeller shaft unshipping.

[0015] Conveniently, a portion of the torpedo which is in front of the rudder horn consists of two rings which can be dismounted and mounted relatively easily according to need for access to the aft end of the propeller.

[0016] The two said rings are preferably designed such that the end surface of each ring is somewhat eccentricaly displaced, so that by rotating the rings individually an adjustment of the rotation gap clearing is obtained.

[0017] Preferably, the portion of the torpedo which is in front of the rudder horn consists of two semi-cylindrical cover plates, side edges of which are flanged so that they can be screwed together in a vertical plane which passes through an axis of the propulsion system, and an aft end of one of said cover plates is flanged so that it can be screwed to a corresponding flange forward of the aft end portion of the torpedo, and the front edge of the aft end portion of the torpedo is designed like the aft end of the rotation gap.

[0018] It is preferred that the rudder horn and a rudder case have the same external profile as the rudder blade,
and that the rudder horn/rudder case is constructed having a constant cross-section through a skin plate of the ship and is secured thereto, and to the deck in the ship’s steering engine room and to vertical braces.

In order that the present invention may be well understood, a number of embodiments thereof, which are given by way of example only will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a lateral view of an embodiment of the invention; Fig. 2 shows a second embodiment of the invention where an unbalanced rudder is used; Fig. 3 is a section through the torpedo arrangement in Fig. 1; Fig. 4 shows two rings which form a portion of the torpedo; and Fig. 5 is a perspective view of a third embodiment of the invention.

In Fig. 1 the main components can be seen: a variable pitch propeller 1, a torpedo 2, rudder horn with rudder case 3, and a semi-balanced rudder 4. The propeller and rudder are positioned as on traditional ships. The propeller 1 is shown as a variable pitch propeller, but may also have fixed pitch. The illustrated outer contour 5 of the propeller hub 6 may either be cast in a single piece with the hub or be a screwed-on or shrunk-on adapter ring having a correct outer contour, adapted to an existing hub.

The torpedo 2, which has its greatest diameter approximately forward of the rudder horn 3, is located in the extension of the propeller hub 6 and is flanged (screwed) 7 into place on the rudder horn 3. The propeller bearing 8 is built into the after end, or aft end, of the torpedo 2. The rudder horn 4 has a notch 9 which accommodates the after end of the torpedo 2.

In Fig. 2 the second embodiment of the invention where an unbalanced rudder 10 is used. The rudder horn 11 here is extended down to the lower edge of the rudder blade 10, and the horn bearing 12 is located at the very bottom. The rudder horn 11 is split by a horizontal flange 13 above the torpedo 14 (for dismounting purposes) and the lower part of the rudder horn is integrated with the torpedo. The rudder blade can be equipped with flaps, if so desired.

Fig. 3 shows a section through the torpedo arrangement in Fig. 1. The propeller hub 6 has a conventional outer contour which has been modified and adapted to the streamlined shape of the torpedo 2 by means of a screwed-on transition ring 5, the after end of which forms one side of the rotation gap 15. The rotation gap 15, as shown in the detailed section, is designed to be conical with the greatest diameter facing abaft. This is to improve the flow conditions over the gap, and also to reduce the effect of any axial deviations between the propeller and torpedo.

The torpedo 2 is divided into three parts, a fixed after part, or aft end portion, 16 which is designed to have a flange 17 on the upper side for attachment to the rudder horn 3 by means of flange connection 7, and two detachable concentric rings 18, 19 which are held in place by a dog bolt 20. Forward of the foremost ring 19 there is a shoulder turning upon which a ring 21 of tear-resistant material is placed. This ring, as is apparent from the detailed section, is adapted to the rotation gap 15.

The horn bearing boss 22 in the lower horn bearing 8 (Fig. 1) is suspended in a bracket 23 which is structurally integrated into the torpedo 2, i.e., in the torpedo’s fixed after part 16.

In order to be able to adjust the clearing of the rotation gap simply, the torpedo may to advantage include two rings 18, 19 which are designed to have eccentrically displaced end surfaces, as is shown in Fig. 4, where the eccentricities are indicated with the letter e.

