March 18, 1941. E. BUGATTI 2,235,605

SCREW PROPELLER

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Fig:1

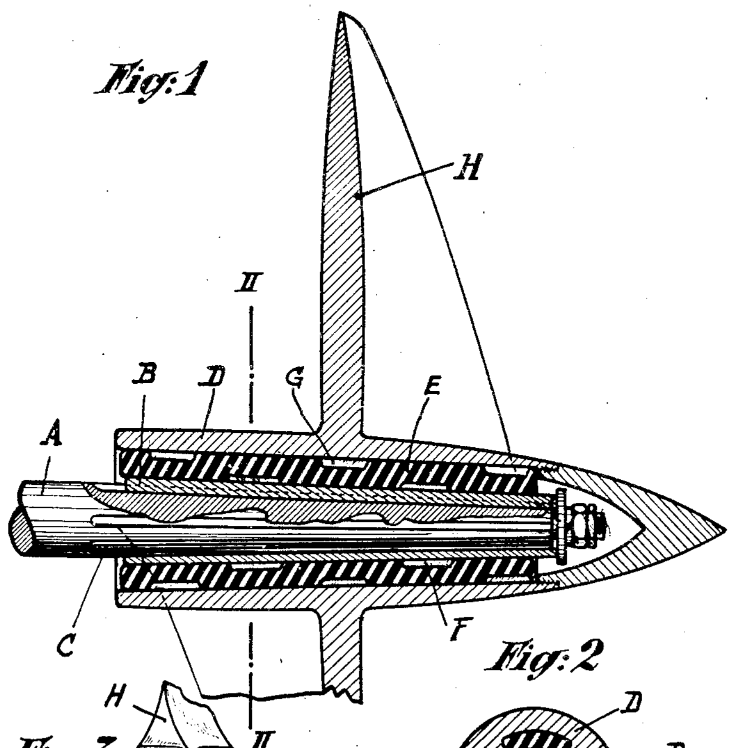

Fig:2

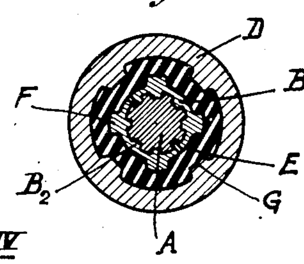

Fig:3

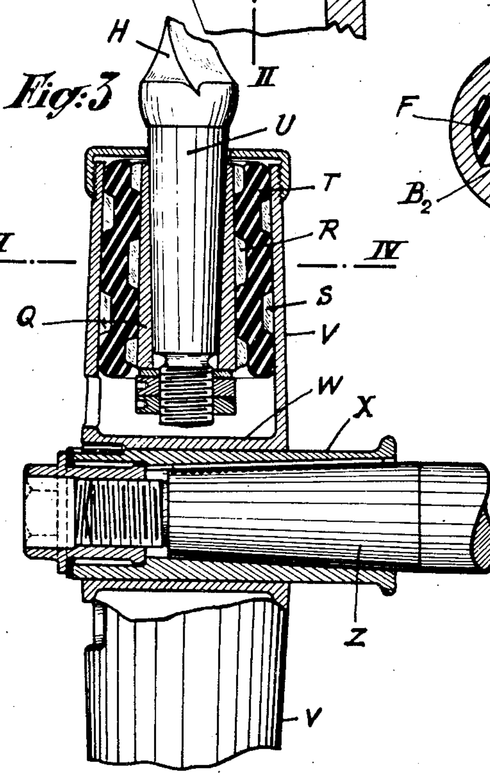

Fig:4

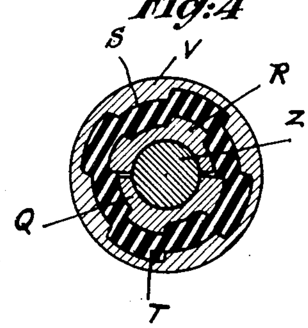

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Fig:5

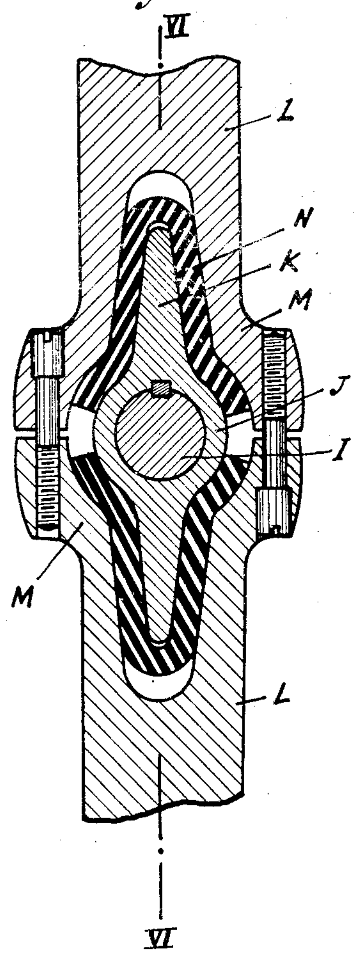
