

Description

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention relates to propellers for watercraft. The term "propellers" shall also include marine screws and like propulsion units.

(2) Prior Art

Conventional propellers have two or more blades fitted to a hub and set at a pitch angle selected as most appropriate for the intended application. The propellers produce a divergent cone of thrust which reduces their efficiency, as the thrust is dissipated in the surrounding water and they also produce a "cocktail" or "rooster-tail" spray above the waterline, especially at higher speeds, indicating that potential thrust energy has been wasted. The divergent coning effect has been partially eliminated by producing shrouded or ringed propellers but these generate increased turbulence and suffer increased drag. Finally, the known propellers produce very little, if any, reverse thrust which can be used to reverse or brake the vessel to which the propellers are fitted.

Various types of propellers have been proposed. For example, US—A—2,087,243 (Caldwell) discloses a propeller of convergent radial height along the propeller, where the forward portion of each blade is forwardly inclined and the rearward portion is rearwardly inclined and where the line of junction of the blade with the hub is "a regular spiral of a given pitch, the peripheral pitch of the blade being greater than that of the junction line". United Kingdom Patent GB—A—8568 of 1909 (Marks) discloses a propeller where the peripheral pitch of the blade increases along the propeller and the radial height of the blade increases in height along the propeller.

In GB—A—16573 (Stevenson-1910), there is disclosed a screw propeller with blades which are connected to a shaft, their places being at an angle of about 45° to the shaft axis. The trailing edges of the blades are situated some distance aft of the point of connection of the blades to the shaft. The point of each blade which enters or cuts the water, is formed with a thin cutting edge and the trailing edge part of each blade which emits the water, is slightly bent, curved or rounded. Each blade commences at the shaft, where its connection thereto is strengthened, and curves round to a point diametrically opposite with a portion being cut away to leave an open space, thereby allowing water to travel along the blade surface and through the space, leaving it clean to run along the shaft.

Even these propellers have not proved satisfactory in overcoming the problems with the known propellers discussed above.

It is an object of the present invention to provide a propeller which generates greater thrust than a conventional propeller of similar dimensions.

It is a preferred object to provide a propeller

which can generate a large braking effect e.g. up to 50% reverse thrust. It is a further preferred object to provide a propeller which creates less turbulence, the propeller producing a convergent cone of thrust.

It is a still further preferred object to provide a propeller which can provide a higher vessel speed for a given propeller speed.

Other preferred objects of the present invention will become apparent from the following description.

In one aspect the present invention resides in a propeller for watercraft including a propeller for watercraft including:

- a hub connectable to a drive shaft; and
- a plurality of blades attached to the hub each blade having a leading portion, a central portion and a trailing portion, wherein:

- the line of junction between at least the central and trailing portions of the blades with the hub is of increasing pitch axially along the hub;

- the leading portion of each blade is inclined forwardly relative to the radial axis of the hub;

- the trailing portion of each blade is inclined rearwardly relative to the radial axis of the hub;

- the central portion extends substantially radially to the hub; and

- the blades are substantially co-extensive along the length of the hub and are disposed in relatively inverted overlapping relationship wherein the leading portion of one blade partially overlaps the trailing portion of the other blade to form a divergent throat between the blades along the propeller to prevent the propeller from choking with water.

Preferably the pitch of the blades increases axially along the propeller from the central portion to the trailing portion of the blades.

Preferably also, the radial height of the blades increases from the leading portion to a maximum radial height at the central portion and then decreases to the trailing portion.

Advantageously, the central portion of the blade commences 70-110° of rotation after the leading edge of the blades.

Also, in side view, the leading portion of each blade can have the configuration of an aerofoil and the trailing portion a cross-section with the configuration of an aerofoil to generate low pressure areas in the water and, hence, draw water into the propeller.

