

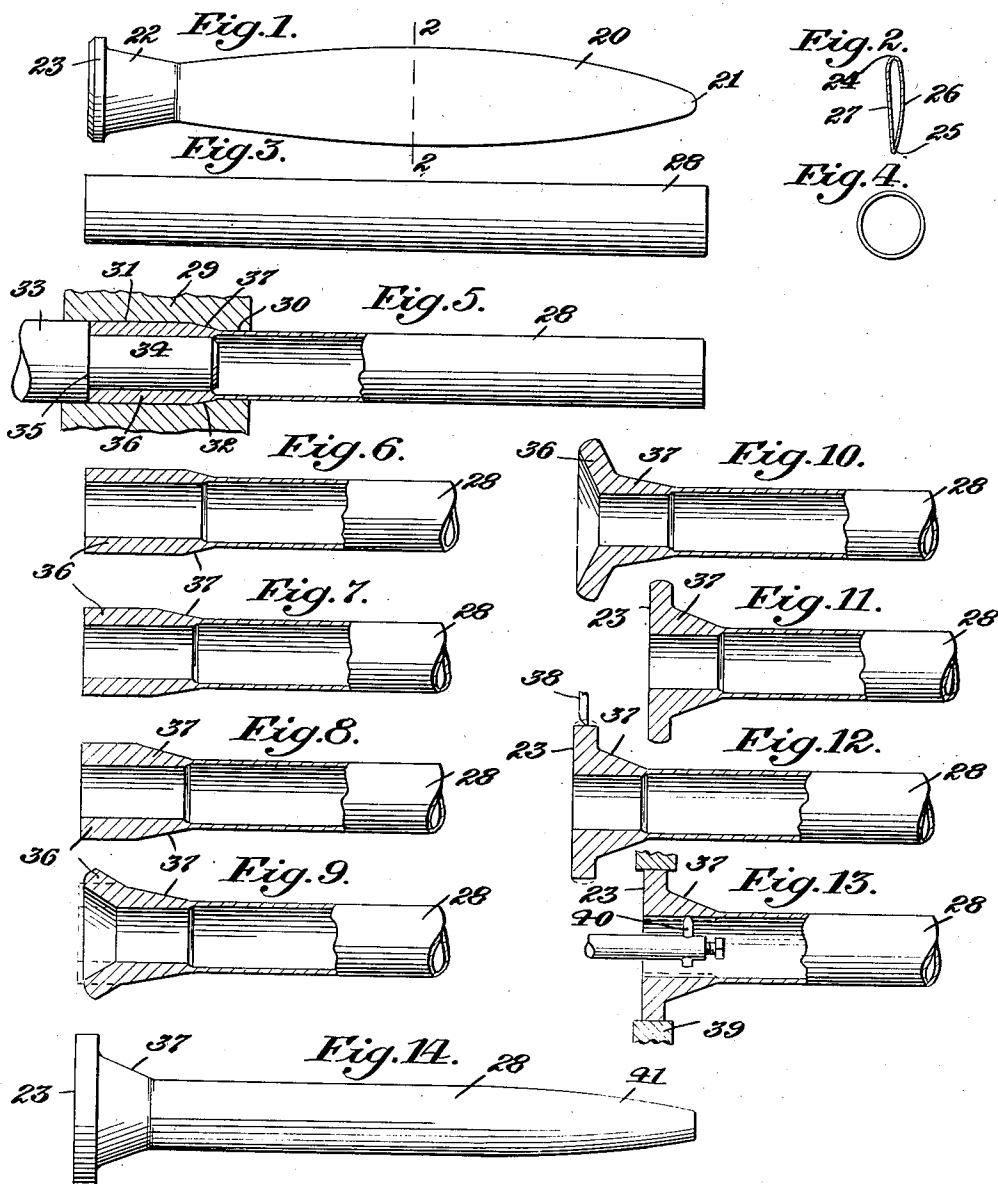
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FLANGING PROPELLER BLANK

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FLANGING PROPELLER BLANK

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The invention relates to airplane propellers and particularly to the separate blades thereof and has to do especially with the flange which is usually provided for mounting such blades in propeller hubs.

While the present invention does not involve all the steps necessary to make a propeller blade, it may be desirable to outline the proceedings in manufacturing the propeller blade so that the relation of the present invention thereto may be clearly indicated.

A hollow metallic propeller blade may be made from a single tube of substantially uniform diameter both internally and externally. One end of the tube is upset and made thicker. This may not only make that end of the tube larger in external but also smaller in internal diameter. A portion of the thickened end of the tube is then turned outwardly to make a circumferential flange and the interior of the thickened end of the tube is dressed to enlarge it to substantially the same internal diameter as the rest of the tube. The other end of the tube may then be swaged or otherwise tapered to a somewhat smaller diameter both internally and externally. The blank may then be held by the flange while there is inserted into it a mandrel under sufficient pressure to bring the internal dimensions of the tube to approximately the size of the mandrel. Thereafter the walls of the tube are brought to appropriate thickness and the smaller end of the blank spun or otherwise closed. The prepared blank may then be deformed in dies to the desired final form of a propeller blade.

