March 12, 1940. W. BAUMANN 2,193,616

SCREW PROPELLER

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Fig. 2.

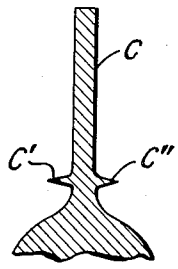


Fig. 3.

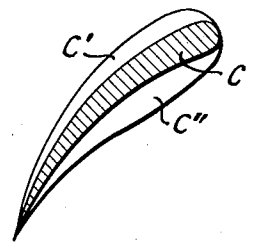


Fig. 1.

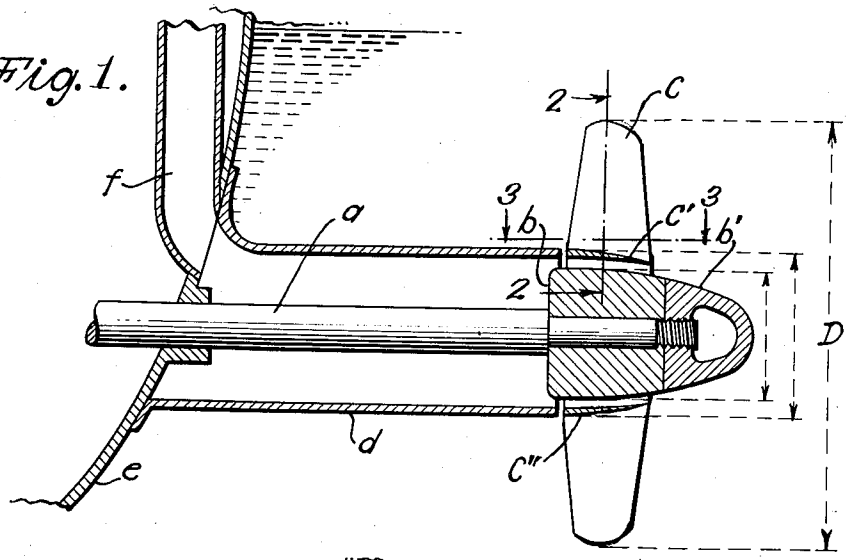
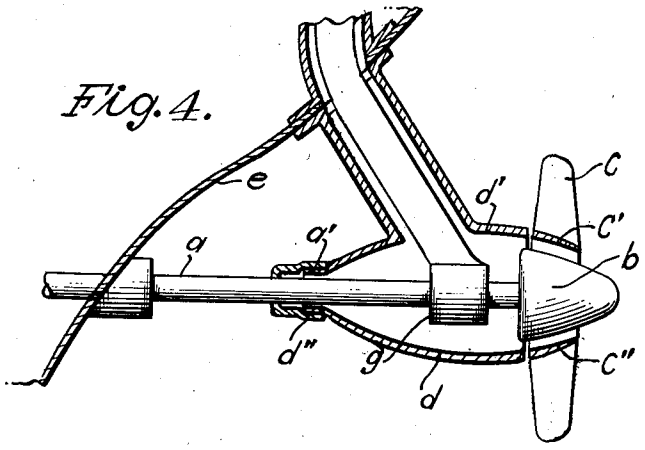


Fig. 4.



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Fig.5.

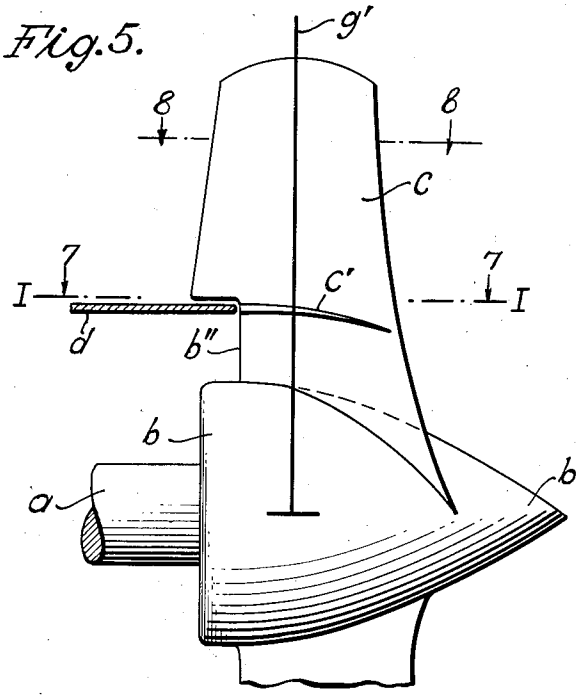


Fig.7.

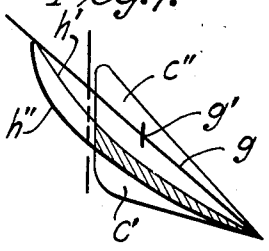


Fig.8.