In the perspective view of the third embodiment of the invention in Fig. 5, the design of the torpedo has been modified relative to that shown in Figs. 1 and 3, such that the part, or portion, of the torpedo 2 which is in front of the rudder horn 3 consists of two semi-cylindrical cover plates 25, 26 (shown drawn apart from one another), whose side edges are flanged so that they can be screwed together in a vertical plane running through the axis of the propulsion system, and the after end 27 of which (only shown for one cover plate 26) is flanged so that it can be screwed to a corresponding flange in the front edge of the after part of the torpedo, and the front edge of which is designed to be the after part of the rotation gap 15 and forms one of the defining surfaces thereof.

Furthermore, it can be seen from Fig. 5 that the rudder horn and the rudder case 3 have the same external profile as the rudder blade 4, and that the rudder horn/rudder case 3 is constructed with a constant cross-section through the skin plate 28 of the ship and is secured (welded) thereto and also to the deck 29 in the ship’s steering engine room and to vertical braces 30.

The torpedo may have reaction fins. Such reaction fins are known, for example, from NO 154,262.

In the embodiments, a streamlined body, termed a torpedo, is used, which has a greater maximum diameter than the propeller hub. The propeller hub and torpedo are designed so that together they form an optimised streamlined profile, i.e., a continuous profile from the front edge of the propeller hub to the aft end of the torpedo, broken only by a narrow gap. The torpedo is mounted fixedly relative to the ship in that it is rigidly secured to the rudder horn. Thus, there is only a minimal rotation gap between the propeller hub (rotating) and the torpedo (stationary). In the case of a variable pitch propeller, the roots of the blades are incorporated into the streamlined profile.

One or both surfaces in the rotation gap may be coated with a tear-proof bearing material. The after part of the torpedo ends behind the axis of the rudder stock,
and cuts into the rudder blade, which has a notch corresponding to the outline of the torpedo. A small clearing is included in this notch so that the rudder blade can swing unimpeded whilst the pressure leakage through the gap is minimal on small rudder deflections. The whole system consisting of propeller blades, propeller hub, torpedo, rudder horn, rudder blade, optional flaps and optional fins is integrated and optimised with a view to optimal propulsion efficiency and manoeuvring characteristics.

[0032] In the case of all the known bulbs having a maximum diameter behind the propeller which is greater than the propeller hub, the forward part of the bulb profile is located behind the propeller centre. The forward part of the bulbs is designed so that the form resistance of the bulb increases and/or is located on a moveable rudder so that the bulb's resistance, and thus the necessary engine output, increase on the small rudder deflections which are necessary to keep the vessel on the planned course.

[0033] The propulsion and steering unit according to the embodiments is designed so that the torpedo and propeller hub form an uninterrupted streamlined profile. This is done to eliminate more efficiently contraction of the propeller slip stream, and also to recover more of the energy loss which is caused by vortex shedding and cavitation behind the propeller hub.

[0034] In the transition between the actual propeller blade and the root of the blade, ie behind the quarter-hollows of the propeller blade, vortices are formed behind each propeller blade. Owing to the streamlined transition between the rotating propeller hub and the fixed torpedo according to the embodiments, these vortices will rotate around the torpedo and the energy loss will therefore be recovered in the transition between the torpedo and the front edge of the rudder.

[0035] None of the structures known hitherto are designed to allow the recovery of this energy loss, and nor are any attempts to exploit this energy loss known to have been described.

[0036] Owing to the fact that the propeller hub, together with the torpedo according to the embodiments, constitute a uniform streamlined profile, it is also possible to increase propulsion efficiency by increasing the load along the propeller blades. In the case of the bulb structures known hitherto, the transition between the propeller hub, torpedo and rudder has been designed such that it is not possible to achieve any appreciable recovery of this increased energy loss caused by more powerful quarter hollow vortices and shedding behind the propeller hub.

[0037] However, with this integrated system there arise new possibilities of optimising the propeller blade geometry, torpedo and rudder as a unit with a view to increasing propulsion efficiency.

[0038] Radial fins mounted on the surface of the torpedo can, in certain cases, be used to recover more of the rotation energy in the propeller slip stream.

