

DESCRIPTION

SHIP PROPULSION DEVICE AND SHIP PROVIDED WITH SAME

TECHNICAL FIELD

[0001]

The present invention relates to a ship propulsion device using a screw propeller, and to a ship provided with the same. The present invention relates more particularly to a ship propulsion device which exhibits an improved propulsion performance of a screw propeller by installing fins provided to a boss cap attached to a boss of the screw propeller, and to a ship provided with the same.

BACKGROUND ART

[0002]

Many ships use a screw propeller as their propulsive device. The enhancement of the propeller characteristics such as propeller efficiency makes a great contribution to an improvement in fuel efficiency. To this end, research has been carried out on propeller blades, such as on the number of propeller blades, blade shapes, expanded areas, pitch angles, and skew angles, and various blade shapes have been developed.

[0003]

For the purpose of enhancing the propeller characteristics, as described in Japanese Examined Patent Application Kokai Publication No. Hei 7-121716, a boss cap 5 with rectification fins, as shown in Figs. 9 to 12, has been developed for enhancing the propeller efficiency by reducing hub vortices in the slipstream of the propeller boss cap 5 in the vicinity of a propeller boss 2.

[0004]

This boss cap 5 with rectification fins has as many (four

in Fig. 9) fins 6 attached to the boss cap 5 as (four in Fig. 9) propeller blades 3. Furthermore, as shown in Fig. 10, the angle α of the attachment of the fins 6 has a relationship ($-20^\circ \leq \alpha - \varepsilon \leq +30^\circ$) with the geometric pitch angle ε of root of propeller blade. From a viewpoint of the longitudinal direction of the fins 6, the front edges of the fins 6 are arranged coinciding with, or rearward of, the rear edges of the roots of the propeller blades 3 in the front-rear direction of the propeller ($b \geq 0$). In addition, the fins 6 are provided in the spaces between the roots of the adjacent propeller blades 3 ($a > 0$). Moreover, as shown in Figs. 11 and 12, the largest diameter ($2r$) of an imaginary circle joining the tips of the fins 6 from the axis of the main body of the boss cap 5 is larger than a diameter D_{ba} of a cap attachment end portion 2a of the propeller boss 2, and not greater than 33% of the propeller diameter ($2R$).

[0005]

The working and effects of this boss cap 5 with rectification fins are explained as follows. The rectification fins 6 produce no thrust by themselves, and work as a rectification plate for reducing the occurrence of the hub vortices in the slipstream of the boss cap 5. This rectification working diffuses the hub vortices in the slipstream of the boss cap 5, and thereby reduces the induced drag which is caused by vortexes on the surfaces of the propeller blades 3. As a result, the propeller characteristics (propeller efficiency) are enhanced to a large extent without increasing the torque.

[0006]

In addition, for example, as described in Japanese Patent

No. 3491890, a proposal was made on a ship propeller including a hub-vortex eliminating device, such as these rectification fins, for eliminating the vortices from the propeller hub, as follows. The hub-vortex eliminating device aimed at enhancing total efficiency of the propeller by being made to fully perform its function, and additionally at bringing out advantages in strength. To this end, the pitch or camber in the root of each propeller blade was set larger than the pitch or camber in the middle portion of the propeller blade.

[0007]

Furthermore, as described in Japanese Published Utility Model Application No. Hei 5-7599 and Japanese Examined utility Model Application Publication No. Hei 7-34795, a proposal was made on a propeller boss with fins which was provided with as many rectification fins as screw propeller blades on the propeller boss downstream of the screw propeller blades, specifically on the side peripheral surface of the boss portion, instead of on the boss cap.

[0008]

On the other hand, the inventors made the following proposals on a ship propulsion device using a screw propeller and a ship provided with the ship propulsion device, starting with an idea that the ship propulsion device using the boss cap with rectification fins would be able to enhance the propeller efficiency further depending on fin shapes, and by conducting experiments in a water tank with many fin shapes which were developed from a diverse range of inspiration.

