

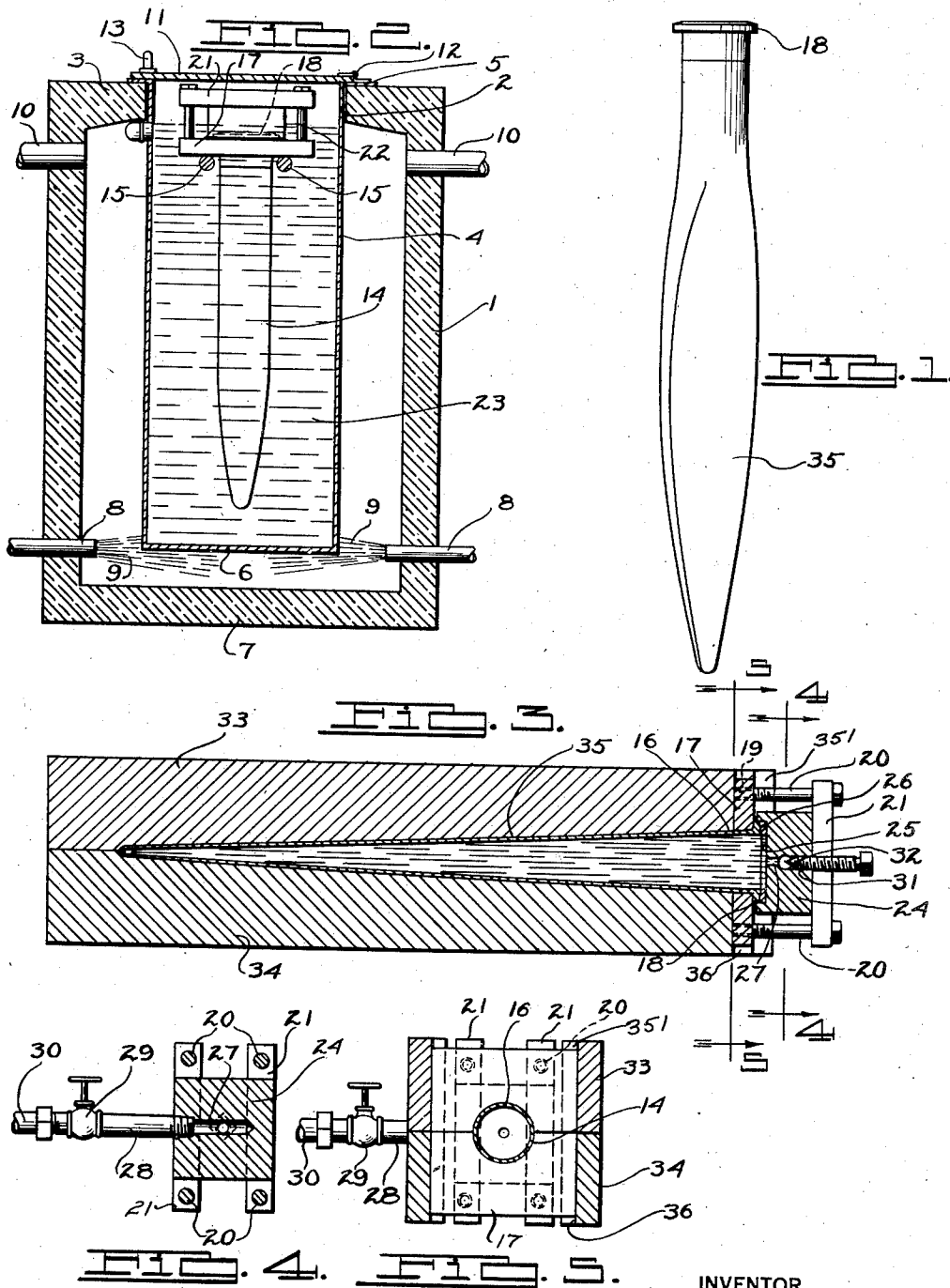
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J. SQUIRES

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METHOD OF MAKING PROPELLER BLADES

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INVENTOR  
John Squires.  
BY  
Harnes, Dickey, Pierce & Harnes  
ATTORNEYS.

