

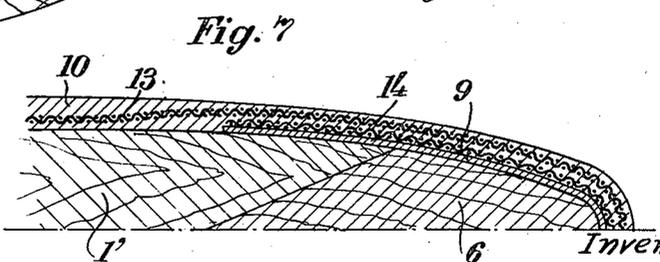
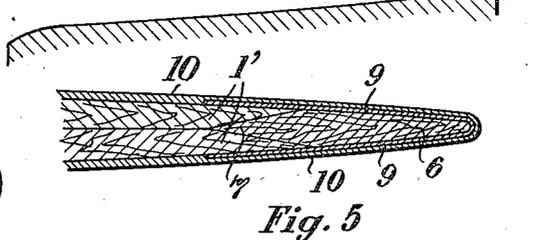
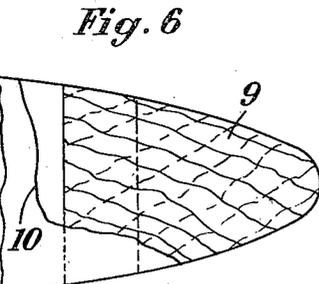
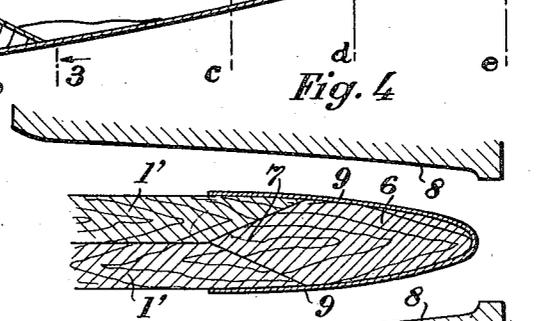
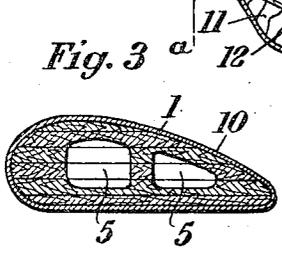
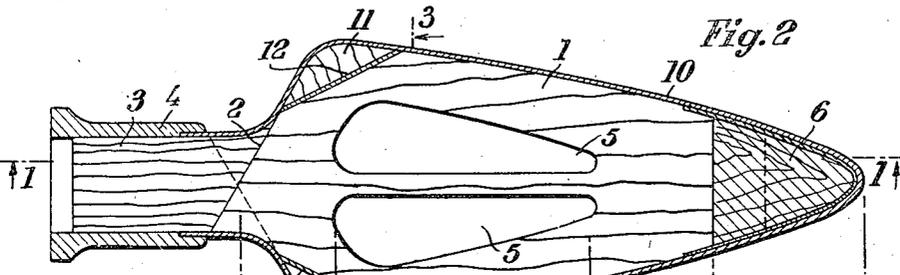
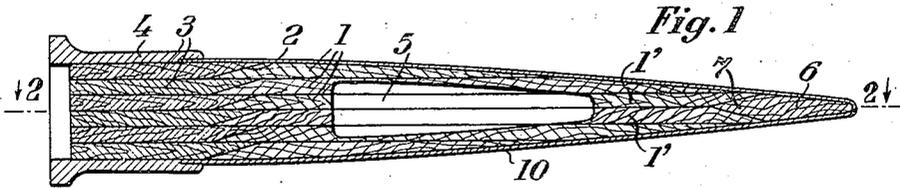
July 9, 1940.

L. HOFFMANN

2,207,200

PROPELLER FOR AIRCRAFT

Filed Dec. 23, 1937



Inventor:
Ludwig Hoffmann
by *Frank Reichard*
Attorney.

UNITED STATES PATENT OFFICE

2,207,200

PROPELLER FOR AIRCRAFT

Ludwig Hoffmann, Berlin-Hermsdorf, Germany,
assignor to Gustav Schwarz Kommanditgesellschaft,
Berlin-Waidmannslust, Germany, a
partnership composed of Gustav Schwarz and
Otto Schwarz

Application December 23, 1937, Serial No. 181,299
In Germany December 24, 1936

3 Claims. (Cl. 170—159)

My invention relates to improvements in propellers for aircraft, and more particularly in non-metallic propellers.

