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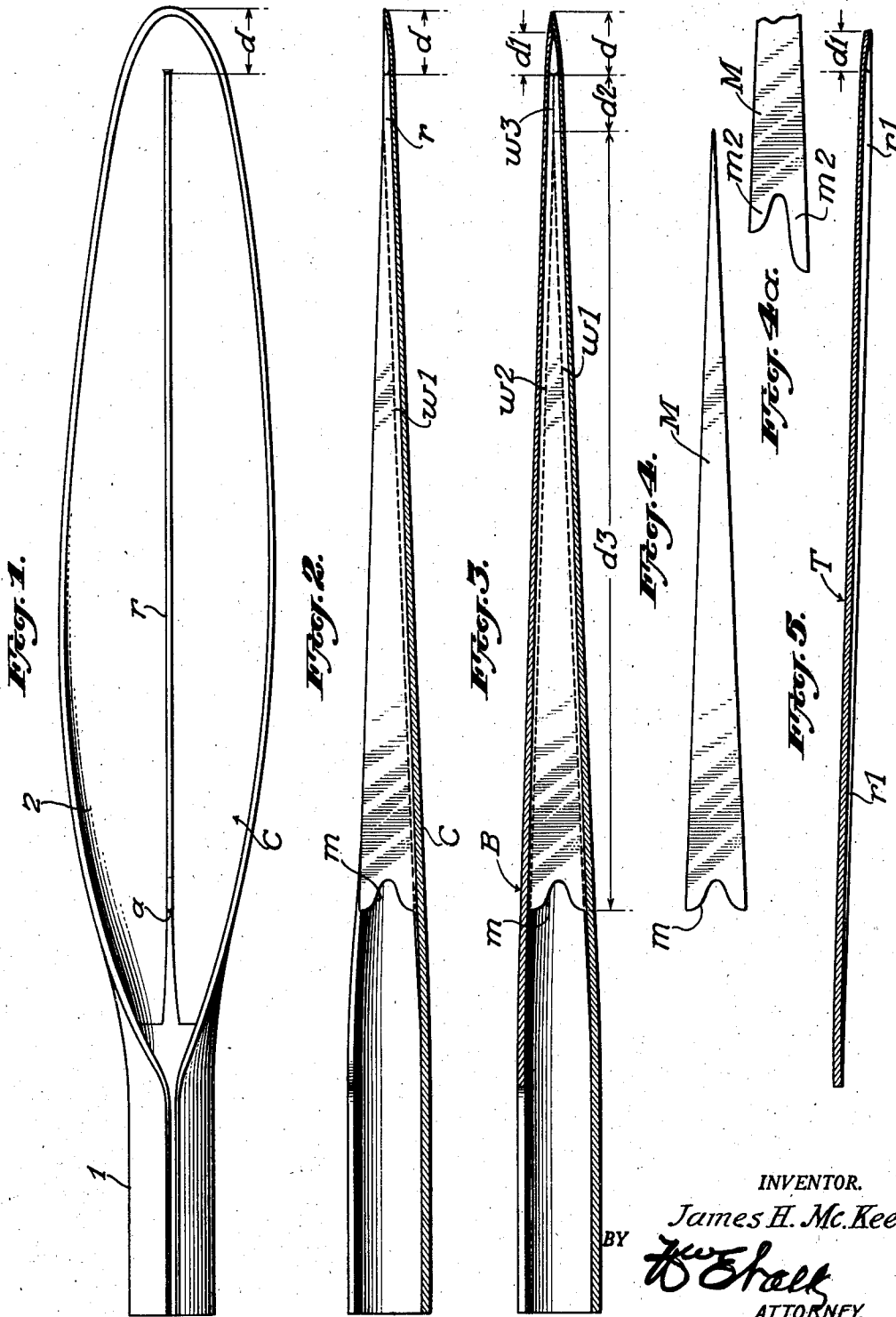
J. H. McKEE

