

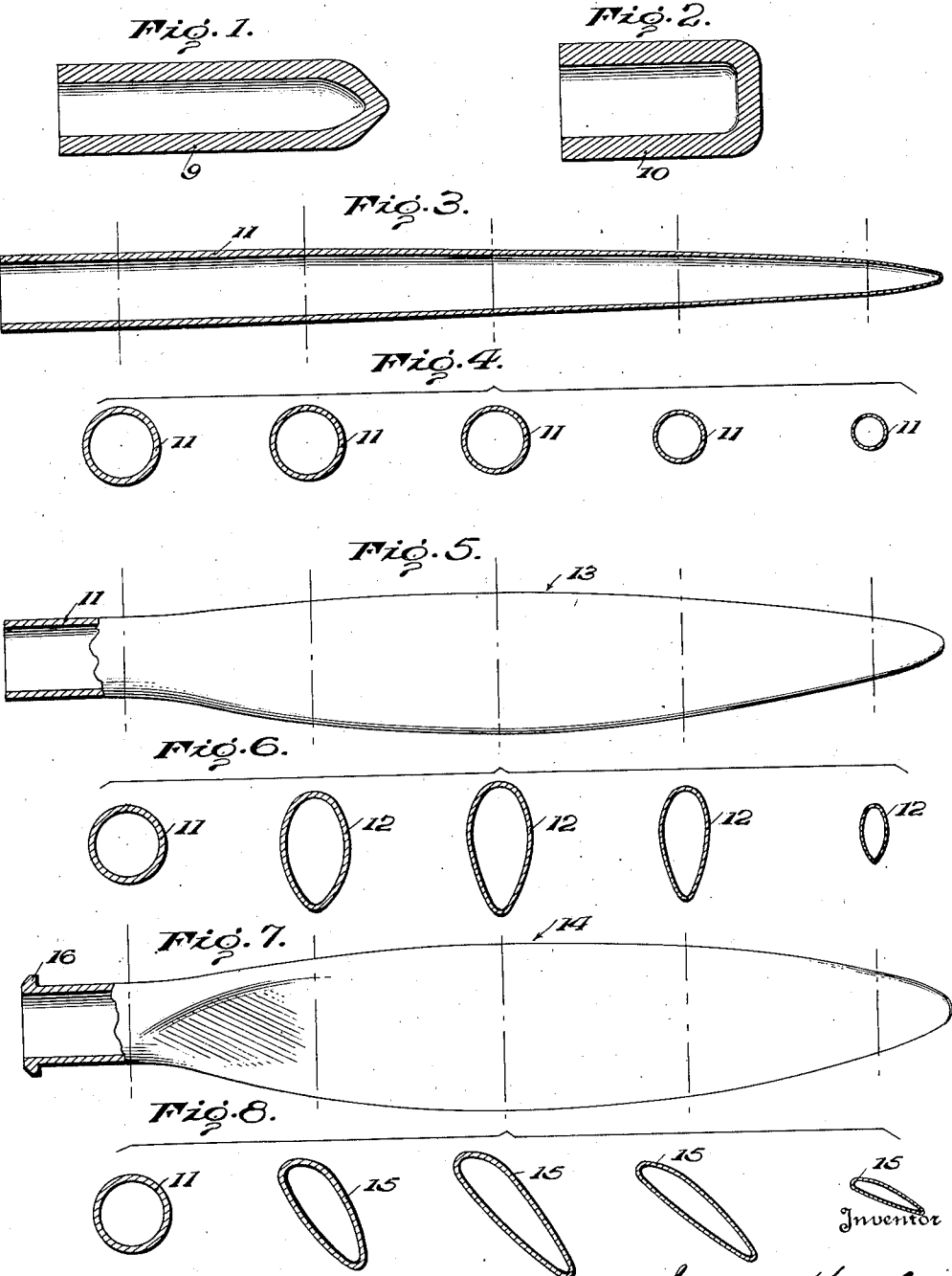
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METHOD OF MAKING PROPELLERS

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METHOD OF MAKING PROPELLERS

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This invention relates to propellers and more particularly to that class of propellers which are particularly adaptable for use on aircraft.

It is an object of the present invention to provide a novel method of making a hollow propeller blade.

Still another object is to provide a novel method of manufacturing a hollow propeller blade the same being constructed without the employment of joints, seams, welds or closures of any type.

A further object is to provide a hollow propeller blade constructed from a cupped metallic member which is manipulated during a series of novel steps to form a seamless and weldless blade.

A still further object is to provide in a method of constructing a hollow propeller blade a novel series of steps which may be carried out in a simple and efficient manner and at a minimum cost, in order to produce a light blade having exceptionally durable qualities.

