Device for reducing the drive power requirements of a watercraft

The invention relates to a device for reducing the drive power requirement of a watercraft, in particular a ship. The device according to the invention is particularly suited for improving the energy efficiency for a drive system of a watercraft.

Devices for reducing the drive power requirement of a watercraft are known from the prior art. In EP 2 100 808 A1 such a device comprises, for example, a fore-nozzle. This fore-nozzle is in particular mounted at a short distance or directly upstream of the propeller when viewed in the direction of travel of the ship. Furthermore, fins, i.e. (guide) fins or hydrofoils, are provided in the fore-nozzle. The fore-nozzle substantially has the shape of a flat cone section, where both openings, both the water inlet and the water outlet opening, are configured as a substantially circular opening and the water inlet opening has a larger diameter than the water outlet opening. As a result, it is possible to improve the propeller inflow and to reduce the losses in the propeller jet by specific generation of pre-swirl by the fins installed in the fore-nozzle. A significant reduction in the drive power requirement and therefore a saving of fuel can be achieved by such a system.

The previously known device described above, however, has a relatively large resistance for the propeller inflow so that the reduction in the drive power requirement in the relevant extent is primarily only established in slower or more heavily laden ships, so that the known device is usually only used in such ships.

Embodiments~~It is therefore the object~~ of the present invention seek to provide a device for reducing the drive power requirement of a watercraft which can also be used particularly effectively in fast and very fast watercraft, for example ships having a speed of 20 knots or more or 25 knots and more.

According to an aspect of the present invention, there is provided a device for reducing the drive power requirement of a watercraft, in particular of a ship, comprising a fore-nozzle, wherein at least one outer fin projects outwards from the fore-nozzle said at least one outer fin comprising a first end and a second end, wherein said first end of the at least one outer fin is fastened to the fore-nozzle in such a way that the first end of the at least one outer fin is fastened to the outer wall surface of the fore-nozzle or that the first end of the at least one outer fin rests inside the wall of the fore-nozzle, wherein said second end of the at least one outer fin is configured as a free end, wherein only the first end of the at least one outer fin is fastened and the remaining region of the at least one outer fin is free-standing and wherein the at least one outer fin is not fastened to a propeller hub.

There is disclosed~~This object is solved whereby in~~ a device for reducing the drive power requirement of a watercraft, comprising a fore-nozzle, at least one outer fin projecting outwards from the fore-nozzle~~ is provided~~. The fore-nozzle is located upstream of a propeller of the watercraft in the direction of travel of the ship or watercraft. The designation "in the direction of travel" is to be understood here as the forwards direction of travel of a ship or a watercraft. No propeller is located inside the fore-nozzle, other than, for example, in Kort nozzles or rudder propellers. Furthermore, the fore-nozzle is located at a distance from the propeller. The fore-nozzle is configured in such a manner that water flow flowing through said fore-nozzle is at least partially guided onto the propeller located thereafter. The fore-nozzle usually has a tubular form. ~~H~~However, fundamentally any other type of cross-sectional shape, for example, an angular cross-sectional shape, is feasible.

The fore-nozzle can be formed in one part or in one piece or be composed of several individual parts to form a fore-nozzle, where the individual parts are preferably welded to one another or welded to the hull. Preferably at least one portion of the fore-nozzle is located underneath the propeller shaft of the ship's propeller.

It is fundamentally feasible that the fore-nozzle comprises only a subsection of a nozzle or a nozzle ring (e.g. a quarter nozzle ring, a third nozzle ring, a half nozzle ring, etc.). In such an embodiment the fore-nozzle is configured to be open when seen over the circumference. Preferably however, the fore-nozzle is configured to be closed in the circumferential direction. For this purpose the nozzle can be configured to be continuous around 360° in the circumferential direction. In a fore-nozzle configured to be multi-part, furthermore in particular with a closed nozzle circumference, the individual parts of the fore-nozzle can be connected to the hull and/or the stern tube so that the hull and/or the stern tube then form part of the nozzle circumference.

As a result of the preferably closed profile of the fore-nozzle around the circumference, this has an inner region which is enclosed by the nozzle surface area of

a fore-nozzle imagined as closed at the two openings (water inlet and water outlet opening). According to embodiments of the invention, the at least one outer fin is now disposed outside this inner region and rather protrudes outwards from the fore-nozzle when viewed from the fore-nozzle. In particular, the at least one outer fin can protrude from the outer side of the fore-nozzle.

