

Aug. 25, 1942.

F. W. CALDWELL

2,293,801

HOLLOW METAL PROPELLER BLADE

Filed Oct. 1, 1938

3 Sheets-Sheet 1

Fig. 1

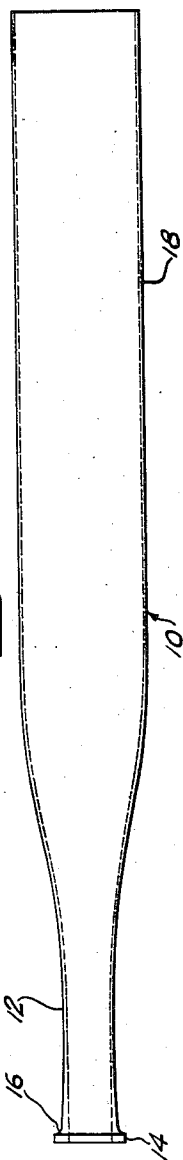


Fig. 2

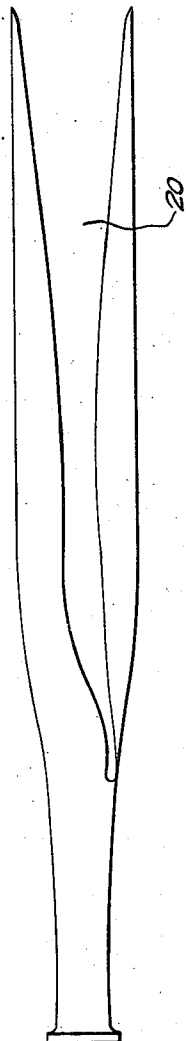


Fig. 3

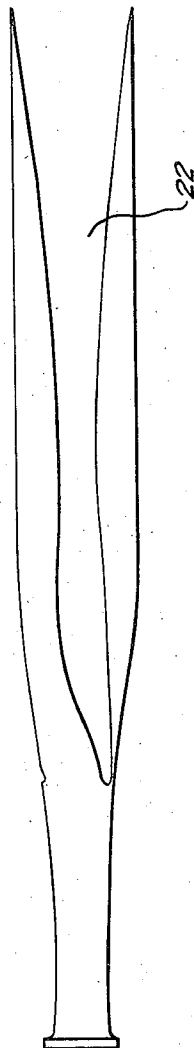
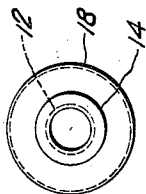


Fig. 4



INVENTOR
Frank W. Caldwell
BY *Harris G. Lucker*
ATTORNEY

Aug. 25, 1942.

