Nov. 28, 1939. E. F. GEHRET 2,181,269

MANUFACTURE OF PROPELLER BLADES

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Fig. 1

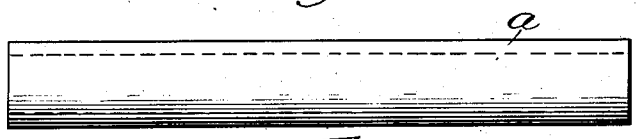


Fig. 2

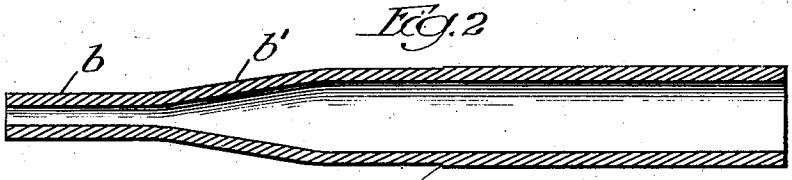


Fig. 3

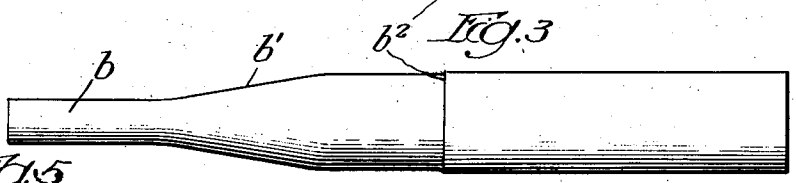


Fig. 5

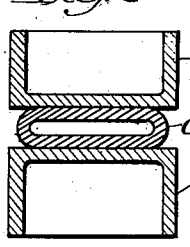


Fig. 4

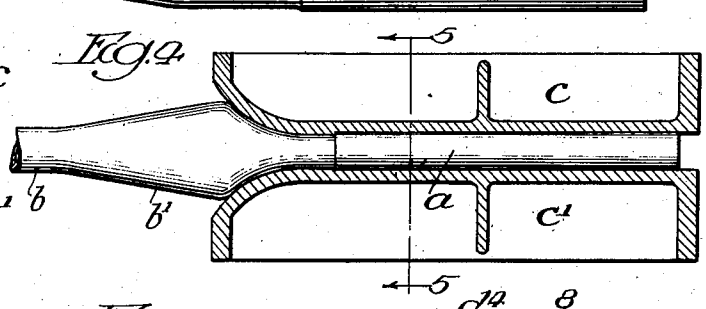


Fig. 6

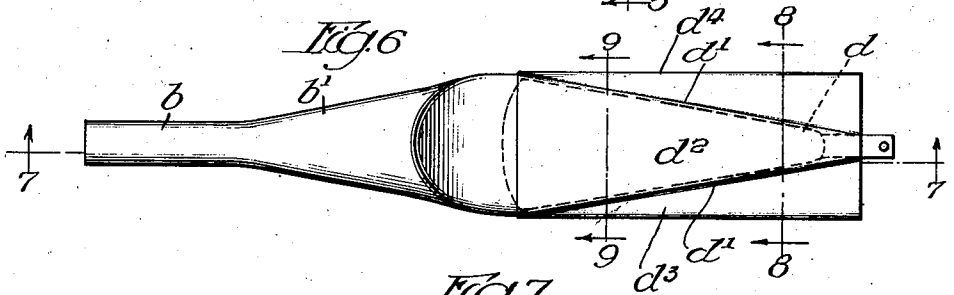
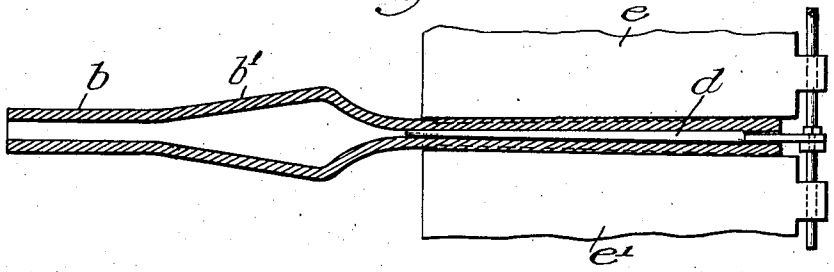


