Aug. 4, 1953 F. A. GRUETJEN 2,647,586

WIDE HOLLOW STEEL PROPELLER BLADE
AND METHOD OF MAKING THE SAME

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Fig. 1

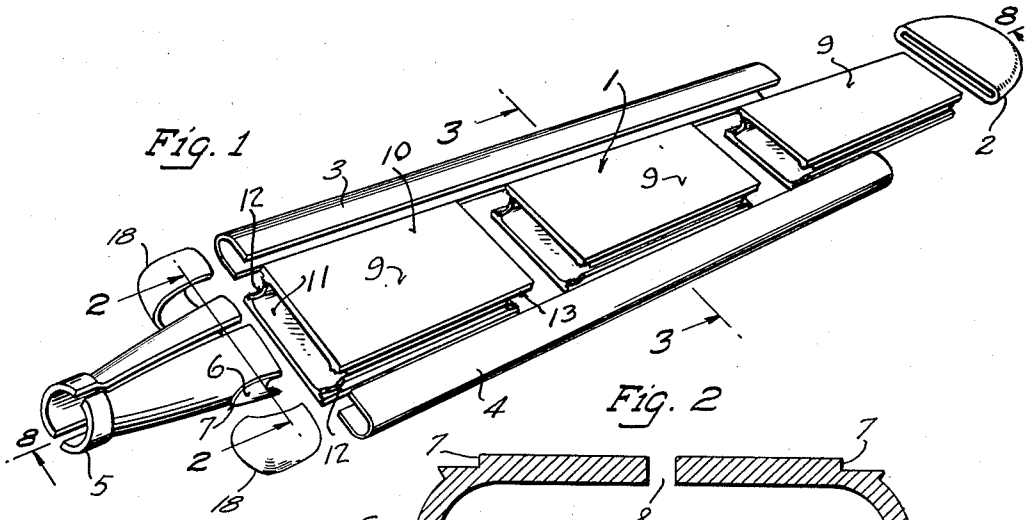


Fig. 2

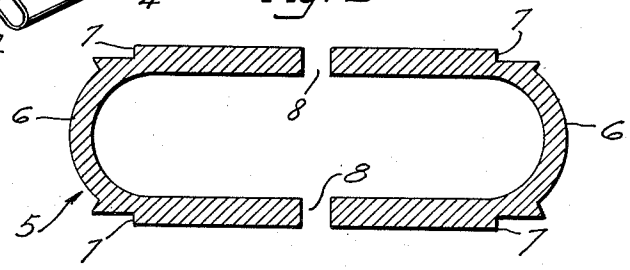


Fig. 3

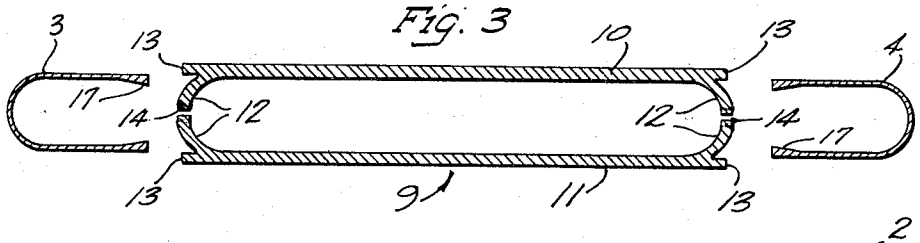
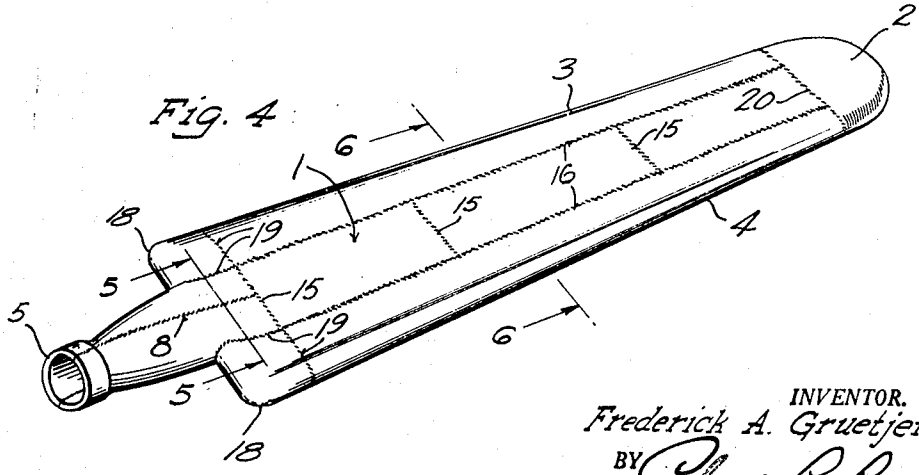


