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METHOD OF MAKING TUBULAR TURBINE BLADES

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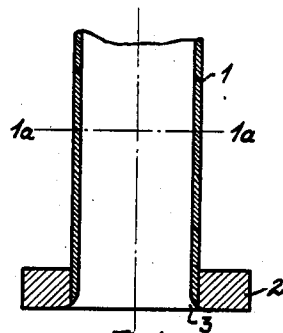


Fig. 1

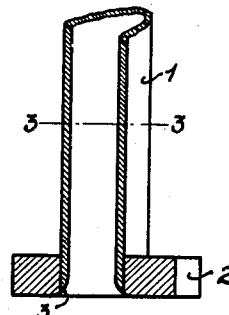


Fig. 2

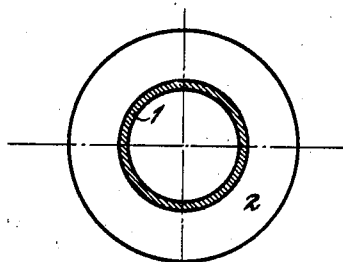


Fig. 1a

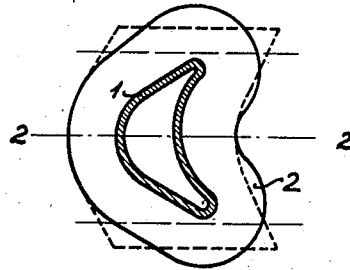


Fig. 3

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METHOD OF MAKING TUBULAR TURBINE
BLADES

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In certain types of gas turbines, the blades are hollow and a cooling medium is caused to flow through them lengthwise, while the hot driving medium (generally hot gases or steam) comes in contact with the outer surfaces of the blades. In the practice prevailing hitherto, a hollow blade of this character was made from a tubular blank of thin metal, one end of which was pressed to form a head, and the other fashioned to a foot form, while the intermediate or working portion of the blade was given a crescent shape. The foot and the blade was provided with an attachment or fastening ring extending, in some cases, all around the end of the tubular blade, and such ring was either made integral with the blade body, as by upsetting and thereby widening and thickening the end of the blade body, or the foot ring was made from separate material connected with the blade body by welding, soldering, or equivalent operations. As a rule, such foot was of rectangular outline or cross section. This customary procedure has the disadvantage of subjecting the material to crushing strains at the junction of the crescent-shaped blade portion with the foot portion, and the resulting deformation was detrimental to the strength of the material and also to an easy flow or guidance of the current of cooling medium passing lengthwise through the blade.

The object of my present invention is to avoid the drawbacks mentioned above. For this purpose, I proceed, according to the preferred embodiment of my invention, by forming upon, or applying to, one end of the tubular blank, of circular cross section, a foot ring likewise of circular cross section, constituting virtually a flange at such end of the tube. This tubular flanged blank is then fashioned by pressure or in any other suitable manner, to give the proper operative shape (crescent-shape) to the body of the blade and to give the foot ring an outline which conforms more or less to such shape of the working portion of the blade. By this procedure, I avoid the detrimental effects which would result from an abrupt transition in the cross sectional shape of the blade body. This is of especial importance when the interior of the blade is employed, as mentioned above, for the passage of a longitudinally flowing cooling medium.

Without desiring to restrict myself to the specific features illustrated, I will now proceed to describe a satisfactory and typical example of my invention with reference to the accompany-

ing drawing, in which Fig. 1 is a longitudinal axial section of a portion of a tubular blank having a foot ring in accordance with my invention; Fig. 1^a is a section on the line 1^a—1^a of Fig. 1; Fig. 2 is a partial longitudinal section, taken on the line 2—2 of Fig. 3 and showing the blade body and the foot ring in their final or completed form; and Fig. 3 is a cross section on the line 3—3 of Fig. 2.

In Figs. 1 and 1^a, the tubular blank 1 is of circular cross section and is shown as of uniform thickness from end to end, but it will be understood that such uniform thickness is not an essential feature. The foot ring 2 is of circular outline or cross section, and fits around one end of the tubular blank or body 1. In the particular embodiment illustrated, such foot ring is a separate element connected with the body 1 by soldering, welding, or like operations; however, as stated above, the foot ring might be formed integral with the tubular body 1, by operations such as drawing, turning, boring, or the like. In either event, the foot ring will form at one end of the tubular body 1, an external flange of circular outline or cross section.

