

[54] DAMPED TURBOMACHINE ROTOR
ASSEMBLY

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[52] U.S. Cl.416/183, 416/244, 416/500
[51] Int. Cl.F01d 5/26
[58] Field of Search416/103, 244, 500; 415/119

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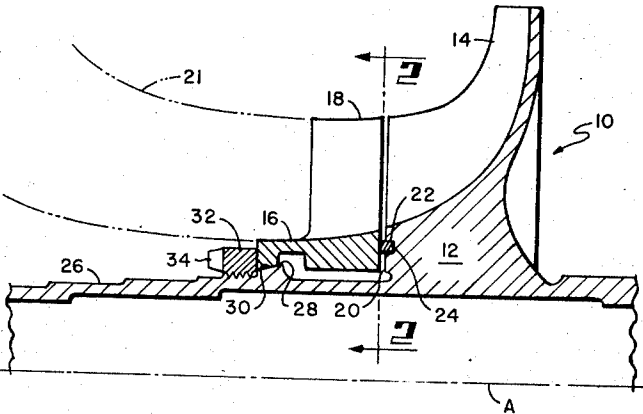
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[57] ABSTRACT

The disclosure illustrates a centrifugal compressor comprising an inducer hub telescoped over an adjacent shoulder of an impeller hub. A nut threaded on the impeller hub maintains the inducer hub, an intermediate annular resilient ring and the impeller hub in abutment with sufficient pressure to damp vibrations in the rotor assembly.