[0039] Tests with models have shown that in relation to the known conventional arrangements with rudder bulbs, the new integrated system according to the embodiments provides a considerably higher degree of propulsion efficiency and thus reduced necessary engine output. The desired effects of using a continuous streamlined profile and torpedo/rudder combination are thus achieved. Tests carried out with models show that in contrast to the previously known bulbs this integrated system gives increased gain on increasing ship speed.

[0040] In the case of some types of vessel, the length/breadth ratio of the hull has been steadily reduced. This has resulted in a number of vessels having poor straight line and course stability. The embodiments with the fixedly mounted torpedo in the propeller slip stream together with the rudder horn, will impart to the vessels improved straight line and course stability. In particular in the case of vessels which operate on long runs, any of the illustrated arrangements will reduce necessary rudder use to maintain course and thus reduce fuel consumption further.

[0041] The illustrated integrated systems will moreover eliminate hub vortices/shedding behind the hub, and will thus contribute towards a considerable reduction in propeller-induced subsea noise.

Claims

1. A propulsion and steering unit for a vessel comprising an integrated propeller/torpedo/rudder arrangement, wherein the torpedo (2) is a part of a rudder horn (3) fixedly mounted in the ship, and where the maximum diameter of the torpedo is greater than the diameter of the propeller hub (6), characterised in that the propeller hub (6), together with the torpedo (2), forms a continuous streamlined body, broken only by a narrow rotation gap, said propeller hub (6) being designed to have a diameter that increases aftward.

2. A propulsion and steering unit according to Claim 1, wherein the rudder is a semi-balanced horn rudder (3, 4) with a horn needle bearing (8) built into an aft end portion (16) of the torpedo (2).

3. A propulsion and steering unit according to Claim 1 or 2, wherein the rudder blade (4) has a notch (9) substantially adapted to the outer contour of the torpedo profile, so that the rudder can swing freely without coming into contact with the torpedo.

4. A propulsion and steering unit according to any one of the preceding claims, wherein the rotation gap (15) between the propeller hub (6) and the torpedo (2) is designed to be conical with the greatest diameter aftward.
5. A propulsion and steering unit according to any one of the preceding claims, wherein the rotation gap (15) between the propeller hub and the torpedo is covered with a tear-proof material (21) on one of the sides thereof.

6. A propulsion and steering unit according to any one of the preceding claims, wherein the upper edge of the torpedo (2) is equipped with a coupling flange (17) (screw connection) which fits against a corresponding coupling flange in a lower end of the horn (3), so that a torpedo (2) and horn bearing bracket (23) can be dismounted relatively easily for propeller shaft unshipping.

7. A propulsion and steering unit according to any one of the preceding claims, wherein a portion of the torpedo (2) which is in front of the rudder horn (3) consists of two rings (18, 19) which can be dismounted and mounted relatively easily according to need for access to the aft end of the propeller.

8. A propulsion and steering unit according to Claim 7, wherein the two said rings (18, 19) are designed such that the end surface of each ring is somewhat eccentrically displaced, so that by rotating the rings individually an adjustment of the rotation gap (15) clearing is obtained.

9. A propulsion and steering unit according to any one of the preceding Claims 1 to 6, wherein the portion of the torpedo (2) which is in front of the rudder horn (3) consists of two semi-cylindrical cover plates (25, 26) side edges of which are flanged so that they can be screwed together in a vertical plane which passes through an axis of the propulsion system, and an aft end (27) of one of said cover plates is flanged so that it can be screwed to a corresponding flange forward of the aft end portion of the torpedo (2), and the front edge of the aft end portion of the torpedo is designed like the aft end of the rotation gap.

10. A propulsion and steering unit according to any one of the preceding claims, wherein the rudder horn (3) and a rudder case have the same external profile as the rudder blade (4), and that the rudder horn/rudder case is constructed having a constant cross-section through a skin plate (28) of the ship and is secured thereto, and to the deck (29) in the ship's steering engine room and to vertical braces (30).