Fig. 4



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WIDE HOLLOW STEEL PROPELLER BLADE AND METHOD OF MAKING THE SAME

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Fig. 5

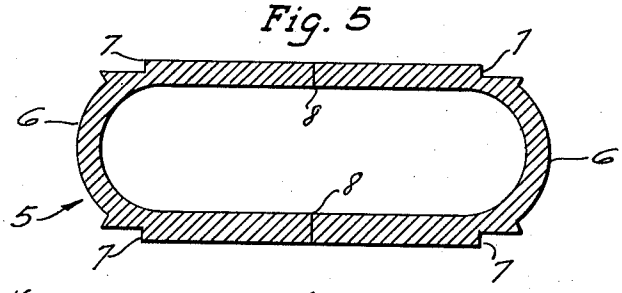


Fig. 6

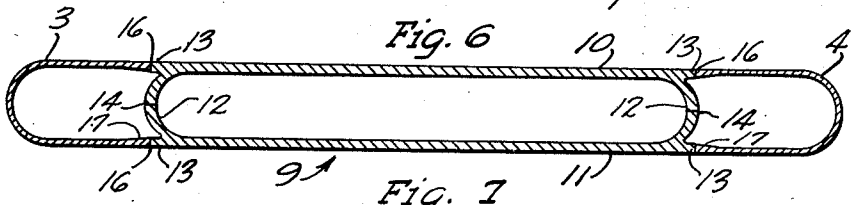


Fig. 7

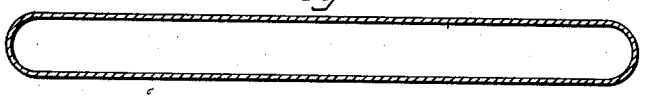


Fig. 8

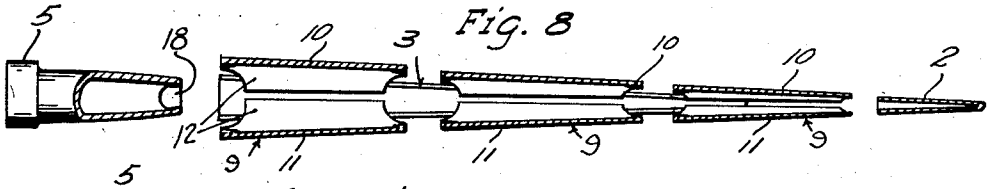


Fig. 9

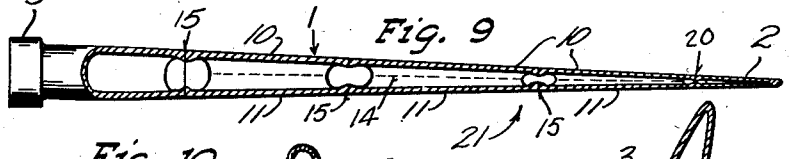


Fig. 10

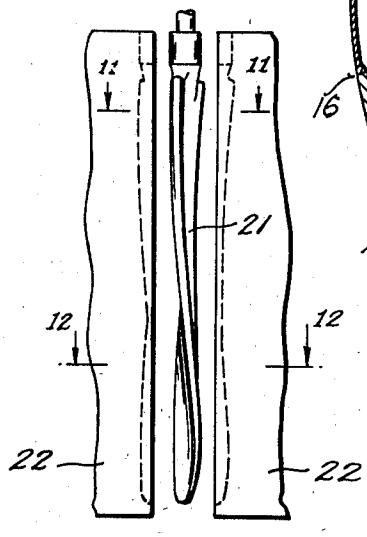


Fig. 11

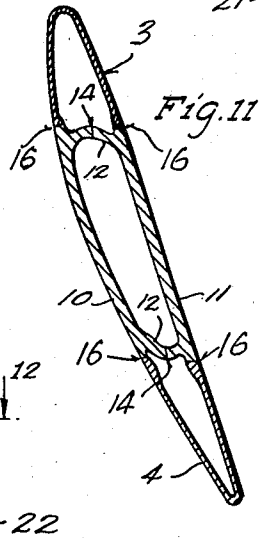
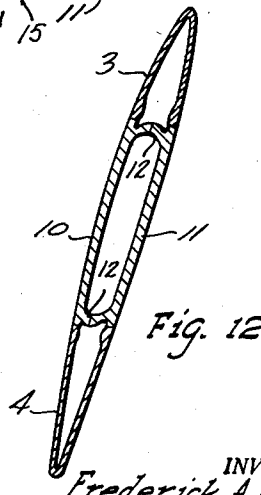