4 Claims, 2 Drawing Figures



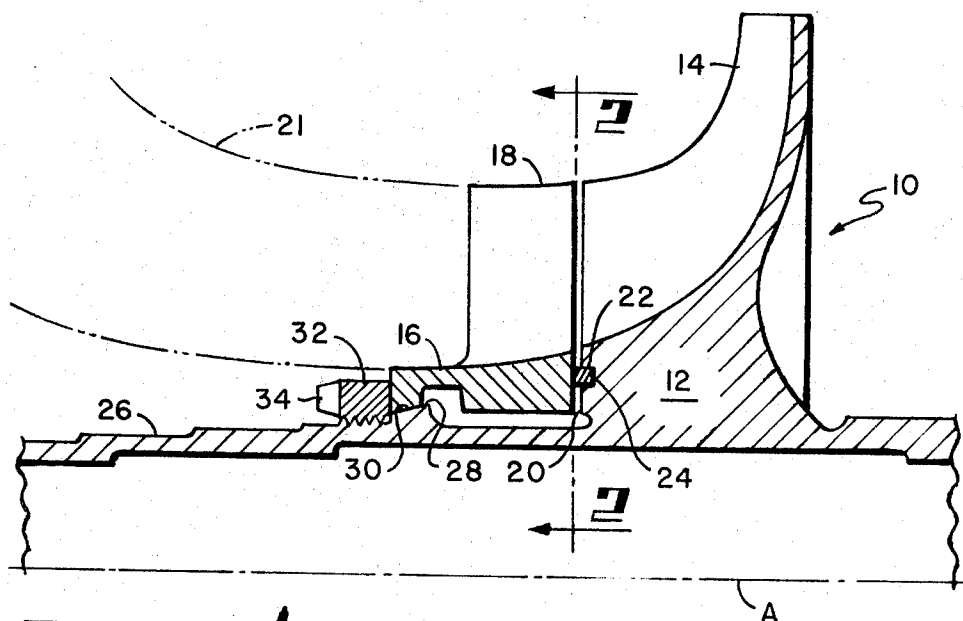


Fig 1

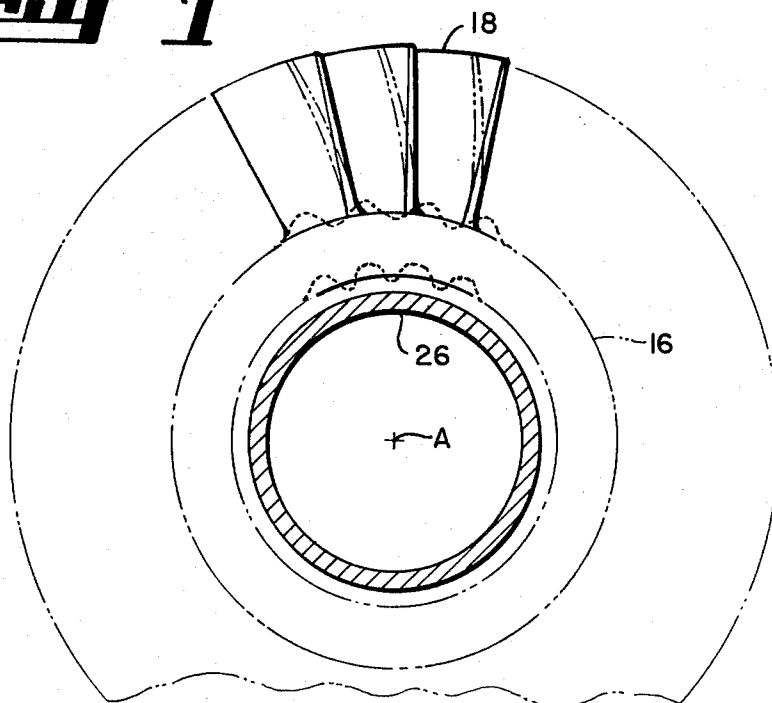


Fig 2

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DAMPED TURBOMACHINE ROTOR ASSEMBLY

The present invention relates to turbomachine rotor assemblies and more particularly assemblies of the type that have provision for damping vibrations.

In the gas turbine art there are numerous devices and approaches to minimize vibration in rotor assemblies. These devices are necessary because the blades in the rotor assembly will vibrate at their natural frequencies with sufficient amplitude to impair their structural integrity.

One type of damping arrangement for this purpose consists of elements formed on one set of blades to rub against adjacent blades and frictionally damp vibrations. While this approach is generally effective, it is expensive to manufacture a rotor that utilizes this type of damping and, in addition, it creates aerodynamic disturbances which may lead to loss of efficiency.

Another approach that has been used may be found in the U. S. Pat. to Birmann, No. 2,405,283, wherein a shoulder adjacent the inner portions of one set of blades is machined away so that only the outer portions of the blades abut adjacent blades. The two hubs that support the blades are held with sufficient axial force to cause the edges of the blades to frictionally engage and damp vibrations. This approach again is effective but it is expensive to manufacture the shoulder and machine the abutting surfaces of the individual blades.

Accordingly, the object of the present invention is to provide a highly efficient and economical means for damping a turbomachine rotor.

The above end is achieved by a damped turbomachine rotor assembly comprising first and second bladed annular hubs that have an annular energy absorbing ring positioned between them. This ring and the hubs are maintained in abutment with sufficient axial pressure to damp vibrations in the rotor assembly.

The above and other related objects and features of the present invention will be apparent from a reading of the description and a study of the accompanying drawing and the novelty thereof pointed out in the appended claims.

In the drawing:

FIG. 1 is a longitudinal sectional view of a centrifugal compressor rotor assembly embodying the present invention;

FIG. 2 is a view taken on lines 2—2 of FIG. 1 which shows the fundamental mode of vibration of the compressor hub.

Referring now to FIG. 1 there is shown a centrifugal compressor rotor assembly 10 with which the present invention may be used. The rotor assembly comprises a first generally annularly shaped hub 12 spaced outwardly from its axis of rotation A. The hub 12 has a series of radially extending blades 14 to form the impeller portion of the rotor assembly 10. A second hub 16 is positioned upstream of the hub 12 and is also annular and spaced outwardly from the axis of rotation A. Hub 16 has a series of inducer blades 18 which extend radially outward but are cambered so as to efficiently receive air from an axially directed inlet, shown in phantom and designated by reference character 21. The inducer blades 18 correspond with the impeller blades 14 to form a generally annular accelerating flow across the centrifugal compressor rotor 10.