The blades of propellers for aircraft, whether they are made from metal or from other material such as wood are substantially uniform all over the length of the blade of the propeller. I have found that this uniform structure does not answer the requirements such as the tension, the deformation, the surface properties, the resistance to oscillations, and the aerodynamic conditions, which requirements are different in the successive zones of the blade from the root to the tip thereof. This is particularly objectionable in propellers which have comparatively broad blades.

A blade which in all the zones answers the tension, deformation, the surface properties and the oscillation properties should be constructed as follows:

First, the part of the blade of the propeller located between the outer end of the root and the tip portion should be as light as possible, as strong as possible and as rigid as possible, and particularly it must be rigid as against bending strains. The weight of the said part should be as small as possible in order to reduce the centrifugal forces; high strength is needed, because the said part of the blade is subject to high centrifugal, bending and torsional forces; and rigidity of the structure is necessary in order to keep down oscillations of the blade. The thickness of the said portion of the blade may be comparatively large, because the circumferential velocity of this part of the blade relatively to the air is comparatively small. But the thickness cannot be reduced at will.

Second, the tip portion of the blade must be rigid, particularly as against torsional stresses. Further, it must be constructed so that it can be made exactly with the desired cross-section which should be in the form of a thin and sharp blade. Further, the weight of the tip portion must be reduced as far as possible. Finally, the said portion must have a particularly hard surface, in view of the strong attack of the said tip portion by outer influences.

Thus the requirements of the structure and the freedom left to the designer in the construction of the blade are entirely different in the successive zones of the blade:

The object of the improvements is to provide a propeller which in a large degree answers the said different requirements, and with this object in view my invention consists in composing the

blade portion, that is the portion included between the outer part of the root and the outer end of the blade, at least of two different structures following each other in radial direction, the said structures being different as to the character of the raw material and the shape thereof and/or being as far as possible adapted by their structure to the requirements of the successive zones of the blade. Preferably the tip portion of the blade consists of compressed material, which permits the said tip portion to be made exactly with the desired thin and sharp cross-section, and imparts thereto a high degree of hardness.

For the purpose of explaining the invention an example embodying the same has been shown in the accompanying drawing in which the same reference characters have been used in all the views to indicate corresponding parts. In said drawing:

Fig. 1 is a sectional elevation of the blade of the propeller taken on the line 1—1 of Fig. 2,

Fig. 2 is a sectional plan view taken on the line 2—2 of Fig. 1,

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2,

Fig. 4 is a plan view of the tip portion of the blade,

Figs. 4 and 5 illustrate the manner of shaping the tip portion, Fig. 4 showing diagrammatically the matrices of a press and the tip portion prior to compression thereof, and Fig. 5 showing the said tip portion after compression, and

Fig. 6 is a fragmentary view in plan of the tip of the blade.

Fig. 7 is a fragmentary view to larger scale and in longitudinal section of the tip of the blade illustrating refinements of structure. The plane of section is the same as that of Fig. 1.

In the construction shown in the figures the blade of the propeller is composed of laminations 1 of comparatively light wood, the said laminations being fixed by a mortise joint 2 to a root composed of laminations 3 of comparatively hard wood and fitted in a metallic sleeve 4. The said blade composed of laminations 1 forms the aerodynamically active part of the propeller while the root 3 has no aerodynamic action. The inner broad portion of the blade 1 is formed with one or more cavities 5 so that the cross-section of the wood is reduced as far as is permissible in view of the forces acting in this part of the blade, particularly bending, centrifugal and torsional stresses. Thereby the mass of this part of the blade is considerably reduced while the rigidity

as against torsional stresses is practically not impaired. The outer or tip portion of the blade is composed of a body 6 of light wood such as balsa wood, the said body being formed with a tapered inner part 7 fitted between the outer ends of a pair of inner laminations 1'. The portion 6 consists of compressed wood, and, as is shown in Figs. 4 and 5, it is made from a body 6 which originally is thicker than the final body. Fig. 4 shows diametrically the matrices 8 of the press by means of which the tip portion 6 is compressed and brought into the desired shape. Thus it is not necessary to impart the final shape to the body 6 by cutting tools, because the blade must be exact in shape particularly at its tip portion. The pressure is exerted not only on the tip portion but also on the adjacent ends of the laminations 1', and it increases gradually from the inner part of the blade towards the outer end thereof.

