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MARINE PROPELLER

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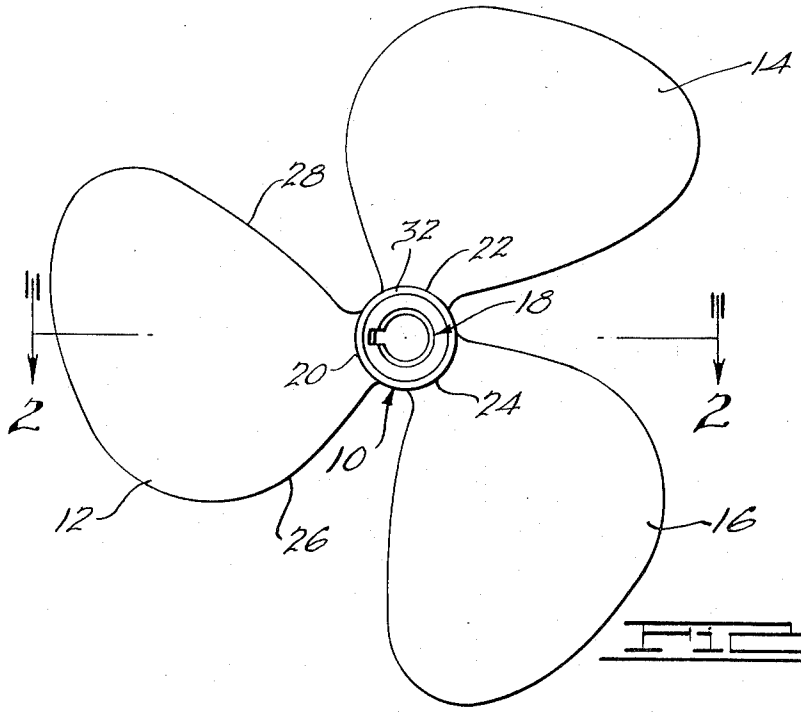


Fig. 1.

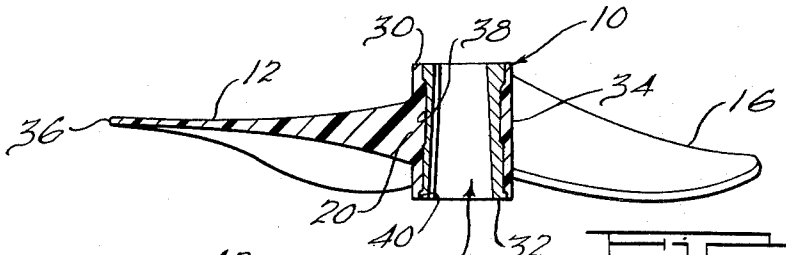


Fig. 2.

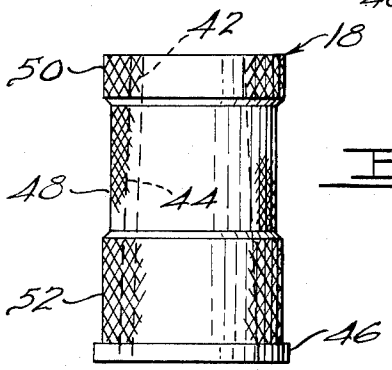


Fig. 3.

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MARINE PROPELLER

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This invention relates to propellers and more particularly to plastic propellers for marine use on pleasure boats and the like.

The concept of plastic boat propellers is not new. The many advantages to be attained from a plastic boat propeller, as compared with conventional metallic propellers, are well known and have resulted in a great deal of effort directed to the development of a successful plastic boat propeller. Among the various advantages of a plastic boat propeller, as compared with a metallic propeller, are reduction in weight, which facilitates storage and handling, simplification of manufacture, and reduction of cost. Apparently, prior efforts to develop a plastic boat propeller have been unsuccessful since most, if not all, boat propellers which presently have any significant commercial success are still metallic.

