

DEVICE FOR REDUCING THE PROPULSION POWER REQUIREMENT OF A WATERCRAFT

The invention relates to a device for reducing the propulsion power requirement of a watercraft, in particular a ship, and for arrangement in the flow direction ahead of a propeller, comprising a flow-guiding surface, in particular a nozzle ring or a partial nozzle ring, at least one inner fin projecting from the flow-guiding surface, wherein the inner fin is attached with one end to the flow-guiding surface and wherein another end of the inner fin is attached to the watercraft when the device is installed on a watercraft, and at least one outer fin projecting from the flow-guiding surface, wherein the outer fin is attached with one end to the flow-guiding surface and wherein another end of the outer fin is configured as a free end. Furthermore, the invention relates to an arrangement comprising such a device, a propeller and a rudder, as well as a ship with such an arrangement.

Prior Art

A device as described above is known from EP 2 591 994 A1. It discloses a device for reducing the propulsion power requirement of a watercraft, which comprises a pre-nozzle, wherein at least one outer fin projecting outwardly from the pre-nozzle is provided. Moreover, the device shown there can also have an inner fin, which is attached with a first end to an inner wall surface of the pre-nozzle and with a second end to a shaft bearing, in particular a stern tube.

Such devices known from the prior art for reducing the propulsion power requirement of a watercraft are usually mounted on a ship, particularly at a short distance or directly in front of the propeller as viewed in the direction of travel. Furthermore, fins attached to the pre-nozzle are designed as guide fins or foils. The pre-nozzle essentially has the shape of a shallow truncated cone, with both openings – the water inlet opening and the water outlet opening – being essentially circular, and the water inlet opening having a larger diameter than the water outlet opening. This makes it possible to improve the inflow to the propeller and to reduce losses in the propeller jet by generating a targeted pre-swirl through the fins installed on the pre-nozzle. Such a system can achieve a

significant reduction in the propulsion power requirement and thus a saving of fuel. Such known devices are typically made entirely of steel.

Description of the Invention: Object, Solution, Advantages

The invention is based on the object of further improving a device for reducing the propulsion power requirement of a watercraft, comprising a flow-guiding surface, at least one inner fin and at least one outer fin. In particular, the energy efficiency of the device is to be further improved.

To this end, a device for reducing the propulsion power requirement of a watercraft, in particular a ship, and for arrangement in the flow direction ahead of a ship's propeller is provided. The device comprises a flow-guiding surface, in particular a nozzle ring or a partial nozzle ring, at least one inner fin projecting from the flow-guiding surface, wherein the inner fin is attached with one end to the flow-guiding surface and wherein another end of the inner fin is attached to the watercraft when the device is installed on a watercraft, and at least one outer fin projecting from the flow-guiding surface, wherein the outer fin is attached with one end to the flow-guiding surface and wherein another end of the outer fin is configured as a free end.

According to the invention, it is further provided that the at least one inner fin and/or the at least one outer fin are made of a composite material. By making the at least one inner fin and/or the at least one outer fin from a composite material, the weight of the device can be reduced, which leads to a higher energy efficiency of the device. Due to the good strength properties of composite materials, sufficient strength can simultaneously be achieved for the loads and stresses to which the device is exposed during operation. This is particularly the case for the at least one outer fin made of composite material, which, due to its construction with a free end, is exposed to the highest bending stresses of all components of the device. Furthermore, manufacturing from composite material allows easier production of the flow-advantageous curved profile of the at least one outer fin and/or the at least one inner fin.

As used herein, the term “composite material” is understood to mean a mixture of two or more pure base materials. The base materials from which a composite material consists are firmly and inseparably bonded together.

The flow-guiding surface can be formed in one piece (integrally) or assembled from multiple individual parts into a flow-guiding surface, wherein the individual parts are preferably welded together and/or to the ship's hull.