Another aspect of the invention provides a propeller for watercraft including:

- a hub connectable to a drive shaft;

- a plurality of blades attached to the hub, each blade having a leading portion, central portion and trailing portion wherein:

- the leading portion of each blade is inclined forwardly relative to the radial axis of the hub and leads progressively into the central portion which is substantially radial to the hub and then into the trailing portion which is inclined rearwardly relative to the radial axis of the hub;

- the peripheral pitch of the blades increases axially along the hub from the leading portion to

the trailing portion and the radial height of the blades increases along the hub from the leading portion to the trailing portion;

the leading and trailing portions both have cross-sections having the configuration of aerofoils to generate low pressure areas in the water to draw the water into the propellor;

the line of junction of at least the central and trailing portions of the blades with the hub is of increasing pitch axially along the hub;

the blades are substantially co-extensive along the length of the hub and are disposed so as to form a divergent throat between the blades; and the aerofoil on the leading portion of the blade is on the opposite side of the blade to the aerofoil on the trailing portion of the blade, the aerofoil on the leading portion operating to generate a low pressure area in the inlet to the divergent throat formed between the blades and the aerofoil on the trailing portion operating to generate a low pressure area at the outlet of the divergent throat.

To enable the invention to be fully understood, a preferred embodiment will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view of the propellor;

Figure 2 is a rear end view of the propellor, parts being shown in dashed lines for clarity;

Figure 3 is a plan view of a blade cut out from a plate before fabrication; and

Figures 4 to 9 are respective sectional views of a blade taken on lines 4—4 to 9—9 respectively on Figure 2.

The propellor 10 has a hub 11 which may be engaged directly to the drive shaft of a vessel or be fitted with a splined driving hub for engagement with the drive shaft.

A pair of blades 12 are provided around the hub 11 for approximately 220° of rotation and each blade has a leading portion 13, central or intermediate portion 14 and a trailing portion 15. The leading portion 13 of each blade has a curved leading edge of increasing peripheral height, the leading edge being relatively "blunt" compared with the tapered leading edge of conventional propellers. The leading portion is forwardly inclined relative to the hub (see FIGS. 4 and 5) and is curved to have the configuration of an aerofoil to create a low pressure area on the surface of that portion of the blade.

The central portion 14 of the propellor commences at approximately 70—90° rotation of the blade and attains the maximum radial height of the blade at approximately 90—110° of rotation. The central portion 14 progressively changes in inclination relative to the hub from forwardly inclined (see FIG. 5), to substantially radial to the hub (see FIG. 6), to rearwardly inclined (see FIG. 7).

The radial height of the blade progressively decreases from the central portion 14 to the trailing portion 15, the latter portion of the blade being rearwardly inclined relative to the hub (as shown in FIGS. 8 and 9).

The trailing portion 15 has a configuration in

side view of a high speed aerofoil to generate a low pressure area on the front face of that portion of the blade, that low pressure area being adjacent to, and downstream of the low pressure area generated on the rear face of the leading portion 13 of the other blade.

The pitch of the line of junction 16 of the blades 12 to the hub 11 increases along the hub, at least from the central portion 14 to the trailing portion 15 e.g. over the range of 70—110° rotation to 220° rotation to form a divergent "throat" between the blades along the propellor.

In various tests, it has been found that the propellor produces a convergent cone of thrust, with very little spray even at high speeds, and that the propellor produces greater thrust than conventional propellers of the same diameter. (On one test, a 40cm. diameter propellor of the present invention was fitted to a vessel in replacement for a damaged 63cm. propellor on the vessel and developed approximately the same thrust). It is believed that the improved performance of the propellers of the present invention is due to the aerofoil configurations of the blades which tend to "suck" the water into the propellor while the divergent "throat" between the blades, due to the increase in pitch of the line of junction of the blades to the hub, prevents the propellor from "choking".

The low pressure areas generated by the aerofoil configurations of the blades at the "inlet" and "outlet" to the divergent throat assist in drawing the water through the propellor.

In addition to the increased forward thrust, the propellers in test have demonstrated a reverse thrust which is up to 50% of the forward thrust. This reverse thrust is much greater than that found with conventional propellers which often have reverse thrusts in the range of 0%—10% of the forward thrust. It is believed that the improved reverse thrust is due to the aerofoil configuration of the blades which also create the low pressure areas within the propellers when in reverse.

The propellers may be cast to the desired shape or may be fabricated, with the blades formed from a sheet of steel or aluminium.