Fig. 7



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Fig. 8

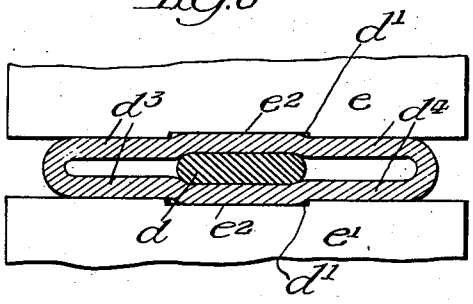


Fig. 9

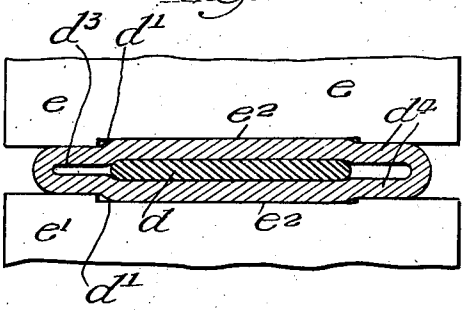


Fig. 10

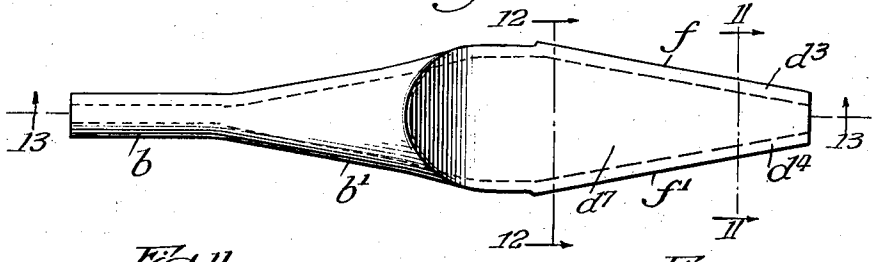


Fig. 11

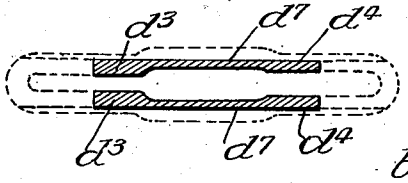
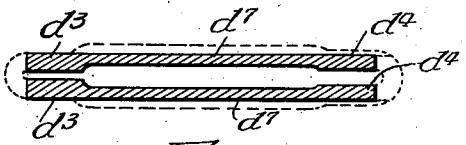


Fig. 12



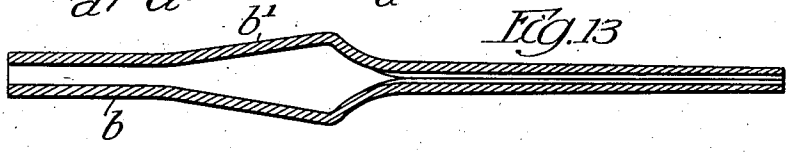


Fig. 13

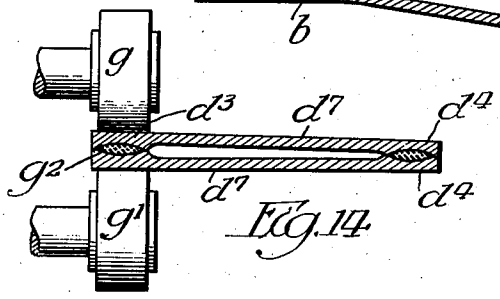


Fig. 14

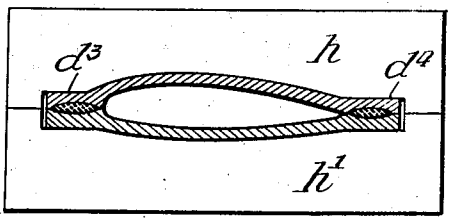


Fig. 15

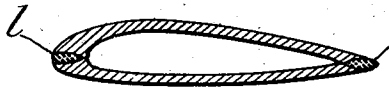


Fig. 16

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UNITED STATES PATENT OFFICE

2,181,269

MANUFACTURE OF PROPELLER BLADES

Edward Fayette Gehret, Jersey Shore, Pa., assignor to Aviation Manufacturing Corporation, Williamsport, Pa., a corporation of Delaware

Application January 12, 1938, Serial No. 184,559

6 Claims. (Cl. 29—156.8)

The invention relates to the manufacture of hollow steel propeller blades for aircraft.

One object of the invention is to provide an improved method by which a hollow steel propeller blade may be fabricated from a tubular blank which comprises slab-milling the outer faces of the flattened portions of the blank to economically produce the face-sections of the blade.

Another object of the invention is to provide an improved method of fabricating a hollow steel propeller blade from a tubular blank which comprises milling the outer faces of a flattened portion of the blank to form face-sections with marginal portions of greater wall-thickness at the leading edge than at the trailing edge of the sections so that an insert strip between the sections at the leading edge can be dispensed with.

Another object of the invention is to provide an improved method for fabricating a hollow steel propeller blade from a tubular blank which comprises flattening a portion of the tubular blank to form face-sections, bending the face-sections to bring portions thereof into relief so that they can be cut away by slab mill-cutting to provide reduced wall-thickness in the central portions, and adequate or greater wall-thickness at the margins, of the face-sections.