Purposes of the present invention include the provision of a propeller blade having a thickened shank portion provided with a securing flange; the provision of a novel method of forming a flange on the shank end of the propeller blade blank; the provision of a method of forming a flange on the shank end of a propeller blade blank including first thickening the metal of such end and then gradually working the extremity of such end outwardly whereby to form a flange without distorting the flow lines of the metal from which the flange is formed; and the provision of a method of forming a flange on the shank end of a propeller blade blank including first thickening the metal of such end by decreasing the internal dimension and increasing the outside dimension and then gradually working the extremity of such end outwardly whereby to form a flange without distorting the flow lines of the metal from which the flange is formed.

In the accompanying drawing, which illus-

trates suitable embodiments of the invention, Figure 1 is a side elevation of a completed propeller blade of a type with which the present invention deals.

Fig. 2 is a transverse sectional view taken through the body of the propeller blade shown in Fig. 1 as on the line 2—2 of Fig. 1.

Fig. 3 is a side elevation, and Fig. 4 is an end elevation, of a tube of the type which preferably forms the initial piece of stock from which the airplane propeller of the present invention is finally formed.

Figs. 5 to 13 inclusive are partially broken, partially sectioned, side elevations which illustrate successive steps of operation upon one end of the piece of stock shown in Figs. 3 and 4 during the formation of a flange thereon which, after subsequent operations, will serve as means for supporting the propeller blade in a hub structure.

Fig. 14 is a side elevation of the piece of stock shown in Figs. 3 and 4 after it has been subjected to the operation illustrated in Figs. 5 to 13 inclusive whereby a flange is formed upon one end thereof, and after it has been tapered and reduced in diameter especially at the opposite end to form a small end.

Referring now to Figs. 1 and 2 of the drawing, a propeller blade of the type particularly adaptable to the practices of the present invention, is shown. This propeller blade is of hollow construction, and preferably formed of steel, and includes a main body portion 20 having a tip 21 at one end thereof and a shank portion 22 at the opposite end thereof. Although, in accordance with the broader aspects of the present invention, the particular means provided in connection with the shank portion 22 for aiding in securing the propeller blade in a hub structure (not shown) is more or less immaterial, a preferred form of such means is shown in Fig. 1 in the form of a single outwardly extending annular flange 23 at the root end of the shank portion 22. It will also be understood that the main body portion 20 of the propeller blade is generally of airfoil section, and provided with a leading edge 24 and a trailing edge 25, and has a front or camber face 26 and a rear or flat face 27 and that preferably the main body portion 20 is more or less twisted or warped over its length in order that each increment of the length thereof has substantially the same pitch as any other such increment. The hollow type of propeller blade is preferred generally for the reason that when properly constructed, it provides maximum

strength for a given weight. While all phases of the invention are not confined thereto, the following description will deal solely with the preferred form and manner of making the propeller blade shown in Figs. 1 and 2. It may also be noted that although the propeller blade shown in Figs. 1 and 2 may be constructed of material other than steel, the following description will deal solely with the construction of such blade made from steel, and should it be desired to form such a blade from material other than steel, those skilled in the art will readily recognize such variations or changes in the methods hereinafter described as will be necessary in such cases.

In Figs. 3 and 4 is shown the piece of stock or blank 28 which forms the starting point for the manufacture of the blade shown in Figs. 1 and 2. This piece of stock or blank 28 is a cylindrical steel tube of suitable length and of an external and internal diameter slightly larger and smaller than the respective external and internal diameters of the finished blade respectively at a point adjacent the outer end of the shank portion 22. Of course, in the broader aspects of the invention, the particular composition of the steel employed may vary in accordance with the desire of the particular designer or manufacturer, but for the purpose of illustration in the present case, will be considered to be of that type known as 4130-X, the composition of which is well known to those in the industry and is disclosed, as for instance, in the S. A. E. Handbook published by Society of Automotive Engineers, Inc., 29 West 39th Street, New York, New York.