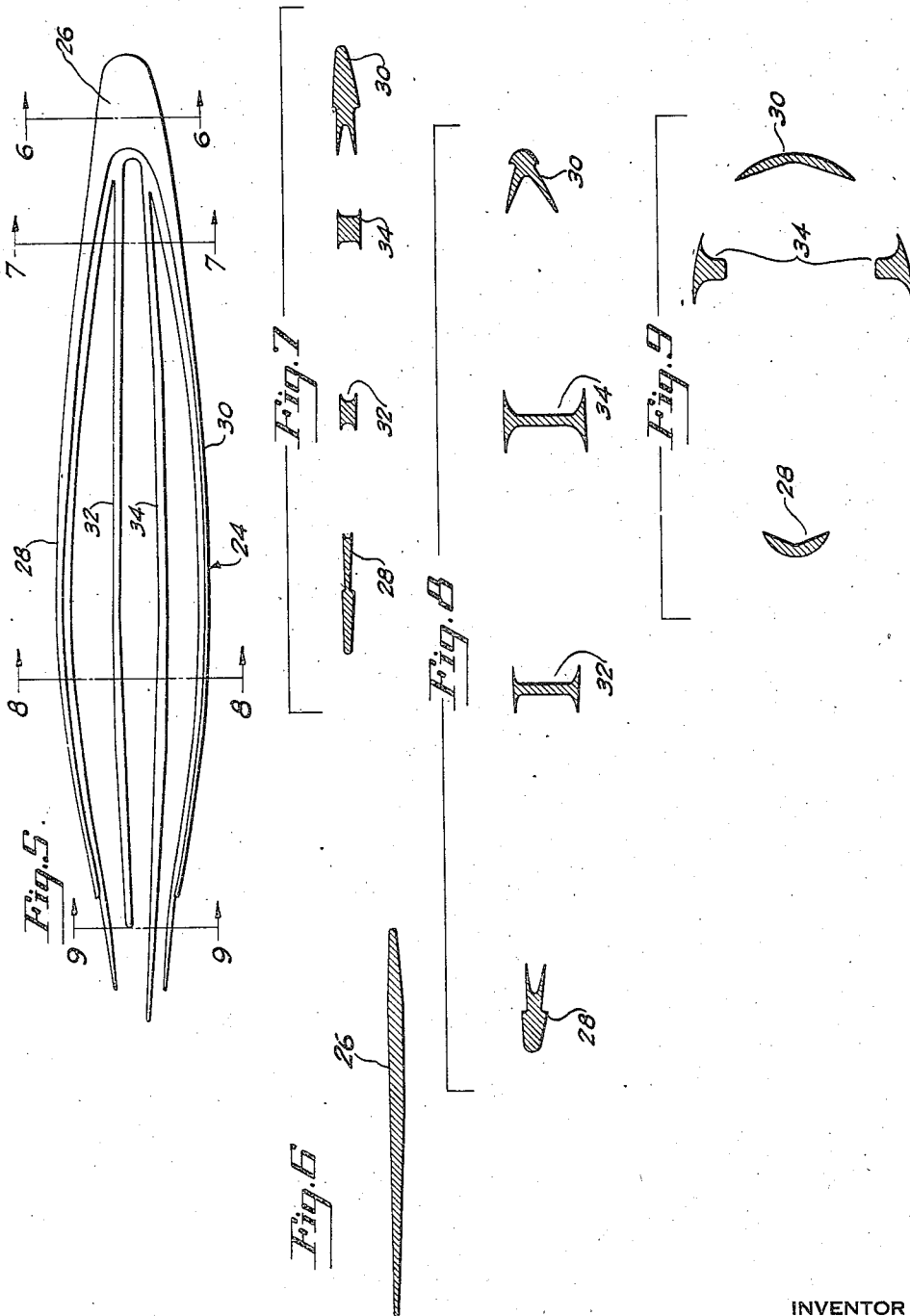
F. W. CALDWELL

2,293,801

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3 Sheets-Sheet 2



INVENTOR
Frank W. Caldwell
BY *Harris G. Luther*
ATTORNEY

Aug. 25, 1942.

F. W. CALDWELL

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HOLLOW METAL PROPELLER BLADE

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3 Sheets-Sheet 3

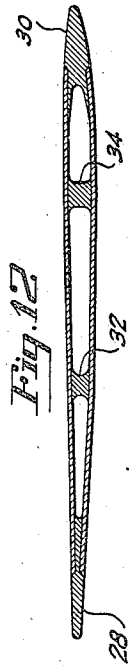
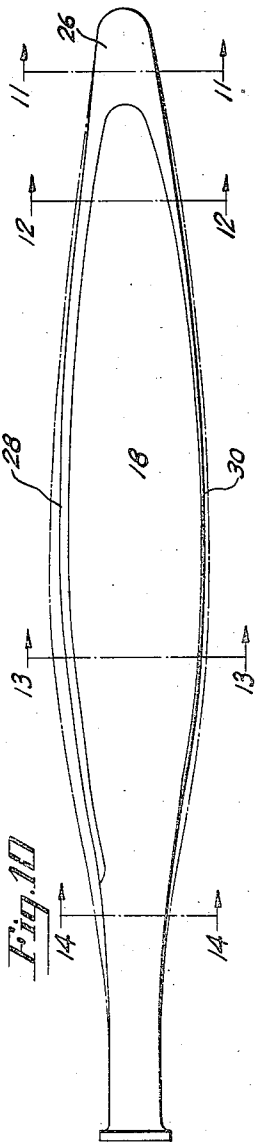


Fig. 11

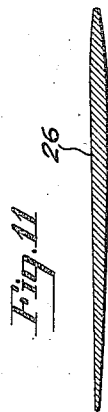


Fig. 12

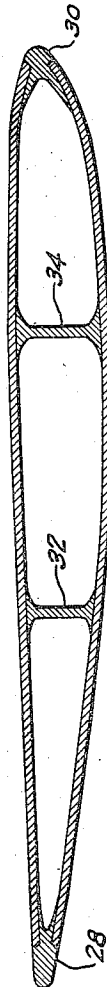
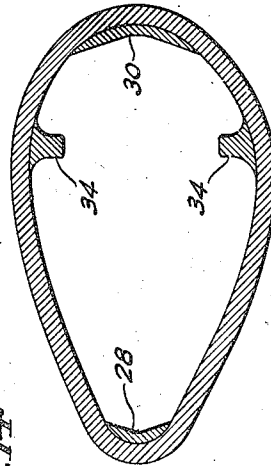