In contrast to the prior art, a fin pertaining to the fore-nozzle, i.e. the at least one outer fin is now provided outside the fore-nozzle. Expediently at least one end region of the outer fin is disposed on the outer wall surface of the fore-nozzle and protrudes outwards from this. That is, the remaining region of the at least one outer fin is located at a distance from the fore-nozzle (except from the one end region of the outer fin). As a result of the arrangement of a fin on the outside of the fore-nozzle for the first time, it is now achieved that the diameter and/or the profile thickness of the fore-nozzle can be significantly reduced compared with the devices known from the prior art and nevertheless, the at least one (outer) fin still reaches those regions in which the flow losses are particularly high and in which a pre-swirl must be produced for efficient operation. If the diameter were simply to be reduced in the devices known from the prior art, in contrast to embodiments of the present invention, the fins would not extend sufficiently far away from the propeller hub (in the radial direction when viewed from the propeller hub) and thus no longer or only to a lesser extent have a positive influence on the inflow onto the respectively associated propeller.

By attaching one or more outer fins to the outer side of the fore-nozzle, the diameter of the fore-nozzle and therefore its resistance can be reduced so that the device can now also be used for fast and very fast ships, where the positive effects on the reduction of the drive power requirement are preserved or possibly even further improved. Since the outer fin projects outwards from the fore-nozzle and not possibly from the propeller hub or the stern tube, this can extend relatively far outwards when viewed from the propeller axis and nevertheless still have sufficient strength, in particular in relation to bending stresses.

axis, a homogenisation of the propeller inflow and therefore a better efficiency can possibly be achieved, adapted to the particular configuration of the hull.

Expediently the fore-nozzle consists of a continuous and/or one-piece annular body or nozzle ring. The fore-nozzle is disposed upstream and at a distance from the propeller in the direction of travel of the ship. The device according to embodiments of the invention can advantageously be used in multi-propeller ships where a fore-nozzle is then expediently to be assigned to each propeller. The propellers assigned to the device are usually installed fixed or in a fixed position on the hull. The fore-nozzle together with the propeller of the watercraft forms a drive system.

Preferably the extension of the individual (outer) fins in the longitudinal direction of the fore-nozzle is smaller or shorter than the length of the fore-nozzle. "Extension" is to be understood in this context as the region or the length of the longitudinal profile of the fore-nozzle over which the fins extend in the longitudinal direction of the fore-nozzle. Particularly preferably the extension of the individual fins in the longitudinal direction of the fore-nozzle is less than 90%, quite particularly preferably less than 80% or even less than 60% of the length of the fore-nozzle. The longitudinal direction substantially corresponds to the direction of flow. It is furthermore preferred that the fins are disposed substantially in the rear region of the fore-nozzle, i.e. in the region facing the propeller. In principle, however, a formation of the fin over the entire extension of the fore-nozzle in the longitudinal direction or a central or front arrangement of the fins in relation to the direction of travel would also be possible.

Advantageously a first end of the at least one outer fin is fixed to the fore-nozzle. Here the first end of the outer fin can either be fixed on the outer wall surface of the fore-nozzle, for example, by flange-mounting or it can be guided into the nozzle profile, i.e. the wall of the fore-nozzle. Alternatively it is also possible to guide the outer fin through the fore-nozzle profile or the fore-nozzle wall. The first end forms the root of the at least one outer end and the second end forms the tip of the at least one outer fin.

Compared to the pure stator arrangements known from the prior art or arrangements with fins without nozzle or nozzle elements, projecting radially from the stern tube, a significantly increased strength of the entire arrangement may beis obtained through the provision of the fore-nozzle. As a result, the complete fins can be designed to be sufficiently long with an ensured fatigue strength in order to optimally influence the inflow onto the propeller or achieve the best possible efficiency. In the aforementioned known arrangements with long fins without nozzle ring, a fatigue strength is frequently not achieved.

The length of the complete fins can fundamentally be larger or smaller than the radius of a propeller of the watercraft assigned to the fore-nozzle. The length of the complete fin is measured from the propeller axis to the outermost (free) end of the outer fin, where optionally the nozzle wall disposed between the two fins (outer and inner fin) is also included. Preferably the length of the complete fin is a maximum of 90% of the radius of the propeller, particularly preferably a maximum of only 75%. A sufficient strength of the device may beis ~~thereby~~ achieved.