To enable the fabrication of the propellor to be readily understood, reference is now made to FIG. 3.

An annular piece of metal is cut out, with an outer radius 17 substantially equal to the maximum radial height of the blade (in the central portion 14) and an inner radius 18 just greater than the outer radius of the hub 11.

A portion of the sheet is removed to leave a blade of approximately 220° rotation about the hub. At approximately 90° from the leading edge (i.e. at point 19), the inner radius of the sheet is increased progressively from the central portion 14 to the trailing portion 15 where the effective inner radius 18a is determined by the formula

$$R = r + a \left(\frac{b}{c} \right)$$

where

r = inner radius for body portion (indicated by line 18)

R = effective inner radius of the central and trailing portions (indicated by line 18a)

a = radius increase ratio.

b = the angular distance from the trailing edge less the angular distance from point 19 to the leading edge (e.g. 90°)

c = angle factor (e.g. 40—45°)

For example

$$R = r + 1.6 \left(\frac{b}{45} \right)$$

Therefore, at the trailing edge of the 220° blade,

$$R = r + 1.6 \left(\frac{130}{45} \right)$$

At the trailing edge, the effective inner radius R is approximately 4—45mm. greater than the radius of the leading portion where the effective radius is increased by approximately 1.6mm. (1/16 inch) for each 45° around the hub from point 19.

The central portion 14 is attached to the hub 11 and the blade 12 is progressively wound around the hub towards the trailing edge. As the effective inner radius R is increased relative to the outer radius of the hub 11, the blade must be pulled rearwardly to draw the blade into engagement with the hub. This increases the pitch of the line of junction of the blade with the hub, while simultaneously reducing the peripheral height of the blade, increasing the peripheral pitch of the blade and causing the rearward inclination of the blade to be increased towards the trailing edge (see FIGS. 6—9). The leading portion of the blade is then attached to the hub and the blade is bent forwardly to enable the tip of the leading edge to be attached to the hub. The forward inclination of the blade is shown in FIGS. 4 and 5.

Comparative tests using conventional propellers and propellers of the present invention of the same marine engines have noted the following improvements in the propellers of the present invention:

1. When the throttle is pushed fully open, the present propeller does not "race" but drives the watercraft as it runs upto full speed and it achieves full speed in approximately two-thirds the distance the craft is driven by the conventional propeller.

2. The maximum speed of the watercraft may be 10—30% higher.

3. In rough water, the propeller does not tend to come out of the water and does not tend to overrun.

4. At speed, the watercraft tends to plane flatter

over the water i.e. the stern rides higher in the water.

5. In sharp turns, the craft tends to heel over like an aircraft and the stern does not tend to skid out.

6. If the engine is shut off, a strong braking effect is noted and in reverse, powerful reverse thrust is obtained (and water may be drawn over the transom as the craft is reversed).

7. The "cocktail" effect is reduced or minimised and the water behind the propeller appears to be "solid" with little wash.

8. It is observed that the water appears to be moving before it enters the propeller as though it is being sucked into the propeller, possibly due to the aerofoil like portions of the blades.

9. The "blunt" peripheral edge of the blades is less liable to damage by chipping or breaking when striking rocks or other submerged objects.

The specific configuration of the propeller e.g. number, shape, diameter, length, pitch and inclination of the blades can be selected to suit the particular intended application.

Various changes and modifications may be made to the embodiments described without departing from the scope of the present invention as defined in the appended claims.

Claims

1. A propeller (10) for watercraft including: a hub (11) connectable to a drive shaft; and a plurality of blades (12) attached to the hub (11), each blade (12) having a leading portion (13), a central portion (14) and a trailing portion (15), wherein:

the line of junction (16) between at least the central and trailing portions (14, 15) of the blades (12) with the hub (11) is of increasing pitch axially along the hub (11);

the leading portion (13) of each blade (12) is inclined forwardly relative to the radial axis of the hub (11);

the trailing portion (15) of each blade (12) is inclined rearwardly relative to the radial axis of the hub (11);

the central portion (14) extends substantially radially to the hub (11); and

the blades (12) are substantially co-extensive along the length of the hub (11) and are disposed in relatively inverted, overlapping relationship wherein the leading portion (13) of one blade (12) partially overlaps the trailing portion (15) of the other blade (12) to form a divergent throat between the blades (12) along the propeller (10) to prevent the propeller (10) from choking with water.

