Dec. 15, 1931. S. A. REED 1,836,989

AERONAUTICAL PROPELLER AND METHOD OF MAKING THE SAME

Filed March 9, 1926

Fig 2

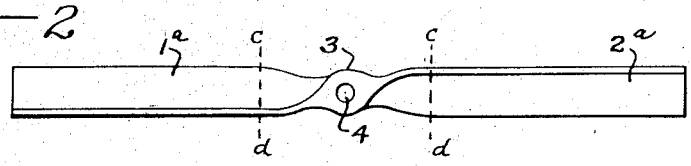


Fig 1

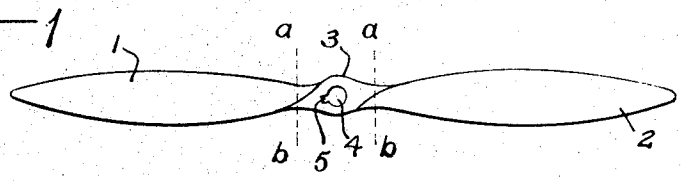


Fig 3

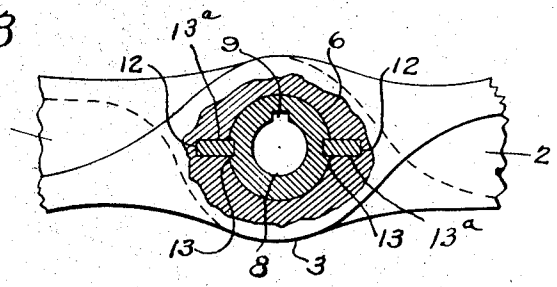


Fig 4

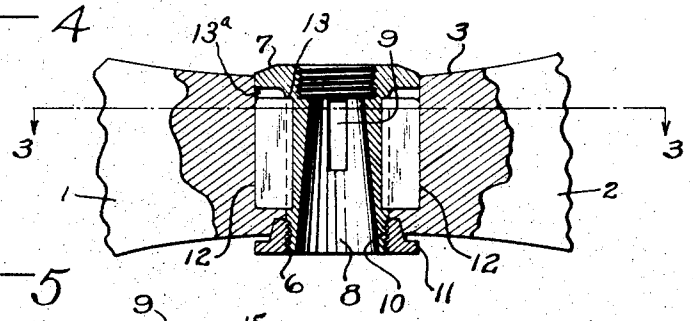


Fig 5

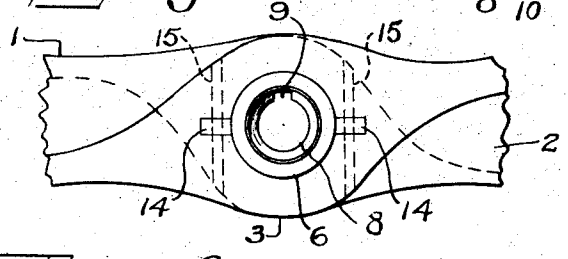
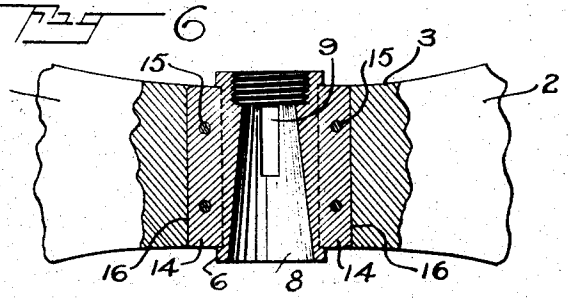


Fig 6



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Patented Dec. 15, 1931 1,836,989

UNITED STATES PATENT OFFICE

SYLVANUS A. REED, OF NEW YORK, N. Y., ASSIGNOR TO THE REED PROPELLER CO., INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

AERONAUTICAL PROPELLER AND METHOD OF MAKING THE SAME

Application filed March 9, 1926. Serial No. 93,412.

This invention relates generally to aeronautical propellers and more particularly to metal propellers of the type devised by me and disclosed in different forms in my U. S. Letters Patent No. 1,463,556, dated July 31, 1923; No. 1,518,410, dated Dec. 9, 1924 and No. 1,542,412, dated June 16, 1925, to which reference may be had for a more detailed description of my types of metal propellers and the novel principles involved. The said patents set forth improved propellers having blades formed of solid metal, for example, duralumin or a similar light-weight strong alloy, or an alloy of magnesium, and characterized by unusually thin blade sections or profiles, which require dependence substantially upon the virtual rigidity imparted by radial tension due to the centrifugal force to maintain the blades in effective operation; the said patented improvements being applicable to propellers having separable blades as well as those of a unitary construction in which the propeller is formed in one piece from tip to tip of the blades.