[0009]

As one example, for the purpose of enhancing the propeller efficiency and machining easiness as well as reducing the weight,

the inventors proposed in Japanese Patent Application Kokai Publication No. 2010-215187 that the rear end portion of the boss cap be formed from an end surface, or the rear end portions be shaped to have a dimension within the range of 20% of the full length of the propeller boss cap; the full length thereof be 0.28 to 0.76 times of the diameter at the front end portion of the cap; and the diameter at the rear end portion of the propeller boss cap be 0.35 to 0.95 times of the diameter at the front end portion of the propeller boss cap.

[0010]

The inventors made another proposal on improvement to the fin with the following findings. Because the fin of the conventional technology was formed in a flat shape, the angle at the root of the fin to the propeller shaft was equal to the angle of the tip of the fin to the propeller shaft. However, as a result of an analysis of flows along the surfaces of the fin using calculation by a computational fluid dynamics, the inventors obtained findings that: directions of flows to the fin were different between the root and the tip of the fin; and the outer peripheral rear edge side of the flat-shaped fin produced resistance.

[0011]

On the basis of the findings, the inventors thought that the cutting of an outer peripheral rear edge side portion of the fin would be able to enhance the propeller efficiency. For the purpose of enhancing the propulsion efficiency and machining easiness as well as reducing the weight, the inventors proposed in Japanese Patent Application Kokai Publication No. 2010-234861 that: when the diameter of the front end portion of the propeller boss cap was used as a reference diameter, the

shape of the rear half portion of each fin be formed such that the diameter of a circle joining portions of the fins in a plane passing the centers between the front ends and the rear ends of the fins was 2.0 times the reference diameter; and the diameter of a circle joining portions of the fins at the positions of the rearmost ends of the fins was 1.5 times the reference diameter.

[0012]

On the basis of the above, the inventors continued the research further, and eventually became sure that the setting of the fin shape in consideration of the directions of the flows to each fin would make it possible to increase the lift at the tip of the fin more positively, and to obtain the fin shape capable of enhancing the propeller efficiency further.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0013]

Patent Document 1: Japanese Examined Patent Application Kokai Publication No. Hei 7-121716

Patent Document 2: Japanese Patent No. 3491890

Patent Document 3: Japanese Published Utility Model Application No. Hei 5-7599

Patent Document 4: Japanese Examined Utility Model Application Publication No. Hei 7-34795

Patent Document 5: Japanese patent application Kokai publication No. 2010-215187

Patent Document 6: Japanese patent application Kokai publication No. 2010-234861

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0014]

An object of the present invention is to provide a ship propulsion device formed from a screw propeller using a propeller boss cap with fins, and a ship provided with the ship propulsion device, which exhibit a better propeller efficiency than a ship propulsion device using a propeller boss cap with fins in a conventional technique-based fin shape and a ship provided with the ship propulsion device.

MEANS FOR SOLVING THE PROBLEM

[0015]

A ship propulsion device to achieve the foregoing purpose is a ship propulsion device in which fins are provided to a propeller boss cap attached on a rear side of a propeller boss of a screw propeller and is disposed rearward of a space between propeller blades, wherein a shape of the fin is formed by creating twist in the fin in a way that front and rear edge parts of a tip of the fin move respectively rearward and forward in a root of the fin.

[0016]

According to this configuration, since the twist is created in the fin in the way that the front and rear edge parts of the tip of the fin are respectively rearward and forward in the root of the fin with consideration given to a direction of a flow to the tip of the fin, it is possible to prevent the tip of the fin from producing resistance, and to increase the lift at the tip of the fin. For this reason, the propeller efficiency can be enhanced further.

[0017]

When the twist of the fin in the ship propulsion device is designed such that the twisting angle of the tip to the root

is an angle within a range not less than 0 degrees but not greater than 20 degrees, the use of a relatively simple reference makes it possible to prevent the tip of the fin from producing resistance, and to increase the lift at the tip of the fin, in almost all ships.

[0018]

In addition, the ship propulsion device to achieve the foregoing purpose is formed such that the fins are provided on a portion of the propeller boss of the screw propeller which is rearward of the propeller blades, instead of on the propeller boss cap. This is because: the fin effect is determined on the basis of a positional relationship of the fin with the propeller blades; and depending on a relationship between the propeller boss and the propeller boss cap, there may be a case where the fin is provided on the propeller boss instead of on the propeller boss cap.