2. A propeller (10) as claimed in Claim 1 wherein: the pitch of the blades (12) increases axially along the propeller (10) from the central portion (14) to the trailing portion (15) of the blades (12).

3. A propeller as claimed in Claim 1 or Claim 2 wherein:

the radial height of the blades (12) increases from the leading portion (13) to a maximum radial height at the central portion (14) and then

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$$R = r + a \left(\frac{b}{c} \right)$$

where

r = inner radius for body portion (indicated by line 18)

R = effective inner radius of the central and trailing portions (indicated by line 18a)

a = radius increase ratio.

b = the angular distance from the trailing edge less the angular distance from point 19 to the leading edge (e.g. 90°)

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Therefore, at the trailing edge of the 220° blade,

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At the trailing edge, the effective inner radius R is approximately 4—45mm. greater than the radius of the leading portion where the effective radius is increased by approximately 1.6mm. (1/16 inch) for each 45° around the hub from point 19.

The central portion 14 is attached to the hub 11 and the blade 12 is progressively wound around the hub towards the trailing edge. As the effective inner radius R is increased relative to the outer radius of the hub 11, the blade must be pulled rearwardly to draw the blade into engagement with the hub. This increases the pitch of the line of junction of the blade with the hub, while simultaneously reducing the peripheral height of the blade, increasing the peripheral pitch of the blade and causing the rearward inclination of the blade to be increased towards the trailing edge (see FIGS. 6—9). The leading portion of the blade is then attached to the hub and the blade is bent forwardly to enable the tip of the leading edge to be attached to the hub. The forward inclination of the blade is shown in FIGS. 4 and 5.

Comparative tests using conventional propellers and propellers of the present invention of the same marine engines have noted the following improvements in the propellers of the present invention:

1. When the throttle is pushed fully open, the present propeller does not "race" but drives the watercraft as it runs upto full speed and it achieves full speed in approximately two-thirds the distance the craft is driven by the conventional propeller.

2. The maximum speed of the watercraft may be 10—30% higher.

3. In rough water, the propeller does not tend to come out of the water and does not tend to overrun.

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over the water i.e. the stern rides higher in the water.

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6. If the engine is shut off, a strong braking effect is noted and in reverse, powerful reverse thrust is obtained (and water may be drawn over the transom as the craft is reversed).

7. The "cocktail" effect is reduced or minimised and the water behind the propeller appears to be "solid" with little wash.

8. It is observed that the water appears to be moving before it enters the propeller as though it is being sucked into the propeller, possibly due to the aerofoil like portions of the blades.

9. The "blunt" peripheral edge of the blades is less liable to damage by chipping or breaking when striking rocks or other submerged objects.

The specific configuration of the propeller e.g. number, shape, diameter, length, pitch and inclination of the blades can be selected to suit the particular intended application.

Various changes and modifications may be made to the embodiments described without departing from the scope of the present invention as defined in the appended claims.

Claims

1. A propeller (10) for watercraft including: a hub (11) connectable to a drive shaft; and a plurality of blades (12) attached to the hub (11), each blade (12) having a leading portion (13), a central portion (14) and a trailing portion (15), wherein:

the line of junction (16) between at least the central and trailing portions (14, 15) of the blades (12) with the hub (11) is of increasing pitch axially along the hub (11);

the leading portion (13) of each blade (12) is inclined forwardly relative to the radial axis of the hub (11);

the trailing portion (15) of each blade (12) is inclined rearwardly relative to the radial axis of the hub (11);

the central portion (14) extends substantially radially to the hub (11); and

the blades (12) are substantially co-extensive along the length of the hub (11) and are disposed in relatively inverted, overlapping relationship wherein the leading portion (13) of one blade (12) partially overlaps the trailing portion (15) of the other blade (12) to form a divergent throat between the blades (12) along the propeller (10) to prevent the propeller (10) from choking with water.