A resilient annular ring 22 is positioned in a groove 24 in hub 12 and projects from axial shoulder 20 so that the ring 22 maintains hub 16 and its corresponding blades out of contact with hub 12 and its corresponding blades 14 (shown in exaggerated scale). Hub 12 has an elongated shaft portion 26 over which hub 16 is telescoped. A pilot diameter 28 on the elongated shaft portion 26 and a corresponding diameter 30 on the inducer hub 16 centers it on elongated shaft portion 26 of hub 12. An internally threaded element 32 is screwed onto the threaded portion 34 of the elongated portion 26 by a suitable tool which engages slots 34 in element 32. Element 32 holds the inducer hub, resilient ring 22 and the impeller hub 12 in

abutment. The threaded element 32 is tightened to hold the elements together with sufficient axial force to damp vibrations as described below.

In operation, the centrifugal compressor rotor assembly 10 rotates at a high rate of speed. Due to many exciting forces the blade 18 and 14 tend to vibrate in their several modes. As shown in FIG. 2, the resultant vibration causes deformation of the annular inducer hub 16 from which the blades 18 extend radially. The deflection of the hub for a swing of blades 18 to the left is shown in exaggerated proportion by the phantom lines of FIG. 2. It can be seen that this deflection generally resembles a sine wave superimposed on the annular shape of the hub. A swing of the blades to the right causes a similar deflection in the opposite direction.

With the resilient ring 22 in abutment between the hubs 16 and 12, the tendency toward this type of deflection causes a frictional rubbing between the ring and the adjacent hubs. This damps the vibration of the blades by absorbing energy created by the deflection of the root of the blades. However, the close coupling of the hubs enables sufficient energy to be absorbed adequately to damp vibrations.

There are a number of resilient materials which may be suitable for this purpose. One type would be fiber and another material would be rubber. It is pointed out that temperature considerations for the rotor influence the selection of the material to be used. For higher temperatures it is necessary to utilize a temperature resistant material.

While the present invention has been described in connection with a centrifugal compressor, it is believed that those skilled in the art can adapt the invention to other turbomachine rotors, such as axial flow types or a centripetal turbine assembly, without departing from the spirit of the present invention. Accordingly, its scope is to be determined solely by the appended claims.

Having thus described the invention, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. A damped turbomachine rotor assembly comprising:
 - a first annular hub spaced from its axis of rotation;
 - a plurality of blades extending generally radially from said first hub;
 - a second bladed annular hub outwardly spaced from its axis of rotation;
 - a plurality of blades extending generally radially from said second hub and corresponding with the blades on said first hub to form a generally annular flow path across said rotor assembly, one of said hubs having a recess for retaining said ring within the periphery of said hubs;
 - an annular resilient ring positioned between said first and second hubs; and
 - means for maintaining said ring and hubs in abutment with sufficient pressure to damp vibrations in said rotor assembly.
2. A rotor assembly as in claim 1 wherein:
 - said first hub further comprises an elongated axially extending shaft portion;
 - said second hub is telescoped over the elongated shaft portion of the other hub; and
 - the means for maintaining said disks and hubs in abutment comprises an element secured to the elongated shaft portion of said first hub.
3. A rotor assembly as in claim 2 wherein said hub is an inducer hub and said first hub is an impeller hub, whereby said rotor assembly comprises a centrifugal compressor.
4. A rotor assembly as in claim 3 wherein said inducer is telescoped over said impeller and said abutment maintaining means comprises a sleeve element threaded over said elongated shaft portion of said impeller hub for holding said disks and hubs in abutment.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,677,663 Dated July 18, 1972

Inventor(s) VAL CRONSTEDT

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 6, "blade" should read "blades" ;

Column 2, lines 47-50 should read as follows:

"rotor assembly;

an annular resilient ring positioned between
said first and second hubs, one of said hubs having
a recess for retaining said ring within the periphery
of said hubs; and"

Signed and sealed this 24th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents