

[54] **TURBINE ROTORS**

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[58] Field of Search 416/96, 97, 213

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ABSTRACT

A turbine rotor is described, particularly for motor vehicle gas turbines, in which a number of identical blade root portions, each formed integrally with a respective turbine blade, are secured, for example by welding, to a central rotor disc, the adjoining outer faces of the root portions forming two substantially continuous annular faces, minimising drag on the rotor when in use.

2 Claims, 4 Drawing Figures

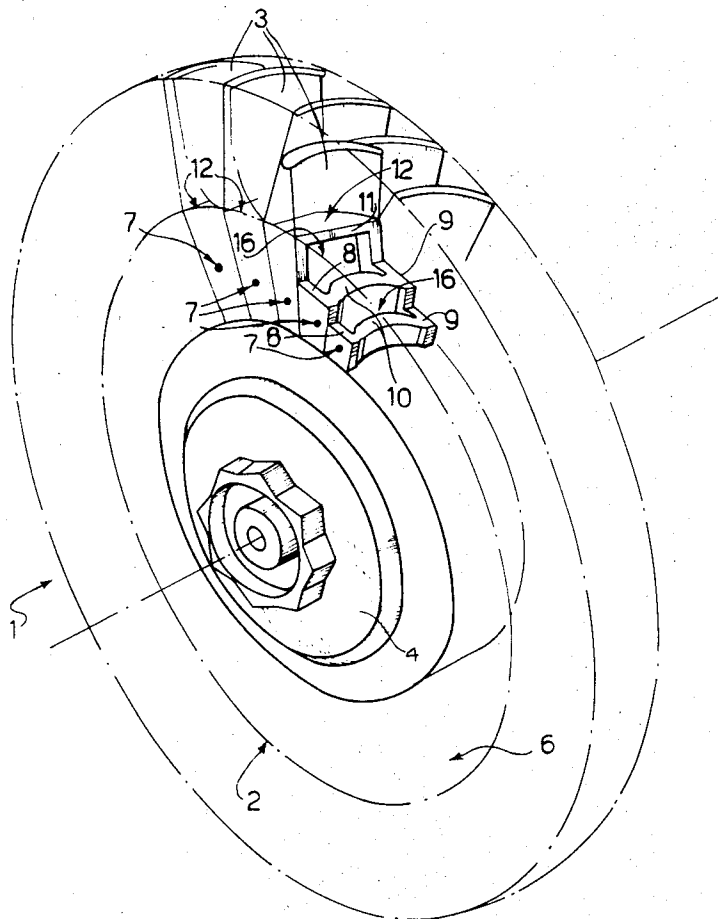
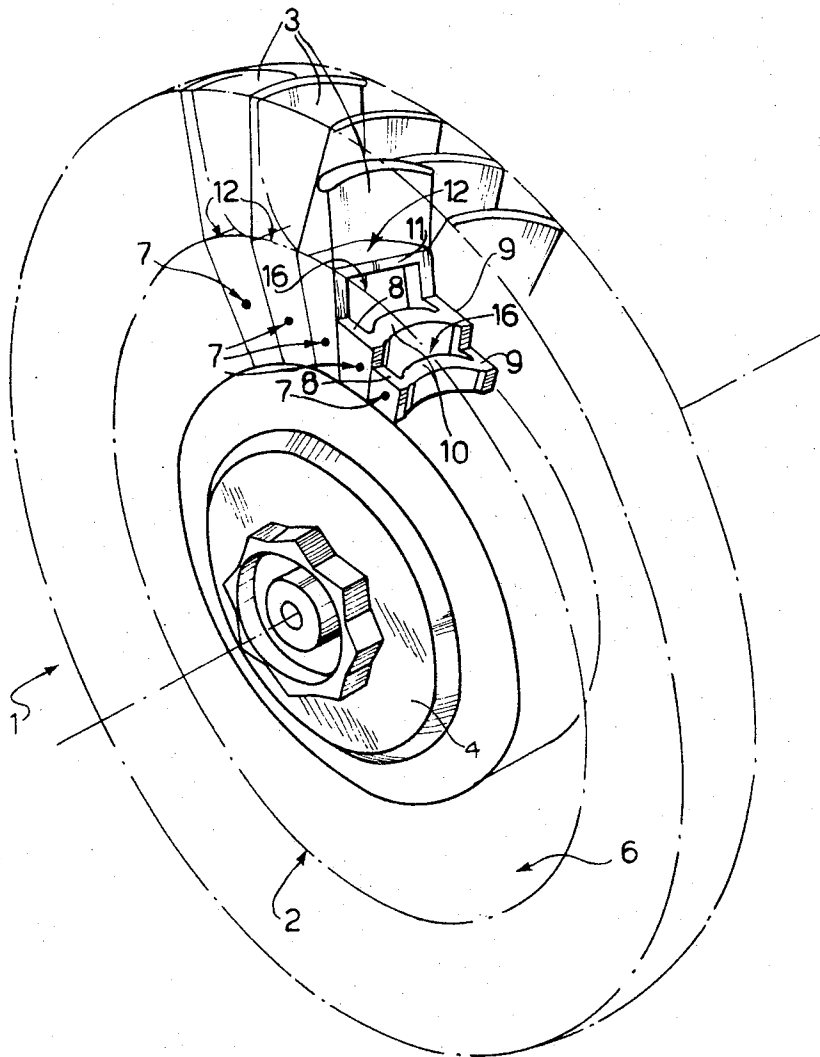