2,406,471

REINFORCED PROPELLER BLADE

Filed July 26, 1943

2 Sheets-Sheet 1



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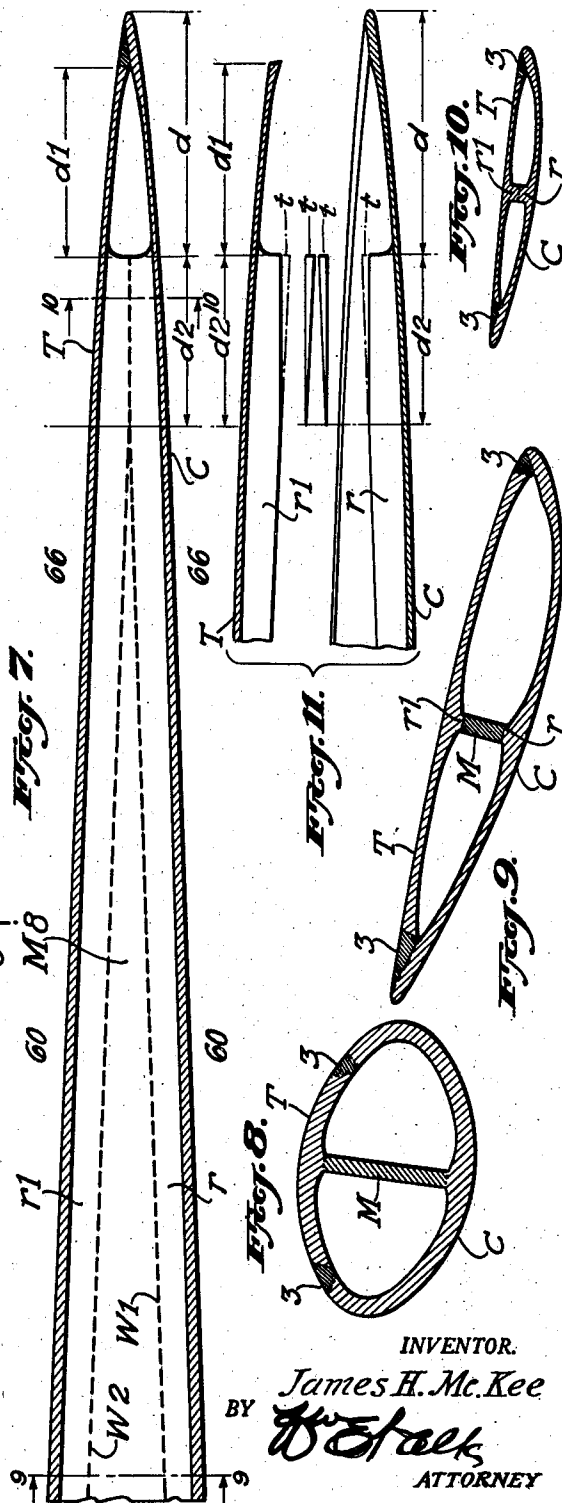
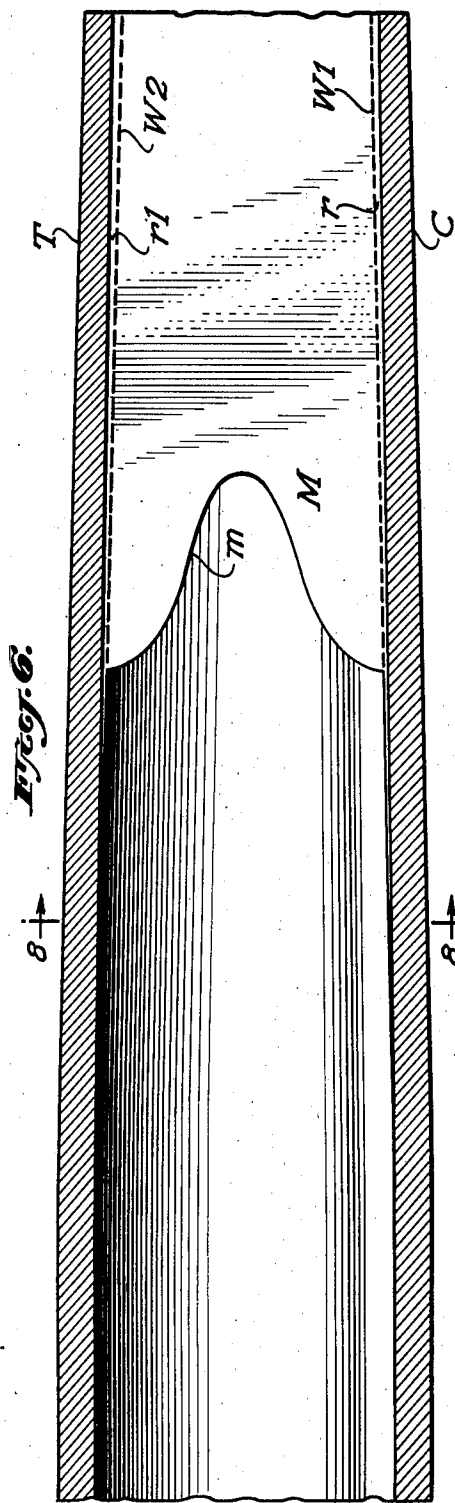
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2 Sheets-Sheet 2