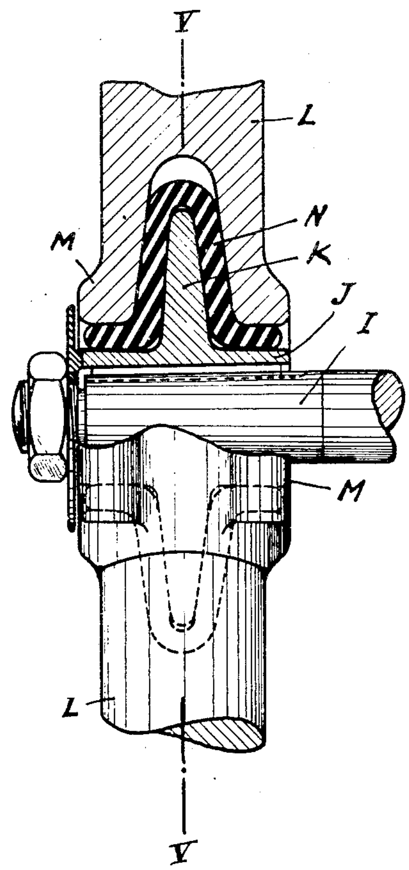


Fig:6



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SCREW PROPELLER

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Fig: 7

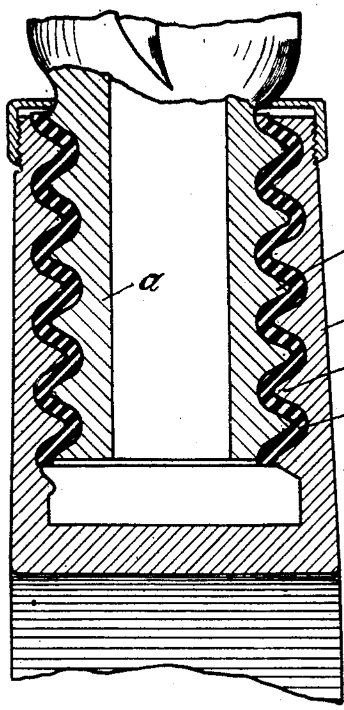
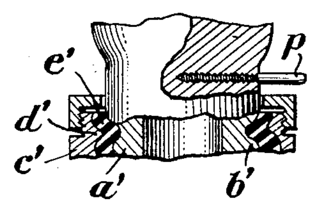


Fig: 10



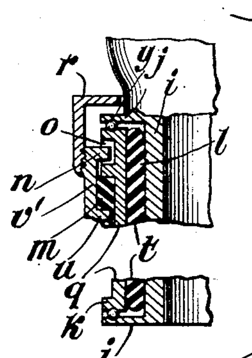


Fig: 11

Fig: 9

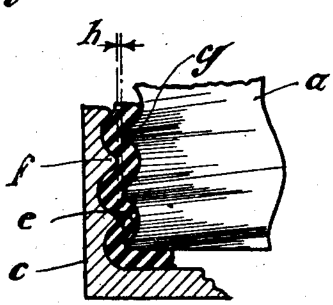
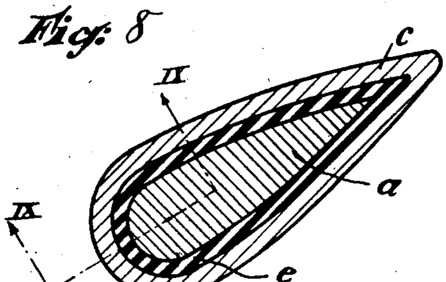