Fig. 12



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Fig. 13

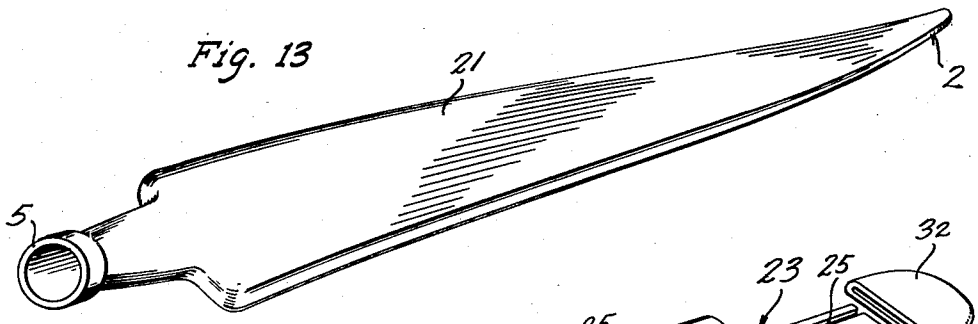


Fig. 14

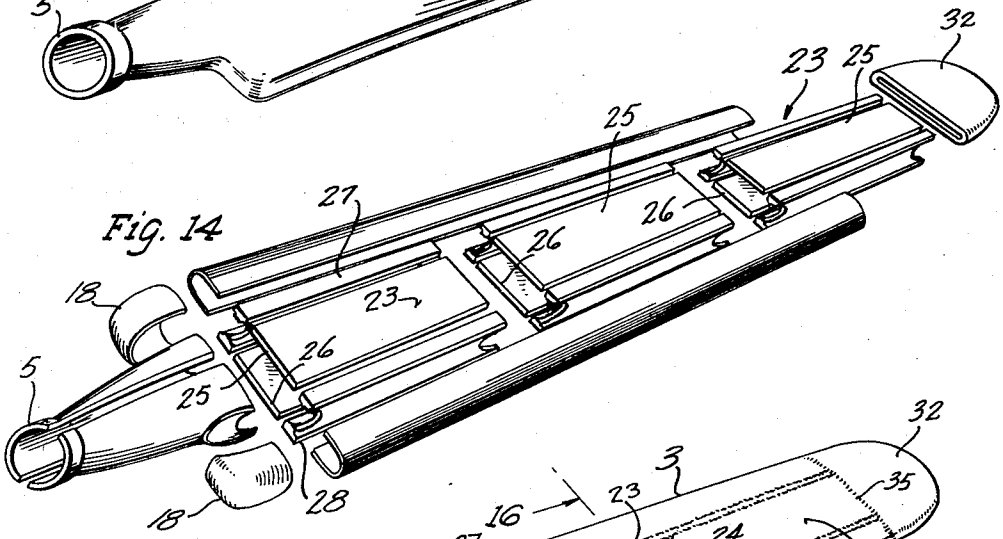


Fig. 15

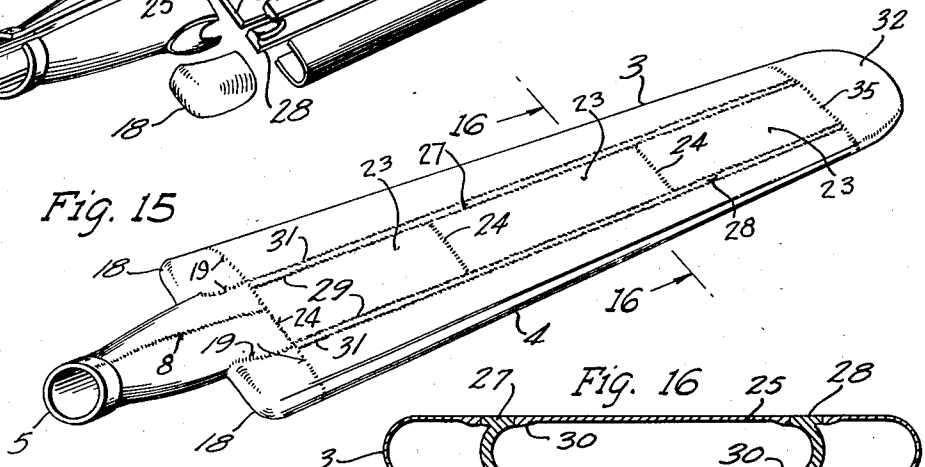


Fig. 16

Fig. 17

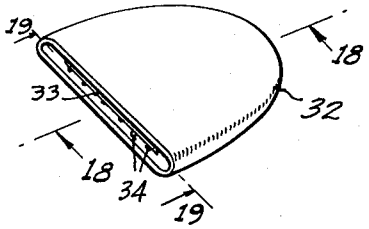


Fig. 18

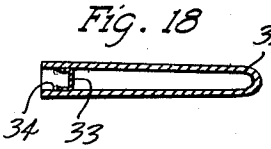
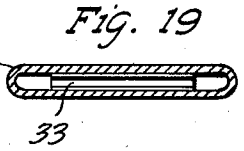


Fig. 19



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2,647,586

UNITED STATES PATENT OFFICE

2,647,586

WIDE HOLLOW STEEL PROPELLER BLADE AND METHOD OF MAKING THE SAME

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Application July 30, 1945, Serial No. 607,697

5 Claims. (Cl. 170—159)

1

This invention relates to a wide hollow steel propeller blade and method of making the same.

The invention is adapted to the construction of large wide propeller blades for airplanes and more particularly for stratosphere flying wherein the rarity of the air is compensated for by providing a blade of much greater width than is ordinarily employed for low altitude flying. With such wide blades, it has been difficult to obtain the desired pitch adjustment in flight due to the high transverse centrifugal moment of the blades. The greater twist of such blades makes their manufacture more difficult.

One of the objects of the invention is to provide a wide blade adapted to stratosphere flying and that has a transverse centrifugal moment that is relatively low and preferably no greater than that ordinarily present in more narrow blades for low altitude flying.

Another object of the invention is to provide a method of making a wide blade of the character referred to by welding parts together while in the untwisted state, and subsequently twisting the blade to final shape.

Another object of the invention is to provide longitudinal strengthening webs in the blade without interfering with the subsequent shaping and twisting of the blade.

Another object is to provide a welded blade blank that can be twisted in either direction to correspond to either a right-hand or left-hand blade.