Fig. 1



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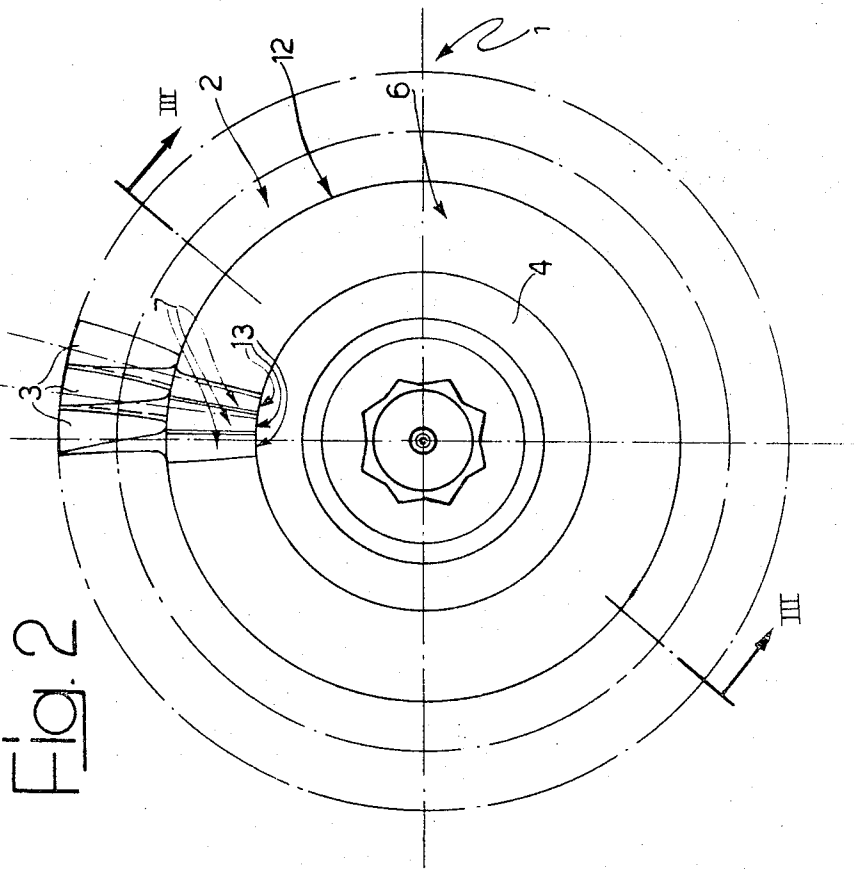
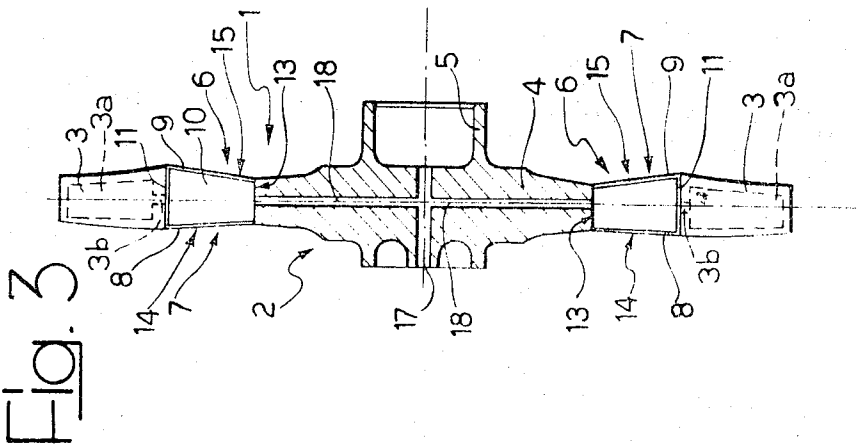