2. A propeller (10) as claimed in Claim 1 wherein: the pitch of the blades (12) increases axially along the propeller (10) from the central portion (14) to the trailing portion (15) of the blades (12).

3. A propeller as claimed in Claim 1 or Claim 2 wherein:

the radial height of the blades (12) increases from the leading portion (13) to a maximum radial height at the central portion (14) and then



decreases to the trailing portion (15).

4. A propellor (10) as claimed in any one of Claims 1 to 3 wherein:

the leading portion (13) of each blade (12) has a cross-section having the configuration of an aerofoil and the trailing portion (15) has a cross-section having the configuration of an aerofoil to generate low pressure areas in the water to draw the water into the propellor (10).

5. A propellor as claimed in any one of Claims 1 to 4 wherein:

the central portion (14) commences 70-110° of rotation after the leading edge of the blades.

6. A propellor (10) for watercraft including:

a hub (11) connectable to a drive shaft;

a plurality of blades (12) attached to the hub (11), each blade (12) having a leading portion (13), central portion (14) and trailing portion (15) wherein:

the leading portion (13) of each blade (12) is inclined forwardly relative to the radial axis of the hub (11) and leads progressively into the central portion (14) which is substantially radial to the hub (11) and then into the trailing portion (15) which is inclined rearwardly relative to the radial axis of the hub (11);

the peripheral pitch of the blades (12) increases axially along the hub (11) from the leading portion (13) to the trailing portion (15) and the radial height of the blades (12) increases along the hub (11) from the leading portion (13) to the trailing portion (15);

the leading and trailing portions (13, 15) both have cross-sections having the configuration of aerofoils to generate low pressure areas in the water to draw the water into the propellor (10);

the line of junction (16) of at least the central and trailing portions (14, 15) of the blades (12) with the hub (11) is of increasing pitch axially along the hub (11);

the blades (12) are substantially co-extensive along the length of the hub (11) and are disposed so as to form a divergent throat between the blades (12); and

the aerofoil on the leading portion (13) of the blade (12) is on the opposite side of the blade (12) to the aerofoil on the trailing portion (15) of the blade (12), the aerofoil on the leading portion (13) operating to generate a low pressure area in the inlet to the divergent throat formed between the blades (12) and the aerofoil on the trailing portion (15) operating to generate a low pressure area at the outlet of the divergent throat.

Patentansprüche

1. Schraube (10) für ein Wasserfahrzeug mit einer Nabe (11) zur Verbindung mit einer Antriebswelle und einer Mehrzahl an der Nabe (11) befestigter Schraubenblätter (12), wobei jedes Schraubenblatt (12) einen Anströmbereich (13), einen Mittelabschnitt (14) und einen Abströmbereich (15) aufweist, dadurch gekennzeichnet, daß die Verbindungslinie (16) zwischen mindestens dem Mittelabschnitt und dem

Abströmbereich (14, 15) der Schraubenblätter (12) und der Nabe (11) axial über die Nabe (11) verlaufend eine zunehmende Steigung aufweist; daß der Anströmbereich (13) eines jeden Schraubenblattes (12) gegenüber der radialen Achse der Nabe (11) nach vorne geneigt ist; daß der Abströmbereich (15) eines jeden Schraubenblattes (12) relativ zur radialen Achse der Nabe (11) nach hinten geneigt ist; daß der Mittelabschnitt (14) im wesentlichen radial zur Nabe (11) verläuft; und daß die Schraubenblätter (12) einen im wesentlichen gleichförmigen Verlauf über die Länge der Nabe (11) nehmen und zueinander umgekehrt und überlappend angeordnet sind, wobei der Anströmbereich (13) eines Schraubenblattes (12) den Abströmbereich (15) des anderen Schraubenblattes (12) teilweise überlappt, so daß über die Länge der Schraube (10) hinweg ein divergierender Kanalabschnitt zwischen den Schraubenblättern (12) entsteht, welcher das Abwürgen (choking) der Schraube (10) durch Wasser verhindert.

2. Schraube (10) gemäß Anspruch 1, dadurch gekennzeichnet, daß die Steigung der Schraubenblätter (12) über die Achse der Schraube (10) hinweg vom Mittelabschnitt (14) bis zum Abströmbereich (15) der Schraubenblätter (12) zunimmt.