Fig: 8



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2,235,605

UNITED STATES PATENT OFFICE

2,235,605

SCREW PROPELLER

Ettore Bugatti, Molsheim, France

Application March 8, 1938, Serial No. 194,661
In France March 10, 1937

2 Claims. (Cl. 170—173)

The screw propellers that are used in navigation are nearly always located at the rear or the prow or stem of the boat that carries them, which means that, under normal conditions of said boat, as well as when the latter is moving backward, they never work in a perfectly homogeneous medium. As a matter of fact, these propellers work in a fluid disturbed by their support, by the hull, and possibly by the effects of other screw propellers. In other words, in the course of one revolution, each blade of the propeller, when sweeping the circle called the propeller disc, is subjected to the influence of water streams, the velocity and direction of which are extremely variable. As a consequence of the rotation speed which, without being extremely high, is still substantial, the blades are subjected to shocks which are highly detrimental for them and for their driving shaft. Furthermore, the vibrations that are produced are transmitted to the hull, and as they are superimposed on the periodical hammering of the hull itself produced by the movement of the blades, they contribute to a lessening of the comfort of passengers present on the boat.

To these actions, must be further added those resulting from navigation in troubled water, for instance the effect of waves, eddies produced by stationary or movable obstacles, and so on, and these external influences are far from negligible when the propeller is immersed to a relatively small distance below the water level (as it is the case with race-boats, such as those of the outboard type).

These phenomena are well known and it has already been endeavoured to obviate them. However, the researches that have been made in this direction tend essentially to improve the shape of the blades so as to reduce the intensity of the shocks, without, however, having succeeded in the elimination of transmission of these shocks, reduced but not destroyed, to the propeller driving shaft.

Phenomena of the same kind occur in the case of propellers and analogous rotary engines which work in a gaseous medium. Besides, it should be noted, concerning them, that the medium in which the propellers and like engines operate is frequently disturbed to a higher degree than the liquid medium in which vessel propellers operate.

The object of the present invention is to provide an arrangement adapted to reduce the disadvantages above set forth, applicable to all devices which rotate at a relatively high speed in a fluid about an axis which does not coincide with an axis of revolution of the geometrical figure constituted by said device. As typical examples of such devices, reference will be had to propeller blades of water and air propellers the geometrical axis (i. e. the longitudinal axis) of which is at right angles to the axis of rotation; this invention is more especially applicable to such blades, the word "propeller" being taken in its broadest meaning and applying, for instance, to rotary blade or wing systems such as those of helicopters and gyroplanes.

The essential feature of the present invention consists in providing, between the portion of a propeller blade or equivalent part which is in direct contact with the fluid medium and the driving shaft for said blade, a plastic and elastic material such as rubber, arranged in such manner that the plasticity and elasticity of this material are taken advantage of.

Owing to this arrangament, the shocks, vibrations, and the like which occur on the blade are not transmitted to the shaft, or at least are very much attenuated in the transmission.

Of course, this improvement in the construction of screw propellers does not exclude those which may be devised with a view to improving the shape and structure of the blades.

Practically, the invention can be carried out in various ways. For instance, the plastic and elastic material may be inserted between the hub of the propeller or similar device and its driving shaft, or again between a blade and the hub, or again between a blade and a blade holder rigidly or elastically connected to the hub, these various solutions being possibly applied simultaneously.

Furthermore, according to another feature of the present invention, I take into acount the nature and the importance of the stresses to be undergone by a blade in service and accordingly dispose the plastic and elastic material in such manner as to improve the resistance of the blade to these stresses. In particular, I arrange the plastic and elastic material in such manner that it acts for absorbing and deadening the stresses resulting from important variations of the rotation speed, and especially the centrifugal stresses in the case of a blade turning at a high speed.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is a longitudinal axial section of a boat propeller made according to a first embodiment of the present invention;

Fig. 2 is a transverse section on the line II—II of Fig. 1;

Fig. 3 is a longitudinal sectional view of the central portion of an aerial propeller which may constitute a variable pitch propeller;

Fig. 4 is a sectional view on the line 4—4 of Fig. 3;

Fig. 5 is a sectional view of another embodiment applicable to the case of a propeller to be used either in air or in water, this view of the central part of such a propeller being at right angles to the axis thereof, on the line V—V of Fig. 6;

Fig. 6 is a partial section, on the line VI—VI of Fig. 5;

Fig. 7 is a sectional view showing part of a modified propeller structure, the section being made in the plane including the longitudinal axis of a blade and the rotation axis of the propeller;

Fig. 8 is a cross-section of a blade root positioned in its blade-holder, according to a further modification;

Fig. 9 is a longitudinal section of a part of the blade root and blade-holder shown in Fig. 8, the section being taken according to line IX—IX.