Another object is to provide a family of blades of various sizes that can be manufactured by employing the same tools for the major component parts and with a slight change in tools for making the edges.

Another object is to provide a method of making wide blades of both right and left-hand twist with a single set of forging and welding dies.

Another object is to provide a blade that is the ultimate in lightness for its size.

Other objects and advantages of the invention will appear hereinafter.

The accompanying drawings illustrate the construction of propeller blades in accordance with the invention.

In the drawings:

Figure 1 is an isometric view of the parts of the blade prior to welding;

Fig. 2 is an enlarged transverse section taken on line 2—2 of Fig. 1 showing the parts forming the shank;

Fig. 3 is an enlarged transverse section taken

2

on line 3—3 of Figure 1 showing the parts forming a body section of the blade;

Fig. 4 is a view similar to Figure 1 showing the welded sections of the blade in isometric arrangement end to end;

Fig. 5 is an enlarged transverse section taken on line 5—5 of Fig. 4 showing the welded shank section;

Fig. 6 is an enlarged transverse section taken on line 6—6 of Fig. 4 showing a welded body section of the blade;

Fig. 7 is an enlarged transverse section across the blade tip;

Fig. 8 is a longitudinal central section taken on line 8—8 of Figure 1;

Fig. 9 is a section similar to Fig. 8 taken after welding of the sections end to end;

Fig. 10 is a schematic side elevation showing a heated blank suspended by its shank in between forming dies;

Fig. 11 is a transverse section taken on line 11—11 of Fig. 10 at about the 24-inch station;

Fig. 12 is a similar section taken on line 12—12 of Fig. 10 at about the 60-inch station;

Fig. 13 is a perspective view of the final twisted blade after balancing;

Fig. 14 is an isometric view of another embodiment showing parts of the blade prior to welding;

Fig. 15 is a similar view showing the welded sections of the blade of Fig. 14 in isometric arrangement end to end;

Fig. 16 is an enlarged transverse section taken on line 16—16 of Fig. 15 showing a welded body section of the blade;

Fig. 17 is a perspective view of the tip before welding;

Fig. 18 is a longitudinal section taken on line 18—18 of Fig. 17; and

Fig. 19 is a transverse section taken on line 19—19 of Fig. 17.

The invention utilizes the principles of electric flash welding of propeller blades as set forth in the applications of William C. Heath, Serial No. 480,682, filed March 26, 1943, now abandoned, and Serial No. 523,504, filed February 23, 1944, now United States Patent #2,493,139 of January 3, 1950, which applications are assigned to the assignee of the present application.

The blade of the invention illustrated in the drawings is fabricated from a central tubular body section 1 which includes the shank and extends to the tip, a tip section 2, a leading edge member 3 and a trailing edge member 4.

The body section 1 constitutes the main stress

carrying member or backbone of the blade and comprises a plurality of tubular sections welded end to end, the number employed depending upon the length and design of the blade and the forging and welding facilities available.

The shank end 5 of the section 1 has a generally cylindrical shape with the blade end thereof flattened and shaped somewhat rectangular to provide the inner end of the foil surfaces of the blades joined by the webs 6 which are curved outwardly.

The shank 5 is formed of two semi-tubular half sections. The half sections are shaped as by forging toward the blade end to provide the described rectangular shape for the final section and in addition to provide longitudinal ridges 7 at the corners which ridges constitute extensions of the foil surfaces referred to. The half sections are welded together along longitudinal lines 8 either in the center of the foil surfaces or of the webs 6.

The remaining tubular sections 9 of the body section 1 are each constructed of the thrust plate 10 and the camber plate 11 joined by the webs 12. Since the tubular sections of the body section 1 are similar it will only be necessary to describe one tubular section.

The foil plates 10 and 11 are formed by rolling and forging plates to a longitudinally tapered thickness and to provide the same with the somewhat curved webs 12, corresponding to the webs 6 of the shank 5, and the thick ridges 13 at the corners thereof, corresponding to ridges 7 of the shank and similarly constituting extensions of the air foil surfaces of the blade. The foil plates are welded together along longitudinal lines 14 preferably in the center of the webs 12.

