

United States Patent

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[54] **TURBOMACHINE ROTOR**
1 Claim, 4 Drawing Figs.

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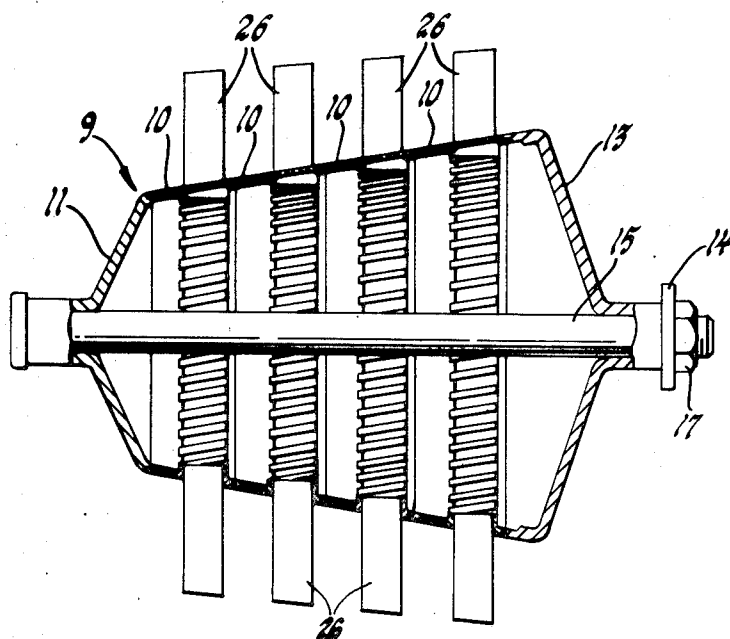
[50] Field of Search **416/230,**
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ABSTRACT: A turbomachine rotor comprises a number of rings forming a drum with end bells at the ends of the drum. Each ring mounts a row of blades with roots which extend through openings in the ring and which are brazed or welded to retain them on the ring. Rings of fibrous composite wrap extend around the blade mounting rings between the rows of blades. The rings may be welded together.