[0019]

In addition, a ship to achieve the foregoing purpose is provided with the foregoing ship propulsion device. This makes it possible to provide the ship which exhibits better propeller efficiency than a ship provided with a ship propulsion device using a propeller boss cap with fins in a conventional technique-based fin shape.

EFFECTS OF THE INVENTION

[0020]

According to the ship propulsion device of the present invention, in the propulsion device including the screw propeller using the propeller boss cap with fins, the twist is created in the fin in the way that the front and rear edge parts of the tip of the fin are respectively rearward and forward of

the root of the fin with consideration given to the directions of the flows to the fin. This makes it possible to increase the lift at the tip of the fin, and enhance the propeller efficiency further.

[0021]

According to the ship provided with the ship propulsion device of the present invention, since the ship propulsion device with the high propeller efficiency is used for the ship, the ship is capable of enhancing its propulsion efficiency. If even the slightest improvement can be made to the propulsion efficiency, the ship whose service duration lasts over 10 years and whose fuel consumption is large will be able to save fuel to a very large extent.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

[Fig. 1] Fig. 1 is a diagram showing a configuration of a ship propulsion device according to an embodiment of the present invention, which is viewed from a stern.

[Fig. 2] Fig. 2 is a side view of the ship propulsion device shown in Fig. 1.

[Fig. 3] Fig. 3 is a side view of a propeller boss cap, which shows a twisting state of a fin, and a twisting angle of the fin.

[Fig. 4] Fig. 4 is a partial perspective view of the propeller boss cap, which shows the twisting state of the fin, and the twisting angle of the fin.

[Fig. 5] Fig. 5 is a cross-sectional view of the propeller boss cap taken along the A-A line of Fig. 3, which is viewed from the stern, and which shows how a rake angle of the fin may be.

[Fig. 6] Fig. 6 is a partial perspective view of the propeller boss cap where the twisting angle is at 10 degrees.

[Fig. 7] Fig. 7 is a partial perspective view of the propeller boss cap where the twisting angle is at 0 degrees.

[Fig. 8] Fig. 8 is a partial perspective view of the propeller boss cap where the twisting angle is at minus 10 degrees.

[Fig. 9] Fig. 9 is a diagram showing a configuration of a ship propulsion device according to a conventional technology, which is viewed from a stern.

[Fig. 10] Fig. 10 is a side view of the ship propulsion device shown in Fig. 9.

[Fig. 11] Fig. 11 is a side view showing a shape of a propeller boss cap according to the conventional technology.

[Fig. 12] Fig. 12 is a side view showing a positional relationship between propeller blades and fins according to the conventional technology.

MODES FOR CARRYING OUT THE INVENTION

[0023]

Referring to the drawings, descriptions will be hereinbelow provided for an embodiment of a ship propulsion device and an embodiment of a ship provided with the same, according to the present invention. The descriptions will be provided citing an example where fins disposed rearward of propeller blades are disposed on a propeller boss cap. The present invention, however, is applicable to a case where the fins are provided on a portion of a propeller boss which is rearward of the propeller blades. It should be noted that, for the purpose of facilitating understanding, Figs. 1 to 5 and Figs. 6 to 12 show the shapes and dimensions of the propeller boss,

the propeller blades, the propeller boss cap, the fins and the like as if different from one figure to another. And these shapes and dimensions in the figures are different from the actual shapes and dimensions. In addition, Figs. 3, 5, 10 and 12 omit the propeller blades and the fins which are visible as a matter of course, for the purpose of making Figs. 3, 5, 10 and 12 easy to look at, and for the sake of drawing and explanatory convenience.

[0024]

As shown in Figs. 1 to 5, a ship propulsion device 1 according to the embodiment of the present invention is formed from a screw propeller composing: a propeller boss (propeller hub) 2; propeller blades 3 attached to the propeller boss 2; a propeller boss cap (propeller hub cap) 5 connected to the rear end of the propeller boss 2; and fins 6 provided to the propeller boss cap 5.