Another object of the invention is to improve the method set forth in application of Glen T. Lampton for Letters Patent of the United States, Serial No. 175,782, filed November 22, 1937.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawings: Fig. 1 is a plan of the tubular blank. Figs. 2 and 3 are, respectively, a section and a plan of the blank after it has been swaged and upset to form the shank and the outer periphery of the shank portion has been faced. Fig. 4 is a view of the blank between dies for flattening the portion of the blank used for forming the face-sections of the blade. Fig. 5 is a section on line 5—5 of Fig. 4. Fig. 6 is a plan of the blank after the face-sections have been bent along convergent lines to provide raised portions or portions in relief, preparatory to the slab-milling of the face-sections of the blank. Fig. 7 is a section on line 7—7 of Fig. 6. Fig. 8 is a transverse section of the blank, taken on line 8—8 of Fig. 6, the bending dies being shown in section. Fig. 9 is a section of the blank taken on line 9—9 of Fig. 6, the bending dies being shown in section. Fig. 10 is a planform of the blank after the portions have been cut away from the outer faces of the face-sections. Fig. 11 is a section on line 11—11 of Fig. 10. Fig. 12 is a section on line 12—12 of Fig. 10. Fig. 13 is a longitudinal section of the blank after the face-sections have been forced together to close the gaps between the margins of the face-sections. Fig. 14 is a transverse section illustrating the margins of the face-sections being welded together at the leading edge. Fig. 15 is a section illustrating the expansion of the welded blank to airfoil section. Fig. 16 is a section through the finished air-foil portion of the blade.

In carrying out the invention, a tubular blank a of uniform diameter and of mild carbon steel, as shown in Fig. 1, is swaged and upset in axial direction adjacent one of its ends to provide a shank b of adequate wall-thickness for attachment to a propeller-hub and a portion b^1 of gradually increasing diameter and decreasing wall-thickness, as shown in Fig 2. The rough outer surface of the blank is removed from the shank-portion of the blade to a point indicated at b^2 so that the wall-thickness of that portion of the blank which is used in forming the face-sections will not be reduced.

Next, the blank is heated to recalescence and placed in a suitable press between flattening dies c, c^1 and between the cross-section shape illustrated in Figs. 4 and 5, the flat portions being spaced apart sufficiently to permit them to be bent in the succeeding operation.

Next, a former d is inserted into the heated blank through its flattened open end and the blank is placed in a press between bending dies e, e^1. These dies are then brought together, as shown in Figs. 7, 8 and 9, to bend the face-sections of the blank along the lines d^1 to form a portion d^2 in relief on the outer faces of both of the flat portions of the blank. The former d has divergent edges and tapers longitudinally in thickness from the flattened end of the blank. The bends d^1 conform to the shape of the former d and the recesses e^2 in the dies e, e^1. Said dies are shaped to bring the marginal portions d^3 of the blank at one side of one of the bends d closer together than the portions d^4 at the other side of the other bend d. The purpose of shaping the blank in this manner is to bring the portions of the marginal face-sections of the blank, which are used in forming the trailing edge, closer together than the portions d^4 which are used in

forming the leading edge, and to leave greater wall-thickness in the marginal portions used in forming the leading edge.

Next, the blank with the former therein is placed in a slab-milling machine with a cylindrical cutter and the face-sections are cut away by cuts in parallel transverse planes. The former d decreases in thickness from its outer end to its inner end so that the face-sections, while on the former d, will be slightly flared. The cuts in parallel transverse planes remove the relieved portion d^2 and produce flat outer faces on the face-sections of gradually decreasing wall-thickness from mid-length to the tip of the blade. As the result of bending the blank, with different spacings, between portions d^3 and d^4 and making the slab-cuts parallel and across the face-sections, the marginal portions d^3, which will have greater wall-thickness for use in forming the leading edge of the blade than the marginal portions d^4 which are used in forming the trailing edge of the blade, and the portions of the face-sections between said marginal portions d^7, will be of less wall-thickness than the marginal portions of the face-sections. The wall-thickness of the face-sections will taper from mid-length to the tip.

Next, the blank is sawed or cut off in some suitable manner on lines f, f^1, as shown in Fig. 10, through both face-sections, so the folds between the face-sections will be cut away, and so the face sections will be approximately of the contour of the airfoil portion of the blade. Next, the former d is withdrawn from the blank, which can then be done by springing apart the face-sections.

Next, the trimmed blank is heated and placed in a press and the face-sections are forced together to bring the inner faces of the marginal portions d^3, d^4 together, as shown in Fig. 13, preparatory to welding them together.

