

Aug. 27, 1946.

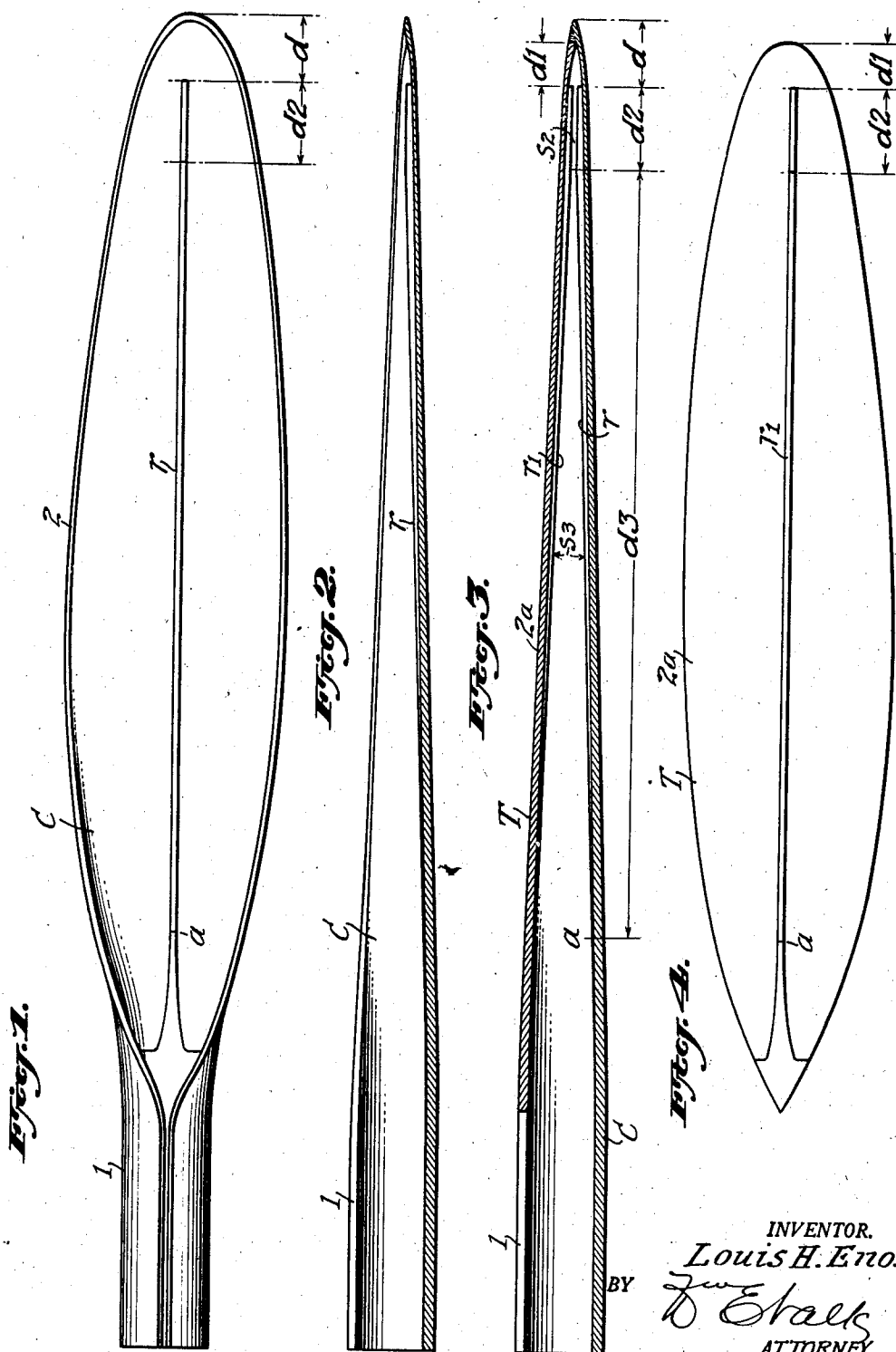
L. H. ENOS

2,406,457

REINFORCED PROPELLER BLADE

Filed Sept. 3, 1943

3 Sheets-Sheet 1



INVENTOR.

Louis H. Enos

BY

J. E. Chalk
ATTORNEY.

Aug. 27, 1946.