[0025]

In addition, the propeller boss cap 5 is formed in the shape of a solid revolution around a propeller axis of rotation P_c , and a rear end portion 5a of the propeller boss cap 5 is formed as a flat surface. The solid revolution is formed by rotating a smooth-curve or straight-line generatrix, and the solid revolution is formed in a shape tapering toward the rear.

[0026]

In this respect, as shown in Fig. 3, when the diameter D_{cf} of a front end portion of the propeller boss cap 5 is used as a reference diameter D_s , it is desirable that: the full length L_c of the propeller boss cap 5 is set to be 0.28 to 0.76 times the reference diameter D_s ; and the diameter D_{ca} of the rear end portion 5a of the propeller boss cap 5 is set to be 0.35 to 0.95

times the reference diameter D_s . Incidentally, the diameter D_{cf} of the front end portion 5f corresponds to the flange diameter of the propeller boss cap 5.

[0027]

In addition, in a case where as shown in Fig. 3, the generatrices of the solid revolution which form an outer peripheral surface 5b of the propeller boss cap 5 are a straight line, the propeller boss cap 5 is shaped like a circular truncated cone, and is accordingly very easy to produce. Otherwise, in a case where albeit not illustrated, the generatrices thereof are a smooth curves, the shape of the propeller boss cap 5 smoothly tapers from fore to stern as well. In this case, it is preferable that the shape deviation of the rear end portion 5a of the propeller boss cap 5 from the truncated circular cone on the cross section perpendicular to the propeller axis of rotation P_c be equal to or less than 20% of the full length L_c of the propeller boss cap 5.

[0028]

In addition, the end surface of the front end portion 5f of the propeller boss cap 5 is formed in a plane shape because the end surface of the front end portion 5f of the propeller boss cap 5 is connected to a rear end surface 2a of the propeller boss 2. Meanwhile, the end surface of the rear end portion 5a of the propeller boss cap 5 may be formed in the shape of a circular cone, a solid revolution or the like which is close to a plane, although it is desirable that as shown in Fig. 3, the end surface of the rear end portion 5a be formed in a plane shape from a viewpoint of machining easiness. Even in this case, the shape of the rear end portion 5a is formed in a way that the distance in the front-rear direction of the propeller boss

cap 5 between the peripheral edge portion and the central portion is equal to or less than of 20% of the full length L_c of the propeller boss cap 5.

[0029]

As shown in Figs. 1 to 4, fins 6 are provided on the propeller boss cap 5 attached to the rear side of the propeller boss 2 of the screw propeller 1, and arranged rearward of the spaces between the propeller blades 3. In other words, when viewed from the front to the rear along the propeller axis P_c , front ends 6bf of roots (6bf to 6ba) of the fins 6 are arranged between the rear ends of the roots of the propeller blades 3. In addition, when viewed from the side, the front ends 6bf of the roots (6bf to 6ba) of the fins 6 are arranged rearward of the rear ends of the roots of the propeller blades 3. Although the fins 6 may be formed having positive or negative cambers, a plane shape is suitable for the fins 6 from viewpoints of machining easiness and a reduction in manufacturing costs. Furthermore, the fins 6 may be attached to the propeller boss cap 5 at a positive or negative rake angle.

[0030]

Since the front ends 6bf and rear ends 6ba of the roots (6bf to 6ba) of the fins 6 need to be arranged on the propeller boss cap 5, it is natural that a restriction be imposed on the length of the fins 6 from a viewpoint of a relationship of an angle α of attachment of the fins 6 with the center line of rotation of propeller boss cap 5. For example, the front ends 6bf of the roots (6bf to 6ba) of the fins 6 are arranged coinciding with, or rearward of, the rear edges of the roots of the propeller blades 3 in the front-rear direction of the propeller boss 2.