Fig. 13



INVENTOR
Frank W. Caldwell
BY *Harris G. Lucher*
ATTORNEY

UNITED STATES PATENT OFFICE

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HOLLOW METAL PROPELLER BLADE

Frank W. Caldwell, Hartford, Conn., assignor to
United Aircraft Corporation, East Hartford,
Conn., a corporation of Delaware

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11 Claims. (Cl. 170—159)

This invention relates to improvements in hollow metal propeller blades and an improved method for manufacturing the same, and has for an object the provision of a metal propeller blade having relatively thin metal walls reinforced by internal struts or web members.

A further object resides in the provision of a hollow metal propeller blade having relatively thin walls and an aerodynamically efficient airfoil section which is not subject to rapid deterioration in use due to load and vibrational stresses.

A still further object resides in the provision of an improved method for manufacturing a hollow metal propeller blade of the character indicated.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawings, in which like reference numerals refer to similar parts throughout, there is illustrated a particular mechanical embodiment of a propeller blade constructed according to the invention as well as various stages in the process of manufacturing such a propeller blade. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting or restricting the scope of the invention as set forth in the accompanying claims.

In the drawings,

Fig. 1 is a side elevational view of a tubular propeller blade blank at a preliminary stage in the manufacturing process.

Fig. 2 is a view similar to Fig. 1 but showing the same side of the tube blank provided with a longitudinal slot for the reception of an internal reinforcing member.

Fig. 3 is a view similar to Fig. 2 showing the opposite side of the propeller blade provided with a slot for the reception of the internal reinforcing member.

Fig. 4 is an end elevational view of the propeller blade blank illustrated in Fig. 1.

Fig. 5 is a plan view of an internal reinforcing member adapted to be inserted in the slotted tubular blank illustrated in Figs. 2 and 3.

Fig. 6 is a sectional view on an enlarged scale at station 6—6 of Fig. 5.

Fig. 7 is a sectional view on the same scale as Fig. 6 at station 7—7 of Fig. 5.

Fig. 8 is a sectional view on the same enlarged scale at station 8—8 of Fig. 5.

Fig. 9 is a sectional view on the aforementioned enlarged scale at station 9—9 of Fig. 5.

Fig. 10 is a plan view of the completed pro-

5 peller blade after the tubular portion, illustrated in Figs. 1 to 4, inclusive, has been assembled with the reinforcing portion, illustrated in Figs. 5 to 9, inclusive.

Fig. 11 is a sectional view on an enlarged scale at station 11—11 of Fig. 10.

Fig. 12 is a sectional view on the same enlarged scale at station 12—12 of Fig. 10.

Fig. 13 is a sectional view on the abovementioned enlarged scale at station 13—13 of Fig. 10 and,

Fig. 14 is a sectional view on the same enlarged scale at station 14—14 of Fig. 10.

It has previously been proposed to form hollow metal propeller blades and especially hollow steel propeller blades from thin walled metal tubing, and a large amount of experimental work has been done with the object of developing a successful hollow, thin walled, metal propeller blade. Blades so constructed have been tried in service and have been found subject to certain defects which it is among the objects of this invention to overcome. Where such blades have been produced by deforming a metal tube of a substantially circular original cross section to an airfoil section it has been found impossible to produce an efficient airfoil section because the leading and trailing edges of such a section require a curvature to which the tube walls cannot be bent without overstraining the metal. It has also been proposed to produce the necessarily sharp leading and trailing edges, particularly the trailing edge, by welding the metal along this edge, but such a weld of the relatively thin tube walls has been found to be too weak to stand the heavy loads imposed on the blades during operation of the propeller. It has also been found that a thin walled tube, when reduced to an airfoil section, does not have sufficient rigidity and is subject, particularly in propeller blades of large size, to twist and flutter during operation. If the wall of the tube blank is made sufficiently thick to resist the tendencies to bend, twist and flutter during operation there is no worthwhile gain in weight saving over a solid blade formed of a relatively light alloy metal such as duralumin. It is among the objects of the present invention to produce a very thin walled light weight propeller blade having an efficient airfoil section and sufficient strength and rigidity to successfully resist the forces tending to produce bending, twisting and fluttering of the blade during operation of the propeller.