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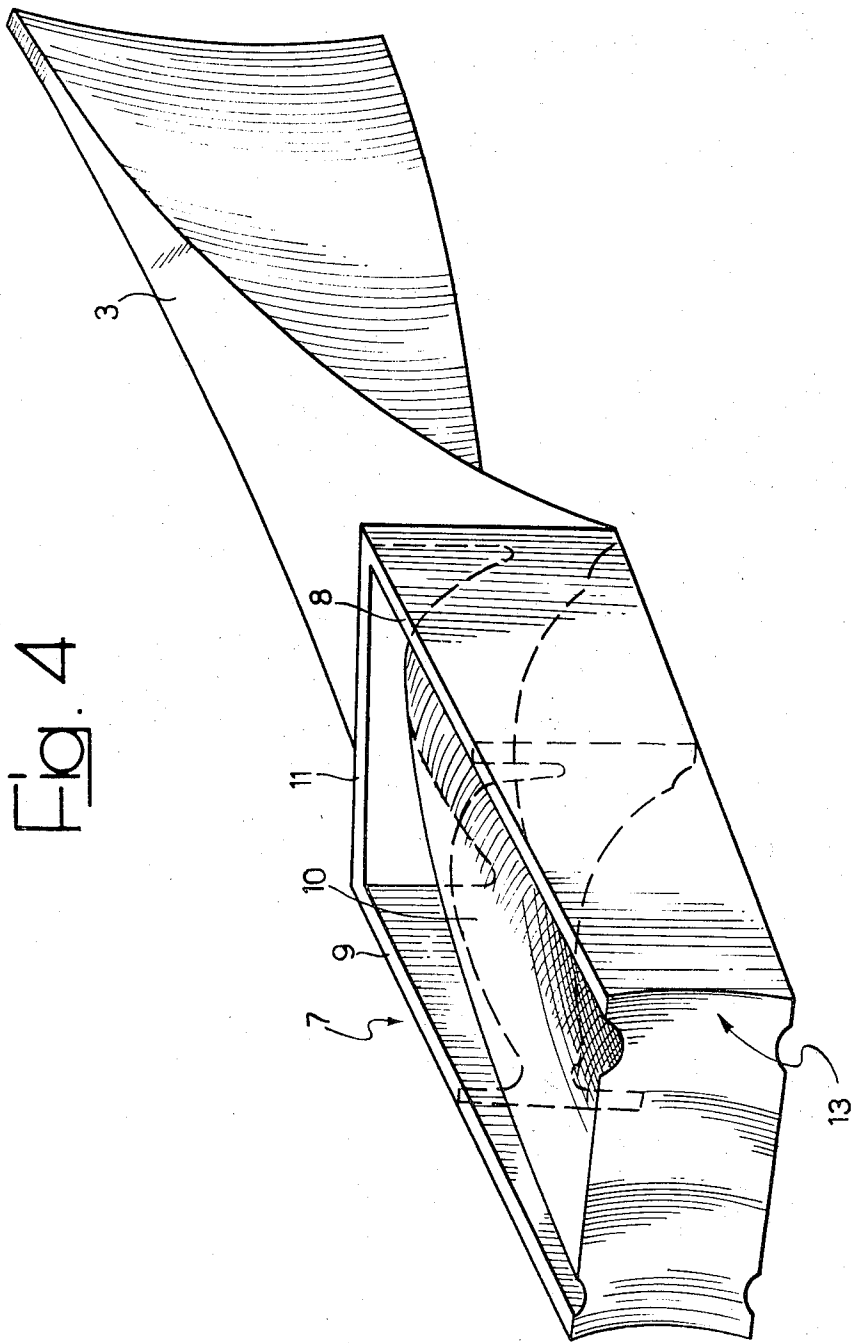
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TURBINE ROTORS

