L. T. FREDERICK.

VARIABLE PITCH PROPELLER.

APPLICATION FILED FEB. 15, 1919.

1,367,132. **Patented Feb. 1, 1921.**

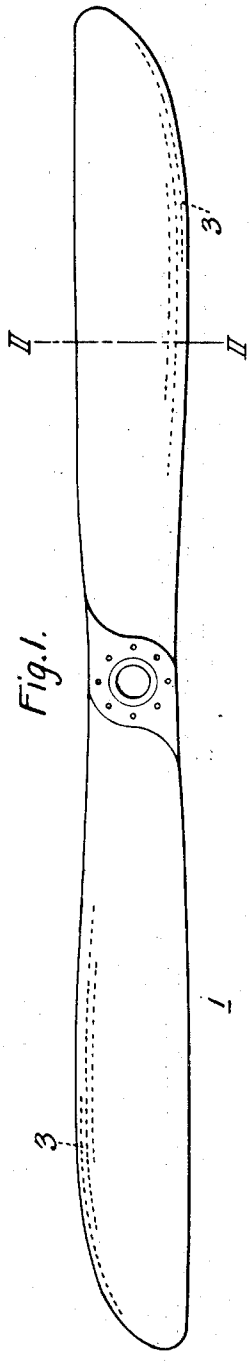


Fig. 1.

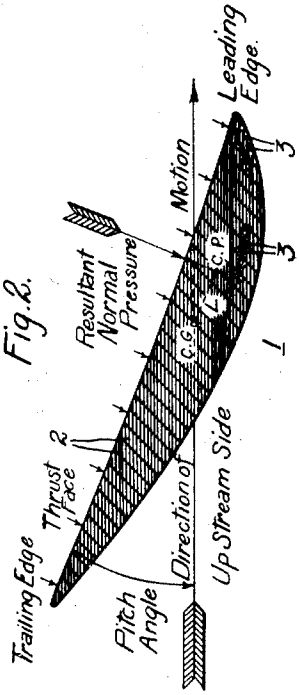


Fig. 2.



Fig. 3.

WITNESSES:

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VARIABLE-PITCH PROPELLER.

1,367,132. Specification of Letters Patent. Patented Feb. 1, 1921.

Application filed February 15, 1919. Serial No. 277,197.

To all whom it may concern:

Be it known that I, LOUIS T. FREDERICK, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Variable-Pitch Propellers, of which the following is a specification.

My invention relates to propellers and more particularly to composite propellers comprising superimposed layers of fibrous material impregnated with a hardened binder, and it has, for its primary object, the provision of a variable-pitch propeller of that type.

Propellers now in use are of a non-variable-pitch type and, as a result, they cause airplane engines driving them to run at different speeds, depending upon the blade thrusts under varying circumstances. For example, with a certain propeller of non-variable-pitch type and an engine driving it with its throttle wide open, the engine attained a speed of 1410 R. P. M. while the plane, upon which the engine and propeller were mounted, was blocked to the ground. During "climb", the engine speed increased to 1450 R. P. M. and, in horizontal flight, ran at 1500 R. P. M.

These undesirable changes in engine speed are caused by changes of torque imposed chiefly by the changes of the propeller pitch which, in turn, are caused partly by the flexibility or resiliency of the material of which the propeller is made and partly because of certain necessary inherent requirements of design.

More particularly, the object of my invention resides in overcoming, to a great extent, at least, changes in propeller pitch, caused by flexibility of the propeller material, by stiffening certain portions of the propeller, relative to the remaining portions.

A still further object of my invention consists in stiffening the leading edge portions of the blades by a suitable disposition of wires between the various layers of sheet material prior to the molding of the propeller, so that they will be firmly embedded in the finished propeller.

With these and other objects in view, my invention will be more fully described, illustrated in the drawings, in the several views of which corresponding numerals indicate like parts, and then particularly pointed out in the claims.

Figure 1 is a front elevation of a propeller constructed in accordance with my invention; Fig. 2 is a partly diagrammatic, sectional view of the propeller, taken on the line II—II of Fig. 1, and Fig. 3 is a view of a wire which may be employed as a reinforcing element.

In a copending application filed by D. A. Dickey, on December 30, 1918, bearing Serial Number 268,949, Case Number 6187, and assigned to the Westinghouse Electric & Manufacturing Company, is disclosed a propeller of composite type comprising a plurality of superimposed layers of fibrous sheet material, such as duck, impregnated with a suitable hardened binder, such as a phenolic condensation product.

As there set forth, a propeller may be formed by cutting the several layers to the proper shapes and sizes, from a sheet of impregnated duck, superimposing the layers thus formed in proper relative positions, dependent upon their shapes and sizes, and curing the propeller body thus assembled by subjecting it to heat and pressure, in a suitably shaped mold, to compact the material and transform the binder to its hard and substantially insoluble and infusible condition.

In practising my invention, I may construct a propeller by following the method disclosed in the above mentioned application, superimposing the several layers of the impregnated sheet material employed in the manner there set forth, with the layers disposed in planes substantially parallel to the faces of the propeller hub.

