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Marine propeller having fin-like protrusions"

The present invention relates to a marine propeller having fin-like protrusions, and has for its object to provide a propeller which is capable of increasing the towing power of a vessel without altering the speed of the vessel when sailing alone, as compared with conventional propellers of this kind, and is especially effective for tugboats, net-trawling fishing boats, oil fence spreading ships, and so on, which require a large towing power.

Conventionally, although variable pitch propellers, Kort nozzle propellers, and the like have been proposed as means for increasing towing power, such known propellers have disadvantages in that they are expensive to install and rather difficult to maintain, and require remodelling of hulls in some cases.

The invention provides a marine propeller having a single arcuate protruding fin on the suction side of each blade, the fins being formed along an arc of rotation of the propeller at a radius of not more than 0.3 times the radius of the propeller from the centre of a boss portion of the propeller.

One form of propeller constructed in accordance with the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side elevation view of a boat to which the propeller may be fitted;

Fig. 2 is a front elevational view showing the propeller as viewed in the direction of the arrows A-A in Fig. 1, to a larger scale than Fig. 1;

Fig. 3 is a section along the line B-B of Fig. 2;

5 Fig. 4 is a section along the line C-C of Fig. 2;

Fig. 5 is a graph showing the distribution of thrust over the length of a blade;

Fig. 6 is a graph showing the distribution of thrust over the length of the blade; and

10 Figs. 7 and 8 are performance comparison graphs for the embodiment 1.

Referring to the drawings, a boat has a stern 1, a propeller 2 with a boss portion 3, a suction side 4, a pressure side 5, and fin-like protrusions 6.

15 The fin-like protrusions 6 extend outwardly from the suction sides 4 of respective blades so as to protrude along an arc of rotation of the propeller.

The thrust of the propeller is increased by the provision of the fin-like protrusions 6, as compared with
20 ordinary marine propellers, and thus the towing power can be increased, without altering the speed of the vessel when sailing alone.

In Fig. 5, the distribution of circulation (Γ) produced in a typical propeller is shown by the solid line, with
25 radius ratio (radius as a fraction of the propeller tip radius) on the abscissa, and it may be

seen that the maximum circulation is reached in the vicinity of a radius ratio of 0.7. Since thrust is proportional to Γ , if the distribution of Γ in Fig. 5 is assumed to be the distribution of thrust represented against the radius ratio of the propeller blades, the state will be as shown by the solid line in Fig. 6. In other words, the thrust developed in the typical propeller is at a maximum in the vicinity of 70% of the tip radius (0.7R), with reduction at both sides, and the thrust of the propeller is represented by the sum of the areas A and B. According to the present invention, however, since the fin-like protrusions 6 are arranged to project at a position radially inwards from the position where the maximum value H of the thrust is produced, it is possible to obtain the thrust increase corresponding to the area C in Fig. 6.

Experimental results from five vessels using conventional propellers and propellers according to the invention are set out in the table.

As is clear from the table, compared the propeller (b) having the fin-like protrusions according to the present invention is superior by approximately 3% in performance during sailing alone, and by about 17% in towing power performance, to the conventional propeller (a) Figs. 7 and 8 give graphs for performance comparison based on column 1 of the table.

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As described so far, it has been found that, with the propeller according to the present invention, an increase in thrust can be achieved, and the phenomenon may be explained as follows:

5 The thrust theory is similar to the for aircraft wings. The lift of an aircraft (which is equivalent to the thrust of the marine propeller) is produced by the wings as represented by following equations.

$$dL = \rho \cdot V \cdot \Gamma \cdot dr \text{ ----- (1)}$$

10 $\Gamma = \int_0^b \Delta V \cdot dy \text{ ----- (2)}$

where dL = increment of lift, dr = increment of blade length, ρ = density of fluid, b = blade width, Γ = circulation, V = velocity, and ΔV = variation of speed on blade surface.

15 On the other hand, the distribution of the circulation with respect to the propeller radial direction is given for a conventional propeller by the following equations:

$$\Gamma = A \cdot \omega \cdot R^2 \cdot x \cdot (1 - x^n) \text{ ----- (3)}$$

20 $x = r/R \text{ ----- (4)}$

Where A = constant, ω = angular velocity, R = propeller tip radius, r = radius of the point under consideration, and n = constant.

Fig. 5 shows the distribution of circulation based on
25 the equations (3) and (4).

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According to the present invention, it has been found that the increase in thrust can be obtained by providing the fin-like protrusions and, as shown in Fig. 5, proper positions for the fin-like protrusions are the positions at X ($r = 0.1$ to $0.3R$) radially inwards from the point of maximum thrust, while, from the configuration of distribution of circulation (thrust) as represented by the equations (3) and (4), the vicinity of $0.3R$ will become a dividing point of the effect. In other words, in a position Y at $r > 0.3R$, no effect can be expected, since such a position is included in the thrust distribution range of the ordinary propellers.

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Embodiments		1	2	3	4	5
Gross tonnage (G/T)		9.44	5.92	13.38	4.92	11.00
Hull (m)	L	13.42	11.40	16.40	10.52	14.20
	B	2.95	2.75	3.43	2.60	3.14
	D	1.09	0.84	1.14	1.42	1.00
Displacement (Tonnes)		22.0	8.8	22.0	7.0	20.0
Engine	BHP	55	54	100	52	130
	RPM	3200	3000	1800	3200	2300
	Reduction Gear Ratio	0.197	5.130	0.235	5.900	3.500
Propeller (m/m) Diam. (conventional) Pitch		840	810	1100	800	900
		560	660	890	640	600
	Expanded blade area ratio (AE)	0.35	0.35	0.35	0.50	0.40
	No. of blades	3	3	3	3	3
Propeller (m/m) Diam. (this invention) Pitch		840	810	1100	800	900
		560	660	890	640	600
	AE	0.35	0.35	0.35	0.50	0.40
	No. of blades	3	3	3	3	3
Ship Speed/Kt' (a) (conventional)		8.76	10.80	11.50	10.00	10.00
Ship Speed/Kt' (b) (this invention)		9.00	11.10	10.85	10.30	10.20
Towing Force/Kg (a) (conventional)		770	650	1250	610	1450
Towing Force/Kg (b) (this invention)		900	750	1450	700	1700

Claims:-

1. A marine propeller having a single arcuate protruding fin on the suction side of each blade, the fins being formed along an arc of rotation of the propeller at a radius of not more than 0.3 times the radius of the propeller from the centre of a boss portion of the propeller.
 2. A marine propeller substantially as hereinbefore described with reference to, and as shown in Figs. 2 to 4, 10bf the accompanying drawings.
 3. A boat fitted with at least one propeller as claimed in claim 1 or claim 2.
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