United States Patent [19]

Dawson et al.

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[54] **BLADED ROTOR FOR A GAS TURBINE ENGINE**

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[52] **U.S. Cl.**.....**416/196**

[51] **Int. Cl.**.....**F01d 5/10,** F01d 5/24

[58] **Field of Search**.....416/196, 194, 195

[56] **References Cited**

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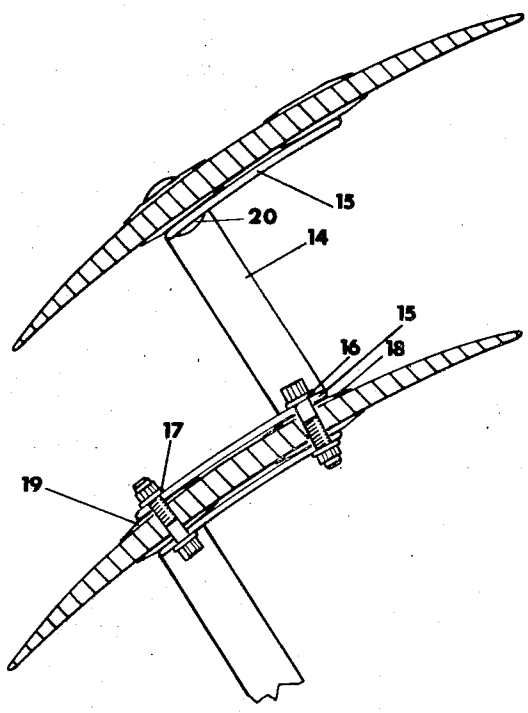
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[57] **ABSTRACT**

A bladed rotor for a gas turbine engine comprising a row of blades in which each blade is tied to the next adjacent blade by a Z-shaped metal tie having a center section which is inwardly curved such that centrifugal forces acting on itself are evidenced as compressive stresses within the tie and end limbs or lugs extending from the center section in opposite directions generally chordally of the blades and each being attached to the blades by bolts spaced apart transversely of the blade, the bolts extending through the blade to also attach a similar limb or lug to the opposite blade face.

3 Claims, 3 Drawing Figures



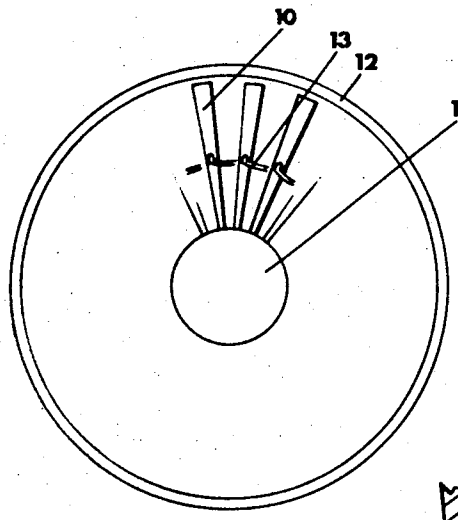


Fig. 1

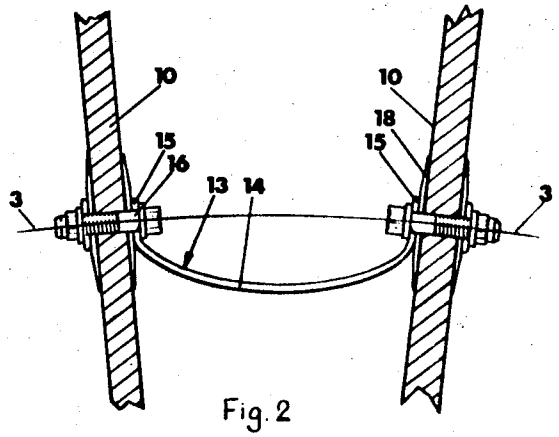


Fig. 2

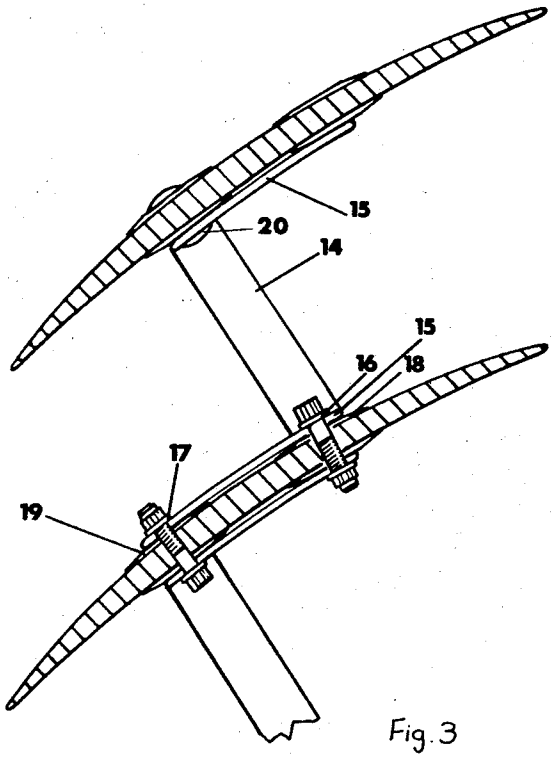


Fig. 3

BLADED ROTOR FOR A GAS TURBINE ENGINE

This invention relates to a bladed rotor for a gas turbine engine.