The tubular sections 9 and the shank section 5 are electric flash welded together end to end by the transverse welds 15 into the tubular body section 1.

The section 1 has a tapering wall thickness to provide for a progressively lighter weight toward the outer tip end of the blade. The webs 12 are of varying height and preferably curved outwardly on a reasonably large radius to provide a bead or corrugation for expansion and contraction of the same in the final forming of the blade.

The sections 9 are welded end to end and the inner section is welded to the shank 5 to complete the backbone 1 of the blade. For this purpose the several sections are designed to provide a progressively tapered thickness from the shank to the thin tip end.

The curved webs 12 are cut away at their ends to provide openings therebetween and facilitate removal of flash on the inside of the transverse welds.

The leading edge member 3 and the trailing edge member 4 are formed from generally thin sheet metal of less thickness than tubular section 1 but preferably of substantially uniform thickness throughout and are joined to the section 1 at the weld joints 16.

The leading edge member 3 is curved into a blunt U-shaped cross-section and provided with the longitudinal thickened edges 17 which are electric flash welded at 16 to the ridges 13 of the body sections 9.

Likewise the trailing edge member 4 is curved into a relatively sharper U-shaped cross-section and provided with longitudinal thickened edges 17 similar to those of edge 3 and which are electric flash welded at 16 to the ridges 13 of the body sections 9.

The added thickness 17 is disposed on the inside of edge members 3 and 4 and tends to provide a strong weld joint between the edges and the central tubular section 1.

The edge members 3 and 4 preferably extend the length of the tubular sections 9. With edge members 3 and 4 of the length described, the members are flash or fusion welded to all of the tubular sections 9 at one time, thereby eliminating end to end welds of the thin edge members.

The inner ends of the edge members 3 and 4 are closed by the cup-shaped sheet metal members 18 which are fusion welded at 19 around the circumference thereof to the shank and edge members.

The tip 2 is spun or drawn to cup shape from a flat plate of sheet metal and then flattened to blade shape. The tip 2 is joined to the body section 1 and to the leading and trailing edge members 3 and 4 by the circumferential flash weld 20 and serves to close the outer end of the blade.

Flash is cleaned from the inside and outside of the blade after each welding operation. Due to the construction of the blade as shown in Fig. 9 the weld areas on the inside of the blade are readily accessible.

After the shank end 5, the body section 1 and tip 2 are welded into the propeller blade 21, as shown in Fig. 9, the blade 21 is subjected to a forming operation as shown in Fig. 10. In this forming operation, the blade 21 is heated to forming temperature and then pressed to blade shape in dies 22.

The die cavity of dies 22 is shaped to give the blade 21 the twist desired. The blade 21 can be formed with either a right-hand or left-hand twist depending upon the dies employed.

In the forming operation the webs 12 of the section 9 and webs 6 of the shank 5, being curved, flex to the new and final shape determined by the shaping of the blade in the dies. The webs may contract in one location and expand in another in order to allow the walls of the blade to be pressed by and against the walls of the die.

After the forming the blade may be heat treated, balanced and otherwise finally completed.

Another embodiment of the invention is illustrated in Figs. 14, 15, 16, 17, 18 and 19.

In this embodiment the shank of the blade is fabricated in the same manner as in the preferred construction. The central section of the blade and the tip section, however, are of different structure.

The body section of the blade as in the previous embodiment, includes the shank 5 and a plurality of sections 23 all joined end to end by the flash weld 24. Each section 23 comprises a thrust plate 25, a camber plate 26, and the I beams 27 and 28 joining the corresponding edges of the plates. The edges of the plates 25 and 26 are joined to the edges of the corresponding flanges of the respective I beams 27 and 28 by the electric flash welds 29.