Some of the more important problems of prior art plastic boat propellers have been lack of dimensional stability; lack of stiffness; water absorption; lack of resistance to attack by environmental agents such as salt water, oil, gasoline, etc.; lack of fatigue resistance; brittleness; excessive size or mass resulting in drag and reduction of efficiency; fracture at points of high stress; inability to provide reliable shaft connecting means; and failure to meet critical performance standards in areas such as high output torque at high r.p.m., planing, vibration, etc.

In prior art plastic boat propellers, one particular difficulty has been the tendency of the blades of such propellers to fracture or shatter, when an object in the water is struck, to the extent that the usefulness of the propeller is very substantially reduced or even destroyed. With a metal propeller of brass or bronze, for example, usually the blades are merely bent and can still be utilized to return to port, if vibration is not too severe. In port, attempts are usually made to straighten the metal blades because of the relatively high cost of a new metallic propeller. With prior art plastic propellers, the blades have tended to shear off completely so that further power operation of the boat may thereafter be impossible until the propeller is replaced.

I have discovered that if the dimensional characteristics of the plastic propeller are closely controlled with the ratio of the thickness of the outermost portions of the blades relative to the thickness of the root portions of the blades being maximized, the blades will tend to break cleanly in only relatively small areas at the tips or along the edges where direct impact occurs. I have further discovered that a plastic propeller made in accordance with the principles of my invention is generally capable of operating without appreciable vibration even after being chipped at the edges by striking objects in the water. This remarkable characteristic is in direct contrast with the performance of prior art plastic propellers and metal propellers which, after striking a similar object, would be bent and probably create difficult vibrational problems in further use without repair.

My inventive principles have been successfully embodied in an illustrative plastic boat propeller as shown on the accompanying drawing in which:

FIGURE 1 is a side elevational view of such a propeller;

FIGURE 2 is a partial cross-sectional view taken along the line 2—2 in FIG. 1; and

FIGURE 3 is an enlarged detail view of a connecting insert in such a propeller.

Referring now to FIGURE 1, a plastic propeller having a hub portion 10 and integrally connected blade portions 12, 14, 16 is shown. An insert bushing 18 is mounted in the hub for attachment of the propeller to the drive shaft of a boat. The pitch and other design parameters of the blades are conventional.

In the preferred embodiment, as shown in FIGURE 2, the propeller hub 10 and blades 12, 14, 16 form an integral one-piece plastic member which has been injection molded about a metallic insert bushing 18. The propeller hub and blades are preferably made from Delrin, or a similar material, and the bushing is made from a material such as naval bronze.

I find that the performance of plastic propellers is markedly improved by the use of plastic materials such as the acetal polymer and copolymer resins. In particular, we have had exceptional results with the acetal resin Delrin, manufactured by Dupont, which is a crystalline form of polymerized formaldehyde having the characteristic of being dimensionally stable in most environments. The fatigue strength of this material is unaffected by moisture or lubricating oil and the material has excellent resistance to practically all solvents. An outstanding characteristic of the material is stiffness and the molding qualities of the material are excellent.

The roots 20, 22, 24 of the blades, i.e., the area of attachment to the hub, are inclined relative to the longitudinal axis of the hub and extend along the periphery of the hub in a generally helical path. The helical length of the blades in the root area from the leading edge 26 to the trailing edge 28 is such that the trailing edge of the blade at the root is located rather closely adjacent the rear end 30 of the hub and the leading edge 26 is also located relatively closely adjacent the front end 32 of the hub. The roots of the blades are thus substantially centered between the front and rear ends of the hub as indicated generally by the intersection at 34 of the blade 16 and the hub 10 in FIGURE 2. In some instances it may be desirable to axially offset the roots of the blades somewhat toward the rear end 30 of the hub whereat maximum thickness of the hub is provided. The outer periphery of the hub in the illustrative embodiment is basically cylindrical except that the outer surface of the hub may be slightly tapered, if desired, to facilitate manufacture and/or to establish a more streamlined flow path from front to rear. It may be noted that the blades are solid throughout, as indicated by blade 12 in FIGURE 2, from the tip 36 to the root 20 and that the hub wall adjacent the root is also solid. In fact, the blades and hub are entirely a solid homogeneous mass of plastic material as compared with prior art devices which have included hollow blades and/or internal reinforcement means.