My invention, however, resides in the provision of means for stiffening the leading edges of the blades, relative to the remaining portions of the blades, whereby I produce a variable-pitch propeller. To accomplish this, I may dispose wires longitudinally of the leading edge portions of the blades and in substantially parallel relation. These wires may be disposed between the layers of fibrous sheet material, as they are being assembled to form the propeller body, or they may be disposed between similar layers of sheet material and held in proper position between such layers by a preliminary application of slight pressure and heat

and the reinforced sheets, thus provided, may be disposed in proper position within the propeller, as it is being assembled.

For example, referring more particularly to Figs. 1 and 2 of the drawings, I disclose a propeller 1, the main body portion of which may consist of superimposed layers 2 of duck or equivalent material, impregnated with a suitable binder, such as a hardened phenolic condensation product. Obviously, paper or other suitable fibrous sheet material may be employed if desired.

Molded within this propeller are a plurality of longitudinally extending, substantially parallel, stiffening wires 3 which may preferably be disposed in one or more groups and which are located in, or near, the leading edges of the propeller blades. The exact location of these wires will depend upon the type of propeller in which they are placed, the pitch of the propeller, and the speed at which it is to be normally driven. For instance, with the type of propeller blade shown in Figs. 1 and 2, groups of wires may be disposed in the blades immediately at the leading edges and along the up-stream sides of the blades while second groups of wires may be disposed between the points of centers-of-pressure of the blades and the leading edges and adjacent the up-stream sides of the blades.

In order to insure a secure anchoring of the wires between the layers of sheet material constituting the body of the propeller, each wire 3, as best shown in Fig. 3 of the drawings, is provided with a covering 4 of cotton or other equivalent material and this covering is preferably impregnated with a binder, such as a phenolic condensation product, prior to the positioning of the wires in the propeller blades. While the wires may be individually positioned between the several layers of the propeller while the propeller is being assembled, I prefer to introduce them in groups already inclosed in moldable plates of superimposed layers of fibrous sheet material and a binder.

In a copending application filed by D. A. Dickey, on Feb. 15, 1919, Serial Number 277,247, Case Number 6902 and assigned to the Westinghouse Electric & Manufacturing Company, is disclosed a method of forming reinforcing elements by which wires covered with cotton, which is impregnated with a suitable binder, such as a phenolic condensation product, are disposed between layers of fibrous sheet material, such as duck, in substantially parallel relation and after which the body thus assembled is subjected to a slight degree of heat and pressure sufficient to somewhat compact the body and cause adhesion between the parts thereof, without affecting the binder. Preferably, I employ "preformed" reinforcing elements of this character and dispose them in proper positions within the blades of the propeller as the latter is being assembled, as, by this means, any liklihood of displacement of the wires, relative to each other, during the assembling and curing of the propeller is avoided.

A propeller, constructed in accordance with my invention, with its leading edge portions stiffened by the molding in of reinforcing wires is variable in pitch and is far superior to the propellers now in use.

For a clearer understanding of the principle upon which my invention is founded, attention is directed to Fig. 2 of the drawings which shows, diagrammatically, a section of a propeller blade, looking toward the hub, with the direction of motion of the section, the pitch angle, leading and trailing edges and the up-stream and thrust faces clearly designated.

The air pressure is, of course, distributed, although not evenly, over the entire thrust face of each propeller blade when the propeller is in action, and the whole blade section is pushed "up stream," the resultant of all this distributed pressure acting through the center of pressure C. P. of the section, as shown. Strangely, however, this center of pressure is nearer the leading edge of the blade than the center of gravity C. G., because of the necessary shaping of the blade, and, consequently, the resultant pressure, acting through the lever arm L, tends to twist the section in a counter-clockwise direction.

The result of this is an increase of pitch angle and consequent increase of torque and drag and a slowing down of the engine. Furthermore, the greater the propeller thrust, the more pronounced this effect will be, which is just the reverse of what is desired as, for maximum efficiency, the pitch angle should decrease as the thrust increases.

By practising my invention, I have provided a propeller in which the leading edges of the blades may be made rigid enough to hold up and allow the trailing edges to deflect relatively more than the leading edges, when the thrust comes on, so that the pitch angle will be decreased as desired, instead of being increased as the thrust is increased.

Obviously, various changes may be made when practising my invention and, for this reason, no limitations are to be imposed upon it other than those indicated in the appended claims.

I claim as my invention:

1. A variable-pitch propeller comprising a composite molded body and longitudinally disposed reinforcing wires molded in the leading edge thereof.

2. A variable-pitch propeller comprising a molded body of superimposed layers of fibrous sheet material and a hardened binder

and reinforcing wires longitudinally disposed between certain of the layers at the leading edges of the blades.

3. A variable-pitch propeller comprising a propeller body formed of superimposed layers of fibrous sheet material, impregnated with a hardened phenolic condensation product, and longitudinally disposed wires embedded in the leading edge portions of the blades in substantially parallel relation.

4. A variable-pitch propeller comprising a propeller body formed of superimposed layers of fibrous sheet material, impregnated with a hardened phenolic condensation product as a binder, and groups of longitudinally disposed wires embedded in and near the leading edges of the blades.

In testimony whereof, I have hereunto subscribed my name this 31st day of Jan., 1919.

LOUIS T. FREDERICK.