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REINFORCED PROPELLER BLADE

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Application July 26, 1943, Serial No. 496,232

4 Claims. (Cl. 170—159)

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My invention relates to a propeller blade provided with a novel reinforcing arrangement.

My invention has particular reference to a propeller blade formed from plates disposed in facing relation and forming an interior chamber, each plate comprising a longitudinally extending rib formed integrally therewith, the ribs facing each other and being suitably secured directly to each other throughout at least a part of the length of said ribs.

My invention has further reference to a propeller blade as described wherein a tapered connecting member bridges the space between and is connected to the aforesaid ribs.

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:

Figure 1 is a plan view showing a camber propeller plate and an attached connecting member as constructed in accordance with my invention;

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

Fig. 3 is a longitudinal, vertical sectional view showing a hollow propeller blade as constructed in accordance with my invention;

Fig. 4 is an elevational view showing a connecting member for the propeller plates;

Fig. 4a is an elevational view showing a feature of the invention;

Fig. 5 is a longitudinal, vertical sectional view showing the thrust plate of my invention;

Figs. 6 and 7 are enlarged, longitudinal, vertical sectional views showing different parts of my novel propeller blade;

Fig. 8 is a transverse, vertical sectional view taken on the line 8—8 of Fig. 6 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. 7 looking in the direction of the arrows; and

Fig. 11 is an enlarged, longitudinal, vertical sectional view showing the rib arrangement adjacent the tip of the propeller blade.

Referring to Figs. 1 and 5, I have shown a metallic camber plate C and a metallic thrust plate T of the general character known in the

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art for forming a hollow propeller blade B as shown in Figs. 6—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 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. 5, 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 C and T 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, 2, 3, 5 and 6. As a result of the described milling operations, 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 con-

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figuration 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, the rim r terminates short of the tapered end of the camber plate C a distance d and the rib $r1$ terminates short of the tapered end of the thrust plate T a distance $d1$. Further, when the two plates C and T are properly assembled to form the propeller blade, facing surfaces of the ribs r and $r1$ are in engagement with each other or substantially so throughout a distance $d2$, Figs. 3 and 7. Still further, when the two plates C and T are assembled as described immediately above, facing surfaces of said ribs r and $r1$ are spaced from each other in a progressively increasing manner from right to left throughout a distance $d3$, Fig. 3. 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 $r1$ 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.

In accordance with the invention, there is disposed in the space between said facing surfaces of the ribs r and $r1$ a connecting or reinforcing metallic member, structure or section of metal M, Fig. 4, which is of suitable tapered configuration so that it will span the space between said facing surfaces of the ribs r and $r1$ either entirely or substantially when the two plates C and T are assembled in blade-forming relation. Ordinarily, the connecting member M is separately formed although, with a broader concept of the invention, said member M may be constituted by weld metal, for example, which is built up between the ribs r and $r1$ by a suitable welding operation.

With a preferred form of the invention, the connecting member M is suitably held in its intended position on the rib r of the plate C prior to the assembly of said plate C and the plate T. While said connecting member M is thus held, it is secured to the rib r in any suitable manner, for example, by a welded joint $w1$ formed at the engaging or facing surfaces of said rib r and said connecting member M, this welded joint being produced in any suitable manner, as by metallic arc, resistance or atomic hydrogen welding. By this operation, the structure shown in Fig. 2 is produced.

Thereupon, the thrust plate T is assembled in proper relation with the plate and connecting member structure illustrated in Fig. 2. As a result, the rib $r1$ is brought into engagement or close relation with the adjacent surface of the connecting member M and, beyond the member M, the two ribs r and $r1$ are caused to engage each other or to be closely adjacent each other.