3. Schraube (10) gemäß Anspruch 1 oder 2, dadurch gekennzeichnet, daß die radiale Höhe der Schraubenblätter (12) sich von dem Anströmbereich (13) ausgehend bis zu einer maximalen radialen Höhe am Mittelabschnitt (14) vergrößert und sodann zum Abströmbereich (15) hin wieder verringert.

4. Schraube (10) gemäß den vorstehenden Ansprüchen 1 bis 3, dadurch gekennzeichnet, daß der Querschnitt des Anströmbereichs eines jeden Schraubenblattes (12) tragflügelartig ausgebildet ist und der Querschnitt des Abströmbereichs (15) tragflügelartig ausgebildet ist, um Niederdruckzonen im Wasser zu schaffen, um somit Wasser in die Schraube (10) einzuziehen.

5. Schraube gemäß den vorstehenden Ansprüchen 1 bis 4, dadurch gekennzeichnet, daß der Mittelabschnitt (14) 70-110° hinter der Anströmkante der Schraubenblätter beginnt.

6. Schraube (10) für ein Wasserfahrzeug mit einer Nabe (11) zur Verbindung mit einer Antriebswelle und einer Mehrzahl an der Nabe (11) befestigter Schraubenblätter (12), jedes Schraubenblatt mit einem Anströmbereich (13) und einem Abströmbereich (15), dadurch gekennzeichnet, daß der Anströmbereich (13) eines jeden Schraubenblattes (12) gegenüber der radialen Achse der Nabe (11) nach vorne geneigt ist und progressiv in den Mittelabschnitt (14) hinein verläuft, der im wesentlichen radial zur Nabe (11) ausgerichtet ist, und sodann in den relativ zur radialen Achse der Nabe (11) nach rückwärts geneigten Abströmbereich (15) übergeht; daß die Umfangssteigung der Schraubenblätter (12) über die Achse der Nabe (11) hinweg von dem Anströmbereich (13) bis zum Abströmbereich (15) zunimmt und die radiale Höhe der Schraubenblät-



ter (12) entlang der Nabe (11) von dem Anströmbereich (13) zum Abströmbereich (15) zunimmt, daß sowohl Anström- als auch Abströmbereich (13, 15) jeweils Querschnitt aufweisen, die tragflügelartig ausgebildet sind, um Niederdruckzonen im Wasser zu schaffen, um somit Wasser in die Schraube (10) einzuziehen; daß die Verbindungslinie (16) zwischen mindestens dem Mittelabschnitt und dem Abströmbereich (14, 16) der Schraubenblätter (12) und der Nabe (11) axial über die Nabe (11) verlaufend eine zunehmende Steigung aufweist; daß die Schraubenblätter (12) einen im wesentlichen gleichförmigen Verlauf über die Länge der Nabe (11) nehmen und so angeordnet sind, daß zwischen den Schraubenblättern (12) ein divergierender Kanalabschnitt gebildet ist; und daß der tragflügelartig ausgebildete Abschnitt des Anströmbereichs (13) des Schraubenblattes (12) an der dem tragflügelartig ausgebildeten Abschnitt des Abströmbereichs (15) der Schraubenblätter (12) entgegengesetzten Seite liegt, wobei der tragflügelartig ausgebildete Abschnitt den Anströmbereichs (13) dahingehend wirkt, daß eine Zone niedrigen Drucks am Eintritt in den zwischen den Schraubenblättern (12) ausgebildeten Kanalabschnitt entsteht, während der tragflügelartig ausgebildete Abschnitt des Abströmbereichs (15) eine Zone niedrigen Drucks am Austritt dieses Kanalabschnittes bewirkt.