[0031]

In addition, as shown in Fig. 10, the fins 6 are attached there in a way that, as in the case of the conventional technology, the angle α of attachment of the fins 6 satisfies a relationship of $-20^\circ \leq \alpha - \varepsilon \leq +30^\circ$, where ε denotes the geometric pitch angle of the roots of the propeller blades 3. Furthermore, the fins 6 are attached in the spaces between the roots of the adjacent propeller blades 3. As shown in Fig. 5, the angle α of attachment of the fins 6 may be provided with a rake angle γ , as in the case of the propeller boss cap 5 with fins of the conventional technology. Fig. 5 shows cases where the fins 6 are attached there, respectively, at no rake angle, at a positive rake angle $(+\gamma)$, and a negative rake angle $(-\gamma)$.

[0032]

Moreover, with regard to the thickness direction of the fins 6, if formed in the shape of a flat plate with a uniform thickness, the fins 6 are easy to machine. However, when even the slightest improvement to the performance is sought, the fins 6 are formed in the shape of a wing. Furthermore, the fins 6 may be provided with a camber by curving the flat plate, or by being formed in the shape of a wing. In the case where the fins 6 are provided with a camber, it is preferable that: with consideration given to a relationship of the shape of the fins 6 with the shape of the propeller boss cap 5, the camber be provided to the roots of the fins 6 in a direction opposite to a direction of the cambers of the propeller blades 3; and thereby, the fins 6 produce torque Q_f whose direction is opposite to that of the torque Q_p produced by the propeller blades 3.

[0033]

Besides, in the present invention, as shown in Figs. 3

and 4, each fin 6 is formed by creating twist in the fin 6 at a twisting angle δ in a way that a front edge part 6tf of a tip (6tf to 6ta) of the fin 6 is rearward of the root (6bf to 6ba) of the fin 6, and the rear edge part 6ta of the tip (6tf to 6ta) of the fin 6 is forward of the root (6bf to 6ba) of the fin 6, with consideration given to a direction of a flow to the root (6bf to 6ba) of the fin 6 and a direction of a flow to the tip (6tf to 6ta) of the fin 6. Furthermore, in most of usual cases, albeit depending on flows around the stern, the propeller and the like, it is preferable that the twisting angle δ of the fin 6 be an angle within a range not less than 0 degrees but not greater than 20 degrees. It is desirable that the twisting angle δ be within this range, because if the twisting angle δ is less than 0 degrees, the twist produces a less lift increase effect, and because if the twisting angle δ is greater than 20 degrees, the resistance is increased. Incidentally, the positiveness and negativeness of the twisting angle δ are reverse to the positiveness and negativeness of the angle α of attachment.

[0034]

This configuration makes it possible to prevent the tip (6tf to 6ta) of the fin 6 from producing resistance, particularly around the rear edge part 6ta of the tip (6tf to 6ta), and to increase the lift at the tip (6tf to 6ta) of the fin 6.

[0035]

Meanwhile, using an example of a rear edge cut-type fin described in Japanese patent application Kokai publication No. 2010-234861 as a conventional technology, experiments were carried out as follows. A propeller efficiency by the fin with

no twist (where the twisting angle δ was at 0 degrees) and a propeller efficiency by the fin with the twist of the present invention (where the twisting angle δ was at 10 degrees) were calculated in series while changing their fin heights (in the horizontal axis). A result of the experiments obtained from the comparison between the two propeller efficiencies was that the fin with the twist exhibited a better propeller efficiency η than the fin with no twist.

[0036]

For reference, Fig. 6 shows a partial perspective view where the twisting angle δ is at 10 degrees; Fig. 7 shows a partial perspective view where the twisting angle δ is at 0 degrees; and Fig. 8 shows a partial perspective view where the twisting angle δ is at minus 10 degrees. It should be noted that it is clear from the range of the twisting angle δ that the fin configurations shown in Figs. 7 and 8 are presented as reference, and are outside the scope of the present invention.

[0037]

In the ship propulsion device 1, the shape of each fin 6 is formed by creating the twist in the fin 6 in the way that the front edge part 6tf of the tip (6tf to 6ta) of the fin 6 is rearward of the root (6bf to 6ba) of the fin 6, and the rear edge part 6ta of the tip (6tf to 6ta) of the fin 6 is forward of the root (6bf to 6ba) of the fin 6, with consideration given to the direction of the flow to the tip (6tf to 6ta) of the fin 6. This makes it possible to increase the lift at the tip (6tf to 6ta) of the fin 6. Accordingly, the propeller efficiency of the ship propulsion device 1 can be enhanced more.