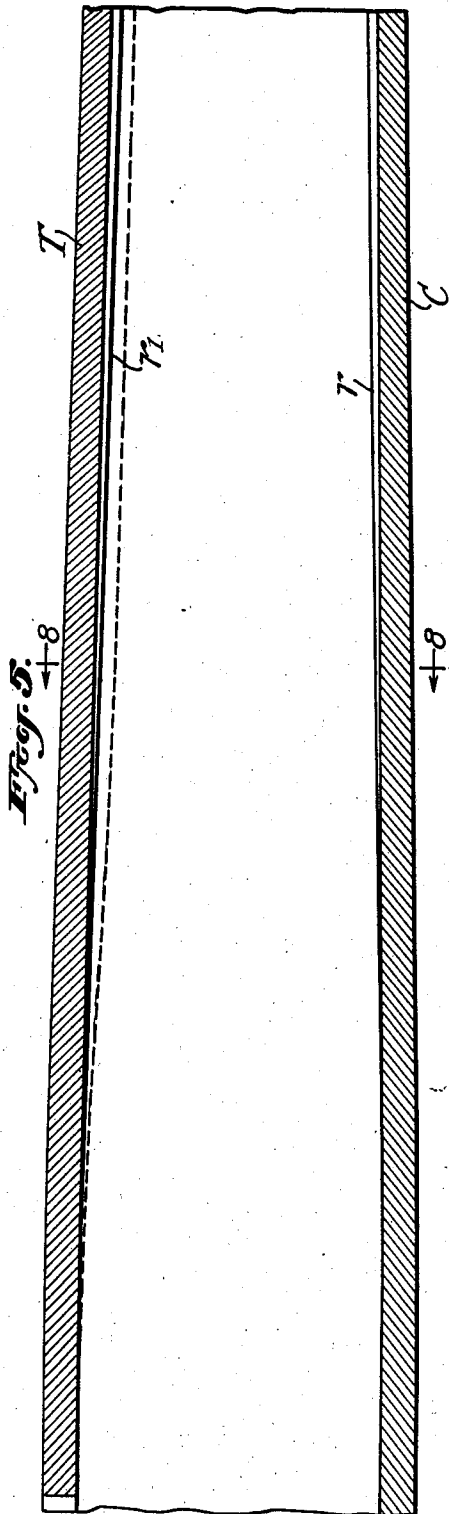
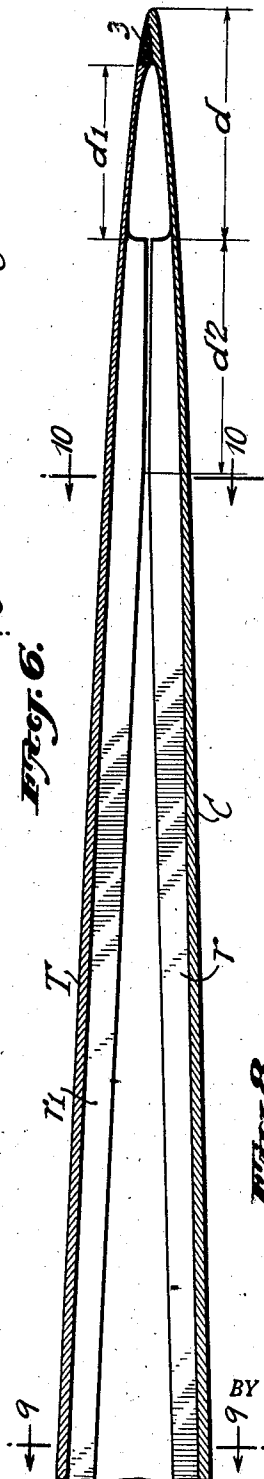
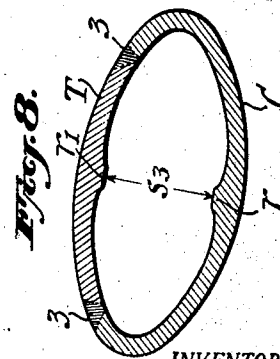
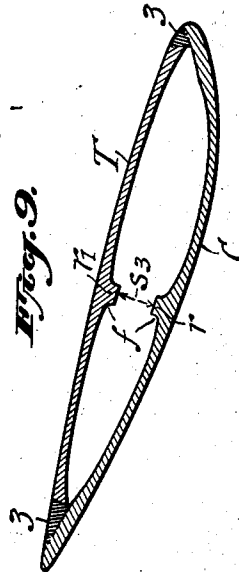
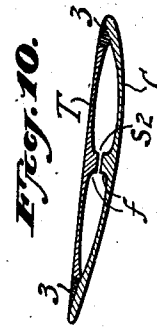
L. H. ENOS

2,406,457

REINFORCED PROPELLER BLADE

Filed Sept. 3, 1943

3 Sheets-Sheet 2



INVENTOR.
Louis H. Enos
BY
J. E. Clark
ATTORNEY.

