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BLADE RETAINING MEANS

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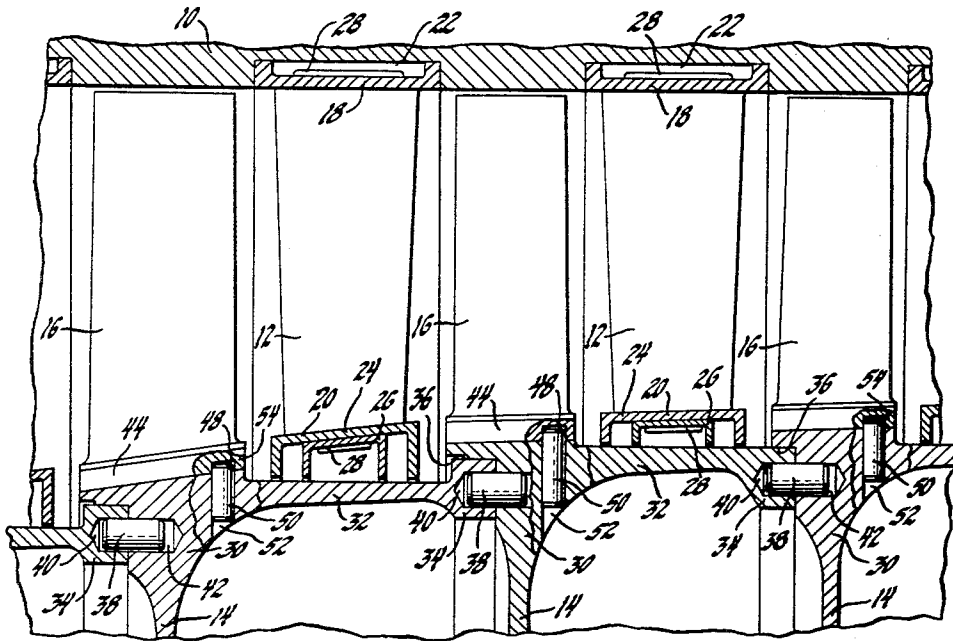


Fig. 1

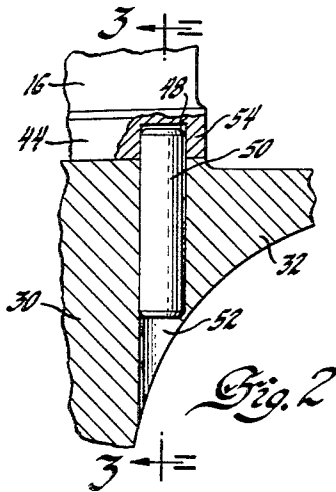


Fig. 2

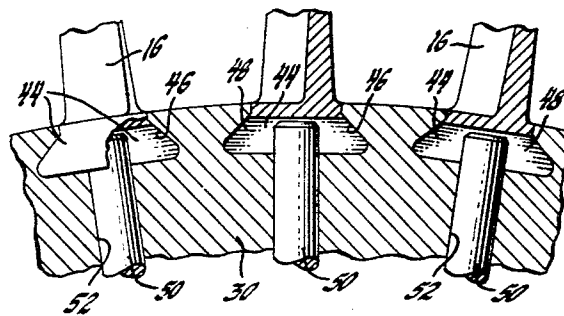


Fig. 3

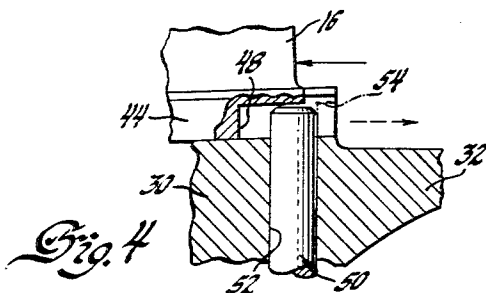


Fig. 4

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BLADE RETAINING MEANS

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6 Claims. (Cl. 253-77)

This invention relates to blading of a type suitable for use in elastic fluid machines such as axial flow compressors and turbines and the like and has for its purpose the provision of a simple and inexpensive blade retaining means which efficiently secures a footed blade against movement in a blade carrying member and which greatly facilitates removal of a damaged blade without damage to the blade carrying member.

In one form of blade retaining means which has been proposed heretofore, a footed blade is secured against movement in a slot contained in a blade carrying member by a retaining pin extending between the blade carrying member and the foot of the blade. The pin is constructed from soft material so as to be sheared off when the blade is driven from the slot for removal. This results in freezing of the pin in the blade carrying member and may necessitate drilling to effect removal of the pin which oftentimes results in damage to the blade carrying member.

In accordance with the present invention, the retaining pin is formed from material having a high shear strength, preferably greater than the foot of the blade and the location of the pin with respect to the end of the blade foot in such that, when removal of a damaged blade becomes necessary, a portion of the foot of the blade may be broken off readily without shearing or damaging the pin, thereby releasing the blade foot from the pin and facilitating removal of both the blade and pin without damage to the blade carrying member.

The principal objects of the invention are to provide an improved structure for bladed machines such as compressors and to facilitate the removal of damaged blades therefrom.

The preferred manner in which these objects of the invention are realized together with the features and advantages attending the invention, will appear more fully from the following detailed description and drawings, wherein: Figure 1 is a fragmentary longitudinal sectional view of an axial flow compressor employing blade retaining means in accordance with the invention; Figure 2 is a fragmentary detail sectional view of a retaining means in accordance with the invention in the same plane as Fig. 1; Figure 3 is a fragmentary transverse sectional view taken in the plane 3-3 of Figure 2; and Figure 4 is a view illustrating removal of a blade in accordance with the invention.