[0038]

The present invention is also applicable to a case where

the fins 6 are provided on a portion of the propeller boss 5 which is rearward of the propeller blades 3. In the case where the fins 6 are provided there rearward of the propeller blades 3, a diameter of the propeller boss along an imaginary circle joining the roots of the trailing edges of the propeller blades 3 is used as the reference diameter. In the case where the fins 6 are provided on the boss cap 5, the front edges of the fins 6 are arranged coinciding with, or rearward of, the rear edges of the roots of the propeller blades 3 in the front-rear direction of the propeller ($b \geq 0$) because of the physical restriction that the boss cap 5 is disposed rearward of the propeller blades 3. On the other hand, in the case where the fins 6 are provided on the portion of the propeller boss 2 which is rearward of the propeller blades 3, the front ends of the fins 6 may be disposed between the propeller blades. In this case, b may be at a negative value, and it is preferable that $-0.5 \times D_{cf} < b < 0$. This makes it possible to reduce the weight of the propeller boss 5 by making its length as short as possible.

[0039]

Ships provided with the ship propulsion device of the present invention include the foregoing ship propulsion device 1. Since these ships use the foregoing ship propulsion device 1, the ships can benefit from the enhanced propulsion efficiency.

INDUSTRIAL APPLICABILITY

[0040]

The ship propulsion device of the present invention is that which is provided with the screw propeller using the propeller boss cap with the fins. The twist is created in each fin 6 in the way that the front and rear edge parts of the tip of the

fin are respectively rearward and forward of the root of the fin with consideration given to the directions of the flows to the fin. Thereby, the lift at the tip of the fin is increased. For this reason, the propeller efficiency can be enhanced more. Accordingly, the ship propulsion device of the present invention can be used as the ship propulsion device.

[0041]

Furthermore, the ships provided with the ship propulsion device of the present invention are capable of saving fuel costs by enhancing the propulsion efficiency, and makes it possible to reduce the weight of the propulsion shaft and the weight of the structure for supporting the propulsion shaft by making the propulsion device lighter in weight. Therefore, they can be used to many of the ship.

EXPLANATION OF REFERENCE NUMERALS

[0042]

- 1, 1X ship propulsion device
- 2 propeller boss
- 2a rear end surface of propeller boss
- 3 propeller blade
- 5 propeller boss cap
- 5a rear end portion of propeller boss cap
- 5b outer peripheral surface of propeller boss cap
- 5f front end portion of propeller boss cap
- 6 fin
- 6ba rear end of root of fin
- 6bf front end of root of fin
- 6ta rear end of tip of fin
- 6tf front end of tip of fin
- a distance in rotational direction between front end of fin

and propeller blade

b distance in front-rear direction of propeller between rear end of propeller blade and front end of fin

Dca diameter of rear end portion of propeller boss cap

Dcf diameter of front end portion of propeller boss cap

Ds reference diameter

Lc full length of propeller boss cap

Pc propeller axis of rotation

α angle of attachment of fin

ϵ geometric pitch angle of root of propeller blade

γ rake angle of attachment of fin

δ twisting angle of fin

CLAIMS

[Claim 1] A ship propulsion device in which fins are provided to a propeller boss cap attached on a rear side of a propeller boss of a screw propeller and is disposed rearward of a space between propeller blades, characterized in that

a shape of the fin is formed by creating twist in the fin in a way that front and rear edge parts of a tip of the fin move respectively rearward and forward of a root of the fin.

[Claim 2] The ship propulsion device according to claim 1, characterized in that the twist of the fin is such that a twisting angle of the tip to the root is an angle within a range not less than 0 degrees but not greater than 20 degrees.

[Claim 3] The ship propulsion device according to claim 1 or 2, characterized in that the fins are provided on a portion of the propeller boss of the screw propeller which is rearward of the propeller blades, instead of on the propeller boss cap.

[Claim 4] A ship providing with the ship propulsion device according to any one of claims 1 to 3.