BACKGROUND OF THE INVENTION

This invention relates to turbine rotors, particularly but not exclusively for use in motor vehicle gas turbines.

More particularly this invention relates to a turbine rotor of the type comprising a central disc having a number of blades extending radially therefrom.

The use of gas turbine engines in motor vehicles is known. Motor vehicle engines, being necessarily of relatively low power and having limitations of size, call for the use of rotors of very reduced diameter. In consequence such rotors cannot conveniently be manufactured by setting the blades on a rotor disc and fixing the blades to the disc by mechanical means.

A solution hitherto adapted to solve this problem is to make turbine rotors for motor vehicles in one piece with blades formed integrally with a central disc, generally by casting. Rotors of this type are satisfactory from the mechanical point of view because cast blades have in general better resistance to corrosion than machine blades.

Nevertheless cast turbine rotors are unreliable in practice. The turbine of a motor vehicle engine is subjected in operation to rapidly varying loads and, therefore, to quick temperature changes. In a turbine rotor the blades have a relatively small thermal inertia, while the central disc has a considerably greater thermal inertia. Consequently a rapid change of temperature tends to cause thermally induced stress in the zones of the rotor disc between adjacent pairs of blades. Such stress can be manifested in the form of small cracks which elongate with continued wear until they lead to the destruction of the rotor.

Various solutions to these problems have been proposed. For example, it is known to provide the two faces of the central disc of the turbine rotor with a system of radial wings each of which extends radially inwardly from the outer periphery of the disc as an effective extension of the profile of a blade. In this way the elasticity of the central disc is increased considerably in the region of its outer periphery, reducing the tendency for cracks to form in use of the disc. The central disc of this type of rotor is, moreover, machined with a thin radial slot between each pair of adjacent blades. Each of the slots ends in a hole with a diameter sufficient to avoid the concentration of stress at the radially inner end of the slot, the holes being filled with material of greater plasticity than that which forms the rotor disc itself.

The rotor described in the preceding paragraph, although satisfactory from the technical point of view, has many disadvantages.

Firstly, since such rotors are formed in one piece by casting, they are uneconomical in manufacture, especially since both the blades and the central disc must be made of a material with very good mechanical and thermal characteristics. Secondly, the price of each rotor is increased by the high percentage of rejects in manufacture which inevitably arise since a defect in the casting of even a single blade, or the breaking of a single blade, of the casting make the whole rotor unserviceable and irreparable. Thirdly, the provision of the aforementioned wing system on the outer peripheral region of the central disc leads to a considerable loss of

power due to the drag produced thereby at high rotational speeds.