In producing the improved propeller blade a tubular blank is first provided having a diam-

eter substantially equal to the maximum width of the finished propeller blade and formed of a high strength steel alloy. One end of the tube is then swedged down and the extreme end portion is upset to provide on the blank, generally indicated at 10, a substantially circular shank portion 12 of reduced diameter and an annular flange 14 joined to the shank portion by a fillet 16 of relatively large radius for retaining the blade in its hub mounting. The swedging and upsetting operation may be carried out as desired or according to some method well known to the art as this part of the process of producing hollow steel propeller blades has already been developed to a relatively high degree of efficiency.

During the swedging and upsetting operation the remainder of the blank is not altered but is left as a substantially circular portion of a diameter substantially equal to the maximum width of the finished blade as indicated by the numeral 18 in Fig. 1. After the original tube blank has been subjected to the swedging and upsetting operations to produce the blank illustrated in Fig. 1 having the shank portion 12, the flange 14 and the generally circular tubular portion 18, the tubular portion 18 is machined to uniformly decrease the wall thickness from the shank outwardly and is then bifurcated by two longitudinal, substantially diametrically opposed, slots of irregular outline, as indicated at 20 in Fig. 2 and 22 in Fig. 3. The form of the slots 20 and 22 will be more fully explained hereinafter.

In addition to the tube blank 10 there is provided a core member generally indicated by the numeral 24 and particularly illustrated in Figs. 5 to 9, inclusive. This core member is preferably formed as a steel forging and has an outline which is the same as the outline of the finished propeller blade and a thickness the same as the thickness of the hollow interior of the blade. The core includes a solid tip portion 26 and a plurality of tine like elements comprising a leading edge bead 28 integral with the tip portion, a trailing edge bead 30, and two spaced apart longitudinal internal strut members 32 and 34, also integral with the tip portion 26. The leading edge and trailing edge tines or beads 28 and 30 are rabbeted on both sides to provide shouldered depressions for the edge portions of the furcations of the tubular blank 10 along the slots 20 and 22, and are machined to provide rounded bead portions extending beyond the sides of the tubular blank and feather edged flange portions along their inner edges. The internal strut members 32 and 34 are machined to a substantial I section in which the end flange portions are tapered outwardly to a feather edge. The spacing and shape of the members 28, 30, 32 and 34 change along the length of the propeller blade to conform to the sectional contour of the blade at every station along its length, certain selected stations having been particularly illustrated in Figs. 6 to 9, inclusive. After the core member 24 has been machined to exact shape it is inserted in the tubular blank 10 through the slots 20 and 22 and the furcations of the tubular blank are then pressed down until the edges of the slots 20 and 22 come into contact with the corresponding shoulders of the rabbeted portion of the leading edge and trailing edge tines 28 and 30, the slots 20 and 22 being so shaped that the edges of the opposite side of the blank conform to the contour of the corresponding shoulders when the blank is pressed down to form with

the core member 24 a blade member of the desired airfoil section. After the furcations of the tubular blank have been pressed down into firm contact with the core member, to constitute a cover therefor the cover member is welded to the core member by some suitable method such as electric resistance welding. According to one preferred method of welding, strips of a suitable heat resisting material such as asbestos are secured along each bead and strut member within the blade so as to overlap the joint between the bead and strut members and the corresponding portions of the tubular blank, and an electric current is then passed through the structure until the contacting surfaces of the outer member and core member become fused together.