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## METHOD OF MAKING PROPELLER BLADES

John Squires, Hagerstown, Md.

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9 Claims. (Cl. 29—156.8)

This invention relates to an improved method for making propeller blades, and particularly to a method for simultaneously heating and filling a tubular propeller blank with an internal supporting medium, and to a method of utilizing such medium as an internal support for the blade blank while it is being pressed to blade shape.

In order to convert a tubular propeller blade blank to blade shape by die forging operations, it is necessary to heat the metal of which the blank is composed to a workable plasticity and to retain the metal in this condition while the blank is internally supported against collapsing and creasing during the compressing operations. When a blank of this kind is initially heated and removed from a furnace, or other suitable heating apparatus, before it is filled with either a liquid or gaseous fluid medium, a substantial temperature drop occurs during the filling period which is generally impossible to offset by raising the initial temperature because of the limits within which the heating operation must be conducted.

The main objects of this invention are to provide a method for simultaneously heating and filling a tubular propeller blade blank with an internal supporting medium: to provide a method of preparing a hollow blank for a compressing operation including introducing a fluid supporting medium having a substantial heat retaining capacity into the blank at the temperature desired for the compressing operation.

Further objects of the invention are to provide an improved method for heating a propeller blade blank in which its entire length and open extremity is immersed in a molten bath of the material that is employed for internally supporting the blank so as to introduce the latter in a heated condition before the blank is removed to a cooling atmosphere and before it is positioned between forming dies; to provide a method for internally supporting the blank by a substantially non-compressible medium in which variations in the capacities of the blank and ultimate blade respectively, are compensated for by permitting a controlled escapement of the medium from the blank during the die forming operation; and to provide a method of this character which can be satisfactorily conducted on a production basis at a low cost and without extremely expensive equipment.

An illustrative embodiment of the invention is shown in the accompanying drawing, in which:

Fig. 1 is a perspective view of a completed

propeller blade of the type formed by my improved method.

Fig. 2 is a transverse vertical section of improved heating apparatus for conditioning a tubular propeller blade blank to receive a die forging operation, showing an elevation, means for supporting the blank while it is in the heating apparatus and for retaining a closure on the open end thereof.

Fig. 3 is a central vertical section of a pair of dies illustrating the manner in which a tubular propeller blade blank is compressed to blade shape while under internal pressure and showing detachable apparatus for forming a controllable outlet for an internal supporting medium at the open end of the blank.

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3.

Fig. 5 is a transverse section taken on the line 5—5 of Fig. 3.

In forming propeller blades in accordance with my improved method, a tubular blank which has been accurately formed so as to present sufficient and properly distributed metal to permit of its compression to a predetermined blade shape, is heated by immersion in a bath composed of a composition which has a fusion temperature that is substantially lower than the temperature desired in the compressing operation. The blank is preferably filled with the molten composition through its substantially unrestricted open end while it is immersed in the bath. Then the open end of the blank is closed by a member which has a controllable outlet and the blank is transferred to the die forming apparatus where it is positioned for receiving the compressing operation.

Prior to compression between the forming dies, the controllable outlet is opened so as to permit a restricted flow of the molten composition from the interior of the blank as its capacity is reduced by the deformation to which it is subjected, the displaced molten composition being returned through a conduit to a suitable reservoir.

The heating apparatus and end closure for the tube, shown in the drawing, illustrate one example of means, with the aid of which my improved method may be successfully conducted. In the form shown, the heating unit includes a thick walled housing 1, preferably formed of refractory material, having an opening 2 in its upper wall 3 through which a tank 4 is suspended. The tank 4 has a marginal flange 5 seated upon the upper wall 3 for supporting the tank and retaining its lower extremity 6 in spaced relation to

the bottom of the housing 1. Heat is supplied to or generated in the interior of the housing 1 in any suitable manner. In the illustration shown, burners 8 are provided in the housing for directing flames 9 upon the bottom portion of the tank 4 and the side walls of the housing have outlets 10 through which the products of combustion are discharged. A closure 11 is hinged at 12 on the marginal flange 5 of the upper end of the tank and is provided with a handle 13 by which it may be conveniently opened and closed.

