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BLADED ROTORS FOR AXIAL FLOW TURBINES AND SIMILARLY BLADED FLUID FLOW MACHINES

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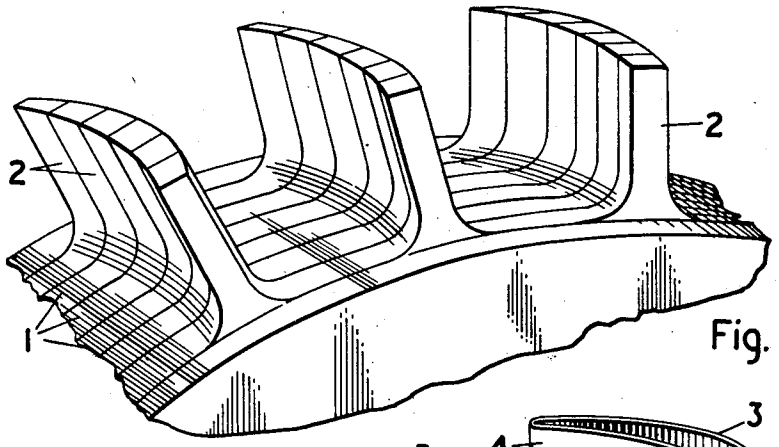

Fig. 1.

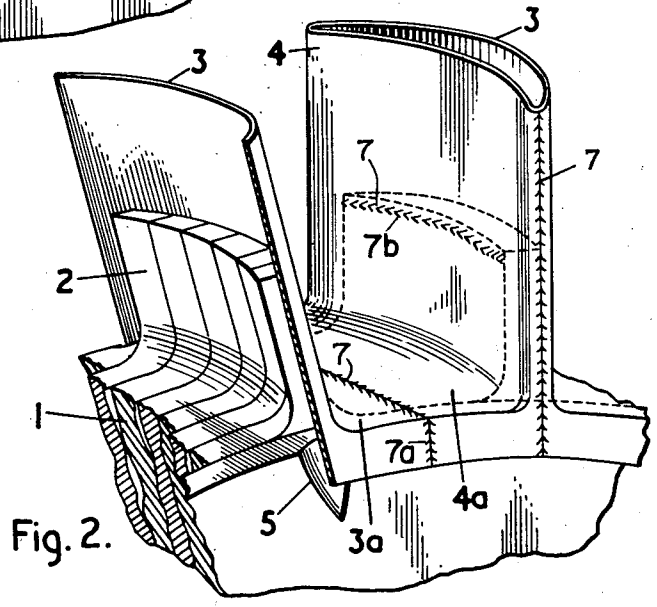

Fig. 2.

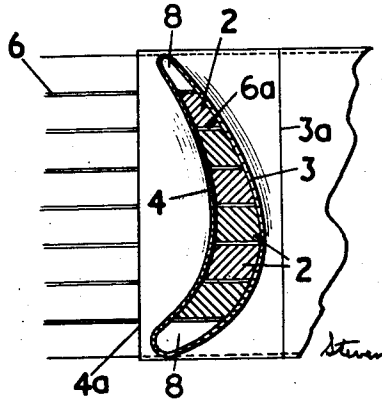

Fig. 3.

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BLADED ROTORS FOR AXIAL FLOW TURBINES AND SIMILARLY BLADED FLUID FLOW MACHINES

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3 Claims. (Cl. 253—39.15)

This invention relates to bladed rotors for axial flow turbines and similarly bladed fluid flow machines, to certain features of the blades and rotors themselves, and to a method of manufacturing and assembling these elements.

In general, the invention has for its object to provide a method of manufacture and form of construction of such a rotor and its component parts which will lend itself to mass production methods of manufacture. In order to achieve this general object the invention seeks to take into account two main factors; firstly the importance of eliminating as far as possible meticulous machining operations; secondly, the advantages that would accrue if the blades could be fabricated from flat metal sheet or strip stock.

According to the invention a bladed rotor for an axial flow turbine or similarly bladed fluid flow machine comprises a rotor body and, disposed peripherally round said body, a plurality of hollow metal blades each fabricated from uniformly thick sheet material, each blade having a profiled working portion and, at the radially inner end of said working portion, a lateral skirt which extends over the peripheral surface of the rotor body and is secured to the corresponding skirt of an adjacent blade.

