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F. WEINBERG

1,916,027

METHOD OF MAKING PROPELLERS

Filed Dec. 13, 1929

Fig. 1.

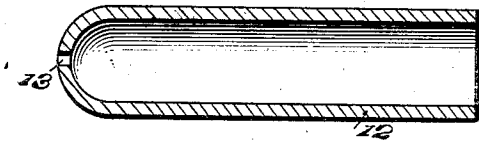


Fig. 2.

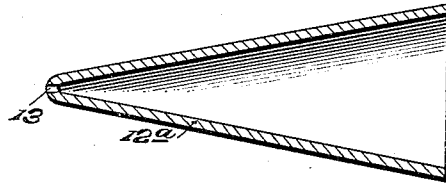


Fig. 3.

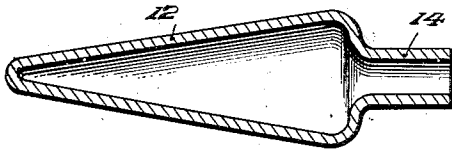


Fig. 5.

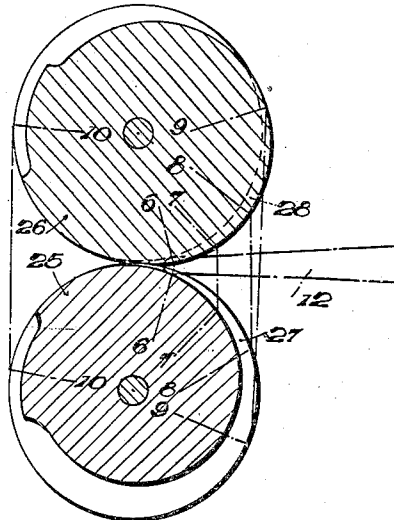


Fig. 6.

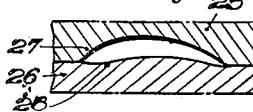


Fig. 7.

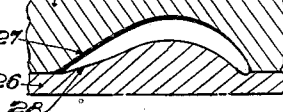


Fig. 8.

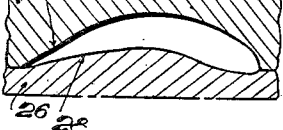


Fig. 9.

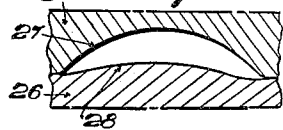


Fig. 4.

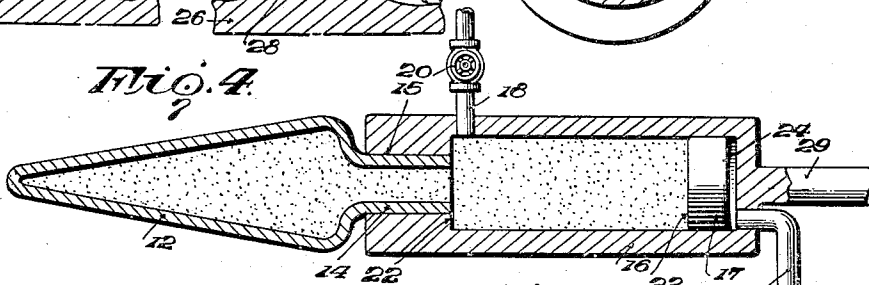


Fig. 11.

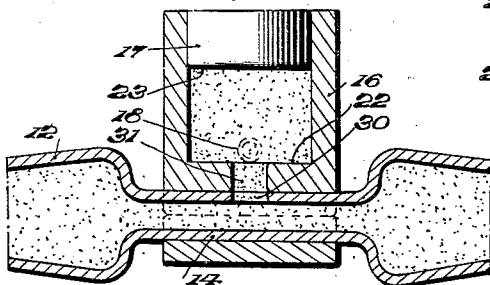
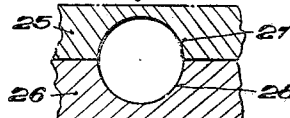


Fig. 10.



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## UNITED STATES PATENT OFFICE

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## METHOD OF MAKING PROPELLERS

Application filed December 13, 1929. Serial No. 413,874.

This invention relates to propellers and more particularly to a method and apparatus for making seamless metal propeller blades.

One of the objects of the present invention is to provide a novel and efficient method of producing a hollow propeller from a seamless metal tube.

Another object is to provide a new and improved method of making hollow seamless metal propellers which is simple, inexpensive, and capable of producing a high grade product.

A further object is to provide a method and apparatus for shaping seamless metal propeller blades by a novel process of rolling, in which the metal is thoroughly protected against buckling, cracking, folding or other distortions.

A still further object is to provide a novel and economical method of manufacturing hollow seamless metal propeller blades, which insures the proper distribution of metal and the required accuracy of shape without impairing the fiber strength of the metal.

Another object is to provide an improved method of making hollow metal propellers from seamless tubing, involving the use of internal pressure and external rolling.

Although certain steps and apparatus used in the method of manufacturing propeller blades in accordance with the present invention, are illustrated diagrammatically in the accompanying drawing, it is to be expressly understood that the drawing is for the purposes of illustration only and is not to be construed as a limitation of the scope of the invention, reference being had for this purpose to the appended claims.

In the drawing:

Figs. 1 and 2 are longitudinal sectional views of two forms of seamless metal tubes which may be used in the present method of making a hollow propeller;

Fig. 3 is a longitudinal sectional view of the metal tube after preliminary shaping;

Fig. 4 is a diagrammatic partial sectional view illustrating apparatus for supplying internal pressure to the tube;

Fig. 5 is a diagrammatic sectional view

showing apparatus for shaping the exterior surface of the tube into that of the finished blade;

Figs. 6 to 10 inclusive represent sections of the rollers of Fig. 5 taken on line 6—6, 7—7, 8—8, 9—9, and 10—10 when the rollers are in such position that these lines are coincident; and

Fig. 11 is a diagrammatic partial sectional view of means for supplying internal pressure when two blades are to be formed from a single tube.

