

Jan. 16, 1934.

J. SQUIRES

1,943,560

METHOD OF MAKING AIRPLANE PROPELLER BLADES

Filed Jan. 25, 1929

2 Sheets-Sheet 1

FIG. 1.

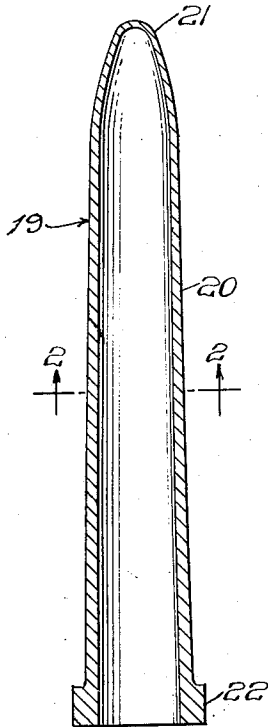


FIG. 3.

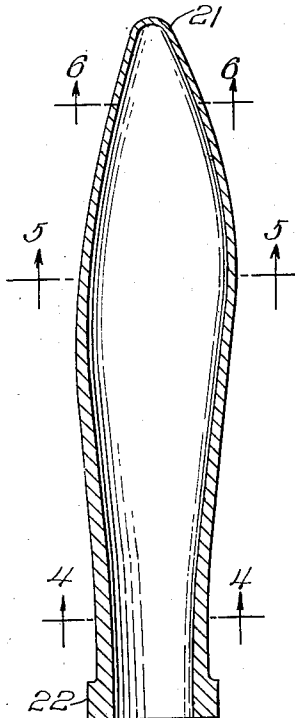


FIG. 10.

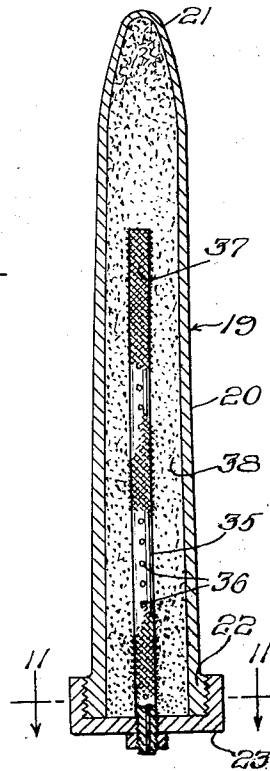


FIG. 4.

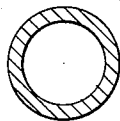


FIG. 11.

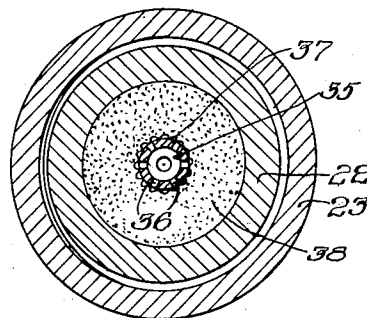


FIG. 2.

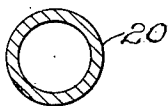


FIG. 5.

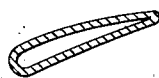


FIG. 6.



INVENTOR
John Squires
BY
Harnes, Dickey & Pierce
ATTORNEYS.

Jan. 16, 1934.