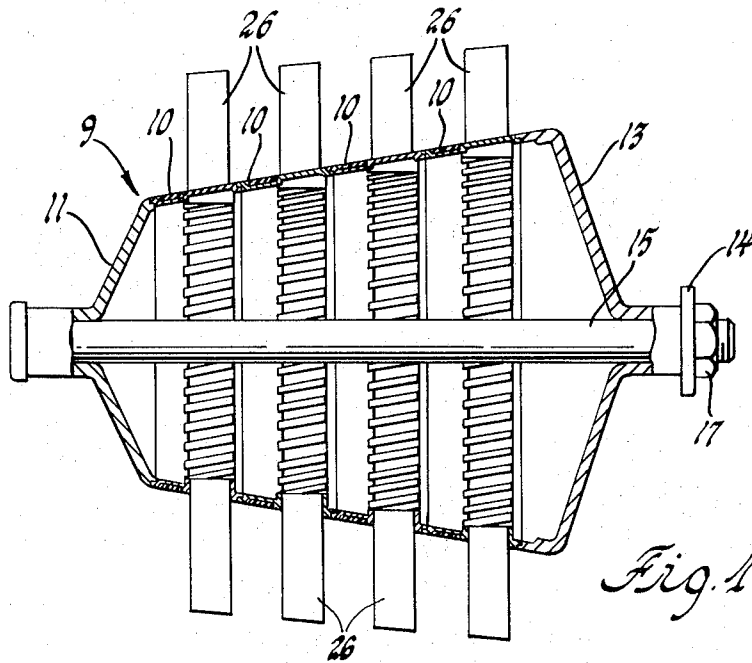


Fig. 1

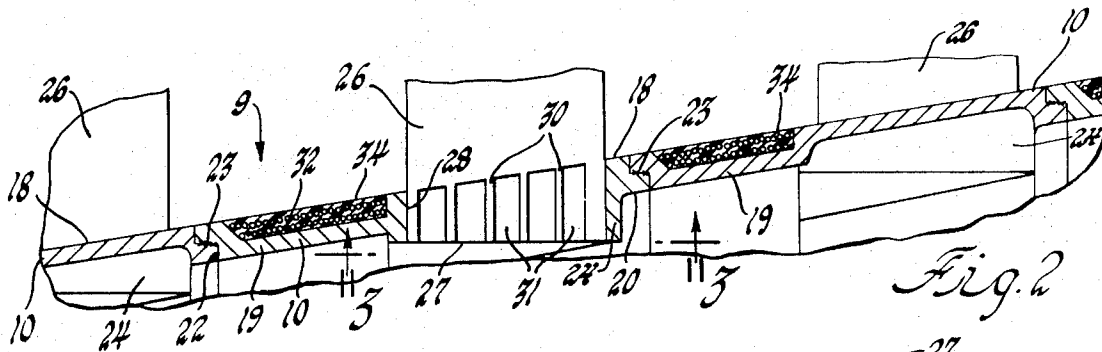


Fig. 2

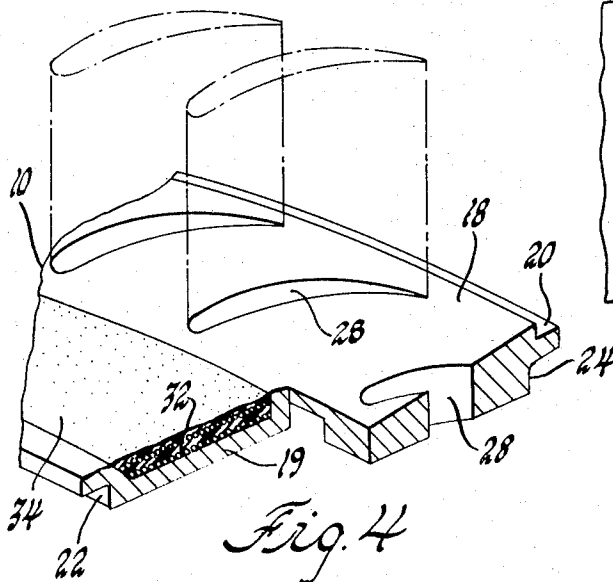


Fig. 4

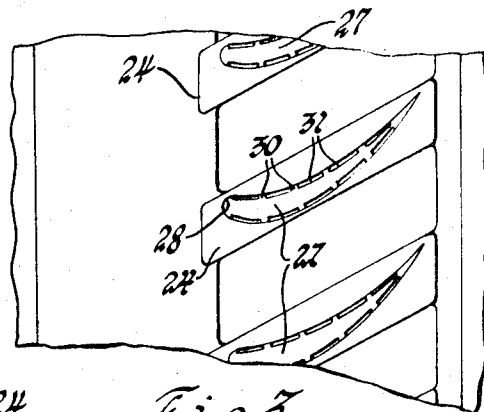


Fig. 5

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TURBOMACHINE ROTOR

My invention is directed to turbomachine rotors and particularly to provide a strong, lightweight rotor for turbomachines such as axial-flow compressors and turbines. In the preferred embodiment, my invention is applied to a multistage axial-flow compressor having a lightweight composite fiber-reinforced drum rotor, but other adaptations of the invention are readily perceived.

The principal virtue of the invention lies in the felicitous use of very high tensile strength fibrous composite wrap to reinforce the metal rotor drum against the very high centrifugal forces exerted upon it, principally by the blades, but also by the structure of the drum itself.

Another feature of my invention is an arrangement by which the blade roots, which are extensions of the blade profile, are inserted through mating openings in the drum and are welded or brazed in place.

The principal objects of my invention are to improve the strength and reliability of turbomachine rotors and to provide an improved rotor structure having light weight and adapted to exploit the advantages of lightweight materials such as titanium and fibrous composite wraps.

The nature of my invention and the advantages thereof will be clear to those skilled in the art from the succeeding detailed disclosure of the preferred embodiment of the invention, which is presented to explain the principles of the invention and is not to be construed in a limiting sense.

FIG. 1 is a sectional view of a drum rotor taken in a plane containing the axis thereof.

FIG. 2 is an enlarged view of a portion of FIG. 1.