The flow-guiding surface may fundamentally have various shapes. It is arranged and designed such that it at least partially guides the water flow onto a propeller. For example, the flow-guiding surface may have the shape of a square or rectangular plate. However, curved or arched configurations are preferred. In cross-section, a curved flow-guiding surface can have a circle, a circular segment, an elliptical segment or another curved shape. The flow-guiding surface has a length in the flow direction (i.e., in the direction of travel of the watercraft). Furthermore, the flow-guiding surface in a plate-shaped configuration has a width, or, in a curved configuration, an arc length. The thickness of the flow-guiding surface is referred to hereinafter as the profile thickness. The length, the width or arc length, and the profile thickness may each be constant over the entire area of the flow-guiding surface or may have different values. For example, the flow-guiding surface may also be formed with a profile. For instance, one edge of the flow-guiding surface could be formed as a rounded edge and have a thinner profile thickness than the middle region of the flow-guiding surface.

Particularly preferably, the flow-guiding surface is configured as a nozzle ring or partial nozzle ring. In the embodiment as a nozzle ring, the flow-guiding surface is closed in the circumferential direction, whereas in the embodiment as a partial nozzle ring it is open in the circumferential direction. Preferably, the embodiment as a partial nozzle ring has a cross-section of an eighth of a ring, a quarter ring, a half ring, a two-thirds ring or a three-quarter ring. In the embodiment as a partial nozzle ring, the arc length of the flow-guiding surface in cross-sectional view is preferably less than 80%, more preferably less than 60%, and most preferably less than 40% or 30% of the circumference of an imaginary fully circumferentially closed nozzle ring. Further preferably, in the installed state, the flow-guiding surface at least partially surrounds the propeller axis of the ship's propeller as viewed in the circumferential direction.

Preferably, the flow-guiding surface is arranged ahead of a propeller. This means that the flow-guiding surface is arranged, in the forward travel direction of the watercraft (or ship), ahead of a propeller of the watercraft. The term “in the travel direction” here is understood to mean the forward direction of travel of a ship or watercraft.

It is further preferred that the flow-guiding surface is arranged at a distance from the propeller. Furthermore, it is preferred that the flow-guiding surface is arranged at a distance from a shaft bearing of the ship, in particular a stern tube. A stern tube serves to support a propeller shaft of the propeller of the watercraft or ship. For this purpose, the flow-guiding surface may be arranged at least in sections above, below or also lateral to the propeller axis. Furthermore, the flow-guiding surface may at least partially surround the propeller axis or the shaft bearing.

Preferably, the flow-guiding surface is arranged above and at a distance from the propeller axis or propeller shaft.

The at least one outer fin is connected at a first end to the flow-guiding surface in a suitable manner, or attached to the flow-guiding surface. The second end of the at least one outer fin is configured as a free end. Thus, the at least one outer fin can project from the flow-guiding surface in any arbitrary direction, wherein the second end of the at least one outer fin is not attached to the flow-guiding surface or otherwise fixed to the ship's body. Preferably, the at least one outer fin projects radially outward from the flow-guiding surface, i.e. away from the stern tube.

The at least one inner fin is connected at a first end to the flow-guiding surface in a suitable manner, or attached to the flow-guiding surface. Preferably, the at least one inner fin projects inward, i.e. toward the shaft bearing or stern tube of the ship, from the flow-guiding surface. The second end of the at least one inner fin is configured to be attached to the watercraft (in particular in the region of the stern tube) when the device is installed on the watercraft. Preferably, the at least one inner fin projects radially inward from the flow-guiding surface.

The term “fin” is understood to mean a guide fin or a foil (wing) which is preferably arranged fixedly on the flow-guiding surface. In principle, the term “fin” can be understood to mean any guide device that influences the propeller inflow, wherein the fin preferably has an airfoil profile, i.e., includes a suction side and a pressure side. Thus, fins in the present context are flow-guiding surfaces in the sense of stators that are arranged on the flow-guiding surface and influence the propeller inflow. In particular, it is preferred that the fins have a suction side that is curved outward (especially in a circular arc) and a substantially flat pressure side.

The profile of the at least one inner fin and/or the at least one outer fin may be uniform or may vary over its length. In particular, the profile along the longitudinal direction of the at least one inner fin and/or the at least one outer fin may be twisted.

The at least one inner fin and the at least one outer fin can be designed independently of one another and each attached to the flow-guiding surface individually. In an alternative embodiment, however, the at least one inner fin and the at least one outer fin may also be made in one piece, in which case such a one-piece fin is guided through the flow-guiding surface. The at least one outer fin and the at least one inner fin can also be arranged one behind the other or offset relative to each other in the radial direction.