Aug. 27, 1946.

L. H. ENOS

2,406,457

REINFORCED PROPELLER BLADE

Filed Sept. 3, 1943

3 Sheets-Sheet 3

Fig. 7.

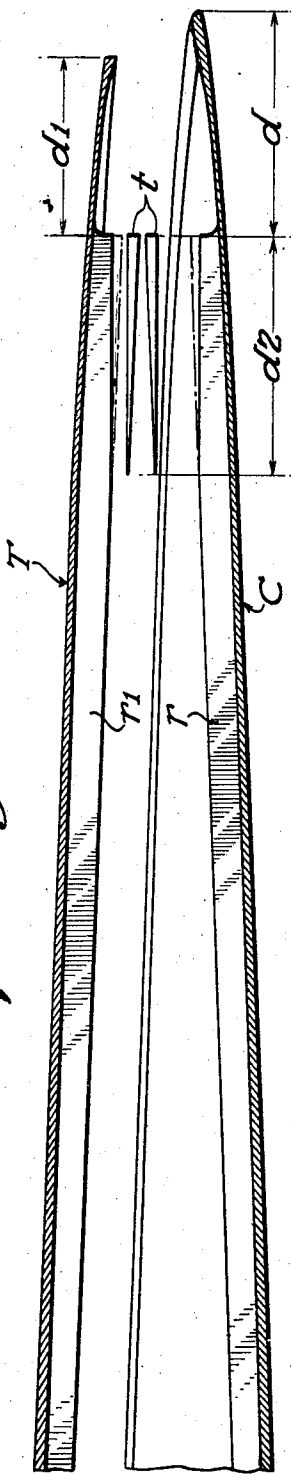


Fig. 12.

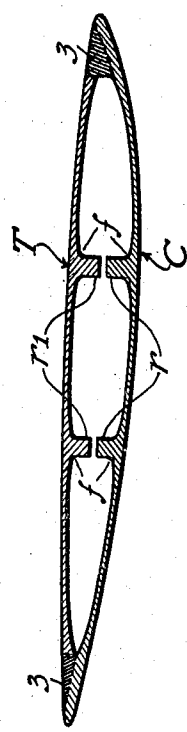


Fig. 13.

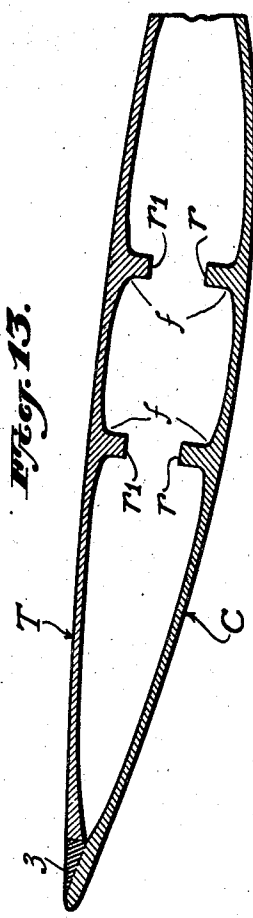
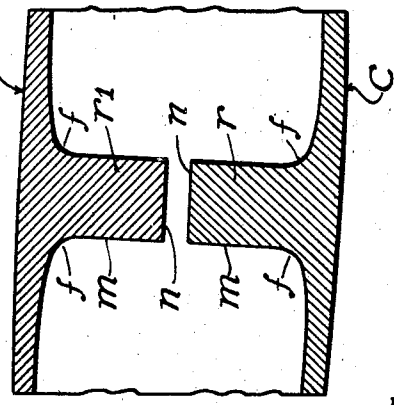


Fig. 11.



INVENTOR.
Louis H. Enos
BY *W. E. Enos*
ATTORNEY

UNITED STATES PATENT OFFICE

2,406,457

REINFORCED PROPELLER BLADE

Louis H. Enos, Montclair, N. J., assignor to Curtiss-Wright Corporation, a corporation of Delaware

Application September 3, 1943, Serial No. 501,190

3 Claims. (Cl. 170-159)

1

My invention relates to a reinforced, hollow propeller blade of novel construction.

My invention has particular reference to a propeller blade comprising facing propeller plates provided with a novel rib arrangement which substantially prevents or largely decreases the amplitude of plate vibration during flight of the aircraft which is driven by said propeller blade.