Patentansprüche

1. Antriebs- und Steuereinheit für ein Schiff mit einer integrierten Propeller/Torpedo/Ruderanordnung, wobei der Torpedo (2) Teil eines fest in dem Schiff angebrachten Ruderhorns (3) ist, und wobei der maximale Durchmesser des Torpedos größer ist als der der Propellernabe (6), dadurch gekennzeichnet, daß die Propellernabe (6) zusammen mit dem Torpedo (2) einen durchgängigen stromlinienförmigen Körper bildet, der nur durch einen engen Drehspalt unterbrochen ist, wobei die Propellernabe (6) so ausgebildet ist, daß ihr Durchmesser nach achtern zunimmt.

2. Antriebs- und Steuereinheit nach Anspruch 1, wobei das Ruder ein halb- ausgewuchtetes Hornruder (3, 4) mit einem Hornnadellager (8) ist, das in einem achternen Endabschnitt (16) des Torpedos (2) eingebaut ist.

3. Antriebs- und Steuereinheit nach Anspruch 1 oder 2, wobei das Ruderblatt (4) eine Aussparung (9) hat, die im wesentlichen an die äußere Kontur des Torpedoprofils angepaßt ist, so daß das Ruder frei schwingen kann, ohne in Kontakt mit dem Torpedo zu kommen.

4. Antriebs- und Steuereinheit nach einem der vorhergehenden Ansprüche, wobei der Drehspalt (15) zwischen der Propellernabe (6) und dem Torpedo (2) derart ausgebildet ist, dass er konisch mit dem größten Durchmesser nach achtern ist.

5. Antriebs- und Steuereinheit nach einem der vorhergehenden Ansprüche, wobei der Drehspalt (15) zwischen der Propellernabe und dem Torpedo auf einer seiner Seiten mit einem reißfesten Material (21) bedeckt ist.

6. Antriebs- und Steuereinheit nach einem der vorhergehenden Ansprüche, wobei die obere Kante des Torpedos (2) mit einem Verbindungsflansch (17) (Schraubverbindung) ausgestattet ist, das auf einen zugehörigen Verbindungsflansch an einem unteren Ende des Ruderhorns (3) paßt, so daß ein den Torpedo (2) und das Ruderhorn tragender Träger (23) relativ leicht demontiert werden kann, um die Propellerwelle freizulegen.

7. Antriebs- und Steuereinheit nach einem der vorhergehenden Ansprüche, wobei ein vor dem Ruderhorn (3) angeordnete Teil des Torpedos (2) aus zwei Ringen (18, 19) besteht, die bei Bedarf relativ leicht demontiert und montiert werden können, um Zugang zu dem Achterende des Propellers zu schaffen.

8. Antriebs- und Steuereinheit nach Anspruch 7, wobei die zwei Ringe (18, 19) so ausgebildet sind, daß die Stirnfläche jedes Rings etwas exzentrisch verschoben ist, so daß durch einzelne Drehung der Ringe eine Einstellung der Größe des Drehspalts
(15) erreicht wird.

9. Antriebs- und Steuereinheit nach einem der Ansprüche 1 bis 6, wobei der vor dem Ruderhorn (3) angeordnete Teil des Torpedos (2) aus zwei halbzylindrischen Deckplatten (25, 26) besteht, deren Seitenkanten derart angeflanscht sind, daß sie sich in einer eine Achse des Antriebsystems durchsetzenden vertikalen Ebene zusammenschräuben lassen, und ein Achterende (27) einer der Deckplatten so angeflanscht ist, daß es sich an einen zugehörigen Flansch vor dem achterlichen Endabschnitt des Torpedos (2) anschrauben läßt, und die Vorderkante des achterlichen Endabschnitts des Torpedos (2) wie das Achterende des Drehspalts ausgebildet ist.

10. Antriebs- und Steuereinheit nach einem der vorhergehenden Ansprüche, wobei das Ruderhorn (3) und ein Rudergehäuse das gleiche äußere Profil wie das Ruderblatt (4) aufweisen und daß das Ruderhorn/Rudergehäuse so ausgebildet ist, dass es im Schnitt durch eine Verkleidungsplatte des Schiffes einen konstanten Querschnitt hat, und an der Verkleidungsplatte des Schiffes, dem Deck (29) des Schiffsteuerungsmaschinenraums und an Vertikalstreben (30) befestigt ist.