Preferably, more than one outer fin and/or more than one inner fin are provided. More preferably, more than two outer fins and/or more than two inner fins are provided, and most preferably exactly three inner fins and/or exactly three outer fins are provided.

Preferably, the composite material comprises a GFRP (glass fiber reinforced plastic), E-composite, E-glass, foam, plastic or carbon fiber, or comprises mixtures thereof. Alternatively or additionally, the composite material preferably includes reinforcing non-metallic fibers, in particular Kevlar fibers, glass fibers, basalt fibers, ceramic fibers, aramid fibers or carbon fibers. Particularly preferably, the reinforcing non-metallic fibers are Kevlar fibers. These preferred embodiments advantageously ensure a high and sufficient strength of the at least one outer fin and/or the at least one inner fin.

Preferably, the flow-guiding surface is made of metal, in particular steel. Further preferably, the at least one inner fin, especially preferably all inner fins, are made of metal, in particular steel. In this preferred embodiment with a flow-guiding surface and inner fin(s) made of metal, only the at least one outer fin, preferably all outer fins, are made of composite material. The outer fins are subjected to particularly high bending loads, so the use of composite material – especially if it is fiber-reinforced – is particularly advantageous for the outer fins. For the inner fins, on the other hand, high strength is important, so it may be advantageous to make these out of steel.

Preferably, the flow-guiding surface has at least one fin mount, in particular made of metal, for mounting the at least one inner fin made of composite material and/or the at least one outer fin made of composite material. Preferably, the fin mount is form-fitting with regard to receiving the at least one inner fin and/or the at least one outer fin. Further preferably, the fin mount is fixedly connected to the flow-guiding surface, in particular by welding. Particularly preferably, the fin mount is configured as a socket into which an end region of each of the at least one inner fin and/or the at least one outer fin can be inserted and then connected thereto. The fin mount allows a durable and stable attachment of the at least one inner fin made of composite material and/or the at least one outer fin made of composite material to the (in particular metal) flow-guiding surface in a simple and secure manner.

Preferably, the at least one inner fin made of composite material and/or the at least one outer fin made of composite material is connected by bolting, bonding, screwing and/or welding to the flow-guiding surface and/or the fin mount.

Preferably, the composite material in this case includes a reinforcing non-metallic fiber, wherein the at least one inner fin made of composite material and/or the at least one outer fin made of composite material has, at its end facing the flow-guiding surface, a connecting element that comprises a hybrid textile structure made of the reinforcing non-metallic fiber and at least one metallic fiber, wherein preferably the metallic fiber is selected from the group consisting of iron, steel, copper, bronze, aluminum, titanium, gold and silver, particularly preferably steel, aluminum and titanium. By means of such a connecting element, a stable connection between the flow-guiding surface and the at least one outer fin or the at least one inner fin can be achieved in a secure manner.

The hybrid textile structure preferably has a longitudinal extent along the longitudinal direction of the at least one inner fin and/or the at least one outer fin, and along the longitudinal extent of the hybrid textile structure a gradient in material composition is preferably present such that the hybrid textile structure at its end facing the flow-guiding surface is formed from 50% to 100% of the metallic fiber and at its other end is formed from 50% to 100% of the non-metallic fiber.

Further preferably, the connecting element has a metallic connecting piece that is materially bonded, preferably welded or soldered, to the end of the hybrid textile structure facing the flow-guiding surface. By means of this connecting piece, the connecting element can be connected to the (in particular metal) flow-guiding surface in a simple manner, in particular by welding.

Furthermore, the underlying objective of the invention is achieved by an arrangement for a ship comprising the above-described device as well as a propeller with a propeller shaft and a rudder downstream of the propeller in the flow direction, wherein the device is arranged upstream of the propeller in the flow direction and at least partially surrounds the propeller shaft. For partially surrounding the propeller shaft, the flow-guiding surface of the device is expediently configured as a nozzle ring or partial nozzle ring.

Finally, the underlying objective of the invention is also achieved by a ship that comprises the above-described arrangement.