Various other objects, advantages and features of my invention will become apparent from the following detailed description.

My invention resides in the reinforced propeller blade, combinations and arrangements of the character hereinafter described and claimed.

For an understanding of my invention and for an illustration of one of the forms thereof, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a plan view showing a camber plate as constructed in accordance with my invention;

Fig. 2 is a longitudinal, vertical sectional view of the camber plate shown in Fig. 1;

Fig. 3 is a longitudinal, vertical sectional view showing a hollow propeller blade and my novel reinforcing rib arrangement therefor;

Fig. 4 is a plan view showing a thrust plate as constructed in accordance with my invention;

Figs. 5 and 6 are enlarged, longitudinal, vertical sectional views showing different parts of my novel propeller blade;

Fig. 7 is an enlarged, longitudinal, vertical sectional view showing the rib arrangement adjacent the tip of the propeller blade;

Fig. 8 is a transverse, vertical sectional view taken on the line 8-8 of Fig. 5 looking in the direction of the arrows;

Figs. 9 and 10 are transverse, vertical sectional views taken on the respective lines 9-9 and 10-10 of Fig. 6 looking in the direction of the arrows;

Fig. 11 is an enlarged, vertical sectional view showing a detailed feature of the invention; and
Figs. 12 and 13 are vertical sectional views showing a modification of the invention.

Referring to Figs. 1 and 4, I have shown a metallic camber plate C and a metallic thrust plate T of the general character known in the art for forming a hollow propeller blade B as shown in Figs. 3 and 5-9 inclusive.

As illustrated, the camber plate C comprises a tubular shank 1 having extending therefrom the plate proper 2 which generally is of convex configuration, the convexity decreasing in a progressive manner as the end of the plate is approached whereby said camber plate C defines a shallow

2

opening of generally elliptical configuration. The thrust plate T comprises a plate proper 2a which generally is of elliptical configuration in correspondence with the aforesaid shallow opening of the camber plate C, and, to less extent than the latter, it has convex shape. As will be noted from Fig. 4, said thrust plate T does not comprise a shank section as does the camber plate C.

As illustrated, the plates C and T comprise the respective longitudinally extending integral ribs r and r' which, when said plates are assembled, are disposed substantially in facing relation or in a common plane. In the form of the invention herein shown, although not necessarily, the ribs r and r' are formed, as described in the pending application of James H. McKee, Serial No. 493,314, filed July 2, 1943, by subjecting uniformly thick plane sheets of metal, which form the blank plates for the respective camber and thrust plates T and C herein disclosed, to two or more milling operations whereby each sheet of metal is longitudinally tapered in such manner that the thickness of each sheet of metal decreases longitudinally therealong toward the tip of the blade. The milling cutter is so shaped that, while the tapering operation proceeds, a longitudinal strip of the original sheet of metal remains intact, this strip of metal forming the aforesaid rib r or r' , the ends thereof toward the left terminating approximately at the respective locations a , Figs. 1, 3 and 4. As a result of the described milling operation, the thickness or height of each of the ribs r and r' increases progressively in a direction extending longitudinally along the propeller blade toward the tip thereof. Further, it is desirable that the milling cutter be so shaped that the described operation causes each of the ribs r or r' to be bordered by fillets f as illustrated.

After the blank plates have been milled as described above, the camber plate C and the thrust plate T are brought to the finished form herein disclosed by subjecting each of the partially completed propeller plates having the integral longitudinal ribs, respectively, to suitable milling, trimming and shaping operations, the convex configuration and the twist being imparted to the plate during the operation last noted, all as generally referred to in said pending application Serial No. 493,314, filed July 2, 1943. Thereafter, the aforesaid shallow opening of the camber plate C is closed by the thrust plate T when the two plates are secured together by weld metal 3 as shown in Figs. 8, 9 and 10 to form the propeller blade.

With the form of the invention herein shown,

3

the rib r terminates short of the tapered end of the camber plate C a distance d and the rib rl terminates short of the tapered end of the thrust plate T a distance $d1$. In accordance with the invention and for a reason hereinafter to be described, material is removed in suitable manner from the thick end of each rib r and rl as defined by tapered sections t having a length as indicated by the distance $d2$, for example, this being done prior to the time that the plates C and T are assembled as described above.