The already high cost of the rotors described above is further increased by the high cost of the machining operations to which the cast rotors have to be subjected. For example the thin radial slots in the central disc are formed by means of very thin diamond drills which are easily broken.

SUMMARY OF THE INVENTION

In order to avoid these disadvantages of known turbine rotors as described previously, this invention provides a turbine rotor in which the central disc is formed by a monolithic central part having a cylindrical outer surface and a number of identical root portions arranged circumferentially adjacent each other so as to form an annular crown secured to the central part and having two substantially continuous annular faces adjoining the end faces of the central part, the root portions being each formed integrally with a respective turbine blade.

Preferably each of the root portions extends radially outwardly from the central part and has a thickness equal to that of the latter, the root portion having at its radially inner end facing the central part a cylindrical surface portion joined to the outer cylindrical surface of the central part by welding.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described, by way of non-limiting example, with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic perspective view partially in section of a turbine rotor according to one embodiment of the invention;

FIG. 2 is an end view of the rotor illustrated in FIG. 1;

FIG. 3 is a cross section taken on line III—III of FIG. 2, and

FIG. 4 is a perspective view of one blade of the rotor of FIGS. 1 to 3, with its root portion.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

In the drawings, reference numeral 1 indicates generally a turbine rotor comprising a central disc 2 and a number of blades 3 extending radially from the central disc 2 and evenly distributed around the outer periphery of the latter.

The central disc 2 itself comprises a central part 4 formed in one piece and having a cylindrical outer surface and a central hub 5. The hub 5 permits the mounting of the rotor 1 on a turbine shaft (not illustrated) adapted to be driven by the rotor. The central disc 2 is formed with an outer annular crown 6 formed by a number of identical segmental root portions 7 arranged side-by-side circumferentially around the rotor disc 2.

The root portions 7 are equal in number to the number of blades 3 and each root portion 7 is formed in one piece, generally by casting, with the respective blade 3.

Each root portion 7 comprises (FIG. 4) two face plates 8 and 9 with flat external faces substantially parallel to each other, a core 10 interposed between the two plates 8 and 9 and connected thereto and a bridge piece 11 connected to the core 10 and spanning the radially outer ends of the plates 8 and 9. The respective blade 3 is connected to the bridge piece 11 and projects

from the surface thereof opposite to that connected to the respective core 10.

Each of the plates 8 and 9 has a shape in plan which is substantially trapezoidal with the smaller base radially innermost and adjoining the outer cylindrical surface of the central part 4 of the rotor disc 2. The bridge piece 11 is on the other hand arranged parallel to the outer cylindrical surface of the central part 4 and interconnects the larger bases of the trapezoidal face plates 8 and 9. The bridge piece 11 has a cylindrical outer surface portion 12, which when the root portion 7 is assembled on the rotor disc 2, is coaxial with the cylindrical outer surface of the central part 4 of the disc. The blade 3 extends radially from the central part of the cylindrical surface portion 12.

The thickness of the core 10 increases radially inwardly from the bridge piece 11, while the width of the core 10 decreases radially inwardly from the bridge piece 11. The core 10 is connected to the inside surface of the bridge piece 11 along a band which extends substantially parallel to the axis of the central part 4, along the middle part of the inside surface of the piece 11. The core 10 has a substantially rectangular cross section at its radially inner end, being connected to the inside surfaces of the plates 8 and 9 along substantially the entire width of said plates.

The radially inner surfaces of the plates 8 and 9 and of the core 10 together form a cylindrical surface portion 13 which is rectangular in plan and which is joined to the outer cylindrical surface of the monolithic central part 4 of the rotor disc 2 by deep welding, generally by means of electron beam welding.

The root portions 7, once joined to each other and welded to the central part 4, form the continuous outer crown 6. Furthermore the outer surfaces of the face plates 8 and 9, when the root portions 7 are joined together, form two continuous annular faces 14 and 15 which are effective continuations of the end faces of the central part 4 of the disc 2.