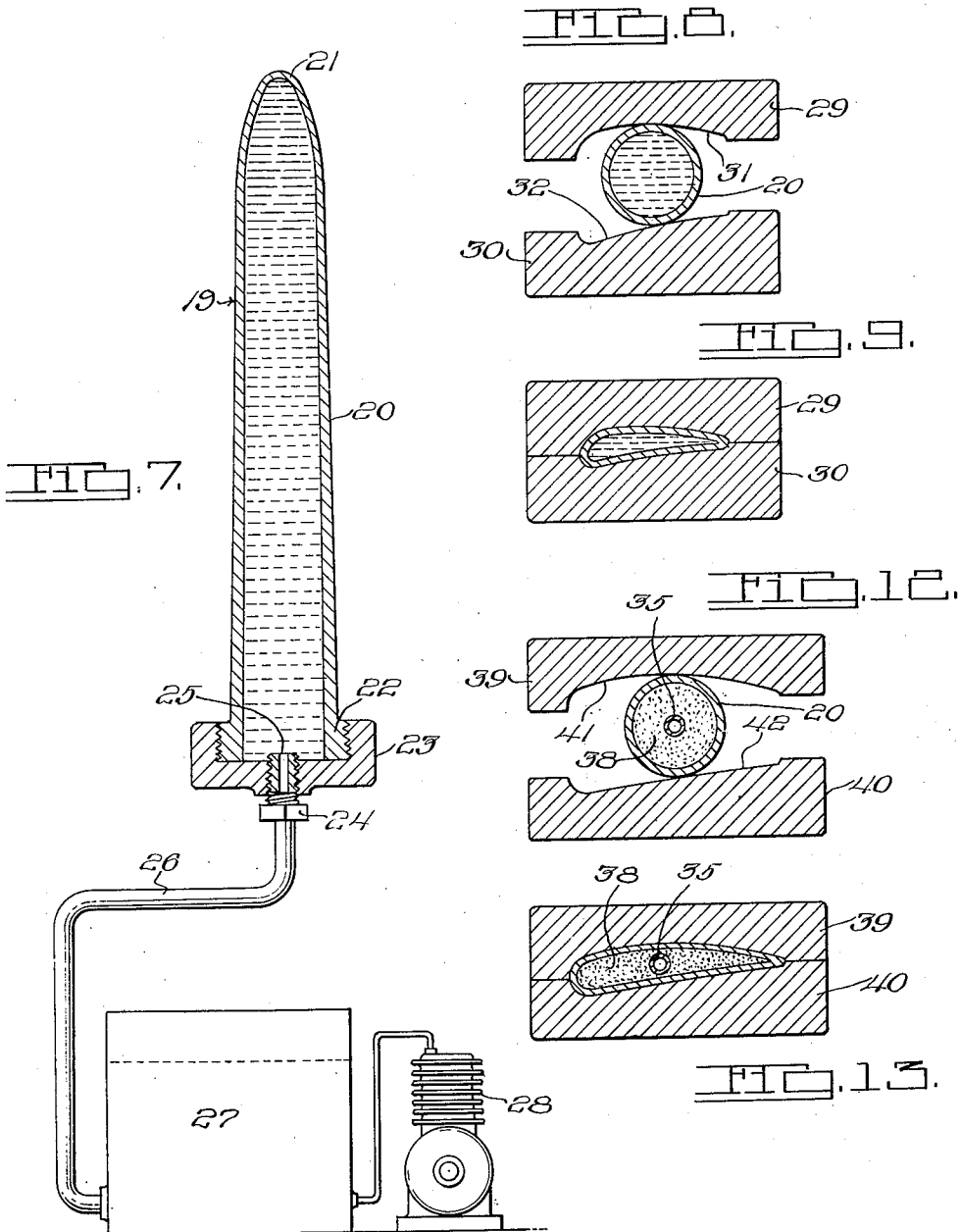
J. SQUIRES

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METHOD OF MAKING AIRPLANE PROPELLER BLADES

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2 Sheets-Sheet 2



INVENTOR
John Squires

BY
Harness, Dickey & Pierce
ATTORNEYS.

UNITED STATES PATENT OFFICE

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METHOD OF MAKING AIRPLANE
PROPELLER BLADES

John Squires, Detroit, Mich.

Application January 25, 1929. Serial No. 334,876

11 Claims. (Cl. 29—156.8)

This invention relates to airplane propellers and particularly to the blades thereof, the principal object being the provision of a new and novel method of making such blades.

Another object is to provide a hollow blade for an airplane propeller formed from a single metal billet suitably forged and shaped.