In certain circumstances it is necessary to stiffen the blades of such a rotor by interconnecting the blades in each row by ties. It is difficult to design ties which are light in weight and sufficiently rigid in the high G environment of such a bladed rotor.

The present invention provides a rotor having ties which are both light in weight and rigid under high centrifugal stresses. At the same time they can adjust themselves to a change in diameter due to the stretch of the assembly.

According to the present invention a bladed rotor for a gas turbine engine comprises a row of blades, each blade being connected to the next adjacent blade by a tie, each tie comprising an inwardly curved metal strip attached at each end to the blades and having a substantially catenary shape so that in operation centrifugal effects on the ties cause the metal strips to be under mainly compressive stress.

Preferably each tie has an outwardly extending lug at each end by which it is attached to the blade.

The lug may be retained to the blade by two bolts which extend through the blade and also retain a similar lug on the opposite blade face.

Thus the ties may be "staggered" and the lugs extend substantially along the chord of the blade from one tie to the next.

In a preferred embodiment the ties are made from single pieces of sheet metal or forgings having a Z-shape, the limbs of the Z-shape being bent up to form the lugs and the interconnection being curved inwardly to form the tie.

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

FIG. 1 is a frontal view of the fan of a gas turbine engine in accordance with the invention:

FIG. 2 is an enlarged section through the fan of FIG. 1 and

FIG. 3 is a section on the line 3—3 of FIG. 2.

In FIG. 1 there is shown a fan comprising a row of rotor blades 10 driven from a hub 11 and working inside a shroud 12. The hub 11 is driven from the gas generator section comprising the remainder of the gas turbine engine (not shown). In order to strengthen, and modify the vibration characteristics, of the fan blades 10, each blade is attached to its next adjacent blades by means of ties 13. The ties 13 are seen in greater detail in FIGS. 2 and 3.

Each tie 13 comprises an inwardly curved center section 14 of substantially constant cross-section. This center section is arranged to lie on substantially a catenary curve. To anchor the center section to the blades at either end, each end is provided with an upstanding lug 15. Each of the lugs 15 has a considerable chordal extent, and is bolted through the blade section in two chordally separated locations 16 and 17. The bolts which fasten the lug 15 of one tie also fasten the lug to the next adjacent tie.

In order to provide a flat location for the lugs on the blade section, the blade section is build up at 16 and 17 on the corresponding points on the opposite surface by pads 18 and 19. In the present case the pads 18 and 19 are formed from glass reinforced plastic, and are stuck by adhesive to the blade. The pads thus provide flat surfaces and also help to spread loads into the blade section.

It will be seen from FIG. 3 that the lugs 15 are formed as continuations of the central portions of the ties and extend in one direction only from the ends of the ties, and in fact they are formed from a Z-shaped piece of sheet material. Thus any tendency for the central section to rotate is opposed by the more distant of the two bolts holding the flanges in place, this bolt acts about a considerable moment arm to oppose such a tendency. It will also be noted that due to the inwardly curved catenary shape of the center portion of the ties, this portion will be under a compressive stress when centrifugal loads act on the tie in operation. The loads transferred to each blade through the lugs 15 will be opposed to some extent by opposite loads produced by the next adjacent tie.

As briefly mentioned above, the ties illustrated are simply manufactured from a Z-shaped piece of sheet metal. It will be seen that by drilling the bolt holes, bending up the lugs 15 and forming the center section to the required catenary shape, the complete tie may be made. It is preferable if the edges of at least the center section of the tie are rounded off both to improve the aerodynamic qualities of the tie and to reduce the possibility of stress raisers and consequent cracks.

It will be appreciated that various modifications can be made to the invention as described above. Thus various methods could be used to fasten the ties to the blades, and the ties need not be made from sheet metal as described in the preferred embodiment. The standard bolts shown on FIG. 2 and 3 are for test purposes only. A preferred bolt would have a shallow domed head as shown at 20 in FIG. 3. It would be used with a sunk sleeve nut which would also serve as a dowel.

We claim:

1. A bladed rotor for a gas turbine engine comprising:

a row of blades and ties, each blade being connected to a next adjacent blade by at least one tie, each tie comprising a single Z-shaped piece of metal having limbs bent up to form lugs extending in opposite directions generally chordally of the adjacent blades and having a center section interconnecting said lugs and being curved inwardly so that operational centrifical forces on the ties cause them to be under com-pressive stress, and a plurality of bolts for retaining each lug to a particular blade, said bolts being spaced apart transversely of and extending through the particular blade and also retaining a similar lug on an opposite face of the particular blade.

2. A bladed rotor as claimed in claim 1 including pads secured to each face of each blade to provide a flat bearing surface for said lugs of said ties.

3. A bladed rotor as claimed in claim 2 in which said pads are made from a glass reinforced plastic material and are adhesively secured to the blade surface.

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