Fig. 10 is a longitudinal sectional view corresponding to Fig. 3, additionally showing means for controlling the pitch of an aerial propeller;

Fig. 11 is a fragmentary longitudinal sectional view of a further embodiment of my invention, illustrating the use of a plurality of shock-absorbing means.

The annexed drawings are to be considered as purely diagrammatic and as illustrating in a conventional manner elements which, for practical purposes, might be made of different shape.

In the example of Figs. 1 and 2, the blades H are, in the usual manner, integral with the hub D of the propeller. On the driving shaft A, I fit, in removable manner, a sleeve B, provided, for instance, with ribs adapted to cooperate with corresponding splines C in shaft A in such manner as to transmit the drive from said shaft to said sleeve. Between sleeve B and hub D, I interpose a plastic and elastic material E such as rubber. This rubber bushing or spacer may be made of one or more parts. In order to avoid a relative sliding between the rubber bushing and the hub and also the sleeve, arrangements have been taken in order to ensure a good connection from one to the other. In the example shown by the drawings, these arrangements include superficial projections F provided on sleeve B and superficial projections G provided on the inner wall of the hub. These projections F and G are disposed in alternating relation, both in the peripheral and in the longitudinal direction and they compress the rubber bushing E so as to project into the latter. As shown by Fig. 2, sleeve B can be made of two elements B_1 and B_2, in order to facilitate the assembly.

In the example of Figs. 3 and 4, the driving shaft Z is surrounded by a sleeve X on which is keyed a support W for the propeller blades H. The support W is rigid with radial sleeves or blade-holders V in each of which is engaged a cylinder or blade-carrier Q carrying the inner end or root portion U of the corresponding blade H. Between the cylinder Q, provided with external projections R and the corresponding sleeve V, which is also provided with projections, but on its inner wall, as shown at S, I provide a packing T, of a plastic and elastic material such as rubber. It should be understood that projections S and R alternate, both in the direction of the length of the blade (Fig. 3) as in that of the periphery thereof (Fig. 4). Cylindrical part Q which is advantageously made of two parts, so as to facilitate assembly, may in the usual manner, be devised in such manner as to permit rotation of the blade about its axis, if the propeller is of the adjustable pitch type.

In the embodiment illustrated by Figs. 5 and 6, the inner end L of each blade is hollow in such manner as to fit upon a driving pin K, which belongs to a hub part J which is, for instance, keyed on the driving shaft I. Between the driving pin K and the blade end L there is interposed a packing of rubber or any other plastic and elastic material N. The blade ends are provided with enlarged portions M which, once assembled together, as diagrammatically shown by the drawings, constitute the hub proper of the propeller.

As a modification, I may provide a propeller wherein the blade root or a carrier therefor and the blade holder or support have corresponding projections shaped as annular or helical beads, so that the intervening plastic and resilient material exhibits a sinuous longitudinal section; consequently the said material, in operation, is mainly stressed to shearing along its larger dimension so that, even though it may have a small thickness, it is quite fit for withstanding drastic centrifugal stresses set up in the blade.

The foregoing modification is illustrated, in a specific embodiment, by Fig. 7; in this instance, the blade root *a* and the blade-holder *c* have facing screw-threads *b* and *d* respectively, which have been shown as formed on the parts; the amounts by which the screw-threads project on the corresponding parts are here assumed to be such that the blade root can be fitted into and removed from the blade-holder only by relative rotation; in other words, screw-threads *d* behave as abutments towards screw-threads *b*, thereby positively excluding separation of the blade from its holder under centrifugal action; a bushing or buffer *e* made of plastic and resilient material such as rubber is interposed, possibly in permanently compressed condition, between the blade root *a* and the blade-holder *c*. The blade root may be screwed into the holder with the bushing previously positioned therein; alternatively I may provide a sectional blade-holder in which case I may first position the bushing around the blade root, then the sections of the blade-holder which are then attached or otherwise assembled together. The rubber or like plastic and resilient material may also be poured in liquid or pasty condition into the space available between the screw-threads and then set to final condition in known fashion. It will be obvious, that the screw-threads *b* may be provided upon a separate sleeve such as shown at Q on Figs. 3 and 4.