Another object is to provide a blade for an airplane propeller comprising a hollow metal structure formed from a single piece of metal without the necessity of welding or otherwise securing any part thereof.

Another object is to provide a hollow metallic blade for airplane propellers, the walls of which decrease in thickness from the root of the blade to the tip thereof, and which blade is formed from a single piece of metal without welding or otherwise securing any portions thereof together.

Another object is to provide a means for forming a propeller blade comprising forging a billet to provide an elongated cup shaped member of substantially circular section, and thereafter shaping the same to effect a propeller blade of the desired section.

Another object is to provide a means for forming a propeller blade comprising in forming a billet into an elongated cup shaped member, the walls of which decrease in thickness toward the closed end thereof, and thereafter placing said cup shaped member between dies whereby to modify it into the proper shape and section to effect a propeller blade.

Another object is to provide a means for forming a propeller blade comprising in forming a billet into an elongated cup shaped member, placing the interior of such member under fluid pressure and then squeezing said member between a pair of dies whereby to cause it to assume the shape or section of the blade desired.

Another object is to provide a method for forming a propeller blade comprising in providing an elongated metallic cup shaped member, filling the interior of the member with a relatively incompressible material, closing said member to the escape of such material, and thereafter operating upon said member with exterior pressure whereby to form it into a blade of proper shape and section.

A further object is to provide a method for forming a propeller blade comprising in forming a billet into a tube-like structure having a closed end, filling the interior of the structure with a relatively incompressible and non-fusing granular material, closing said structure to the es-

cape of such material, heating the structure, and then forging it to shape desired.

The above being among the objects of the present invention, the same consists in certain features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which show a suitable embodiment of the present invention, and in which like numerals refer to like parts throughout the several different views;

Fig. 1 is a vertical sectional view taken through the axis of a tubular metallic structure such as is employed in making a propeller blade in accordance with the present invention.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical sectional view of a propeller blade constructed from a tubular member such as is shown in Figs. 1 and 2.

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3.

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 3.

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 3.

Fig. 7 is a more-or-less diagrammatic partially sectioned view illustrating the manner in which the member shown in Fig. 1 is placed under an internal pressure for the purpose of being operated upon to form it into a propeller blade of proper shape and section.

Fig. 8 is a more-or-less diagrammatic view illustrating the member shown in Fig. 1 placed under internal pressure as in Fig. 7 and placed between forming dies previous to operation thereon by the dies.

Fig. 9 is a view similar to Fig. 8 but showing the dies in closed position and the member being operated upon in the shape formed by the operation of the dies.

Fig. 10 is a more-or-less diagrammatic vertical sectional view illustrating how the member shown in Fig. 1 may be prepared for formation into a propeller blade of desired shape and section by the employment of the modified method of forming the same.

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 10.

Fig. 12 is a view similar to Fig. 8 but showing the member in Fig. 10 positioned between a pair of dies previous to the forging operation.

Fig. 13 is a view similar to Fig. 12 at the completion of the forging operation.

The present invention deals with a propeller blade of maximum strength, together with a method of manufacturing the same. I am well aware that heretofore solid propeller blades have been formed by a forging process, but such blades are constructed of light metal in order to obtain the proper lightness in weight and consequently may be limited as far as strength is concerned, and particularly as respects the ability to withstand centrifugal forces acting thereon at high rotational speeds. I am also aware that propeller blades have heretofore been built up of sheet metal by welding, riveting or otherwise securing together two or more separate parts. These blades are quite satisfactory, although because of the excessive amount of welding that is liable to be necessary in their manufacture, and other limitations, they are relatively expensive to produce and oftentimes are liable to rupture along the line of welding. By the employment of the present invention I provide a propeller blade formed from a single piece of metal devoid of welding or any other securing means for maintaining any portions thereof together, such blades being of hollow construction, the walls of which preferably decrease in thickness towards the tip and which consequently provides a blade of minimum weight and maximum strength, and which may be formed of steel.