Having thus produced a tubular blank of circular cross section which has an external flange of circular outline, I subject this article to pressure in a mold or die, or treat it in any other suitable manner to give the body of the tubular blank the proper crescent shape for efficient operation (Figs. 2 and 3), and to give the foot ring 2 an outline parallel or conforming more or less to the said crescent form of the working portion of the blade. Preferably, the shape given to the outline of the ring 2 by pressure or otherwise at this time is the approximate heart-shape indicated by full lines in Fig. 3. After the blade and its foot ring have been fashioned by pressure or otherwise as just described, the outline of such foot ring may be modified to facilitate the firm mounting of the blade on the body or carrier of the turbine rotor. Thus, Fig. 3 indicates by dotted lines a modified outline embodying a concave arc, a convex arc of similar curvature, and two straight parallel sides connecting said arcs. The change from the heart-shaped outline to the one having these straight sides may be effected by operations such as planing, milling, turning etc.

In cases where a cooling medium is caused to flow lengthwise through the tubular blade, it may be desirable to round off the inlet end of the blank (at the foot) as indicated at 3 in Figs. 1 and 2, to promote with greater certainty

an even flow of such medium; this rounding off is made before the flanged tubular blank is transformed from the shape shown in Fig. 1 to that shown in Fig. 2.

- 5 Various modifications may be made without departing from the nature of my invention as set forth in the appended claims.

I claim:

1. The method of making tubular turbine
10 blades, which consist in producing, at one end of a blank of circular cross section which is tubular from end to end, an external annular flange of circular outline surrounding such
15 the body of said blank and said flange into non-circular forms of similar outline or cross section.

2. The method of making tubular turbine
20 blades, which consists in producing, at one end of a blank of circular cross section which is tubular from end to end, an external annular flange of circular outline surrounding such
25 the body of said blank into a shape of crescent cross section, and said flange into a shape conforming to that of such crescent-shaped cross section.

3. The method of making tubular turbine
30 blades, which consists in producing, at one end of a tubular blank of circular cross section, an external annular flange of circular outline, enlarging the entrance end of the passage surrounded by said annular flange, and then transforming said flange and the body of said blank
35 into non-circular forms of similar outline or cross section.

4. The method of making tubular turbine
40 blades, which consists in producing, at one end of a blank of circular cross section which is tubular from end to end, an external annular flange of circular outline surrounding such tubular end of the blank, pressing the body of said blank into a shape of crescent cross section, and simultaneously pressing the said flange
45 into a shape conforming to that of such crescent-shaped cross section.

5. The method of making tubular turbine blades, which consists in producing, at one end of a blank of circular cross section which is tubular from end to end, an external annular flange of circular outline surrounding such tubular end of the blank, and then transforming the body of said blank into a shape of crescent cross section, and said flange into a shape conforming to that of such crescent-shaped cross section, and thereupon modifying the outline of said flange to give such outline two parallel sides connected by a concave arc and a convex arc.

6. The method of making tubular turbine blades, which consists in producing, at one end of a blank of circular cross section which is tubular from end to end, an external annular flange of circular outline surrounding such tubular end of the blank, and then transforming the body of said blank into a shape of crescent cross section, and said flange into a shape conforming to that of such crescent-shaped cross section, and thereupon modifying the outline of said flange to facilitate the mounting of the blade in a turbine rotor.

7. The method of making turbine blades, which consists in producing, at one end of a blank of predetermined initial cross section which is hollow from end to end, an external flange of predetermined initial outline surrounding such hollow end of the blank, and then transforming said blank and said flange into predetermined subsequent noncircular forms.

8. The method of making turbine blades, which consists in producing, at one end of a blank of predetermined initial cross section which is provided with an interior bore extending from end to end of said blank, an external flange of predetermined initial outline surrounding said end in flush relation with the one end of said bore, and then transforming the body of said blank and said flange into predetermined subsequent noncircular forms of similar outline or cross section.

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