According further to the invention the rotor body is provided with a plurality of evenly spaced radially upstanding peripheral projections each of which is at least partly enclosed by one of the blades, and means may be provided for attaching each of the blades to the projection enclosed thereby.

The blades for a bladed rotor in accordance with the invention are preferably made in two complementary parts from flat strip or sheet material, each part being cut and pressed to provide the shell for one face of the blade profile and the two parts being joined (usually after assembly) along the leading and trailing edges of the blade as by welding.

By means of the invention in its broadest aspect each sheet metal blade may be provided with a skirt portion at its radially inner end shaped to conform to the surface of the rotor body, which skirt portion may meet edge to edge the skirt of the next adjacent blade and be secured thereto by, for instance, welding. In this way the entire periphery of the rotor will be sheathed in a skin of sheet metal which may be arranged without difficulty, to extend radially inwardly over either or both the end faces of the rotor. If desired it may also be arranged that this skin at least in some regions shall be spaced from the surface of the rotor body to provide a cooling air film between the two parts, although in some cases it may be found preferable to provide good thermal contact between the skin and the body over the maximum possible area. In this way also the blades are integrated (independently of any further provision for their individual attachment to the rotor) to form a continuous ring which is capable of resisting centrifugal loads on each constituent blade and so is effective in contributing to the support of the blades.

In the practical execution of the invention it is proposed that the rotor should be provided with radially upstanding tooth-like projections which are made to conform at least partly to the internal shape of the blades, the latter being mounted so that each encloses a projection and being secured thereto, as for example by welding or brazing at a region radially outward of the inner end of the blade. It will be apparent that by suitable choice of the radial height of the projections the radial location of the region of attachment of a blade with respect to its radial height may be made to conform to any desired relation between wall thickness and blade stress.

As a further feature, the invention contemplates that the projections on which the blades are mounted may be formed to provide air passages for the flow of cooling air through the blades.

This might be achieved by grooving the external surface of the projections or by providing suitable internal passages therein or by arranging that a free space will be left within the blade at certain regions such as the leading and trailing edges; or, again, each projection may be subdivided transversely to the direction of working fluid flow past the blade by passages extending across the whole cross-sectional thickness of the projection. In any of these cases the blade may be attached to the projection, as by welding or brazing over an extended area to provide a good thermal connection. It will be noted in this respect that the invention offers the possibility of a particularly good heat path from the blade to the main rotor body.

According to a further important feature of the invention the rotor and its projections are built up from a series of laminae. The use of a rotor of this type (which is not new per se) has the advantage that the formation of suitably shaped projections to receive the blades is greatly facilitated, since successive laminae may be provided with projections each of which is required to occupy only a small part of the internal cross section of a blade. The projections on successive laminae may therefore be differently dimensioned initially, having in mind the dimension of the blade cross-section at the region to be occupied, and the individual projections can readily be made to conform with sufficient accuracy to the internal profile of a blade partly by being pressed or otherwise worked to shape and partly by effecting appropriate relative angular displacement of successive laminae so that successive projections are in appropriately staggered relationship. If, as is preferred, the laminae are of sheet metal, manufacture is even further simplified since the projections may be produced by such operations as stamping and pressing. The use of a laminated construction also lends itself well to the provision of cooling passages between or around the individual projection associated with any one blade, more particularly in permitting a series of transverse passages to be provided across the entire internal cross-section of the blade profile, and in allowing certain parts of the internal cross-section of the blade to be left vacant, which may be done by the simple expedient of omitting the projections from any desired laminae.

An example of construction of a rotor in accordance with the invention is illustrated in the accompanying drawings as applied to a laminated rotor body.

In the drawings Figure 1 is a partial perspective view of a laminated rotor assembled ready for the mounting of blades thereon; Figure 2 is a similar view in which the blades are shown partially assembled; and Figure 3 is a view section illustrating a modified type of laminated blade construction in accordance with the principles of the present invention.