My present improvements pertain more especially to the said unitary form of construction of the said patented propellers, and I now provide the same with an integral central boss or hub, formed preferably with a shaft hole and capable of direct mounting upon the engine-shaft of an air-plane. This boss has the form of a central bulge or enlargement in the direction of the plane of rotation, so that the propeller is a unitary structure and can be made, not from a rolled plate as referred to in said patents, but from a forged bar of metal, and yet have its blades made with the same typical unusually thin profiles as in said patents and which features permit me in my present improvements, to give to the blade portions nearest the boss or axis, more correct pitch angles so as to obtain as high general efficiency as possible in my present new form, wherein the effective blade pitch angles are brought very close to the axis of rotation and the blade roots are favorably disposed for damping blade vibration.

In addition to the simplicity of construction and design of my newly devised integral structure of the propeller, I have devised a method of making the same as well as making a blank from which the propeller is conveniently and quickly made, so that a material saving in cost of manufacture is thereby effected.

I have illustrated types of my inventions in the accompanying drawings, wherein

Fig. 1 shows an end elevation of a propeller embodying my inventions, the view being taken in the direction of the shaft-hole.

Fig. 2 is a similar view in elevation to that of Fig. 1, of a propeller blank embodying my invention.

Fig. 3 shows an enlarged view in end elevation of the central or hub portion of a propeller provided with a hub lining member in accordance with my invention, with said member and a part of the hub shown in section at right-angles to the axis.

Fig. 4 shows a central vertical sectional view of the parts shown in Fig. 3, and on an enlarged scale, the view being at right-angles to that in Fig. 3.

Figs. 5 and 6 are similar views to those shown in Figs. 3 and 4, respectively, of another form of the hub liner, as embodied in my invention.

Referring to the drawings, the propeller shown in Figs. 1 to 6, inclusive, is a single solid piece of forged metal with its solid blades 1 and 2, integrally united by a central enlargement, or boss, or hub portion 3. This central part is enlarged in the direction of the shaft diameter and at the points of connection with the blade roots, there are extensions which merge with the blade roots in sudden tapering formation. The blades 1 and 2, are of such thinness relative to the thrust loads for which they are intended, that without the compensating influence of centrifugal force they would deflect to a degree disqualifying them from service.

At the blade-radius *a*—*b*, the blade may be of such thinness that, in case of metal of the duralumin type, it does not exceed one-inch thickness for a propeller of nine-feet diameter, that is to say one-fifty-fourth of the blade length. By this means I reduce the total weight and at the same time maintain

the blade angles steady under the stresses of flight service, and there is also an advantage in obtaining propulsive effect from all portions of the blades, including those close to the axis of rotation.

Hitherto, in airplane propellers made of wood or hollow metal and having an integral central enlargement for mounting on the engine-shaft, the portions of the blade at one-tenth blade-radius, have necessarily been made so thick that they have practically no propulsive effect and in fact are usually only an obstructive and resistant element to the torque force of the engine-shaft. By the use of strong light-weight material having substantially the physical properties of duralumin, and by appropriate gradation of the thickness, widths and contours, in conjunction with the use of the integral boss with its superior inner blade sections, I have obtained a propeller whose blades have superior propulsive properties, including those portions close up to the boss.

The die process of forging is the most economical, but in commercial production there is a demand for individual propellers of various designs, diameters, widths and angles, and a set of dies for each different type would be of prohibitive expense. Many types, however, may be so grouped as to have identical shape and size in the central region of the propeller, and as the latter formation is the most expensive part of the process, I have found it economical to form the central part of about thirty-inches length, namely, about fifteen-inches each side of the axis, with dies, and at this stage to leave the blades in the rough condition resulting from the first forging of the starting bar material, and in annealed condition, to be finished afterwards by carving, milling or by special dies, and then twisted cold to the desired pitch angles, and finally heat-treated. Fig. 2, represents a propeller blank of solid metal in such intermediate stage, in which the central region from about between the dotted lines *c*—*d*, is stamped hot between dies, with the curved surfaces required at that part, whereas the blades beyond *c*—*d*, are of angular section, preferably rectangular and substantially flat, the entire blank being in the annealed condition.

The hot die forging of the hub and blade roots results also in hot die twisting the blade roots to such positions that the rough blade blanks are then at angles to the intended plane of rotation of the propeller, which angles are appropriate for the desired pitch at the blade radii corresponding to half the length of said hot forged region.