Preferably, the first operations upon the blank 28 are in connection with the formation of the shank 22 and flange 23, as disclosed in Figs. 5 to 13, inclusive. The first of these operations, as indicated in Fig. 5, includes placing one end of the blank 28 in a die structure, indicated generally at 29. This die structure is provided with an opening 30 therein, which relatively closely embraces the circumference of the blank 28 at one end of the die structure and beyond such end of the die structure the opening is enlarged in diameter in concentric relation with respect to the opening 30, as at 31, this portion being joined to the opening 30 through a tapered shoulder portion 32. In positioning the blank 28 in the die structure 29, as illustrated in Fig. 5, the left hand end of the blank 28 is preferably located slightly inwardly or to the right from the left hand face of the die structure, and the blank 28 is suitably anchored against movement to the right, as indicated in Fig. 5. As indicated in Fig. 5, there is employed a ram 33 of a diameter to be freely received within the enlarged portion 31 of the opening in the die structure 29, and thereby to be guided therein. The ram 33 is provided with a pilot extension 34 of slightly smaller outside diameter than the internal diameter of the blank and which accordingly provides a shoulder 35 at the junction of the ram and pilot 34. The pilot 34 is entered into the bore of the blank 28 and the body of the ram 33 is entered into the opening 31 a sufficient distance to bring the shoulder 35 into contact with the corresponding end of the stock 28 and sufficient pressure is exerted upon the ram 33 to cause the corresponding end of the blank 28 to be upset and thereby cause it to conform externally to the walls of the opening 31 and of the shoulder 32 and internally to conform to the diameter of the pilot 34. This operation forms an enlarged cylindrical portion 36 which eventually will provide the flange 23 and an out-

wardly tapered portion 37 which when brought to completed form will provide part of the shank portion 22. This end of the blank has, of course, preferably previously been brought to a forging temperature, approximately 2200° F. in the case of the particular steel disclosed, for the purpose of subjecting it to this step of operation.

Upon completion of this operation, the blank 28 is removed from the die structure, and the upset end thereof is again brought to forging temperature and again placed in a die structure similar to the die structure 29, to be again acted upon by a ram similar to the ram 33. In this case, however, the opening in the die structure which corresponds to the opening 31 in Fig. 5 is of greater diameter than the opening 31, while the opening in the die structure corresponding to the opening 30 in Fig. 5 is the same as in Fig. 5, and accordingly the length of the shoulder in the die structure corresponding to the shoulder 32 in Fig. 5, is correspondingly increased. The diameter of the ram in this case, corresponding to the ram 33 is of course increased in accordance with the increase in diameter of the opening in which it is to be received, and the diameter of the pilot corresponding to the pilot 34 in Fig. 5 is slightly reduced over the diameter of the pilot 34. With the modified die structure and ram the upset end of the blank 28 is again acted upon in substantially the same manner as described in connection with Fig. 5, the result being substantially as indicated in Fig. 6, that is, the external diameter of the portion 36 is increased, and the internal diameter is decreased over that indicated in Fig. 5, and the length of the tapered shoulder 37 is increased while the length of the end operated on is somewhat decreased.

The upset end of the blank 28 may be then again heated to forging temperature and may be again subjected to the action of apparatus similar to that disclosed in Fig. 5 to further increase the diameter of the portion 36 and the length of the shoulder 37 and decrease the internal diameter of the blank over the length of these portions so as to bring this end of the blank into substantially the form indicated in Fig. 7. This end of the blank 28 is subjected to as many repetitions of this type of operation as is deemed necessary to bring this end of the blank into approximately the condition indicated in Fig. 8, having proper regard to the grain structure and flow lines of the grain of the metal in such end. For this latter reason it will be apparent that, although the end of the blank as indicated in Fig. 3 could be brought to the condition illustrated in Fig. 8 in a single operation instead of a plurality of operations as disclosed, the grain structure of the metal in such case might be adversely affected and the flow lines of the grain of the metal might be unduly distorted from the viewpoint of obtaining maximum strength in this portion of the final product. By following out a suitable number of operations as described, it is possible to maintain substantially the same grain structure and grain flow lines as occur in the original piece of stock or blank 28.

When the blank 28 reaches the form indicated in Fig. 8, the tapered shoulder portion 37 has assumed substantially the form and size of the shank portion 22 in the finished blade, its size of course being slightly larger for the purpose of leaving sufficient stock thereon to clean it up in subsequent machining operations. The thickness of the portion 36 at this stage of operation is substantially greater than the thickness of the

flange 23 in the final product. The internal diameter of the blank over the length of the portions 36 and 37, as indicated in Fig. 8, has been reduced sufficiently so that upon removing the excess metal from the interior of the blank at this point to bring it into conformance with the diameter of the main body portion of the blank, any roughness or other imperfections which may have appeared on the interior of the blank at this point during the upsetting operation will be fully removed.

It will be understood that the exact sizes or proportions indicated in the drawing are not essential and that the deformation of the end of the blank 28 and at other points in the operation may be carried out to whatever extent is desired or expedient to produce the desired propeller blade or blank.