The housing 1 and tank 4 may be as long as desired so as to accommodate a predetermined number of propeller blade blanks 14. Mounted in the tank 4 are longitudinally extending parallel bars 15 which form a rack for supporting the blanks. In practice each blank 14 is inserted through an aperture 16 in a plate 17 including separable sections and held against downward displacement from the plate by the flange 18 which extends radially from the open extremity of the blank. The blanks are located between the bars 15 and the plates thereof are seated upon the bars in the manner shown in Fig. 2. Threaded in aperture 19 in the respectively opposite corner portions of each plate 17 are adjustable bolts 20 on which are shiftably mounted clamping members or plates 21. The sections of the plate 17 are held together by the bolts 20 and plates 21 which are held against displacement from the supporting plate 17 by the heads of the bolts 20 and while the blade is being heated, the clamping member 21 is held in spaced relation to the open end of the blank 14 by removable blocks 22.

The tank 4 is filled with a fusible composition 23 such as a salt like sodium chloride or any suitable salt having a proper fusion temperature. The fusible composition is maintained in a substantially fluid condition by the heat which is supplied by the burners 8 and its level is maintained above the elevation of the open extremity of the blank so as to permit the molten composition to flow freely thereinto and fill the blank to its capacity while the latter is being heated.

After the metal of the blank has been brought to the fusion temperature of the contents of the tank, the door 11 is opened and a closure 24 in the form of a pre-heated block of metal is inserted between the flanged extremity of the blank 14 and the clamping plate 21. The closure 24 has a recess 25 for receiving the flange 18 of the blank and the recess is provided with a compressible gasket 26, preferably comprising a copper asbestos material, which forms a seal between the open end of the blank 14 and the closure 24 when the bolts 20 are tightened while the closure is in place.

Formed in the interior of the block shaped closure 24 is an L-shaped passage 27 which communicates at one end with the recess 25 and with the interior of the blank. The other end of the passage is located at one side edge of the closure and it communicates with a nipple 28 having a valve 29 which is connected by a conduit 30 to a reservoir or receiver; not shown. Threaded in an aperture 31 in the block shaped closure 24 which communicates with the passage 27 is a variable valve 32 that extends between the clamping plates 21. This valve is adapted to close the branch of the passage 27 that communicates with the interior of the blank so as to prevent the molten composition from escaping while the blank is being transferred from the heating apparatus to the dies 33 and 34 between

which it is converted to the propeller blade 35.

As the blank 14 is placed between the dies the respectively opposite edge portions of the plate 17 are received in grooves 351 and 36 in the die parts 33 and 34, respectively, which properly locate the blank longitudinally with respect to the die recesses.

During the compressing operation the valve 32 is set in a partially opened position so as to permit the molten composition to flow from the interior of the blank at a predetermined rate in order to allow displacement of the composition as the capacity of the blank is reduced during deformation thereof. By predetermining the rate of flow of the molten composition from the blank with relation to the rate at which the die parts 33 and 34 are moved together, a desired internal pressure is created within the blank which internally supports the same collapsing, and prevents crimping or creasing of the walls of the blank during compression thereof to blade shape. Pre-heating of the closure prevents solidifying of the composition as it flows through the passage in the block and avoids clogging thereof.

The molten salt bath has a substantial heat retaining capacity and it therefore prevents rapid cooling of the blank while it is being removed from the heating apparatus and positioned between the die parts. If desired, the interior of the blank may be filled with a molten or highly heated composition of one kind while the blank is submerged substantially to its open end in a molten or highly heated composition of another kind or while the blank is being heated in any suitable manner.

Although but one specific means for carrying out this invention has been herein shown and described, it will be understood that numerous details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

#### I claim:

1. The method of forming a propeller blade from a tubular blank having an open end which consists in submerging the blank in a bath composed of a molten composition having a predetermined fusion temperature with the open end of the blank uncovered so as to fill the same with the molten composition, capping the open end of the blank, while the interior of the latter is filled with said molten composition and compressing the capped blank to blade shape between forming dies while permitting controlled escapement of the composition from the interior of the blank.