Brief Description of the Figures

Embodiments of the invention are described in more detail below with reference to the drawings. Shown schematically are:

Fig. 1: a perspective view of a device according to an embodiment of the invention;

Fig. 2a, 2b: a top view and a side view of a device according to an embodiment of the invention;

- Fig. 3: a front view in the inflow direction of a device according to an embodiment of the invention;
- Fig. 4: a section through a device according to an embodiment of the invention, which shows the inner and outer fins; and
- Fig. 5: a fin mount according to an embodiment of the invention.

Detailed Description of the Figures

Fig. 1 shows a perspective view of a device according to an embodiment of the invention. This device 100 comprises a flow-guiding surface 110 and several outer fins 120a, 120b, 120c (exactly 3 pieces) and inner fins 130a, 130b, 130c (exactly 3 pieces). Here, the outer fins 120a, 120b, 120c are attached to the flow-guiding surface 110 with the aid of fin mounts 140, with one fin mount 140 provided for each outer fin 120a, 120b, 120c.

This device 100 is configured to be mounted on a ship in the flow direction ahead of a ship's propeller (not shown here). In particular, the ends of the inner fins 130a, 130b, 130c that face away from the flow-guiding surface 110 are configured to be attached and fixed to a ship, in particular to a stern tube of a ship, especially by welding. For this purpose, the inner fins 130a, 130b, 130c as well as the flow-guiding surface 110 are made entirely of metal, in particular steel.

The flow-guiding surface is configured as a partial nozzle ring, which in the installed state preferably partially encompasses the propeller shaft. The arc angle of the partial nozzle ring is between 90° and 120°. This partial nozzle ring with the attached fins is advantageously positioned between an 8 o'clock and 1 o'clock position with respect to the direction of rotation of the propeller (viewed from the stern of a ship), in order to accelerate the inflow to the propeller and generate counter-rotating vortices to compensate for the vortices generated by the propeller. For this purpose, the outer and/or inner fins preferably have a curved profile.

The inner fins 130a, 130b, 130c project essentially radially inward from the flow-guiding surface 110. The outer fins 120a, 120b, 120c project essentially radially outward from the flow-guiding surface 110 and are arranged in the radial direction behind the

corresponding inner fins 130a, 130b, 130c. The outer fins 120a, 120b, 120c are made of a composite material, in particular a fiber composite material. The use of a composite material for the outer fins 120a, 120b, 120c enables a reduction in weight and an easier production of the flow-advantageous curved profile of the outer fins 120.

Figures 2a and 2b show side views, and Figure 3 shows a front view of the device 100 shown in Fig. 1. Here, Fig. 2a shows the device 100 from above, Fig. 2b from the starboard side, and Fig. 3 shows the device 100 in the inflow direction. In particular, it is shown that the profile of the outer fins 120a, 120b, 120c can be different in order to allow optimal vortex reduction. In Figure 3 it can also be seen that an inwardly projecting support strut 131 is provided at one end of the flow-guiding surface. This support strut 131 serves for attachment to a ship and for the strength and stability of the device 100. As a rule, it does not have an airfoil profile.

Fig. 4 shows a longitudinal section through the inventive arrangement. In particular, it is shown how the outer fins 120 are attached to the flow-guiding surface with the aid of the fin mount 140.

Fig. 5 shows the attachment of an outer fin 120 in detail. The outer fin 120 is inserted into the fin mount 140 and is held by it in a form-fitting manner. Furthermore, the outer fin 120 is fastened in the fin mount 140 by means of bolts 150 running transversely through the fin mount 140 and the outer fin 120. Alternatively or additionally, the attachment of the outer fin 120 to the fin mount 140 may also be carried out by bonding or welding.

For better attachment to the fin mount, the end of the outer fin facing the fin mount is preferably made partly of metal, particularly preferably of iron, steel, copper, bronze, aluminum, titanium, gold or silver, and most preferably of steel, aluminum or titanium. In particular, the composite material can include a non-metallic fiber, and the outer fin made of composite material can have, at its end facing the flow-guiding surface, a connecting element that comprises a hybrid textile structure made of the non-metallic fiber and at least one metallic fiber. The metallic fiber can be selected from the group consisting of iron, steel, copper, bronze, aluminum, titanium, gold and silver, preferably steel, aluminum and titanium, and most preferably steel. Preferably, the outer fin

further has a metallic connecting piece that is materially bonded, preferably welded or soldered, to the end of the hybrid textile structure facing the flow-guiding surface 110.