Revendications

1. Module de propulsion et de direction pour un bâtiment comprenant un agencement hélice/torpille/gouvernail intégré, dans lequel la torpille (2) fait partie d'une corne (3) de gouvernail montée de manière fixe dans le navire, et où le diamètre maximum de la torpille est supérieur au diamètre du moyeu d'hélice (6), caractérisé en ce que le moyeu d'hélice (6) forme, avec la torpille (2), un corps profilé continu, interrompu seulement par un étroit espace de rotation, ledit moyeu d'hélice (6) étant conçu pour avoir un diamètre qui augmente vers l'arrière.

2. Module de propulsion et de direction selon la revendication 1, dans lequel le gouvernail est un gouvernail à corne semi-équilibré (3, 4) avec un roulement à aiguilles (8) de corne intégré dans une partie d'extrémité arrière (16) de la torpille (2).

3. Module de propulsion et de direction selon la revendication 1 ou 2, dans lequel la lame (4) de gouvernail comporte une encoche (9) sensiblement adaptée au contour extérieur du profil de la torpille, de façon que le gouvernail puisse osciller librement sans venir au contact de la torpille.

4. Module de propulsion et de direction selon l'une quelconque des revendications précédentes, dans lequel l'espace de rotation (15) entre le moyeu d'hélice (6) et la torpille (2) est conçu pour être conique, avec son plus grand diamètre à l'arrière.

5. Module de propulsion et de direction selon l'une quelconque des revendications précédentes, dans lequel l'espace de rotation (15) entre le moyeu d'hélice et la torpille est couvert d'un matériau à l'épreuve des déchirures (21) sur un de ses côtés.

6. Module de propulsion et de direction selon l'une quelconque des revendications précédentes, dans lequel le bord supérieur de la torpille (2) est équipé d'une bride d'accouplement (17) (connexion vissée) qui s'ajuste contre une bride d'accouplement correspondante située dans une extrémité inférieure de la corne (3), de telle sorte qu'une potence (23) de support de torpille (2) et de corne peut être démontée relativement facilement pour le démontage de l'arbre de l'hélice.

7. Module de propulsion et de direction selon l'une quelconque des revendications précédentes, dans lequel la partie de la torpille (2) qui est en face de la corne (3) de gouvernail est constituée de deux bagues (18, 19) qui peuvent être démontées et montées relativement facilement selon les besoins d'accès à l'extrémité arrière de l'hélice.

8. Module de propulsion et de direction selon la revendication 7, dans lequel lesdites deux bagues (18, 19) sont conçues de façon que la surface d'extrémité de chaque bague est quelque peu déplacée de manière excentrique, si bien que, en faisant tourner les bagues individuellement, on obtient un réglage du jeu de l'espace de rotation (15).

9. Module de propulsion et de direction selon l'une quelconque des revendications 1 à 6, dans lequel la partie de la torpille (2) qui est en face de la corne (3) de gouvernail est constituée de deux plaques protectrices semi-cylindriques (25, 26) dont les bords latéraux comportent une bride de telle sorte qu'ils peuvent être vissés ensemble dans un plan vertical qui passe par un axe du système de propulsion, et une extrémité arrière (27) de l'une desdites plaques protectrices comporte une bride de telle sorte qu'elle peut être vissée à une bride correspondante devant la partie d'extrémité arrière de la torpille (2), et le bord avant de la partie d'extrémité arrière de la torpille a le même dessin que l'extrémité arrière de l'espace de rotation.

10. Module de propulsion et de direction selon l'une quelconque des revendications précédentes, dans lequel la corne (3) de gouvernail et un capot de gouvernail ont le même profil externe que la lame (4) de gouvernail, et la corne de gouvernail/le capot de
gouvernail présente une section transversale constante à travers une plaque de paroi (28) du navire et est fixé(e) à cette dernière, et au plancher (29) de la salle des machines de direction du navire et à des entretoises verticales (30).