When the root portions 7 have been mounted on the central part 4, the core 10 and the two face plates 8 and 9 of each portion 7 delimit, together with the core 10 and the plates 8 and 9 of the two adjoining root portions 7, two adjacent radially extending chambers 16 tapered radially inwardly towards the central part 4 and closed at their radially outer ends by the bridge pieces 11 of the said root portions 7. Each radial chamber 16 communicates with a central axial duct 17 in the central part 4 by way of a respective radial conduit 18 (FIG. 3). Each radial chamber 16 also communicates with a cavity 3a (broken outline) formed within the respective blade 3, by way of a further conduit 3b, shown diagrammatically in broken outline. By means of the duct 17, the radial conduits 18, the radial chambers 16, and the conduits 3b it is possible to feed air into the outer crown 6 and into the blade cavities 3a in order to effect efficient cooling thereof.

As regards the resistance of the rotor 1 to thermally induced stress it will be noted that each root portion 7 forming the outer crown 6 is joined in the central part 4 of the rotor disc 2 at its radially inner end, independently of the adjacent root portions 7. In consequence small radial clearances are formed between neighbouring root portions 7 guaranteeing sufficient elasticity to the outer crown 6 of the rotor disc 2. Furthermore, the root portions 7 can warp radially independently of each

other without causing internal stresses leading to fracture of the central disc 2 of the rotor 1.

As stated previously, each root portion 7 and the respective blade 3 are formed in one piece by casting. Each portion 7 is subsequently welded on the central part 4 of the rotor 1. It is, however, possible to form the outer crown 6 from a number of groups of root portions 7 welded on the central part 4: the root portions 7 forming each group are firmly joined to each other — for example the group may be cast in one piece — and each group forms, together with its respective blades 3, a single piece separately welded to the central part 4. It should, however, be pointed out that as the number of root portions 7 in each such group formed by casting in one piece increases, the mechanical and thermal characteristics of the resulting rotor 1 become less favourable; optimum characteristics are obtained only when the root portions 7 with their respective blades 3 are cast singly and attached by welding one at the time on the outer cylindrical surface of the central part 4 of the rotor 1.

Finally power losses due to drag on the rotor 1 are reduced to a minimum because the annular faces 14 and 15 of the outer crown 6 are substantially continuous and therefore do not cause any substantial turbulence in the air surrounding the central disc 2 of the rotor 1 in use of the same, as contrasted with the previously known rotor constructions referred to.

It will be understood that details of practical embodiments of the invention can be widely varied from the example described and illustrated herein, without departing from the scope of this invention.

I claim:

1. In a turbine rotor comprising a central disc having a monolithic central part provided with two end faces, a cylindrical outer surface and a plurality of identical turbine blades having root portions welded to the central part and arranged circumferentially adjacent each other to form an annular crown having two substantially continuous annular faces contiguous with the end faces of the central part, each of said root portions comprising two parallel face plates with flat outer surfaces, a core interposed between and connected to said face plate, and a bridge piece connected to said core and interconnecting the radially outer ends of said two faced plates, said bridge piece supporting the respective blades on its radially outer surface, said core and said two face plates having radially inner end surfaces defining a cylindrical radially inner surface portion of the root portion complementary in curvature to the cylindrical outer surface of the central part, said core and said two face plates of each root portion delimiting, together with the core and face plates of adjacent root portions, two circumferentially adjacent radially extending chambers closed at their radially outermost ends by adjacent ridge pieces of said root portions, said central part having a central cooling air duct and a plurality of conduits interconnecting said chambers with said duct and each of said blades having an internal cavity in communication with a respective one of said chambers.

2. A turbine rotor as set forth in claim 1 wherein said core of each root portion tapers from a thicker radially inner portion to a thinner radially outer portion, said radially inner portion having a substantially rectangular cross-section connected to the inside surface of the two face plates over substantially the entire width of said plates.

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