FIG. 3 is a view taken on the plane indicated by the line 3-3 in FIG. 2.

FIG. 4 is a fragmentary axonometric view of a rotor ring.

FIG. 1 shows a rotor for a four-stage axial-flow compressor. The rotor comprises a drum 9 made up of four rings 10 and two end bells 11 and 13. As illustrated, the end bells are integral with stub shafts by which the drum may be mounted for rotation in suitable bearings, one stub shaft having a driving flange 14. The parts 10, 11, and 13 as shown are held together by a tie bolt 15 and nut 17. The end bells may have any suitable shape and the tie bolt may or may not be present, depending upon the particular design. In many cases, it is preferred to weld the rings 10 together, in which case the tie bolt is ordinarily omitted.

As shown, the rings 10 progressively increase in diameter, although they may not and, in general, they are as nearly alike as feasible, although they may differ in width and, ordinarily, in the number of blades mounted on the rings.

My invention lies primarily in the structure of the blade mounting rings and the mounting of the blades to the rings, which are shown more clearly in FIGS. 2, 3, and 4. Referring to these figures which illustrate a welded rotor structure, each ring 10 includes a blade mounting portion 18 and a flange portion 19. The blade mounting portion includes a pilot 20 which extends into an annular recess 22 at the edge of the flange portion of the adjacent ring 10. Adjacent rings thus are piloted together and centered and, in the form illustrated, they are welded together as indicated at 23 by a suitable process such

as electron beam welding.

Each ring 10 bears on the interior of its blade mounting portion 18 a ring of bosses 24 each providing a mount for one of the ring of blades 26 mounted on the particular rotor ring. The blades are of suitable airfoil shape, ordinarily a cambered airfoil with a concave and a convex face, as most clearly apparent in FIGS. 3 and 4. Each blade includes a root portion 27, of the same overall airfoil contour as the blade 26, which is mounted in its respective one of the bosses 24. As shown most clearly in FIGS. 3 and 4, each boss is machined to provide a blade mounting hole 28 extending through the boss. The mounting holes are of the same airfoil configuration as the blade root 27 and closely fit the root. The bosses 24 and holes 28 may be formed on the ring 10 by electrochemical machining or electric discharge machining, or by any other available process capable of producing the desired shape to a fair degree of precision.

The blades 26 are fixed to the rotor by welding or brazing the root 27 in the holes 28. To improve the braze joint in the case of a brazed airfoil, it is preferred to provide flutes 30 (FIG. 2) on the roots 27 between which are defined shallow recesses 31 to receive the braze metal.

The flange portion 19 defines a shallow annular trough 32 which receives a reinforcing wrap 34. This wrap is a fibrous wrap of suitable high tensile strength fibers such as glass fibers, boron fibers, or other material, plus an epoxy resin which binds the fibers together. The reinforcing rings thus provide a very substantial addition to the hoop strength of the ring 10. Since the flange portion 19 overlies the adjacent blade mounting portion 18, it accepts centrifugal stresses from both adjacent rows of blades.

It will be apparent to those skilled in the art from the foregoing description that my invention provides a lightweight rotor structure which is readily fabricated and which is particularly adapted to withstand the stresses of operation in high speed turbomachinery.

The detailed description of the preferred embodiment of the invention for the purpose of explaining the principles thereof is not to be considered as limiting or restricting the invention, as many modifications may be made by the exercise of skill in the art.

I claim:

1. An axial-flow turbomachine rotor drum comprising, in combination, a plural number of open-centered metal rotor rings arranged coaxially in successive abutting relationship to define a rotor drum, each rotor ring including a blade mounting portion and a flange portion extending axially from the blade mounting portion, a ring of blades mounted on and fixed to each blade mounting portion, the blades having airfoil-contoured roots and the mounting portion defining airfoil-contoured holes receiving the blade roots, a fiber-reinforced tensile wrap disposed on the outer surface of each flange portion, the flange portion overlapping the exterior of the blade mounting portion of an adjacent rotor ring, the roots of the blades having spanwise-extending flutes thereon defining shallow recesses between the flutes, and braze metal within the recesses fixing the blades to the rotor rings.

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