The foil plates 25 and 26 are rolled to provide tapered thickness therefor longitudinally of the plates and the thick edge portions 30 for flash welding to the respective inner flanges of the beams 27 and 28.

After the shank 5 and the sections 23 are joined end to end by the flash welds 24, the leading edge

member 3 and trailing edge member 4 of the preferred embodiment are joined by flash or fusion welding to the corresponding outer flanges of I beams 27 and 28 along the longitudinal seam 31. The edge members are welded to all of the sections 23 at one time.

The cup shaped metal members 18 of the preferred embodiment are welded to the edge members 3 and 4 and the shank 5 to close the inner ends of members 3 and 4.

The tip 32 is drawn to shape from sheet metal and has a reinforcing channel member 33 inserted in the mouth thereof and extending part way across the tip. The channel member 33 is secured in place by spot welds 34 and serves to support the tip against welding electrode pressures during flash welding to the sections of the blade. The tip 32 is joined to the outer section 23 of the body section of the blade and the leading and trailing edge members 3 and 4, by the circumferential flash weld 35, and serves to close the same.

The welded blade is then subjected to the same forming operations as the blade 21 of the previous embodiment, under which it is twisted and pressed to blade shape. The completed blade has substantially the same appearance as the blade of the previous embodiment illustrated in Fig. 13.

The invention provides a propeller blade of unusually wide proportions and great strength in which the transverse centrifugal moment is maintained at a minimum.

Various embodiments of the invention may be employed within the scope of the accompanying claims.

I claim:

1. A hollow metal propeller blade of welded construction and having at least one longitudinal expansible and deformable strengthening web, the leading and trailing edge portions of the blade being of relatively light weight to provide a low transverse centrifugal moment for the blade, and said web being outwardly curved and spaced from the edge portion and providing a completed web which is expanded in part and contracted in part after hot shaping the blade to final shape and twist after fabrication.

2. A wide hollow metal propeller blade of welded construction having a body section comprising a pair of spaced foil plates with the longitudinal edge portions thereof provided as curved webs and having integral flanges extending longitudinally of the corners of each plate, welds joining the edges of the corresponding webs of the plates together to provide a generally tubular cross-section in said body section, and a pair of substantially U-shaped edge members welded to the corresponding opposed flanges of the respective foil plates at a line removed from said webs to space the webs from the edge members and flanges, the curving and spacing of the webs providing for adjustments of the blade during forming and twisting.

3. A wide hollow metal propeller blade having a heavy weld fabricated backbone section presenting air foil surfaces and comprising the shank of said blade and a plurality of generally tubular sections welded together end to end and with aligned longitudinally extending flanges provided at the corners of said shank and tubular sections, a pair of substantially U-shaped light sheet metal members welded to said flanges to provide the edges of the blade, and a tip welded to the end of said backbone section and said edge members to complete the blade, said edge members having their inner ends closed by corresponding cup-shaped members welded thereto and to the ridges of the blade shank and their outer ends closed by said tip.

4. The method of making hollow metal propeller blades, comprising fabricating a blade substantially devoid of pitch twist and with a body section having a longitudinally extending tubular member with expansible outwardly curved reinforcing web portions, and deforming said web portions with parts of said web portions being expanded and other parts being contracted to effect a pitch twist in the blade.

5. In the manufacture of hollow metal propeller blades, the method of fabricating a body section of the blade comprising forming separate substantially rectangular foil plates with longitudinal ridges at the edges of the foil surfaces thereof and with outwardly curved generally thinner longitudinal flange portions extending inwardly from each foil plate and the ridges thereon, welding the corresponding curved flange portions of a pair of foil plates together to provide a tubular body section, forming substantially U-shaped leading and trailing edge members of varying depth corresponding to the variation in width of the body section, securing the edge members to the corresponding ridges of said foil plates along substantially parallel lines extending longitudinally of the body section and spaced from said flange portions and deforming said curved flange portions with parts of said flange portions being expanded and other parts being contracted to effect a pitch twist in the section.

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