According to a further modification, I may provide a blade and a blade-holder having a non-circular cross-section, preferably one which is egg-shaped or streamlined as shown in Figs. 8 and 9. In such instance, while I may use a sectional blade-holder as above described to enable assembling of the parts where the projections on the blade root and blade-holder are arranged in staggered and intermeshing relation, as set forth with reference to Fig. 7, I may also, as illustrated by Figs. 8 and 9, leave an amount *h* of clearance which enables of introducing the blade root edgewise into its holder.

In any one of the foregoing embodiments, the plastic and resilient material may be stuck or glued onto the metal parts between which it is positioned, for instance by being vulcanized thereto; again, as is known in the art of joints, it may be permanently attached to inner and outer sleeves or like members which are then attached to the blade and the blade-holder respectively.

Where the propeller is a variable pitch-propeller as illustrated in Fig. 10, the bushing or buffer e' of plastic and resilient material may be used as a torsional joint to enable, against resilient biasing stress, a rotation of the blade in its holder. In said Fig. 10, member P is the lever whereby the pitch of the blade is regulated or controlled. Elements a', b', c', d', and e', correspond to elements a, b, c, d and e described above with reference to Fig. 7. Alternatively, as illustrated in Fig. 11, I may provide two bushings of plastic and resilient material, one of which operates mainly or solely as a torsional joint while the other one operates mainly or solely to resiliently damp any forces other than torques. In this connection, I may prevent any relative rotation between the parts having the second bushing as an intervening member, by means of a device such as a clutch with keys slidable in splines; likewise, I may provide rigid or resilient abutments between the parts interconnected by the resilient torsional bushing to prevent substantial sliding relative displacements. The two bushings are preferably made of rubber having different softness.

In said Fig. 11 the propeller blade is provided with a stem or root portion i preferably of uniform diameter having abutments j at each end thereof. A tubular member q encloses root i and is connected with abutments j by suitable ball elements y. By this arrangement, resilient bushing l, interposed between member q and root i, and preferably bonded or cemented thereto as by vulcanization, forms the joint primarily adapted to absorb torsional shocks. The exterior of member q is provided with splines o (only one shown) into which project suitable keys n, (only one shown) to prevent relative rotation of member q and sleeve or blade holder v'. Member q and blade holder v' are provided with projections t and u on their outer and inner peripheries, respectively. In the space formed thereby is cemented the ring-like resilient bushing m, which forms the second joint referred to above, primarily adapted to absorb forces other than torques such as longitudinal or centrifugal stresses. Obviously, a plurality of projections t, u and intermediate bushings m may be provided, although only one set is shown in the figure.

Blade holder v' is provided with a housing member or cap r screwed over its upper end, which cap has a suitable opening through which the propeller blade passes.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition, and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. In a rigid structure adapted to revolve about an axis, the combination of a hollow blade holder located on one side of said axis, a blade having a stem or root portion receivable in said blade holder, an intermediate tubular member enclosing said stem and protected against substantial sliding displacement relative to said stem by abutments on said stem; a resilient bushing disposed between said tubular member and said stem and bonded thereto, for the absorption of torsional stresses developed by said blade; peripheral projections on the interior of said blade holder and the exterior of said tubular member, a bushing disposed between said blade holder, said tubular member and said projections and bonded thereto, for the absorption of longitudinal stresses or the like developed by said blade; and loose-fitting spline and key members interlocking said blade-holder and said tubular sleeve against substantial relative sliding movement.

2. In a rigid structure adapted to revolve about an axis, the combination of a hollow blade holder located on one side of said axis, a blade having a stem or root portion receivable in said blade holder, an intermediate tubular member enclosing said stem and protected against substantial sliding displacement relative to said stem by abutments on said stem, a resilient bushing disposed between said tubular member and said stem and bonded thereto for the absorption of torsional stresses developed by said blade; peripheral projections on the interior of said blade holder and the exterior of said tubular member, a bushing disposed between said blade holder, said tubular member and said projections and bonded thereto, for the absorption of longitudinal stresses or the like developed by said blade; loose-fitting spline and key members interlocking said blade-holder and said tubular sleeve against substantial relative sliding movement; and a housing member covering the assembly at the end of said blade holder and having an opening for said blade.

ETTORE BUGATTI.