Revendications

1. Hélice (10) pour embarcations, comportant un moyeu (11), prévu pour être relié à un arbre d'entraînement, et une pluralité de pales (12) fixées au moyeu (11), chaque pale (12) présentant une zone d'attaque (13), une zone centrale (14) et une zone de fuite (15), dans laquelle:

la ligne de raccordement (16) d'au moins la zone centrale (14) et la zone de fuite (15) des pales (12) avec le moyeu (11) présente un pas qui va en croissant dans le sens axial le long du moyeu (11);

la zone d'attaque (13) de chaque pale (12) est inclinée vers l'avant par rapport à un axe radiale du moyeu (11);

la zone de fuite (15) de chaque pale (12) est inclinée vers l'arrière par rapport à un axe radial du moyeu (11);

la zone centrale (14) s'étend de manière sensiblement radiale par rapport au moyeu (11);

et dans laquelle les pales (12) couvrent sensiblement la même partie de la longueur du moyeu (11) et sont disposées l'une par rapport à l'autre de manière à se recouvrir mutuellement, la zone d'attaque (13) de l'une des pales (12) recouvrant ainsi partiellement la zone de fuite (15) de l'autre pale (12), en formant une gorge divergente entre les pales (12) précitées, dans le sens de la longueur de l'hélice (10), pour éviter l'engorgement de la circulation de l'eau dans l'hélice.

2. Hélice (10) selon la revendication 1, dans laquelle le pas des pales (12) va en augmentant dans le sens axial de l'hélice (10), en allant de la

zone centrale (14) vers la zone de fuite (15) des pales (12).

3. Hélice (10) selon l'une des revendications 1 ou 2, dans laquelle la cote radiale des pales (12) va en augmentant à partir de la zone d'attaque (13), pour atteindre une valeur maximale à l'endroit de la zone centrale (14), et pour diminuer ensuite en allant vers la zone de fuite (15).

4. Hélice (10) selon l'une des revendications 1 à 3, dans laquelle la zone d'attaque (13) de chaque pale (12) présente en coupe transversale un profil analogue à celui d'une aile d'avion, et dans laquelle la zone de fuite (15) présente en coupe transversale le profil d'une aile d'avion, pour produire dans l'eau des zones de dépression afin d'attirer l'eau dans l'hélice (10).

5. Hélice selon l'une des revendications 1 à 4, dans laquelle la zone centrale (14) de chaque pale commence à environ 70 à 110° de rotation après le bord d'attaque de ladite pale.

6. Hélice (10) pour embarcation, comportant un moyeu (11) prévu pour être relié à un arbre d'entraînement, et une pluralité de pales (12) fixées au moyeu (11), chaque pale (12) présentant une zone d'attaque (13), une zone centrale (14) et une zone de fuite (15), dans laquelle:

la zone d'attaque (13) de chaque pale (12) est inclinée vers l'avant par rapport à un axe radial du moyeu (11), en évoluant progressivement vers la forme de la zone centrale (14) qui est sensiblement radiale par rapport au moyeu (11), et se raccorde à la zone de fuite (15) qui est inclinée vers l'arrière par rapport à un axe radial du moyeu (11);

le pas périphérique des pales (12) va en augmentant dans le sens axial le long du moyeu (11), en allant de la zone d'attaque (13) vers la zone de fuite (15), et la cote radiale des pales (12) va en augmentant dans le sens de la longueur du moyeu (11) en allant de la zone d'attaque (13) vers la zone de fuite (15);

la zone d'attaque (13) et la zone de fuite (15) présentent l'une et l'autre en coupe transversale un profil analogue à celui d'une aile d'avion, pour créer des zones de dépression dans l'eau, afin d'attirer l'eau dans l'hélice (10);

la ligne de raccordement (16) d'au moins la zone centrale (14) et la zone de fuite (15) des pales (12) avec le moyeu (11) présente un pas qui va en croissant dans le sens axial le long du moyeu (11);

les pales (12) couvrent sensiblement la même partie de la longueur du moyeu (11), en étant disposées de manière à former une gorge divergente entre les pales (12);

et dans laquelle le profil en aile d'avion de la zone d'attaque (13) d'une pale (12) est situé du côté opposé de la pale (12), par rapport au profil en aile d'avion de la zone de fuite (15) de la pale (12), le profil de la zone d'attaque (13) ayant pour effet de créer une dépression à l'entrée de la gorge divergente formée entre les pales (12), et le profil de la zone de fuite (15) ayant pour effet de créer une dépression à l'endroit de la sortie de la gorge divergente.