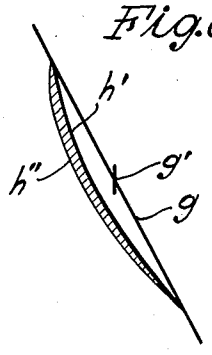
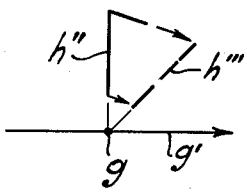


Fig.6.



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UNITED STATES PATENT OFFICE

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SCREW PROPELLER

Werner Baumann, Paris, France

Application June 29, 1938, Serial No. 216,519
In Luxemburg July 10, 1937

7 Claims. (Cl. 115—34)

The efficiency of ship propellers is appreciably smaller than the efficiency of propellers of water turbines. This difference is due to the shape of the blades and the depression caused by the hub.

The most advantageous shape of the blades would be that of the lifting surfaces of aerodynamics, but the application of these forms has been impossible until now, the reason being that the small hubs forced constructors to deform the bases of the blades for reasons of resistance and in order to decrease the suction effect caused by the rotation of the blades.

A proposal described in the French Patent No. 786,636 seeks to harmonize these two conditions by providing a hub that may have up to 35% of the optimum diameter of the propeller. In other proposals an attempt is made to lessen the importance of the vortex by supplying atmospheric air to the rear face of the hub (see the French Patent No. 776,656 and the British Patent No. 311,674).

It has even been proposed, through misjudgment of the effect, to send air to those points of the blades where a depression might occur. These two proposals do not provide a solution of the problem, for they produce no effect about the hub and do not permit the application of blades with lifting surfaces.

By the present invention, the difficulties above referred to are avoided, and a construction is provided which displaces water from the central portion of the propeller by the use of a hub having a diameter which is made at least 40% or more of the effective diameter of the propeller. The use of a hub of such diameter makes it possible to employ six or more blades and to give the same a profile having the contour of the best known lifting surface, i. e., one having a nearly uniform thickness and depth over the greater portion of its active part.

By means of constructional devices, which will be referred to later on, the ventilation by the atmospheric air of the whole surface of the hub and of the base of the blades is effected, and not only the rear face of the hub, the air being at the same time prevented from penetrating along the back of the blades to the places where a depression might be produced.

This arrangement requires a great volume of air which could not be conducted to the propeller through a hollow shaft or even a hollow hub without creating in this feed conduit a depression that would be such as to annul the benefit of the ventilation.

According to the present invention the air of ventilation is introduced by a conduit having a diameter greater than that of the propeller hub. The conduit, which is made of sheet metal thick enough to withstand the pressure of the water, is fixed to the vessel and surrounds the end of the hub in such a way as to nearly touch the blades. In this manner an annular space of large section is formed between the hub and the conduit. Owing to this arrangement, which is of capital importance, the hub and the base of the blades are completely separated by the air from the water, which makes it possible to strengthen the profiles at their base according to the needs of their resistance without having to trouble about the influence of this strengthening on efficiency since the propeller bases no longer furnish motive work.

This air introducing device does not take part in the rotation, does not need any stuffing box and has no contact with the main shaft or the propeller; the expansions and vibrations have no influence on its action, and there is not to be feared any friction which always absorbs motive force and is responsible for wear and a certain cost of upkeep.

If the main shaft has no external bearing, the conduit is fixed to the hull of the boat and is continued as a tube disposed in the interior of the boat and extends above the water line, as in the arrangement shown. If the main shaft has an external bearing, its support, which is hollow for this purpose and connected to the air chamber surrounding the bearing, will serve as the air conduit. The air chamber, which has a hydrodynamic shape, opens below in the central region of the propeller and closes again above around the shaft by means of a collar having a certain play and is surrounded by a flange integral with the shaft so that in spite of the play little water will enter the chamber. The air conduit must have a very large section in order to convey the atmospheric air to the propeller with a minimum of depression.

A hub of a section of 1.6 m^2, when equipped according to the present invention, requires 10 to 15 m^3 of air per second, and it will thus be understood that it is impossible to introduce this volume of air through a shaft with a hollow sleeve as proposed in one of the previously cited patents.

In the present invention thin ribs are provided on the two faces of each propeller blade at the level of the wall of the air conduit, in order to extend the action of the conduit to the whole surface of the hub. The purpose of the ribs is

to prevent on the one hand the water from approaching the hub at the points where the water pressure exceeds the centrifugal force of the incipient vortex, and to prevent on the other hand the radial displacement of the air along the back of the blades.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal section showing the stern of a boat equipped with propelling means in accordance with the invention;

Fig. 2 is a fragmentary sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view taken on the line 3—3 of Fig. 1, and shows the profile of a blade of the character employed in the present invention;

Fig. 4 is a sectional view similar to Fig. 1 but showing a modified form of the invention;

Fig. 5 is a fragmentary perspective view showing another modified form of a propeller provided in accordance with the invention;

Fig. 6 is an explanatory diagram;

Fig. 7 is a sectional view taken on the line 7—7 in Fig. 5; and

Fig. 8 is another sectional view taken on the line 8—8 in Fig. 5.