The above and other features of novelty will appear more fully hereinafter from the following detailed description when taken in connection with the accompanying drawing. It is to be expressly

The above and other features of novelty will appear if illustration only and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing, wherein similar reference characters denote like parts throughout the several views,

Fig. 1 is an axial section of a hollow billet suitable for forming a blank employed in making a propeller blade in accordance with the present invention;

Fig. 2 is an axial section of a cupped disk or plate which may be employed for forming a blade blank;

Fig. 3 is a longitudinal section of a blade blank after treatment of the members shown in Fig. 1 or 2;

Fig. 4 illustrates a series of transverse sections taken at suitable intervals through the blank illustrated in Fig. 3;

Fig. 5 is a plan view partly in section of the blank after modification of its circumferential dimensions;

Fig. 6 illustrates a series of transverse sections through the blank of Fig. 5;

Fig. 7 is a plan view partly in section of the finished blade; and

Fig. 8 illustrates a plurality of transverse sections through the finished blade.

The novel method constituting the present in-

vention contemplates the employment of a suitable cupped metal member, which may be suitably manipulated to form a hollow cylindrical tube or blank closed at one end. The blank thus formed, after decreasing the thickness of the wall from the open end of the blank toward its closed end, is expanded to form a resultant blank having cross sections of substantially ovate elliptical shape, the circumferential dimensions of which correspond with those of the blade to be formed. Suitable flanges are thereafter formed adjacent the inner end of the resultant blank which are adapted to be engaged by a suitable hub member, and the blank is thereafter given its final form which includes an axial twist in order to effect the proper pitch or angle of incidence. These last two steps may be reversed if desired.

Referring now to the drawing and more particularly to Figs. 1 and 2 thereof, there is respectively disclosed therein, a hollow metallic billet 9 and a cupped metallic member 10 preferably formed from a disk or plate which member may, according to the present invention be suitably formed by a series of steps, referred to more particularly hereinafter, into a hollow propeller blade without joints or seams of any type whatsoever.

In order to form a blank, suitable for subsequent transformation into a blade of the above character, the billet 9 or cupped member 10 is elongated in any suitable manner, such as by rolling or successive drawing, to form a hollow cylindrical blank 11, which is preferably tapered toward the closed end thereof. As shown, Figs. 3 and 4, the thickness of the wall of the blank 11 is gradually decreased from the open end toward the closed end, this being accomplished by a suitable rolling or machining process, while preserving the circular cross sections of the blank, as illustrated in Fig. 4.

The circumferential dimensions of the blank thus formed are then varied by the use of suitable pressures and dies to provide for the necessary width of blade desired. Preferably, the blank 11 is placed in a mold or two-part die of sufficient size to admit of the desired expansion of the blank and strong enough to prevent expansion of the blank beyond the desired amount, and sufficient pressure, such as for example, fluid pressure, is introduced interiorly of the blank to effect the expansion of the walls of the blank to the shape of the mold or die. As shown, Fig. 6, the circular cross sections of the blank 11 are, with the exception of that portion of the blank immediately adjacent the root end, transformed into ovate ellipses 12, it being pointed out that

the perimetrical dimensions of the resultant blank illustrated in Fig. 5 correspond with those of the blade to be formed. However, in certain instances, it may be desirable to vary the dimensions referred to above, in which event the perimeter of successive sections of the blank 11 may be greater or less than the corresponding sections of the finished blade.

It is to be noted that during the intermediate forming step above described, the expansion of the blank has taken place only in the direction of the major axes of the ovate elliptical sections, Fig. 6, the minor axes being of no greater extent than the unexpanded diameters shown in Fig. 4. In certain instances, however, it may be desirable, during this step, to actually decrease the minor axes, in which case the compression of the die members slightly flattens the blank. This last-mentioned feature may be especially desirable in instances wherein very wide blades are to be formed, and this step may be performed as two separate steps employing various shaped dies, if desired. It will be apparent, however, that in either case, the resultant blank indicated generally at 13, Fig. 5, is a flattened member resembling somewhat the shape of a paddle, that is, a member having no axial twist or warp.

In order to transform the blank 13 into a completed blade 14, as illustrated in Fig. 7, a two-part die or mold, generally similar to that heretofore employed except that the internal form thereof corresponds with and is adapted to transform the various ovate elliptical cross sections 12 into aerofoil cross sectional forms 15, Fig. 8, is utilized in combination with a suitable pressure medium, interiorly of the blade, to cause the walls of the latter to conform smoothly to the interior of the die. During this operation, the ovate elliptical sections 12 are further flattened into aerofoil sections 15, and the blank 13 is axially twisted, as indicated in Fig. 8, in order to impart the desired pitch or angle of incidence to the finished blade.

Since the blank 13, Fig. 5, has already been expanded so that the circumferential dimensions thereof correspond with those of the finished blade, it is contemplated that the internal pressure employed during the last step referred to above, need be sufficient only to prevent wrinkling or collapse of the blank during pressure of the die members. However, in instances of wide blades, for example, further expansion may be desirable, in which case the internal pressure may be increased to effect the necessary additional expansion, and the die members correspondingly formed.

