BLADED ROTORS FOR USE IN GAS TURBINE ENGINES

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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ABSTRACT OF THE DISCLOSURE

A clapper for a rotor blade of a gas turbine engine is made up of bundles of fibres extending lengthwise of the clapper, the ends of the fibres being turned alternately up and down in order to fit into slots in the flank of the blade. The turned up ends of one clapper being bonded to the turned up ends of a clapper on the other side of the blade helps to prevent de-lamination of the fibres.

This invention relates to bladed rotors for use in gas turbine engines and relates more particularly to clappers for attachment to the blades of a bladed rotor.

The term clapper is meant to include lateral supports projecting from the aerofoil surfaces of the blades into the space between the blades.

According to the present invention a clapper for a rotor blade comprises at least one bundle of fibres extending lengthwise of the clapper and in which at least one end of the bundle is divided longitudinally into a plurality of end portions each of which is turned through substantially 90 degrees to its own length and in the opposite sense to the next adjacent end portion in order to fit into slots formed longitudinally in the blade flanks.

Preferably the bundle is formed from a plurality of fibrous laminae attached together side-by-side, and the end portions of the fibres of adjacent laminae which are to be attached to a blade are turned alternatively in opposite directions substantially at right angles to the clapper axis.

In a preferred construction the clapper comprises a plurality of bundles of fibrous laminae spaced apart chordwise of the clapper and separated by a low density filler material. The filler material may be an aluminium honeycomb structure or expanded polystyrene.

The invention also includes a bladed rotor in which the blades are provided with clappers of the type described.

The clappers are preferably attached to the blades by inserting the turned ends of the fibres into slots cut in the blades and fixing them in position by a bonding or adhesive process.

The fibrous laminae may be adapted to extend completely across the space defined between two adjacent rotor blades on the bladed rotor in which case both ends of the laminae will be turned in order to fit into the slots in adjacent blades.

In such an arrangement every alternate clapper, or every third clapper around the blade ring would be split in order to facilitate assembly of the rotor end blades.

Alternatively each blade may be provided with two clappers, one on each side, each clapper extending from the surface of the blade towards the next adjacent blade. In this case the clappers may be joined where they meet in the space between the blades.

The clappers are preferably covered by a sheet covering and may also be provided with a further coating to cut down erosion.

The fibres are preferably high strength fibres, for example, aluminium coated silica fibres, coated carboniferous fibres, or boron fibres.

The invention will now be described, in more detail merely by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 shows a gas turbine engine with a front portion cut away to show the first stage compressor rotor which has blades provided with clappers according to the present invention.

FIGURE 2 shows a group of the clapper blades of FIGURE 1.

FIGURE 3 shows a bundle made up of fibrous laminae. FIGURE 4 is an exploded view of FIGURE 3 showing the individual laminae.

FIGURE 5 is a section on line "a—a" of FIGURE 6. FIGURE 6 is a section on line "b—b" of FIGURE 5 and illustrates an alternative embodiment of the invention.

FIGURE 7 is a section through line "c—c" of FIGURE 5.

Referring now to the drawings, FIGURE 1 shows a gas turbine engine comprising compressor means 1, combustion equipment 2, turbine means 3, all in flow series in the usual manner. The compressor means comprises a plurality of stages of rotor blades 4 and stator blades 5. The first stage rotor blades are joined together generally in pairs by means of clappers 6 which are attached to the blades at approximately ½ of their length.

The clappers 6 comprise a plurality of bundles 7 of laminae 8, which are spaced apart laterally or chordwise of the clapper and each laminae is made up of a plurality of fibres.

In one embodiment of the invention the fibrous laminae 8 are arranged to span the whole gap between two adjacent blades 4, the end portions of the laminae being adapted to be connected to the blades and every alternate or third clapper being split in order to facilitate assembly of the ring of blades. The split clappers are bonded or glued together after or during assembly.

The end portions 9 and 10 of the laminae are turned in the plane of the laminae through 90° in opposite directions. For convenience the portions which are turned upwardly are all labelled 10 and the portions which are turned downwardly are labelled 9.

A bundle of laminae is formed by connecting, say, four laminae together side-by-side with the end portions of alternate laminae arranged to be alternatively turned in opposite directions as shown in FIGURE 3.

Slots 11 are made in the blade and extend longitudinally of the blade. The slots are of such length as to be capable of receiving the turned ends 9 and 10 of the laminae.

FIGURE 5 shows a pair of bundles of laminae joined together in one of the slots 11 of a blade 4, the turned portions 9 and 10 of laminae bundles from both sides of the blade are interlinked in the blade slot and fixed in position by a bonding or adhesive process.

The clappers are formed from a plurality of such laminae bundles and the spaces 12 between the bundles are filled with a low density filler material, for example, expanded polystyrene, an aluminium honeycomb structure, or a foamed metal or ceramic.

The laminae bundles and filler material are contained inside a skin 15 which may be a fibre reinforced plastic, and a coating 16 of a suitable material is provided on the outside of the skin to protect the clapper against erosion.

In an alternative construction the clappers 6 may extend only partially across the space defined between two adjacent blades and the lengths of the fibres and the filler material of the clapper may be cut short in an irregular
pattern across the width of the clapper so that when two adjacent clappers are joined in between the blades the line of the join is irregular and thus the tendency of the join to break-up is reduced. Such a construction is shown in FIGURE 6.

By joining the clappers to the blade in the manner described the fibres are continuous across the join and this tends to eliminate peeling of the clappers from the blades.

Further by bonding the fibres of the clappers from both sides of the blade together within the blade, the forces produced by one clapper in bending which tend to delaminate the fibres of that clapper in the blade, are resisted by the fibres of the clapper on the opposite side of the blade.

I claim:

1. A bladed rotor comprising a rotor disc, a plurality of blades mounted on the periphery of the disc, at least one flank of each blade being formed with slots therein, a clapper secured to the blade, at least one bundle of fibres extending longitudinally of the clapper, at least one end of the pack being divided longitudinally into a plurality of end portions each of which is turned through substantially 90 degrees to its own length and in the opposite sense to the next adjacent end portion, the end portions being bonded into the slots in the blade to secure the clapper to the blade.

2. A bladed rotor as claimed in claim 1 and in which the bundle of fibres comprises a plurality of fibrous laminae secured together side-by-side, the fibres of which extend longitudinally of the laminae.

3. A bladed rotor as claimed in claim 2 and in which one end of each of the laminae comprises one of said end portions of the bundle.

4. A bladed rotor as claimed in claim 3 and comprising a plurality of said bundles of fibrous laminae spaced apart chordwise of the clapper and separated by a low density filler material, a covering skin being provided over the surface of the clapper.

5. A bladed rotor as claimed in claim 1 and in which each end portion of a fibre bundle of a clapper on one side of a blade, is secured side-by-side in a blade slot to an end portion of a fibre bundle, of a clapper on the opposite side of the blade, which has been turned in the same sense.

6. A bladed rotor as claimed in claim 5 and in which each blade is provided with a clapper extending laterally from each blade flank, the adjacent ends of the clapper extending between two adjacent blades being secured together.

7. A bladed rotor as claimed in claim 1 and in which the fibres are made from a carboniferous material.

8. A bladed rotor as claimed in claim 1 and in which the fibres are made from silica and are coated with a thermosetting resin.

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