The method I employ in forming a propeller blade in accordance with the present invention is to first take a billet of steel, or other metal if desired, and by suitable heating and forging process, well known to those familiar with the forging art, form it to the shape of a tubular member, designated generally as 19, of circular section such as is shown in Fig. 1, having side walls 20 and a closed end 21. The open end is preferably provided on its exterior with a circumferential flange portion 22 which not only facilitates the later formation of the blade, but also acts in the finished product as a means for securing the blade to the propeller hub. The member 19 shown in Fig. 1 is preferably so formed that the metal of the walls thereof decreases in thickness from the flange 22 to the closed end 21, and the member itself is preferably tapered in diameter from a maximum at the open end towards the closed end thereof as indicated.

Referring to Figure 7, the flange 22 is then threaded to receive the cap 23 which closes the open end thereof and in which is received a fitting 24 having an opening 25 therein connecting with the interior of the member 19. The interior of the member 19 is then filled with a suitable liquid and the fitting 24 is connected by means of a tube or pipe 26 to a reservoir 27 of such liquid under suitable relatively high pressure which may be provided by a pump mechanism such as 28 or other suitable means. The member 19 thus closed and filled with liquid under pressure is then placed between die halves such as 29 and 30 shown in Figs. 8 and 9, which halves are provided with suitable depressions 31 and 32 therein formed to the shape of the desired finished product. The die halves 29 and 30 are then forced together by any suitable means, such as a power press (not shown), the member being formed thereby as indicated in Fig. 9 to correspond to the shape of the depressions 31 and 32, thus forming such member into a propeller blade of suitable shape and section. The interior of the member in being maintained under a suitable fluid pressure, insures

its outer surface remaining in contact throughout the surface of the depressions 31 and 32 when the die halves 29 and 30 are brought together. By this method substantially no stretchings of the walls 20 occurs when operated upon by the die halves 29 and 30, and consequently the depressions 31 and 32 must be designed with this in mind and so that when the die halves are together the outer surface of the walls 20 contact with the surfaces of the depressions 31 and 32 over substantially their entire area. Furthermore, because of the fact that substantially no stretching of the metal occurs in the forming operation, the interior volume of the member will be reduced when being operated on by the die halves, and consequently the pressure means must be so designed to allow a feed back of the liquid from the member 19 through the tube 26 without a drop in pressure. This may be taken care of by providing an air chamber in the upper part of the reservoir 27. The depressions 31 and 32 are, of course, shaped throughout the length of the die halves so that the finished product will have the proper shape, pitch and section. The result is a propeller blade as indicated in Figs. 3, 4 and 5, and which may have the sections indicated as in Figs. 4 to 6 inclusive, the blade being substantially round adjacent that end thereof adapted to be secured to the propeller hub and varying in thickness and in width therefrom to the tip. This provides a propeller blade formed from a single piece of metal of hollow construction whereby maximum strength and minimum lightness is assured, and in which the metal, because of the forging operation, is of maximum strength.

This process of forming the member shown in Fig. 1 into a blade as shown in Fig. 3 may be modified as shown in Figs. 10 to 13 inclusive. In this modification the member is provided with a cap 23 the same as in the previous views, but in this modification, instead of filling the interior of the member with a liquid, I fill it with a mass of quartz fragments, sand, or any other suitable material 38 of like nature which, as a mass, is relatively incompressible, and in cases where the member is formed of a metal requiring heating in forging, of a nature to withstand the forging heats without melting. It may be desirable in some cases, when employing this method, to provide means for the escape of any gases that may become apparent within the member upon heating, and this may be taken care of as illustrated in the drawings by providing a tube such as 35 within the member and secured to and projecting through the cap 23. The tube 35 may be provided with a plurality of relatively small vent openings such as 36 therein and the tube then covered with a protecting screen of fine wire mesh such as 37 to prevent possibility of the particles of material in the member from escaping into the tube. The tube is, of course, vented through the cap 23. The member prepared as in Figs. 10 and 11 is then heated, where necessary in a forging operation to permit proper flow of the metal, and is then placed between a pair of die halves such as 39 and 40 shown in Figs. 12 and 13, the die halves being brought together as illustrated in Fig. 13 to form the finished product, the particles of material within the member 19 in this case being unable to escape from the member, and being substantially incompressible, cause the walls of the member to stretch and flow, inasmuch as the volume within the mem-