After the completion of the above-mentioned operations, the butt end of the blade may be suitably fashioned, as by rolling, forging or machining, in order to form a circumferential flange 16 which is adapted to engage a correspondingly formed portion of a suitable hub member in which the blade may be secured.

There has thus been provided by the present invention a novel propeller and method of constructing the same whereby the resultant blade is of an entirely integral and seamless construction and consequently extremely rugged and efficient during operation. The elimination of all seams, welded joints and spun closures in the blade obviates all danger of rupture or seam-opening of the blade which is extremely dangerous when the propeller is in operation. In the novel method described herein, the intermediate step of forming the blank into a member

having ovate elliptical cross sections, the circumferential dimensions of which correspond to those of the finished blade, enables the finishing step to be easily performed. Each of the steps of the method is carried out in a simple manner and thus permits the method to be practiced efficiently and at low cost.

While only one product and method of constructing the same has been illustrated, it is to be understood that the invention is not limited thereto. For example, instead of imparting the angular twist to the blank in one step, the same may be initiated during the intermediate step, if desired. It is also to be understood that the metal members from which the blank is initially formed, may be manipulated in a manner other than that illustrated, it being borne in mind, however, that the same is provided with a closed end integrally formed with the body thereof. Various other changes may be made in the details of construction and in the method of manufacture without departing from the spirit of the invention as well understood by those skilled in the art. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. The art of producing a propeller blade which comprises elongating a cupped metal member to form a tube closed at one end, varying the perimetrical dimensions of the tube to correspond with those of the blade to be formed, and pressing the resultant work-piece into the shape to be given the blade.
2. The art of producing a propeller blade, which comprises elongating a cupped metal member to form a tube closed at one end, decreasing the thickness of the tube circumferentially from one end toward said closed end to correspond with the thickness of the wall of the blade to be produced, varying the perimetrical dimensions of the tube to correspond with those of the blade to be formed, and then pressing the resultant work-piece into the shape of blade desired.
3. The method of producing a propeller blade which comprises, successively drawing a cupped metal member to form an elongated tube closed at one end and open at the other, decreasing the thickness of the wall of the tube circumferentially from the open end toward the closed end, expanding the tube to form a substantially elliptical blank the circumferential dimensions of which correspond with those of the blade to be formed, and pressing the resultant blank into the shape to be given the finished blade.
4. The method of producing a propeller blade from a hollow tube which includes increasing the circumferential dimensions of the tube to form a blank having substantially ovate elliptical cross sections the perimetrical dimensions thereof corresponding with those of the blade to be formed, and thereafter pressing the resultant blank into the aerofoil shape to be given the finished blade.
5. The method of forming a hollow propeller blade which comprises elongating a metal member closed at one end to form a hollow blank, expanding the blank by internal pressure to form a substantially elliptically shaped blank, and employing external and internal pressure to form the resultant blank into the shape desired to be given the finished blade.
6. The method of forming a hollow propeller blade which comprises drawing a metal billet to form a hollow tube, expanding the tube to increase the circumferential dimensions of the tube

to conform to the circumferential dimensions of the blade to be formed, and employing external and internal pressure to transform the resultant work-piece into the shape desired to be given the finished blade.

5 7. The method of producing a hollow propeller blade from an elongated metal blank closed at one end and open at the other including gradually decreasing the thickness of the wall of the blank from the open end toward the closed end, expanding the blank into a work-piece having
10 ovate elliptical cross sections the perimetrical dimensions of which correspond with those of the blade to be formed, and thereafter transforming the work piece by the utilization of internal and
15 external pressures into the shape desired to be given the blade.

8. The method of forming a hollow propeller blade comprising forming a hollow billet closed
20 at one end into a hollow tube, expanding the tube to form a paddle-like work-piece having ovate elliptical cross-sections and thereafter shaping said work-piece to transform said ovate elliptical cross-sections into aerofoil cross-sections.

9. The method of producing a hollow propeller blade comprising expanding a hollow tube having a closed end into a blank having an ovate elliptical cross-section and thereafter pressing the blank into the shape desired having an aerofoil
5 section.

10. The method of forming a hollow metal propeller blade comprising elongating a cupped member to form a hollow tube, employing internal and external pressures to increase the perimetrical
10 dimensions of the tube into a paddle-like work-piece, deforming the work-piece to form a blade of aerofoil section and forming an annular flange on the root end of the blade from the metal
15 thereof.

11. The method of forming a hollow propeller blade from a seamless, metal blank closed at one end and open at the other including expanding the blank into a paddle-like work-piece, and thereafter employing external and internal pressures to deform the work-piece into a finished
20 blade having an axial twist and an aerofoil section.

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