List of Reference Numerals

- 100 device
- 110 flow-guiding surface
- 120, 120a-120c outer fins
- 130, 130a-130c inner fins
- 131 support strut
- 140 fin mount
- 150 bolt

Claims

1. Device (100) for reducing the propulsion power requirement of a watercraft, in particular a ship, and for arrangement in the flow direction ahead of a ship's propeller, comprising:
a flow-guiding surface (110), in particular a nozzle ring or a partial nozzle ring;
at least one inner fin (130) projecting from the flow-guiding surface, wherein the inner fin (130) is attached with one end to the flow-guiding surface (110) and wherein another end of the inner fin (130) is attached to a watercraft when the device is installed on a watercraft; and
at least one outer fin (120) projecting from the flow-guiding surface, wherein the outer fin (120) is attached with one end to the flow-guiding surface and wherein another end of the outer fin (120) is configured as a free end,
characterized in that
the at least one inner fin (130) and/or the at least one outer fin (120) are made of a composite material.
2. The device according to claim 1, wherein the composite material comprises a GFRP, E-composite, E-glass, foam, plastic or carbon fiber, and/or wherein the composite material comprises reinforcing non-metallic fibers, in particular Kevlar fibers, glass fibers, basalt fibers, ceramic fibers, aramid fibers or carbon fibers, particularly preferably Kevlar fibers.
3. The device according to claim 1 or 2, wherein the flow-guiding surface (110) is made of metal, in particular steel, wherein preferably the at least one inner fin (130), more preferably all inner fins (130a-d), are made of metal, in particular steel, and wherein preferably the at least one outer fin (120), more preferably all outer fins (130a-c), are made of composite material.
4. The device according to any of the preceding claims, wherein the flow-guiding surface (110) has at least one fin mount (140) for mounting the at least one inner fin (130) made of composite material and/or the at least one outer fin (120) made of composite material, wherein in particular the fin mount is made of metal.

5. The device according to claim 4, wherein the at least one fin mount (140) is configured as a socket into which an end portion of each of the at least one inner fin (130) and/or the at least one outer fin (120) is inserted and connected thereto.
6. The device according to any of the preceding claims, wherein the at least one inner fin (130) made of composite material and/or the at least one outer fin (120) made of composite material is connected by bolting (150), bonding and/or welding to the flow-guiding surface and/or the fin mount (140).
7. The device according to any of the preceding claims, wherein the composite material includes a non-metallic fiber and wherein the at least one inner fin (130) made of composite material and/or the at least one outer fin (120) made of composite material has, at its end facing the flow-guiding surface (110), a connecting element that comprises a hybrid textile structure made of the non-metallic fiber and at least one metallic fiber.
8. The device according to claim 7, wherein the hybrid textile structure has a longitudinal extent along the longitudinal direction of the at least one inner fin (130) and/or the at least one outer fin (120), and wherein along the longitudinal extent of the hybrid textile structure a gradient in material composition is present such that the hybrid textile structure at its end facing the flow-guiding surface (110) is formed from 50% to 100% of the metallic fiber and at its other end is formed from 50% to 100% of the non-metallic fiber.
9. The device according to claim 7 or 8, wherein the metallic fiber is selected from the group consisting of iron, steel, copper, bronze, aluminum, titanium, gold and silver, preferably steel, aluminum and titanium, and particularly preferably steel.
10. The device according to any of claims 7 to 9, wherein the connecting element has a metallic connecting piece that is materially bonded, preferably welded or soldered, to the end of the hybrid textile structure facing the flow-guiding surface (110).

11. The device according to any of the preceding claims, wherein the at least one outer fin (120) is continued through the flow-guiding surface (110) as an inner fin (130), wherein the inner fin (130) is preferably made of steel.
12. An arrangement for a ship, comprising:
 - a device (100) according to any of the preceding claims;
 - a propeller with a propeller shaft;
 - a rudder downstream of the propeller in the flow direction,
 - characterized in that the device is arranged upstream of the propeller in the flow direction and at least partially surrounds the propeller shaft.
13. A ship comprising an arrangement according to claim 12.