ber remains substantially constant. The depressions 41 and 42 in the die members 39 and 40 must, of course, be designed with this in view, as indicated in the figures. Where a considerable flow of the metal with constant thinning of the walls of the member occurs, as in this method of formation, the original walls of the member 19 may of course be formed of the proper thickness to permit such thinning, and yet be of the proper thickness in the completed product.

Formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. The method of forming a propeller blade comprising forging a billet into an elongated integral cup-shaped member tapering in diameter throughout its length, and then deforming said member into a blade of required shape and section of the finished blade.

2. The method of forming a propeller blade comprising forging a billet to produce an integral elongated cup-shaped member of similar cross-sectional contour throughout its length, placing said member between dies having cooperating depressions therein simulating the shape and contour of the desired finished product, and then closing said dies.

3. The method of forming a propeller blade comprising forging a billet to produce an integral elongated cup-shaped member of tapered formation throughout substantially its entire length, placing said member between dies having cooperating depressions therein simulating the shape and contour of the desired finished product, and then closing said dies, while maintaining the interior of said member under pressure.

4. The method of forming a propeller blade comprising forming an integral elongated cup-shaped metallic member, filling the interior thereof with a substantially incompressible material, sealing said interior against the escape of said material, and then forging said member to the desired blade shape without materially altering its longitudinal dimension.

5. The method of forming a propeller blade comprising forming an elongated cup-shaped metallic member, filling the interior of said member with a substantially incompressible material non-fusible at the temperature required for forging the metal from which said member is formed, sealing said member against the escape of said material, and then heating and forging said member to the required blade shape.

6. The method of forming a propeller blade comprising forming an elongated metallic cup-shaped member, and then modifying the shape thereof to that desired for said blade while

maintaining the interior thereof at an approximately constant volume and the length thereof against material change.

7. The method of forming a propeller blade comprising forming an elongated metallic cup-shaped member internally tapered throughout substantially its entire length, heating said member, and then forging it to the desired shape and contour while maintaining the interior volume thereof at an approximately constant value.

8. The method of forming a propeller blade comprising forming an elongated metallic cup-shaped member having walls tapering in thickness throughout substantially its effective length, filling said member with a mass of relatively finely divided incompressible solid material substantially non-fusing at the forging temperature of the metal from which said blade is constructed, closing said member to the escape of said material, and then heating and forging said member to the desired shape and contour while maintaining the length thereof against substantial change.

9. The method of forming a propeller blade comprising forming an elongated metallic cup-shaped member, filling said member with a mass of relatively finely divided incompressible solid material substantially non-fusing at the forging temperature of the metal from which said blade is constructed, closing said member to the escape of said material by means formed to vent the interior of said member to permit the escape of gas therefrom, and then heating and forging said member to the desired shape and contour.

10. The method of forming a propeller blade comprising forging a metal billet into an elongated cup-shaped member, filling the interior of said member with a mass of relatively finely divided solid material substantially non-fusing at the temperature required to forge the metal from which said member is made, closing the interior of said member to the escape of said material by capping the open end thereof with a cap provided with a venting member extending into said mass of material, and then heating and forging said member to the desired shape and contour.

11. The method of forming a propeller blade comprising forming a blank of circular cross section having a closed end and an open end, filling said blank with a relatively incompressible solid material capable of flowing under pressure, closing the open end of said blank against the escape of said material, venting said material to the atmosphere by means of a perforated tube extending into said material and sealed against the escape of said material by a surrounding wire screen, and then deforming said blank to bring it to blade shape.

JOHN SQUIRES.