As can be seen from the drawings, the rotor body is built up from a series of laminae 1 (preferably of sheet

metal) certain of which are provided with radially upstanding projections 2, these projections having been initially dimensioned to suit the width of the part of the blade profile to which they are to correspond, and having been then pressed so that their lateral faces conform to the internal shape of the blade profile at that part, the laminae composing the rotor body having been appropriately relatively displaced so that the projection formed by the aggregation of the individual projections 2 corresponds closely with a portion of the internal shape of the blade profile.

Each blade is made in two parts 3, 4 by pressing suitably dimensioned flat sheets to an appropriate curvature and to provide skirt portions 3*a*, 4*a*, the parts 3, 4 being the respective faces of the finished blade and being formed so that their longitudinal edges abut to form the leading and trailing edges of the blade. As seen in Figure 2, these blade parts are now assembled, one on either side of each projection on the rotor body, and welded together down their leading and trailing edges as shown at 7. Alternatively the two parts of a blade may be welded together before being assembled on the rotor body, using a jig or former. The latter method may aid the attainment of accuracy of the blade form. It will be noted that the skirt portions 3*a*, 4*a* of successive blades are also arranged to abut and these are seam welded together at 7*a*, whilst the parts 3 and 4 of the blade are secured, also by welding at 7*b*, to the rotor projections.

As will be clearly seen from the drawings the two axially outermost laminae may be devoid of projections so that a space 8 is formed in the leading and trailing edges of the blade for the passage of cooling air, entry of which may be provided for by a recess 5 in the rotor. As is best seen in Figure 3, it is arranged that there are gaps at 6 between successive laminae and corresponding gaps 6*a* between successive sections of the blade carrying projections, through which gaps 6, 6*a* cooling air may be supplied from a radially inner region of the rotor.

What I claim is:

1. A bladed rotor for an axial flow turbine or similarly bladed fluid flow machine comprising a plurality of discs with integrally formed radially extending projections spaced around their peripheries, the discs being concentrically integrated to form a rotor body having the projections on successive discs arranged to form groups spaced evenly around the periphery of said rotor body, a disc free of projections on each face of the integrated rotor body and an open ended hollow blade extending over each group of projections and overlying a portion of the periphery of the projection-free discs, each hollow blade and at least one of said projection-free discs being so spaced as to define therebetween a gas flow passageway leading to the hollow interior of said blade, each blade having a working portion and being positively attached to the rotor body solely by attachment to at least some of the projections of the group over which it extends only at a point spaced outwardly from the inner end of said working portion, and a skirt portion extending from the inner end of said working portion peripherally of the rotor body to meet the corresponding skirt of an adjacent blade.

2. A bladed rotor for an axial flow turbine or similarly bladed fluid flow machine comprising a plurality of discs with integrally formed radially extending projections spaced around their peripheries, the discs being concentrically integrated to form a rotor body having the projections on successive discs arranged to form groups spaced evenly around the periphery of said rotor body, a disc free of projections on each face of the integrated rotor body and a hollow blade extending over each group of projections and overlying a portion of the periphery of the projection-free discs, each hollow blade and said projection-free discs being so spaced as to define therebetween gas flow passageways leading to the hollow interior of said blade at each end of the rotor, each blade having a working portion and being positively attached to the rotor body solely by attachment to at least some of the projections of the group over which it extends only at a point spaced outwardly from the inner end of said working portion, and a skirt portion extending from the inner end of said working portion peripherally of the rotor body to meet the corresponding skirt of an adjacent blade.

3. A bladed rotor for an axial flow turbine or similarly bladed fluid flow machine comprising a generally cylindrical rotor body having radial projections spaced evenly around its periphery, the rotor body extending axially beyond the projections at each of its ends to provide a portion having a projection-free periphery at each end of the rotor body, an open ended hollow blade extending over each projection and overlying the adjacent area of the projection-free periphery at each end of said body, each hollow blade and at least one of said portions having a projection free periphery being so spaced as to define therebetween a gas flow passageway leading to the hollow interior of said blade, each blade having a working portion and being positively attached to the rotor body solely by attachment to the projection over which it extends only at a point spaced outwardly from the inner end of said working portion, and a skirt portion extending from the inner end of said working portion peripherally of the rotor body to meet the corresponding skirt of an adjacent blade.

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