The hub is in the form of a relatively thin wall sleeve having a central passageway in which the metallic insert 18 is mounted. A portion 38 of the sleeve intermediate the ends of the hub is enlarged and extends radially inwardly toward the central axis of the hub to form a rib-like protuberance which extends axially a substantial distance. At least a major portion of the rib 38 may be seen to be axially aligned with the roots of the blades. In the illustrative embodiment, the rib 38 is axially offset toward the rear end 30 of the hub. An annular seat 40 is formed in the front end of the sleeve to matingly receive a flange on the insert bushing.

Referring now to FIGURE 3, a tapered central opening 42 in the insert bushing is provided with a keyway 44 for securing the propeller to the boat drive shaft. A flange 46, received by the seat 40, is provided at the

front end of the bushing and groove means 48 are located intermediate the ends of the bushing. In the preferred embodiment, the groove means comprises a single portion of reduced diameter which extends a substantial axial distance, about 1 inch in the exemplary propeller shown, and is located majorally nearer the rear end of the bushing having the smallest diameter opening. Alternatively, although particularly advantageous results are attained with a single groove, a plurality of narrower width grooves may be utilized. The depth of the groove means is only about 1/16 of an inch in either case. The outermost peripheral surfaces 50, 52 of the insert are provided with a relatively course knurl and the innermost peripheral surface at the bottom of the groove 48 is provided with a relatively fine knurl. Surprisingly, I have found that a plastic hub molded about such a bushing forms a permanent connection therewith which will not fail even under the most extreme operating conditions.

I have discovered that plastic propellers made in accordance with the foregoing principles and having certain dimensional characteristics produce optimum results. In order to have maximum strength with minimum bulk and to decrease adverse effects due to striking objects in the water, it appears that the propeller blades and hub should have certain dimensional relationships. For example, a plastic propeller, of approximately 13-inch diameter and 11-inch pitch, having the following approximate dimensional characteristics has been developed for use at engine speeds as high as 3800 r.p.m.:

(1) Maximum radial length of blades, root at hub to tip: 5¼".

(2) Maximum thickness of blade roots at hub: ¾".

(3) Minimum thickness of blade roots at hub: ½".

(4) Length of blade roots at hub, trailing edge to leading edge: 2".

(5) Average thickness of blade tips opposite blade root: ¼".

(6) Average thickness of leading edges of blades: 5/16".

(7) Average thickness of trailing edges of blades: 5/16".

(8) Outside diameter of hub: 1 3/16".

(9) Wall thickness of hub on coarse knurl: 7/32".

(10) Wall thickness of hub on fine knurl in groove: 9/32".

(11) Length of hub: 2¼".

The peripheral edges of the blades are suitably rounded so that the opposite surfaces of each blade are connected by a smooth curvilinear surface. Consequently, the aforerecited measurements of blade thickness are measurements adjacent to, but slightly inwardly spaced from, the extremities of the blades. The thickness of the blades tapers from a maximum at the root connection to the hub to a minimum at the blade tips with the degree of dimensional taper being higher at the root and gradually diminishing toward the tip.

In the illustrative embodiment, the ratio of the hub wall thickness to the peripheral blade thickness is approximately 1:1; the ratio of the blade root thickness to the blade tip thickness is approximately 3:1; the ratio of the radial length of the blade to tip thickness is approximately 20:1; the ratio of the hub diameter to propeller diameter is approximately 1:7; and the plastic propeller weighs about 1½ pounds whereas a brass or bronze propeller of the same size would weigh approximately 10 pounds.

A propeller embodying the aforementioned principles and characteristics has been tested on a 25-foot Owens cruiser having a 185 horsepower V–8 engine with direct drive. The propeller performed satisfactorily at all engine speeds including engine speeds as high as 3800 r.p.m. without failure. There appears to be no perceptible loss of pitch at any of the speeds. Although the propeller blades were chipped at the edges as a result of striking objects in the water, the major portions of the blades were undamaged and there was no appreciable vibration induced by chipping at the edges.