2. In forming a propeller blade from a tubular blank having an opening, the method of conditioning the blade for receiving a deforming operation which consists in heating said blank externally by submerging it in a molten composition, filling the interior of said tubular blank while the latter is submerged with a heated, non-compressible fluid medium, and closing said opening while said blank is filled with said molten composition.

3. In forming a propeller blade from a tubular blank having an opening, the method of conditioning the blade for receiving a deforming operation which consists in heating said blank externally by submerging it in a molten composition, filling the interior of said tubular blank while the latter is submerged with a heated, non-compressible fluid medium, and fixing a closure having a controllable outlet over said opening while said blank is filled with said medium.

4. In forming a propeller blade from a tubu-

lar blank having an externally flanged open extremity, the method of conditioning the blank for compression to blade shape between forming dies which consists in inserting said blade axially through a recess in a support, securing clamping apparatus to said support, suspending the entire length of said blank from its flanged end in a bath of molten salt so as to simultaneously heat and fill the blank, and clamping a pre-heated closure having a controllable outlet upon the open end of said blank by said clamping members.

5. In manufacturing a propeller blade from a tubular metal blank having an open extremity and an opposite closed extremity, the method of forming said blank to blade shape which consists in heating said blank by submerging it directly in a bath composed of a molten composition, filling said blank while submerged with said molten composition, detachably securing a closure having an outlet on the open end of said blank when the latter is filled and heated to the fusion temperature of said bath, and pressing said blank externally to blade shape between solid dies and against the yielding internal pressure provided by the escapement of molten composition through said outlet.

6. In manufacturing a propeller blade from a tubular metal blank having a closed extremity and an opposite open extremity surrounded by a radial flange, the method of forming said blank to blade shape which consists in providing a collar around the open end of said blank adjacent the inner side of said flange, supporting said blank by said collar in submerged relation in a bath comprising a molten composition and in direct contact with said composition so as to simultaneously heat said blank to the fusion temperature of said composition and fill the interior thereof with said composition, detachably fixing a closure having a metered outlet opening to said collar and over the open end of said blank when the latter is filled and heated, and pressing said blank externally to blade shape between solid dies and against the yielding internal pressure provided by the escapement of molten composition through said outlet.

7. In manufacturing a propeller blade from a tubular metal blank having a closed end and an opposite open extremity, the method of forming said blank to blade shape which consists in heating said blank externally to a desired temperature,

filling said blank while the latter is heated with a molten composition having a fusion temperature substantially the same as said desired temperature by submerging said blank in said molten composition, detachably fixing a closure having a metered outlet on the open end of said blank, and pressing said blank externally between solid dies against the yielding internal supporting pressure provided by escapement of said molten composition through said outlet and while said blank is maintained substantially at said desired temperature by said composition.

8. In manufacturing a propeller blade from a tubular metal blank having an open end and an opposite closed extremity, the method of forming said blank to blade shape which consists in heating said blank to a desired temperature by completely submerging it in a bath composed of a molten composition having a fusion temperature substantially the same as said desired temperature and simultaneously filling the interior of said blank with said molten composition, detachably fixing a closure having a metered outlet on the open end of said blank, and pressing said blank externally between solid dies against the yielding internal supporting pressure provided by escapement of said molten composition through said outlet and while said blank is maintained substantially at said desired temperature by said composition.

9. In manufacturing a propeller blade from a tubular metal blank having an open end and an opposite closed extremity, the method of forming said blank to blade shape which consists in heating said blank to a desired temperature by completely submerging it in a bath composed of a molten composition having a fusion temperature substantially the same as said desired temperature and simultaneously filling the interior of said blank with said molten composition, detachably fixing a preheated closure having a metered outlet on said open end of said blank before the latter is removed from said bath, and pressing said blank externally between solid dies against the yielding internal supporting pressure provided by escapement of said molten composition through said outlet and while said blank is maintained substantially at said desired temperature by said composition.

JOHN SQUIRES.

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