Referring now to the drawing wherein like reference characters indicate like parts throughout the several views, the present method of manufacture of metal propeller blades utilizes a hollow, seamless drawn metal tube 12, as the material from which the blade is made. The tube may be either cylindrical in shape, as shown in Fig. 1, or a tapered tube 12<sup>a</sup> of the type shown in Fig. 2 may be used, but in either case, one end is closed by a rolling or spinning process and the final hole 13 welded up. The tube is next provided, as shown in Fig. 3, with a rounded neck 14 of decreased diameter, which, in the final product, will form the blade root or stem. This neck may be formed by either a rolling or spinning process, or by upsetting.

The tube is then prepared for the blade shaping operation by filling the interior with a fluid substance and subjecting said substance to a high pressure. In the embodiment shown in Fig. 4, the neck 14 of the tube is secured by suitable means (not shown) in an opening 15 at one end of a pressure cylinder 16, having a freely movable piston 17. Cylinder 16 is also provided near opening 15 with an inlet pipe 18 which leads to a reservoir (not shown) containing a substantially non-compressible fluid substance such as a very heavy oil or very fine sand, while at the opposite end of the cylinder is another pipe 19 which leads to a source of high fluid pressure (not shown) such as a compressed air tank, or a water or oil pump. Pipes 18 and 19 are provided with stop valves 20 and 21 respectively.

Having secured neck 14 of the tube in

opening 15 in any suitable manner, valves 20 and 21 being closed, valve 20 is opened and the fluid from the reservoir flows into and fills tube 12 and the space in cylinder 16 between the cylinder wall 22 and face 23 of piston 17. Valve 20 is then closed, and valve 21 opened, admitting the high pressure fluid to chamber 16. This pressure acts upon the face 24 of piston 17 and forces said piston toward tube 12, causing great pressure to be transmitted to the inside of the tube through the medium of the fluid within. Valve 21 remains open.

The next operation is that of shaping the tube to the proper contour of the finished blade, and is accomplished by the use of a novel rolling mechanism. As shown in Fig. 5, two rollers 25 and 26 between which the tube is rolled, are geared together and rotated by any suitable means (not shown). These rollers have positive and negative profile portions 27 and 28 cut in their opposing faces, various sections of which are shown in Figs. 6-10. Tube 12 is then fed between rollers 25 and 26 as by means of a handle 29 formed on cylinder 16, and is compressed to the desired contour of the finished blade in conformity with the profile portions of the rollers, the fluid on the inside acting as a shape retaining medium to prevent collapsing, folding or distortion of the metal. Any fluid displaced from the interior of the tube by the change in shape flows back into cylinder 16 pushing piston 17 backward against the pressure of the air or other medium entering through pipe 19 and valve 21.

As will be apparent to those skilled in the art, the finished blade may be removed from between the rollers either by reversing their direction of rotation, or by separating the rollers by any suitable means.

When using tubes of a metal which may be rolled cold such as aluminum alloys or ordinary steel, heavy oil may be used as the shape retaining medium on the inside of the tube, but when using alloyed steel, the rolling may preferably be done while the metal is hot, in which case fine sand should be substituted for the oil.

It may also be preferable, when certain metals are used, to submit the tube to a preliminary rolling so that the blade will initially assume a shape of less curvature than the finished product. This may be done by increasing the distances between the roller centers, either manually or automatically, or by rolling the tube in a separate set of rollers of different and slightly less profile curvatures in accordance with this general method, before subjecting it to the final rolling process as hereinbefore described.

Should it be desired to form two blades from a single tube, the above method and apparatus may be modified as indicated in Fig. 11 by closing both ends of the tube, providing the rounded neck portion 14 in the middle of the tube with an opening 30, and changing the construction of the opening in the pressure cylinder 16 to one of a T-shape, as shown at 31.

It will be evident from the above description that the present invention provides a simple inexpensive method of producing hollow seamless propeller blades from seamless metal tubing, and utilizes novel apparatus for so doing. The blades are formed by a new method combining the use of internal fluid pressure and external roller pressure with the result that the blade surface is not only accurately shaped but also the metal of the blade is fully protected against folding, buckling or other distortions. The apparatus used in the present invention is also new and is simple in structure and economical in operation and manufacture.

Although certain steps, apparatus and materials used in the method of making metal propeller blades according to the present invention have been illustrated and described in detail, it will be apparent that the invention is capable of embodiment in various forms, many of which will now occur to those skilled in the art, without departing from the spirit of the invention. Reference is therefore to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. The method of forming a propeller blade of aerofoil section from a hollow seamless metal tube comprising tapering said tube from one end to the other, closing the end of said tube of smaller diameter, reducing the diameter of the opposite end of the tube to form a root portion, filling said tube with a fluid under pressure, and rolling the tube in order to shape the tube into the blade desired to be formed.

2. The method of forming a propeller blade of aerofoil section from a hollow seamless metal tube comprising tapering the tube from one end to the other, reducing the diameter of one end of the tube to form a blade root portion, closing the other end of the tube, introducing a substantially non-compressible deformable medium within the tube, subjecting said medium to the pressure of a second medium under pressure, and rolling the tube in order to shape the tube into the blade desired to be formed.

In testimony whereof I have signed this specification.

FRED WEINBERG.