Next, the marginal portions of the blanks are joined together by resistance-welding under pressure between rolls g, g^1. At this stage, the marginal portions d^3 of the face-sections have sufficient wall-thickness for forming the thick curved leading edge of the blade, the marginal portions d^4 of the face-sections are of less, but sufficient, thickness for forming the sharp trailing edge of the blade, and the central portions d^7 between the marginal portions are of reduced wall-thickness for lightness. The inner faces of marginal portions d^3, d^4 are of sufficient area for efficient lap-welding between the face-sections.

Next, the welded blank is heated and placed in a suitable press between dies h, h^1 and the central portions of the face-sections having the lesser wall-thickness are expanded by the introduction of a suitable gas under pressure into the blank, which forces said portions into the die-cavities which are shaped to give the face-sections the desired contour for pressure and suction faces of the blade.

Next, the edge formed by portions d^3 are rounded by grinding, as at l, to form a wide leading edge for the blade and the edge formed by the portions d^4, as at l^1, to form a sharp angle or edge at the trailing edge. The blade will then have the desired cross-sectional shape for its airfoil portion and leading and trailing edges. The blade is then finished by polishing its outer surfaces.

The invention exemplifies an improved method of producing a hollow steel propeller blade with face-sections having sufficient wall-thickness at the leading edge to provide adequate metal for forming said edge without an insert welding strip, with wall-thickness at the marginal portions for the trailing edge of lesser thickness and intermediate face-portions of reduced wall-thickness to provide a blade of great strength and endurance and light in weight.

The invention also exemplifies a method of producing hollow steel propeller-blades with face-sections of different wall-thickness at its margins and central portions which can be economically and expeditiously produced by slab mill-cutting.

The invention also provides an improved method for forming portions in relief on the face-sections for simplifying the milling operations in forming the face-sections.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. That improvement in making a hollow steel propeller blade from a tubular blank, which comprises flattening a portion of the blank to form substantially flat face-sections, embossing the sections to form portions in relief thereon in the central portion thereof and to space their marginal portions different distances apart, slab-milling the embossed portions of the face-sections in substantially flat planes to leave greater wall thickness in the face-sections adjacent one margin of the face-sections and lesser wall-thickness at the other margin and reduced wall-thickness between the marginal portions, welding together the inner faces of the marginal portions, and shaping the face-sections to airfoil form.

2. That improvement in making a hollow steel propeller blade from a tubular blank, which comprises flattening a portion of the blank to form substantially flat face-sections, embossing the sections to form portions in relief thereon in the central portion thereof and to space their marginal portions different distances apart, cutting off the embossed portions of the face-sections in substantially flat parallel planes to leave greater wall thickness in the face-sections adjacent one margin of the face-sections and lesser wall-thickness at the other margin and reduced wall-thickness between the marginal portions, and shaping the face-sections to airfoil form.

3. That improvement in making a hollow steel propeller blade which comprises shaping a tubular blank to form a shank thereon, flattening a portion of the blank to form face-sections, placing a former of approximately the planform of a blade-face in the flattened blank, bending the face-sections around the former to form portions in relief on the face-sections, cutting away portions of the outer faces of the sections in substantially flat planes, trimming away the folded portions between the face-sections, removing the former from the blank, joining together the margins of the face-sections and shaping the sections to airfoil contour.

4. That improvement in making a hollow steel propeller blade which comprises shaping a tubular blank to form a shank thereon, flattening a portion of the blank to form face-sections, placing a former of tapering thickness and approximately the planform of a blade-face in the flattened blank, bending the face-sections around

the former to form face-sections in relief on the opposite face-sections, cutting away portions of the outer faces of the sections in substantially flat parallel planes, trimming away the folded portions between the face-sections, removing the former from the blank, joining together the margins of the face-sections and shaping the sections to airfoil contour.

5. That improvement in making a hollow steel propeller blade which comprises shaping a tubular blank to form a shank thereon, flattening a portion of the blank to form face-sections, placing a former of approximately the planform of a blade-face in the flattened blank, bending the face-sections around the former to form face-sections in relief on the opposite face-sections, cutting away portions of the outer faces of the sections in substantially flat planes, trimming away the folded portions between the face-sections on lines outwardly of the former, removing the former from the blank, joining together the margins of the face-sections, and shaping the sections to airfoil contour.

6. That improvement in making a hollow steel propeller blade which comprises shaping a tubular blank to form a shank and an integral tubular portion for the airfoil section of the blade, flattening the blank to form face-sections, embossing the sections to form portions in relief on the outer faces of the face-sections, to bring the sections adjacent one margin closer together than the portions at the other margin, cutting away the outer faces of the face-sections on substantially flat planes so as to leave greater wall-thickness at the close marginal portions of the sections than at the other, welding together the inner faces of the marginal portions of the inner faces of the sections, and finishing the sections to airfoil form, with their leading edge of greater thickness than the thickness at the trailing edge of the blade.

EDWARD FAYETTE GEHRET.