The act of assembling the plates C and T in the manner referred to above causes the ribs r and rl to be disposed preferably in facing relation. Throughout the distance $d2$, the facing surfaces of said ribs r and rl are spaced apart a distance $s2$, Figs. 3 and 10, which preferably is uniform or constant throughout said distance $d2$. Throughout a distance $d3$, Fig. 3, said facing surfaces of the ribs r and rl are spaced apart a distance $s3$, this distance increasing in a progressive manner in a direction from right to left, Fig. 3.

As understood in the art of producing a hollow propeller blade from a pair of facing plates as hereinbefore referred to, the inner, facing plate surfaces, in the area adjacent the tip of the blade, are closely spaced. This spacing is so close that there would be interference between the ribs in said tip blade area were it not for the fact that the material defining a tapered section t of each rib is removed in the manner described above. The material defining said tapered rib sections t , then, is removed for this purpose and, in this connection, it will be noted that the distance $s2$ between facing rib surfaces in said blade area is so chosen that the ribs do not engage each other should there be some vibration of the two plates C and T .

The blade reinforcement comprising the ribs r and rl increases the stiffness of the propeller plates with resultant decrease in the amplitude of plate vibration or deflection which may be excited aerodynamically or by engine pulsations. As a result, stresses within the plates are reduced. Further, such increase in stiffness of the propeller plates raises the natural frequency thereof above the range of objectionable frequencies to some extent at least and this decreases the amplitude of plate vibration or deflection.

With respect to a propeller blade wherein the interior chamber is sealed, deformation of the airfoil surface may arise due to the difference of aerostatic pressures exteriorly and interiorly of the blade, this being caused (1) by pressure differences resulting from changes in altitude and (2) by pressure differences due to centrifugal action on the air in the interior blade chamber. The aforesaid blade reinforcement comprising the ribs r and rl together with the connecting member M decreases this deformation of the airfoil surface.

As hereinbefore stated, the thickness or height of each of the ribs r and rl increases progressively in a direction extending longitudinally along the propeller blade toward the tip thereof. Therefore, said ribs r and rl , even though the aforesaid tapered sections t have been removed therefrom have maximum height or thickness in the tip area of the propeller blade. This is desirable for the purpose of the invention.

From a consideration of Figs. 3 and 11, it will

4

be understood that each of the ribs r and rl is a lengthy structure having dimensions suitable for the intended purposes. Thus, as shown in Fig. 11, each of said ribs has substantially parallel side walls m , m joined by a transverse wall n . Said ribs, then, have length, height and breadth; therefore, they have the requisite stiffness for decreasing the amplitude of blade vibration.

It shall be understood that, if desired, a plurality of sets of the ribs r and rl may be utilized in lieu of the single set of ribs as hereinbefore referred to. Thus, as shown in Fig. 12, the plate C may comprise a pair of spaced ribs r and, likewise, the plate T may comprise a pair of similarly spaced ribs rl , the ribs of each set, preferably, facing each other when said plates are assembled to form the propeller blade. Obviously, the propeller blade construction may comprise more than two sets of ribs if desired.

It shall be understood that my invention is applicable to various forms or types of hollow propeller blades and that it is not to be restricted to a propeller blade formed from two plates. Thus, the "plates" referred to in the claims may be formed from a single piece of material. They need not be separate plates secured together in suitable manner, for example, at their edges as illustrated.

While the invention has been described with respect to certain particular preferred examples which give satisfactory results, it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended therefore in the appended claims to cover all such changes and modifications.

What is claimed as new and desired to be secured by Letters Patent is:

1. A hollow metallic propeller blade comprising plates having aerfoil configuration and disposed in facing relation to form an interior chamber said plates decreasing in thickness gradually from shank to tip, each of said plates having an integral rib which projects into said chamber, each rib increasing in height as the thickness of the plates decreases by an amount substantially equal to the gradual decrease of the thickness of the plate, and each rib being free of contact with the other rib.

2. A hollow metallic propeller blade comprising plates having aerfoil configuration and disposed in facing relation to form an interior chamber, said plates decreasing in thickness gradually from shank to tip, at least one of said plates having an integral rib which projects into said chamber, said rib increasing in height as the thickness of the plate decreases by an amount substantially equal to the gradual decrease in thickness of the plate.

3. A hollow metallic propeller blade comprising plates having aerfoil configuration and disposed in facing relation to form an interior chamber, said plates decreasing in thickness gradually from shank to tip, at least one of said plates having an integral longitudinally extending stiffening rib which projects into said chamber the height of which when added to the thickness of the adjacent plate is substantially equal to the thickest section of the plate, said rib being spaced from and out of contact with the opposite plate.

LOUIS H. ENOS.