It may be seen that I have thus provided a plastic propeller having a relatively thin walled hub and relatively thin blades which has surprising strength and rigidity in use. I have been able, to a surprising degree, to maximize the ratio of the effective driving areas of the propeller blades relative to the drag areas created by the blade edges and the propeller hub while maintaining necessary strength and rigidity in use.

It will be readily appreciated by those skilled in the art to which this invention relates that I have provided a plastic propeller which is vastly superior to prior art propellers. The propeller is capable of operating under substantial load at engine speeds as high as 3800 r.p.m. without breakage or substantial loss of pitch. The blades do not shatter or tend to break at the hub when an object in the water is hit, but, rather, the blades tend only to chip at the edges without substantial impairment of basic operating characteristics. The diameter of the hub has been reduced to minimal percentage of the total propeller area thereby minimizing drag to a point heretobefore thought to be unattainable. Tests indicated that a boat using such a propeller planes more readily and that a smoother ride is obtained than with a conventional metallic propeller under similar operating conditions.

Since many of the inventive principles disclosed are capable of being adapted to and incorporated in various propeller forms, the appended claims are intended to protect both the generic inventive principles herein disclosed and the specifically disclosed embodiments thereof to the fullest extent warranted.

What is claimed is:

1. A plastic boat propeller rotatable about a central axis and having a plurality of generally radially extending solid plastic blade means, a generally cylindrical plastic hub, the roots of said blade means being integrally connected to said hub, a central axially extending passageway formed in said hub and defining a support wall, a separate insert buhing mounted in said central axially extending passageway, groove means and rib means formed along said insert bushing, and along the interior surface of said support wall with said rib means extending into said groove means to permanently secure said insert bushing in said hub during use of said propeller, the connections between the roots of said blade means and said hub extending substantially from end to end of said hub, the thickness of said blade means at the roots being substantially greater than the thickness of said blade means at the tips, the major portions of said blade means being substantially thinner than said roots whereby damage caused by impact forces tends to be concentrated only at the tips of said blade means, and the average thickness of said annular wall being approximately the same thickness as the tips of said blade means and substantially thinner than the thickness of the roots of said blade means.

2. The invention as defined in claim 1 and wherein said insert bushing is metallic, and the outer periphery of said insert bushing being knurled.

3. The invention as defined in claim 1 and said groove means being formed in said insert bushing and having a substantial width many times greater than its depth and extending at least coextensively axially with a major portion of the roots of said blade means.

4. The invention as defined in claim 3 and wherein said groove means is axially offset toward the rear of said propeller.

5. The invention as defined in claim 1 and wherein said plastic boat propeller is made from an acetal polymer type material.

6. The invention as defined in claim 1 and wherein the ratio of the diameter of said hub to the diameter of said propeller blade means is approximately equal to or greater than 1:7.

7. The invention as defined in claim 2 and wherein said metallic insert comprises an elongated bushing, a

groove of substantial width provided in the outer periphery of said bushing, the portions of said bushing adjacent said groove being knurled, and the periphery of said groove being knurled.

8. The invention as defined in claim 7 and wherein the knurl in said groove is finer than the knurl outside said groove.

9. A propeller for marine usage in the form of a one-piece injection molded hub-blade member made of acetal polymer having stiffness sufficient to prevent loss of pitch in use and comprising a plurality of generally radially extending solid plastic blade means, hub means integrally connected to and supporting said blade means, the thickness of said blade means in the roots being substantially greater than the thickness of said blade means at the tips, the major portions of said blade means being substantially thinner than said roots, and the difference in thickness between the tip portions of said blade means and the central portions of said blade means and the root portions of said blade means being such as to provide

sufficient impact resistance over the major surface area of the blade means whereby impact with objects in water in use tends to chip the tips of the blade means rather than fracturing the blade means in the central portions and the root portions.

References Cited by the Examiner

UNITED STATES PATENTS

1,809,131	6/1931	Maison	170—156
2,212,072	8/1940	Newnham.	
3,033,293	5/1962	Bihlmire	170—159

FOREIGN PATENTS

207,625	3/1956	Australia.
1,079,271	4/1960	Germany.

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