A comparison of Figs. 4 and 5 shows that the original cross-section of the tip portion 6 is similar to the final shape, so that the work of compressing the parts is not unnecessarily large. The tip portion is reinforced as against torsional stresses, and for this purpose it is coated by two- or multilayer wood veneers 9 which are fixed thereto by gluing while the tip portion 6 is being compressed. The grains of the superposed layers of the wood veneers cross one another, and they are disposed obliquely of the axis of the blade, as is indicated in Fig. 6 in which the grains of the superposed layers are shown respectively in full and dotted lines. Thereby the rigidity as against torsional stresses is further increased. If desired also the laminations 1 and 3 have the grains running obliquely of the axis of the blade.

After the blade has thus been shaped it is coated by a jacket 10 consisting of a suitable cellulose derivative such as Celluloid or the like, which is applied thereto in a semi-plastic state and under high pressure, and the said coating may have a reinforcing body of wire or fibre fabric 13 embedded therein. Therefore the blade has a very hard surface, and the strength of the surface is preferably increased at the tip portion by embedding an additional fabric 14 of wire within the same when the tip is not sufficiently reinforced by the wood veneer 9 and the single reinforcing fabric. Fig. 7 shows a portion of the blade and its coating on an enlarged scale.

When the blade is very broad it is preferred to construct the outer portions 11 as separate bodies which are fixed to the body 1 by gluing. Preferably the joint 12 of the said portions is constructed so that the lines of force passing from the outer part of the blade into the root 3 do not pass through the said separate portions 11. Therefore deflection of the lines of force is prevented though the lateral portions 11 project from the root portion 3 laterally, and excessive stresses at the part where the blade merges into the root are avoided. This function may be fur-

ther improved by locating the portions 1 and 11 of the blade so that the grains of the median portion 1 are nearly parallel to the joint 12 while in the portion 11 they are substantially perpendicular thereto. Further, it is preferred to make the portions 11 from particularly light material such as balsa wood.

From the foregoing description of the invention it will be understood that the blade comprises four zones of different structure which are disposed radially one beyond another. The inner zone is included between the lines *a-b*, and it comprises a median part formed by the laminations 1 and the lateral portions 11 which are fixed thereto and do not take part in the transmission of the forces, the second part extends from the line *b* to the line *c*, and it consists of the said hollow body, the third part extends from *c* to *d*, and it is solid, and the fourth part extends from *d* to *e*, and it consists of an inner filling body of particularly light material and a reinforcing surface coating.

The laminations 1 may be made from wood such as pine of comparatively low specific gravity, and the weight of the said part is further reduced by the cavities 5. The outer or tip portion 6 is made from a material which has still smaller specific gravity, such as balsa wood or porous artificial material, and the said portion 6 is reinforced by a coating of veneer or fabric, or by a coating of veneer and fabric. This coating provides a reliable surface protection of the tip portion of the blade, which is particularly important when the tip portion is made from balsa wood, which substantially acts as filling material.

I claim:

1. A propeller for aircraft comprising a blade having its side portions projecting laterally beyond the root portion, the said side portions comprising outer parts formed as separate integers which are fixed to the main part of the blade over meeting surfaces that lie beyond the lines of major stress generated in the blade when in service.

2. A propeller as claimed in claim 1, in which the said side portions are made from wood having the grain running substantially transversely of the axis of the blade.

3. A propeller blade for aircraft having an aerodynamically active part and a part for connecting the same to a hub, said aerodynamically active part comprising four zones of different structure disposed in radial succession from the inner end to the tip; the first zone in succession from inner end to tip comprising a median part of laminated wood, with lateral portions formed as separate integers and secured thereto; the second zone, integral with the first, being provided internally with weight-reducing hollow space; the third, integral with the first, being solid; and the fourth, of less specific gravity than the third, being formed of wood and provided with a re-enforcing coating.

LUDWIG HOFFMANN.