United States Patent Office

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AXIAL FLOW COMPRESSORS
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2 Claims. (Cl. 250—134)

This invention relates to axial flow compressor blading particularly, but not exclusively, for compressors of gas turbine jet reaction engines.
While the invention may be applied either to stator or rotor blading, more important applications may be to rotor blading.
According to one aspect of the present invention there is provided an axial flow compressor blade having a working portion of aerofoil cross-section, a root portion at one end of said working portion, and a strengthening insert incorporated in said root portion said strengthening insert lying in a spanwise sense and being curved so that it lies substantially parallel to the mean profile camber radius of the working portion.
The strengthening insert may be formed from a metal or a thermosetting resin material and the remaining portions of the blade may be formed from reinforced thermosetting resin material. Thus the strengthening insert may be formed from magnesium or aluminium.
In a preferred arrangement the reinforced thermosetting resinous material comprises fibres of glass or asbestos impregnated with a phenolic or an epoxy resin. Preferably the reinforced thermo-setting resinous material extends the full length of the blade from the tip of the blade to the root portion and encloses the strengthening insert.
The strengthening insert is preferably substantially triangular in cross-section, the lower wall of the triangle being contained in the plane of the lower wall of the root portion.
The root portion of the blade is preferably dovetail shape in cross-section.
According to the present invention in another aspect an axial flow compressor rotor is provided with compressor blades formed from reinforced thermosetting resinous material, each blade incorporating in its root portion a metal strengthening insert, the strengthening inserts of some of the compressor blades being formed from a heavier material than the inserts of the remaining compressor blades so that, by suitably disposing the blades with heavier strengthening inserts around the periphery of the rotor, the assembly of rotor and compressor blades can be dynamically balanced.
Blades according to the present invention may form part of an axial-flow compressor of a gas turbine engine adapted to be mounted with its longitudinal axis vertical so as to produce an upward component of thrust on the aircraft in which it is mounted.
Experience in reinforced synthetic resin rotor blades has shown that such blades are susceptible to failure should the reinforcing fibres have to be severely bent during moulding to achieve any given shape, particularly at the intersection of a cambered blade profile with its platform or root.
By curving the strengthening insert in the manner set forth above, the bending or “kinking” is minimised, while the angle through which radial fibres must be bent to fit over the strengthening insert is kept to a minimum.
One embodiment of the present invention will now be described by way of example, with reference to the accompanying drawings in which—
FIGURE 1 is a side elevation of a gas turbine engine with parts broken away to show the compressor rotor thereof.
FIGURE 2 is an axial-section through part of the said compressor rotor, the said compressor rotor including rotor blades incorporating the present invention.
FIGURE 3 is a view in the direction of arrow 3 indicated on FIGURE 2.
FIGURE 4 is a section through the rotor blade taken on the line 4—4 indicated in FIGURE 2.
FIGURE 5 is a section taken on the line 5—5 indicated on FIGURE 4.
FIGURE 6 is a section taken on the line 6—6 indicated on FIGURE 4.
FIGURE 7 is a section taken on the line 7—7 indicated on FIGURE 4, and
FIGURE 8 is a section taken on the line 8—8 indicated on FIGURE 2.
The gas turbine engine shown in FIGURE 1 comprises an axial flow compressor 10 which receives air from an air-intake 11 and delivers compressed air to combustion equipment 12 where fuel is burned in the air, the products of combustion passing through a turbine section 14 before passing into a jet-pipe 14 and being exhausted to atmosphere through a propelling nozzle 15.
The turbine section 13 is arranged to drive a compressor rotor 16 forming part of the compressor 10 through shafting (not shown). The compressor rotor 16 includes axially-spaced rows of compressor rotor blades 17 which alternate with axially-spaced rows of stator blades 18 secured to the casing of the compressor 10.
Each compressor rotor blade 17 is formed from reinforced thermo-setting resinous material such as glass or asbestos fibres impregnated with a phenolic or an epoxy resin and comprises a working portion 17a of aerofoil cross-section and a root portion 17b by which the blade is secured to the compressor rotor disc 16.
The root portion 17b is of dovetail shape in cross-section and is received in a correspondingly shaped slot 19 formed in the periphery of the rotor disc 16. Each rotor blade 17 is retained axially in position on the rotor disc 16 by means of synthetic resin lug 20 and a metal tab 21. The lug 20, which is provided at one end of the root portion 17b, contacts the upstream face of the rotor disc 16. The metal tab 21 lies between the lower end of the root portion 17b and the lower wall of the slot 19, one end of the tab 21 having an outwardly directed flange 21a which engages the lug 20, and the other end of the tab 21 having a radially-inwardly directed flange 21b which contacts the face of the rotor disc 16.
Each root portion 17b is strengthened by means of a strengthening insert 22 which is disposed within the root portion 17b in a spanwise sense and which is curved in a plane transverse to the radial plane of the working portion 17a. The radius of curvature of each strengthening insert 22 is the same as the mean profile camber radius of the working portion 17a. The mean profile camber radius is shown by the chain dotted line 23 indicated on FIGURE 4.
The strengthening inserts 22 are substantially triangular in cross-section, the lower wall of the triangle being contained in the plane of the lower wall of the respective root portion 17b.
As will be seen more clearly in FIGURES 5 to 7 the glass fibres 24 of the blade material extend the full length of the blade 17 from the tip thereof to the root portion and enclose the strengthening insert 22. The remainder of each root portion 17b is built up with pads 25 of synthetic resin material to give the straight dovetail shape.
By curving the strengthening insert 22, the angle through which the radial glass fibres 24 are bent to fit over the strengthening insert 22 is kept to a minimum. The strengthening inserts 22 are preferably formed from magnesium or aluminium, although they may be formed from any other metal or from a thermo-setting resinous material.

In order to balance the compressor rotor disc 16 dynamically, some of the rotor blades 17 of a blade row may be provided with magnesium inserts 22 and the remaining rotor blades of the blade row may be provided with aluminium inserts 22 which are suitably disposed around the periphery of the rotor disc 16.

We claim:

1. In an axial flow compressor rotor having a plurality of radially outwardly extending blades, said blades having working portions of aerofoil cross-section, and having root portions at one end of said working portions, said working portions having curved mean profile camber radii and being formed from reinforced thermo-setting resinous material, each of said blades having a metallic strengthening insert imbedded within and secured to the root portion of said blade, said metallic strengthening insert lying in a chordwise sense and being curved so that it lies parallel to the mean profile camber radius of the working portion, said metallic strengthening inserts of the plurality of blades being formed from varying density metals with the inserts of some of the blades being of heavier metal than the inserts of the remaining blades, whereby the assembly of rotor and compressor blades can be dynamically balanced by suitably disposing the blades with the heavier strengthening inserts around the periphery of the rotor.

2. In an axial flow compressor rotor as claimed in claim 1, said heavier metal inserts comprising aluminium and the remaining metal inserts comprising magnesium.

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KARL J. ALBRECHT, Primary Examiner.

JOSEPH H. BRANSON, Jr., Examiner.