Referring now to the drawing, and particularly to Fig. 1, a fragment of the ship's hull is shown at *e* from which extends a driving shaft *a* having affixed to its outer end hub *b* that carries a plurality of propeller bades *c*, the hub being retained in place by means of a nut *b'*. The ventilating air for the hub *b* is conveyed by a conduit comprising a tubular wall *d* that extends outwardly from and is supported by the hull and surrounds shaft *a*. The air for ventilation is supplied to the conduit *d* by means of a tube *f* disposed within the ship's hull.

As the intensity of the vortex is proportional to the square of the speed of rotation, it becomes small for low speeds, which is the reason why the air at low speed does not surround the hub; it is therefore useless to give the nut *b'* a hydrodynamic form in order to diminish the suction which a surface perpendicular to the axis might exhibit at low speed. The ribs *c'*, *c''* are disposed one on each side of blade *c* and are arranged to follow up the wall *d*, but they may be placed a little closer to or a little farther from the axis and their inclination may vary within the limits of the region where a partial vacuum may start.

According to the embodiment shown in Fig. 4, *d* is the wall of the air chamber, *g* the bearing, *d'* the annular part of the air chamber, *d''* a collar, *a'* the sleeve integral with the shaft. The air reaches the chamber through the suspension *h* of the bearing forming an air conduit.

The greatest diameter of the hub must be adjacent the end of the air chamber, and diminish toward the rear to facilitate the expansion of the air. If this condition is fulfilled, the hub, especially its rear part, may be of any shape as it has no contact with the air. Seeing that the water does not close again immediately behind the air chamber, if only on account of the speed of the boat through the effect of inertia, the inertia would be sufficient to create a vacuum around the hub in the first third of the propeller even if there were no vortex. After the first third the effect of the centrifugal force asserts itself. In the two cases the ribs are useful and their effect varies according to their shape and height.

It must be pointed out that by increasing the number of the blades the propeller becomes less subject to vibrations than propellers having two, three or four blades, its efficiency being therefore enhanced.

On the other hand, the present invention makes it possible to arrange the external bearing closer to the propeller without creating harmful vortices, the bearing being in the interior of the chamber.

The advantages springing from the principle of the total ventilation of the center of the propeller are shown in a still more concrete shape by the following constructional features.

The bases of the metal blades may be cut away in such a way that the wall of the air chamber can be put in deeply. The front edge of the blades then extends beyond the edge of the air chamber, so that the wall of the chamber penetrates this region where the radial displacements of the air or the water are most to be feared.

Fig. 5 shows an embodiment of the invention employing blades cut away at their forward edge in the manner indicated. Here, the blade *c*, shown as extending upwardly from the hub *b*, has its forward edge cut away to provide a relatively deep notch *b''* at a point adjacent the hub. Into this notch the wall *d* of the air conduit extends, the clearance provided admitting of but little play. The fin on the side of the blade, which guides the air from the conduit over the hub *b*, is shown at *c'*.

Fig. 6 illustrates a principle to be observed in achieving proper design for the profiles of blades provided in accordance with the invention. The radius about which the blade is generated, shown at *g'* in Fig. 5, is also denoted *g'* in Fig. 6. The trace of the chord of a profile is shown as a point *g* on radius *g'*, the normal section of the profile being accordingly shown at *h''*. This section is in effect displaced to the position shown at *h'''* by the instantaneous velocities indicated by the arrows in Fig. 6. The blade may then be generated by moving a profile of a section which is substantially uniform adjacent the hub but slopes away from the forward edge so as to reduce the mass and thickness of the blade. This is shown more particularly in Figs. 7 and 8.

The profile in Fig. 7 is drawn on the base of the wetted part of the blade. This profile is carried to the outside on the radius *g'* passing through the center of the chord *g* of the lower profile, while giving it an angle of incidence corresponding to its distance from the center of the propeller. It is recommended to leave the lower profile *h'* for manufacturing and efficiency reasons. On the other hand the upper profile *h''* which follows the course *g'* will be progressively inclined during the advance toward the outside; in this manner the profile is reduced and the one illustrated by Fig. 8 is obtained. This solution offers great advantages in founding with respect to molding.

It is of course important to make the play be-

tween the wall of the air chamber and the blades of the propeller as slight as possible.