In a further preferred embodiment, the at least one outer fin and/or the at least one inner fin are disposed at an angle of attack radially to the propeller axis and/or to the longitudinal axis of the fore-nozzle. In particular, the at least one outer fin and the at least one inner fin can have different angles of attack. If a plurality of outer fins and/or inner fins are provided, these can also have different angles of attack amongst one another. By setting the different angles of attack, it is possible to optimise the pre-swirl. The angle of adjustment is, for example, enclosed by a chord running from the nose strip to the end strip of the respective fin or also the longitudinal axis of the fin in cross-sectional view and the propeller axis or the longitudinal axis of the fore-nozzle.

In a further preferred embodiment the at least one outer fin has a free end which forms the region of the outer fin most remote from the fore-nozzle. At this free end region a fin end piece protrudes from the outer fin. Thus, for example, a longitudinal axis of this fin end piece can be located at an angle to the longitudinal axis of the outer fin. The term "protruding fin end piece" in the pre-

sent case fundamentally means all the components disposed in the region of the free end of the outer fin which are not disposed precisely in the extension of the outer fin but protrude obliquely from the outer fin or at a specific angle from the outer fin or deviate from the fictitiously extended profile contour of the outer fin. The fin end piece therefore protrudes from the fin plane. Such a protruding fin end piece acts similar to the "winglets" known from aircraft aerofoils and may reduces the probability of vortices becoming detached in the end region of the outer fin and of cavitation occurring in the same.

The fin end piece can transform into the free end region of the outer fin at a radius. Alternatively the fin end piece can be mounted at an angle on the free end of the outer fin so that the fin end piece plane and outer fin plane are at this angle.

In principle, the fin end piece on both sides, i.e. both on the pressure side and on the suction side, of the outer fin, can protrude from this or only on one of the two sides. In the last embodiment it is preferred that the fin end pieces only protrude towards the suction side of the outer fin since as a result the greater hydrodynamic effects in relation to the reduction of vortex formation can be achieved. For the embodiment in which the fin end piece protrudes or projects on both sides of the outer fin, two separate fin end pieces can also be provided which then each protrude on one side. In principle, however, in this embodiment a one-piece design of the fin end piece is possible.

It is further preferred that in the presence of at least one outer fin and at least one inner fin, the outer fin has a larger length than the inner fin. In particular, the length of the outer fin can be at least one and a half times, preferably at least twice as large as the length of the inner fin. As a result of this embodiment, an improved effect in relation to the drive power requirements and in relation to the stability of the device ismay be achieved. As a result of the length distribution in this preferred embodiment, the fore-nozzle or the nozzle ring is disposed relatively close to the shaft bearing of the propeller shaft so that the device hascan have a relatively low resistance and can also be used for very fast ships. Fundamentally,

however, a design is possible in which the at least one inner fin has a greater length than the at least one outer fin, e.g. at least one and a half times or at least twice the length, or in which both have approximately the same length.

Similarly it is advantageous if the diameter of the fore-nozzle is no more than 85%, preferably no more than 70%, particularly preferably no more than 50% or no more than 35% of that diameter of the (ship's) propeller to which the fore-nozzle is assigned. This may also ensures that the nozzle profile or the nozzle ring overall is not too large and therefore the resistance of the fore-nozzle is so low that it is possible to also use the device in fast and very fast ships. If the fore-nozzle should not be rotationally symmetrical or cylindrical or conical, instead of the diameter, the greatest extension of the fore-nozzle in height or width can be related to the propeller diameter. Furthermore, the outside diameter of the fore-nozzle should expediently be used.

In order to ensure a sufficiently low resistance of the device, according to a further embodiment it can be provided that the profile thickness of the fore-nozzle is no more than 10%, preferably no more than 7.5%, particularly preferably no more than 6% of the length of the fore-nozzle. Here the maximum profile thickness and the maximum extension in the longitudinal direction, i.e. from one opening of the fore-nozzle to another, should be used. Through this, the resistance of the device may beis ~~also~~ reduced further.

In a further preferred embodiment, a stabilizing strut is further provided which is disposed between shaft bearing and inner side of the fore-nozzle and is fastened both on the shaft bearing and on the fore-nozzle. Such a stabilizing strut can be provided if according to local conditions or particular configuration of the device, an additional stabilization or retaining of the device or the fore-nozzle is desired. Outside the fore-nozzle in extension of the stabilizing strut usually no further strut or even an outer fin is to be provided. The strut can fundamentally be configured as a normal compression or tension rod without flow-guiding properties. Alternatively, the stabilizing strut itself can also have a fin