Thereupon, the aforesaid rib $r1$ of the thrust plate T is suitably secured, as by a welding or equivalent operation, to those surfaces of the connecting member M and rib r which it faces. In the form of the invention shown, although not necessarily, by a stitch or spot welding operation, a welded joint $w2$ is thus formed between the rib $r1$ and the connecting member M, a welded joint $w3$ being formed between the ribs $r1$ and r in

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the sections thereof at the right of said connecting member M, Figs. 3 and 7, to secure said last named rib sections directly together throughout the distance $d2$.

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, at the area adjacent the tip of the blade are closely spaced. This spacing is so close that there would be interference between the rib in said tip blade area were it not for the fact that the material defining a tapered section t of each rib is removed, Fig. 11, as referred to above. Therefore, in order to permit proper assembly of the plates C and T, the material defining said tapered rib sections t is removed as described.

The operations described above result in the production of a hollow propeller blade B wherein the thrust plate T is secured to the camber plate C and wherein the reinforcing structure comprising the ribs r and $r1$ together with the connecting member M is operatively related to the two plates to reinforce them.

The blade reinforcement comprising the ribs r and $r1$ together with the connecting member M 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 $r1$ together with the connecting member M decreases this deformation of the airfoil surface.

Entirely independently of the connecting member M and the direct connection between the ribs r and $r1$ near the tip of the blade, it will be understood that these ribs serve to stiffen the plates B and C in a desired manner. Further, each of said ribs r , $r1$ together with their respective fillets f serve in a highly advantageous manner as a base or extended support to which the connecting member M is secured as described.

With respect to the connecting member M hereinbefore described, it will be noted that the end thereof toward the left, Figs. 2, 3, 4 and 6, is cut away or recessed as indicated at m to form a "fish mouth," the sides of the cut-away section being symmetrical. As shown in Fig. 4a, the cut-away section is non-symmetrical by reason of the fact that the upper and lower rib sections $m2$ have unequal length. These recessed arrangements are advantageous because lessening stress concentrations and producing a more flexible joint between the propeller plates.

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

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suitable manner, for example, at their edges as illustrated.

While the invention has been described with respect to a certain particular preferred example which gives 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 metallic propeller blade comprising plates disposed in facing relation and forming an interior chamber, a longitudinally extending rib integrally formed with each of said plates, the taper of each of said plates decreasing and the height of each of said ribs increasing in a direction extending longitudinally along the propeller blade toward the tip thereof the height and thickness combined being substantially the same as the thickest part of the respective plates, adjacent facing surfaces of said ribs being disposed substantially in contact with each other near the tip of said propeller blade, other facing surfaces of said ribs being substantially spaced apart in a progressively increasing manner throughout a longitudinal section of the propeller blade removed from the tip thereof, a tapered connecting member between the facing surfaces second named, and metallic fusion bonding means for securing the facing surfaces first named directly together and for securing said connecting member to the facing surfaces second named.

2. A metallic propeller blade comprising plates disposed in facing relation and forming an interior chamber said plates decreasing in thickness

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from shank to tip, a longitudinally extending rib integrally formed with each of said plates and gradually increasing in height from shank to tip, and means for connecting said plates together through said ribs, the connection comprising a tapered connecting member, said means including a fused metallic bond between said member and ribs.

3. A metallic propeller blade comprising a tubular shank from which extend plates disposed in facing relation and forming an interior chamber, said plates decreasing in thickness from shank to tip, a longitudinally extending rib integrally formed with each of said plates increasing in height from shank to tip, and means for connecting said plates together through said ribs, the connection comprising a tapered connecting member disposed between spaced faces of said ribs and bonded thereto by metallic fusion, one end of said tapered connecting member terminating closely adjacent the tip of said propeller blade but short of the tip end of said ribs, said ribs beyond said member being in contact with one another and bonded together by metallic fusion and the other end of said tapered connecting member being spaced a substantial distance from said tubular shank.

4. A plate construction adapted to be associated with another plate construction to form a propeller blade, said first named plate construction comprising a plate decreasing in thickness from shank to tip having a longitudinally extending rib integrally formed with said plate increasing in height from shank to tip, and a tapered connecting member bonded by metallic fusion to said rib.

JAMES H. McKEE.