In the practice of the present invention, care should be taken to annul the effect of a possible electrolytic corrosion by selecting for the edge of the air chamber a metal or facing of suitable material, which is easy to apply as there is no contact between the air chamber and the rotating body.

The inlet of the air conduit which is necessarily placed above the surface of the water, may be inside the vessel or on the outside, according to regulations and the desire of the constructor.

Thus the system here proposed enables one to make the blades of very slight depth and to employ speeds at which the belly of the blade becomes the only active surface and the back is so-to-speak no longer in contact with the water. While there is a substantially complete absence of water in the space directly surrounding the hub, due to the presence of the air blown over the hub as herein provided, it is possible for a little air to escape at the back of the blades, and to avoid this, the pressure is increased above atmospheric by a small amount, for example, .2 to .3 of an atmosphere. There will therefore no longer be any vaporization and condensation, which are the principal agents of the wear of cavitation. On the other hand, it is not possible to create a depression on the back of the blade beyond the vacuum, while it is possible to increase pressure on the belly without impairing efficiency which is always high at this point. (Zwangläufige Flüssigkeitsbewegung!) A little air on the back may be desirable, and the proposed system enables the constructor to determine the air at will. The filament of water can detach itself more readily from the back at the front edge and has less tendency to come down on the back.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a construction for screw propellers for ships and the like, the combination with a hub of a diameter at least 40% of the effective diameter of the propeller provided with a driving shaft powered from a point within the ship's hull, of a plurality of blades secured about said hub, each of which has the profile of an aerodynamic lifting surface, an air sleeve of diameter greater than said hub disposed about said shaft and positioned to discharge air rearwardly over said hub, and fins on said blades, one on each side and positioned to be in line with the wall of said air sleeve and serving as continuations thereof over said hub.

2. In a construction for screw propellers for ships and the like, the combination with a hub of a diameter at least 40% of the effective diameter of the propeller provided with a driving shaft powered from a point within the ship's hull, of a plurality of blades secured about said hub, each of which has the profile of an aerodynamic lifting surface, an air sleeve of diameter greater than said hub disposed about said shaft and positioned to extend rearwardly a slight distance over the forward end of said hub, and fins on said blades, one on each side and positioned to be in line with the wall of said air sleeve and serving as continuations thereof over said hub.

3. In a construction for screw propellers for ships and the like, the combination with a hub of a diameter at least 40% of the effective diameter of the propeller provided with a driving shaft powered from a point within the ship's hull, of a plurality of blades secured about said hub, each of which has the profile of an aerodynamic lifting surface, an air sleeve of diameter greater than said hub disposed about said shaft and positioned to discharge air rearwardly over said hub, said blades being recessed at the forward edges adjacent said hub and having the rear edge of said air sleeve penetrating therein, and fins on said blades, one on each side and positioned to be in line with the wall of said air sleeve and serving as continuations thereof over said hub.

4. In a construction for screw propellers for ships and the like, the combination with a hub of a diameter at least 40% of the effective diameter of the propeller provided with a driving shaft powered from a suitable point, of a plurality of blades secured about said hub, each of which has the profile of an aerodynamic lifting surface, an air sleeve of diameter greater than said hub disposed in advance of and concentrically with said propeller and arranged to discharge air rearwardly over said hub, and means associated with said propeller for causing air issuing from said sleeve to envelop said hub and completely displace water from about the same.

5. In a construction for screw propellers for ships and the like, the combination with a hub of a diameter at least 40% of the effective diameter of the propeller provided with a driving shaft powered from a suitable point, of a plurality of blades secured about said hub, each of which has the profile of an aerodynamic lifting surface, an air sleeve of diameter greater than said hub disposed in advance of and concentrically with said propeller and arranged to discharge air rearwardly over said hub, and recesses cut into said blades adjacent said hub at the forward edges of said blades; said air sleeve being arranged to extend rearwardly and penetrate sufficiently into said recesses in order that the air supplied about said hub may completely envelop the same.

6. In a construction for screw propellers for ships and the like, the combination with a propeller hub of hydrodynamic form and having a driving shaft provided with an external bearing, of a plurality of blades having an aerodynamic profile secured about said hub, an air chamber having a discharge sleeve of diameter greater than said hub disposed about said shaft and external bearing, said chamber having an external streamlined contour and provided with an air supplying conduit, and fins on said blades positioned near the base thereof and arranged to serve as continuations of the wall of said air sleeve over said hub.

7. In a construction for screw propellers for ships and the like, a blade of aerodynamic form as called for in claim 1, in which the profile of the inner wetted portion adjacent the hub is substantially uniform while that of the outer portion slopes away from the forward edge so as to reduce the mass and thickness of the blade.

WERNER BAUMANN.