The next steps of operation deal with the outward bending of the portion 36 so as to form a blank, as indicated in Fig. 11 from which the flange 23 may be formed. These steps of operation include preferably three or more steps as indicated in Figs. 9, 10, and 11 in which the portion 36 of the blank, as indicated in Fig. 8, is gradually bent outwardly with respect to the axis of the blank until the metal of such portion is brought into a plane perpendicular to the axis of the blank as indicated in Fig. 11. These operations are preferably not of an upsetting character but consist rather of an outwardly bending or belling the portion 36 so as not to disturb the grain structure or grain flow lines of this portion and, of course, are preferably conducted while this portion of the blank is at about forging temperature. The operation may be performed in any suitable number of steps. The final step of operation in bringing this end of the blank to the form indicated in Fig. 11 may, if necessary, include a certain amount of forming, as distinguished from pure bending or belling, in order to obtain the desired contour of this end. The entire procedure may be effected by any suitable known means which are not shown.

The next operation, which is illustrated in Fig. 12, consists in mounting the blank 28 in a lathe or steady rest or other suitable structure (not shown) in which the blank may be accurately centered and by means of a tool such as 38 turning the periphery of the flange portion 23 into a cylindrical form concentric with the axis of the blank 28.

This end of the blank 28 is then accurately centered, as by means of a steady rest 39, or in a lathe or other structure (not shown) and the excess metal in the bore formed during the upsetting process disclosed in Figs. 5 to 8, inclusive, is then removed, as by means of a tool such as 40 where the amount of metal to be removed is relatively large, or by other suitable means, so as to bring this portion of the bore into substantially accurate conformance with the initial bore of the blank, and then this portion is ground, buffed or otherwise acted upon to bring the internal surface thereof into smooth, polished and unbroken relation with respect to the main body portion thereof.

The blank having been provided with the flange as described may then be tapered and considerably reduced in diameter at the other end 41 of the blank as shown in Fig. 14. This and the following steps in completing the propeller blade form no part of the present invention and may be performed in any suitable way. They are referred to here merely to indicate one char-

acter of completed article for which the present invention may be suitable. The tapered blank may be brought to exact internal dimensions by forcing into it a properly sized mandrel so as to cause the metal of the blank to set to the size of the mandrel. The blank may be suitably treated to reduce its wall thickness if necessary and the small open end may be closed by some such operation as spinning. The blank so prepared may be deformed as by dies to the preferred shape and contour for an airplane propeller. Various other suitable or intermediate operations may be performed upon the blank when necessary or desirable.

Variations in the operations and results indicated may be adopted or effected when desired without departing from the present invention.

I claim as my invention:

1. In forming a radially outwardly extending flange on a tube, the steps of upsetting an end of the tube to increase its external dimensions and decrease its internal dimensions, belling a portion of said end and outwardly bending the belled portion of said end to form the flange.

2. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of the blank including upsetting one end of the tube to form an end portion of increased and substantially uniform wall thickness and an adjoining portion of varying wall thickness, belling a portion of said end and outwardly bending at least a portion of said belled end portion outwardly to form a flange.

3. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of the blank including upsetting one end of the tube to form a cylindrical end portion of a different thickness and an adjoining portion of tapering formation, belling the cylindrical portion of said end and outwardly bending the belled cylindrical portion to form a radially outwardly directed flange.

4. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of the blank including upsetting one end of the tube to form an end portion of increased and substantially uniform wall thickness and an adjoining portion of varying wall thickness by a series of axially upsetting operations each conducted while the end is in heated condition, and outwardly belling the portion having a uniform wall thickness by a series of outwardly bending operations, each conducted while the end is in heated condition, to form an annular outwardly directed flange.

5. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of the blank including upsetting one end of the tube to form an end portion of increased outer and decreased inner dimensions, bending the extremity of the end portion outwardly to form an outwardly directed flange, and removing metal from the interior surface of the end portion to bring its dimensions into substantial conformance with the original inner dimensions of the tube.

6. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of said blank including upsetting one end of said tube to form an end portion of increased and substantially uniform wall thickness and an adjoining portion of varying wall thickness, and outwardly bending a portion only of said end portion to form a flange.

7. In the formation of a propeller blade blank

5 from a hollow metal tube, the steps in the formation of the shank end of said blank including upsetting one end of said tube to form a cylindrical end portion of a different thickness and an adjoining portion of tapering formation, and then outwardly bending said cylindrical portion to form a radially outwardly directed flange.

10 8. In the formation of a propeller blade blank from a hollow metal tube, the steps in the formation of the shank end of said blank including upsetting one end of said tube to form an end por-

tion of increased and substantially uniform wall thickness and an adjoining portion of varying wall thickness by a series of axially upsetting operations each conducted while said end is in heated condition, and then outwardly belling said portion having a uniform wall thickness by a series of outwardly bending operations, each conducted while said end is in heated condition, to form an annular outwardly directed flange.

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