The partly finished propeller shown in Fig. 2, is the product of my method of starting with a blank bar of solid metal, such as an alloy of the character hereinabove described, and suitably forging the bar while hot into an elongated piece with a central boss or enlargement having suitable dimensions for a hub, and with flat portions such as indicated at 1^a and 2^a, in Fig. 2. This forged unitary piece is then subjected to the second step consisting in die-forging the central region of the piece while hot, said dies operating upon the same over a length of about fifteen-inches each side of the transverse axis which is coincident with the axis of rotation. This die operation produces the structure shown in Fig. 2, wherein the hub is formed with properly curved extensions projecting therefrom and merging in tapering formation with the roots of the blade portions 1^a and 2^a, which are still in the flat rough condition left from the first forging work thereon. This piece thus partly formed is an important feature of my present invention and while in annealed condition it may be afterwards finished by suitable carving, milling or by special dies, and then the outer portions twisted cold to the desired pitch angles, and finally heat-treated and cooled in the usual manner to develop the desired qualities the metal.

When using material having the physical properties above named, the propeller may be mounted directly upon the engine-shaft, either by securing the boss 3, to an end flange on the engine-shaft, or by boring a hole 4, in the boss, and providing the hole with a keyway 5, thus dispensing with the complication and expense of a separate member for attaching the propeller to the driving-shaft, or I may use other means suitable for such attachment. But I may also use such a separate member as is shown in Figs. 3 and 4, consisting of a flanged liner tube 6, inserted in a hole through boss 3, and having a flange 7, and bored with a hole 8, to fit the engine-shaft, and provided with an internal keyway 9, to secure tube 6, to said engine-shaft. The liner tube 6, is harder metal than the propeller and has at one end an outside thread 10, to receive a screw-flange 11, adapted to clamp the liner tube 6, firmly between the two faces of the boss 3. To prevent rotation of the tube 6, in the boss 3, under the torque of the engine-shaft, I provide the keys 12, which project into shallow external keyways 13, in the liner tube 6, and into deeper keyways 13^a, in the boss 3, thus providing a larger bearing surface of the liner tube 6, and the keys 12, may each be made in two parts each to be inserted from an opposite face of the boss, in a manner well known. I prefer to use steel for the liner tube 6.

Another form of the tubular hub liner 6, is shown in Figs. 5 and 6, and is characterized by the integral fins 14, adapted to a close fit in deep keyways 16, in the boss 3, and by anchor-pins 15, passing through both the boss and the fins sidewise, and preferably retained in place by blind forging the metal

of the boss to close the pin holes and cover the ends of the pins.

By die-forging the central part of the propeller as shown in Fig. 2, I provide blanks from which different sizes of propellers may be made, as there is a large amount of metal afforded by the flat rough forged blade portions 1^a and 2^a, so that one set of dies will serve the purpose in making quite a range in sizes of propellers.

The thinness of the propeller blades is such that relative to their intended thrust loads that, without the compensation of centrifugal force, they would deflect to a degree disqualifying them from service.

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

1. An aeronautical metal propeller having thin solid metal blades and an integral central hub-forming enlargement forged as a unit, the blade sections at about 1/10 blade length being of a thickness not exceeding about 1/54 of said blade length and of such thinness relative to their intended thrust loads that they require dependence substantially upon centrifugal force to maintain the blades in effective operation.

2. An aeronautical metal propeller having thin solid blades made from a single-piece of solid forged metal with the central hub part and blade-roots hot forged to substantially final shapes while the main portions of the blades are cold-twisted and cold worked, said blade-roots being twisted in the hot-forging thereof.

3. A process of forming metal propellers which comprises forging while hot a bar of light weight strong metal so as to form an elongated blank with a central enlargement and with blade extensions extending therefrom, with said hub portion finished in substantially final form, and with the outer portions of the blade rough forged, and then milling said outer portions of the blades while cold into final shape and design.

4. A process of forming metal propellers which comprises forging while hot a bar of light weight strong metal so as to form an elongated blank with a central enlargement and with blade extensions extending therefrom, with said hub portion and at least one fourth of the inner portion of the blade extending therefrom finished in substantially final form, and leaving the outer portions of the blade substantially flat and rough forged, then milling and twisting the outer portions of the blades while cold to final shape and design, and then heat-treating the propeller to develop the good qualities of the metal.

5. An aeronautical metal propeller having metal blades, and a central hub enlargement for mounting on an engine shaft forged substantially in final shape as a unit with said blade and having at least the outer third of the blade milled cold to substantially its final shape.

6. A forged metal blank for a single piece thin blade metal propeller, said blank having a die forged central part with blade extensions projecting therefrom and with the outer portions of the blade milled cold to substantially the final shape.

In testimony whereof, I have hereunto signed my name, this 8th day of March, 1926.

SYLVANUS A. REED.