When the welding operation has been completed a blade is produced of the form and character particularly illustrated in Figs. 10 to 14, inclusive. The tip portion 26 and the leading and trailing edge beads 28 and 30 are integral portions of the core member and the weld joints between the cover member and the core member are located at some distance from the leading and trailing edges. Furthermore, the thickness of the bead members between opposed edges of the cover members is sufficient to provide a strong weld construction at the indicated location. The leading edge and trailing edge beads 28 and 30 are shaped to provide the necessarily sharp ends at these edges so that the adjacent portions of the tube walls do not have to be sharply bent and the internal struts 32 and 34 are located so as to maintain the opposed portions of the tube wall in the exact shape and position desired and to provide internal bracing for the blade to render the blade sufficiently strong and rigid to resist the load and vibration forces imposed thereon during operation. As is clearly illustrated in Figs. 12 to 14, inclusive, the tube wall is tapered from the shank to the tip end and the outer portion thereof is made extremely thin. It is therefore apparent that the above described construction will provide a propeller blade of minimum weight consistent with the necessary strength and rigidity since the component parts are reduced to their minimum weight and reinforcement is provided only where additional strength is required. The core elements are not only shaped to provide the minimum weight consistent with the necessary degree of reinforcement but also to distribute and equalize the blade stresses, particularly at the shank end of the blade. For accomplishing this latter purpose the leading edge and trailing edge beads 28 and 30 are shouldered and tapered at their shank ends, as is clearly illustrated in Fig. 5, the internal strut 32 is terminated short of the ends of the other core elements and the shank end of the strut 34 is cut out as is clearly illustrated in Fig. 14 and tapered to avoid any abrupt change in the stress transfer between the cover member and the core member. By bringing to a feather edge all portions of the core member which contact and are secured to the cover member, localized highly stressed areas in the blade are avoided.

While a particular mechanical embodiment of a propeller blade constructed according to the invention and one practical method of manufacturing such a blade have been hereinabove described and illustrated in the accompanying drawings for the purpose of disclosing the invention, it is to be understood that the invention is not limited to the particular method and

construction so illustrated and described but that such changes in the size, shape and arrangement of the various parts of the propeller blade and such changes in the order and character of the various steps of the improved method may be resorted to as come within the scope of the sub-joined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what is claimed and what it is desired to secure by Letters Patent is as follows:

1. A hollow metal propeller blade comprising, a multi-tined core member having a pair of outside tines constituting the leading and trailing edge portions of the blade, and a bifurcated cover member having an integral shank portion, said cover member receiving the major portion of said core member and welded thereto along contacting surfaces.

2. The arrangement as set forth in claim 1 in which said core member and said cover member are both formed of the same material.

3. The arrangement as set forth in claim 1 in which said core member and said cover member are both formed of high strength steel.

4. The arrangement as set forth in claim 1 in which all portions of said core member contacting said cover member are provided with feather edges to distribute the stresses transmitted between said cover member and said core member.

5. A hollow metal propeller blade comprising, a core member including a solid tip portion and a plurality of tines integral with said tip portion, and a bifurcated cover member having an integral continuous shank portion in which said core member is received in the bifurcated portion of said cover member and the outside tines of said core member constitute the leading and trailing edges of said blade, said outside tines being rabbeted to receive the edge portions of the cover member furcations to provide a smooth external surface for said blade.

6. The arrangement as set forth in claim 1 in which the wall thickness of said cover member decreases from said shank portion to the tip end of said member.

7. A hollow metal propeller blade comprising, a core member including a solid tip portion and a plurality of spaced apart longitudinal tine like portions integral with said tip portion, and a

bifurcated cover member having an integral shank portion and flange portion receiving said core member between the furcations thereof, in which the outside tine like portions constitute the leading and trailing edges of said blade and are welded to the edge portions of said cover member furcations and intermediate tine like members constitute internal reinforcing ribs extending longitudinally through said blade and welded at their opposite edges to said cover member.

8. A hollow propeller blade comprising, a shank portion having integral extensions forming the side portions of the blade, and a tip portion having integral extensions forming the leading and trailing edges thereof and reinforcing members for said blade, said portions being secured together substantially longitudinally of said blade.

9. A hollow propeller blade comprising, a shank portion having opposed longitudinal extensions forming substantially the entire side portions of the blade, and a tip portion having integral extensions forming the leading and trailing edges thereof and reinforcing members for said blade, said portions being secured together substantially longitudinally of said blade.

10. A hollow metal propeller blade comprising, a multi-tined core member in which the outside tines constitute the leading and trailing edge portions of the blade and at least one intermediate tine, and a bifurcated cover member having an integral shank portion receiving the major portion of said core member and welded thereto along contacting surfaces.

11. A hollow metal propeller blade comprising, an integral multi-tined core member having a portion constituting the blade tip, one tine constituting one edge of said blade and at least one other tine constituting a reinforcing member, and an integral bifurcated cover member having a portion constituting the blade shank, and portions constituting the blade faces, said cover member receiving the major portion of said core member with said face portions contacting said tines, said first-mentioned one tine separating said face portions at said one edge of said blade, said core member and said cover member being welded together along contacting surfaces.

FRANK W. CALDWELL.