Referring to the drawings, the invention is shown embodied in the rotor of an axial-flow compressor of a type employed in gas turbine aircraft jet engines. Only a portion of the compressor is shown, the remainder of the engine being omitted in the interest of clarity of the drawings and conciseness of the specification, since the general structure of such an engine is well understood by those skilled in the art.

The compressor shown in Figure 1 is of the multi-stage type and comprises a casing or stator 10 which mounts a number of rows of stator vanes 12 and a rotor member mounted on a shaft (not shown) and defined

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by a plurality of axially spaced rotor disks 14 each having a number of rotor blades 16 mounted about the circumference thereof.

The compressor casing is formed by a pair of semi-cylindrical sections which are fastened together by means of flanges (not shown) provided along the sides thereof. The stator vanes 12 of each stator stage are mounted between outer and inner shroud bands 18 and 20, both of which are constituted by a pair of semi-circular segments corresponding to the halves of the casing 10. The outer shroud band 18 is seated in a groove 22 in the inner surface of the casing, and retained in a suitable manner (not shown). The inner shroud band 20 comprises a pair of concentric channel members 24, 26 having superimposed webs, which may be spot welded together, and inwardly directed flanges. The outer shroud band 18 and the inner shroud band 20 function principally to support and radially space the stator vanes 12, the inner shroud band serving further to provide an effective fluid seal between the stationary and moving parts of the compressor. The ends of the stator vanes are shaped to provide projecting tangs or tenons 28 which are received in apertures in the shroud bands. The tenons are headed, welded, or brazed to secure the vanes 12 to the shroud bands.

The rotor disks 14, which are mounted for rotation in known manner on a stub shaft (not shown) journaled within the compressor casing are each constituted by a thickened rim 30 and a spacing ring or flange 32 integrally formed thereon and extending rearwardly therefrom. The after end 34 of the spacing ring of each rotor disk engages a mating shoulder 36 formed in the forward edge of the rim of the succeeding rotor disk. The rotor disks are coupled by a number of short dowel pins 38 which extend parallel to the axis of the compressor and are closely fitted in holes 40 circumferentially spaced about the edge of the spacing ring. A number of similar openings 42 are provided in the forward edge of each rotor wheel rim to receive the pins 38 extending from the spacing ring. The pins 38 serve to lock the rotor wheels against rotational movement relative to one another and to transmit torque therebetween. The disks are held assembled by a tie bolt (not shown) extending between the hubs of the end disks of the assembly in known manner.

As best shown in Figure 3, the rotor blades 16 are provided with an integrally formed foot 44 which is received in one of a plurality of mating dovetail slots 46 formed in and spaced about the periphery of the rim 30 of each rotor wheel. For the purpose of securing the blade against movement in the dovetail slot, a transverse slot 48 (Figs. 2 and 3) is formed intermediate the ends of the foot of the blade to receive a retaining pin 50 which is driven through a hole 52 in the after portion of the wheel rim after a blade is located in its slot, whereby a simple, efficient, positive lock is provided between the blade and the rotor rim. The pin is retained by friction in the hole 52.

The foot recess 48 may extend transversely across the base of the foot of the blade and is preferably located a short distance from the downstream end of the blade foot.

The rim of the rotor disk and the pin 50 are preferably of a strong material such as alloy steel. The blade foot may be of a more easily fractured or broken material. In any event, the size of the pin 50 and the thickness of the lip 54 on the blade foot behind the slot 48 may be so proportioned that if the blade is driven forward in the slot, the lip 54 will be broken off without bending or damaging the pin.

The removal of the blade by breaking the frangible lip 54 is illustrated in Fig. 4. After the blade is driven out, the pin 50 may be driven or pressed out preparatory to inserting a new blade. While the removal operation damages the blade, this is immaterial, as the blades are

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not ordinarily removed unless they have been damaged. The removal of the undamaged pin does not damage the rotor.

Where the blade root groove has a substantial radial component due to the taper of the rotor surface, as particularly appears in the left-hand disk of Fig. 1, centrifugal force urges the blade rearwardly. This force is exerted against the pin 50 by the main body of the root, which is easily capable of taking this load.

Even if the forces on the blade tend to slide it so as to load the lip 54, the latter can be made strong enough to accept the operating load, but to break when the blade root is driven out for replacement.

There is thus provided a simple and inexpensive blade retaining means which is not only simple to install and replace, but which also provides an efficient positive lock for securing a footed blade in a blade carrying member and which greatly facilitates removal of a damaged blade from its slot without damage to the blade carrying member.

Although the present invention has been described with reference to one specific embodiment, it will be understood that the invention is susceptible of embodiment in other forms.

We claim:

1. In combination, a blade having a foot having axially extending sides and transversely extending ends, a blade carrying member containing a mating axially extending slot for slidably receiving said blade foot, the blade foot having a recess formed therein adjacent one end thereof, and means for retaining said blade in said slot comprising a pin inserted from said blade carrying member to engage within the recess in said blade foot, the pin being more resistant to fracture than the portion of the blade foot between said recess and said one end, whereby the said portion of said blade foot may be readily broken off to free said blade of said pin for removal of the blade.

2. In combination, a blade having a foot having axially extending sides and transversely extending ends, a blade carrying member containing a mating axially extending slot for receiving said blade foot, means for retaining said blade against movement in said slot comprising a pin inserted through said blade carrying member to engage a recess located in said blade foot and adjacent one of the ends of the foot of said blade and the corresponding end of said slot, said recess extending transversely thereacross, said retaining pin having a shear strength greater than that of said blade foot, whereby a portion of said blade foot may be readily broken off to free said blade of said pin for removal of the blade.

3. In combination, a footed blade, a rotor member having a tapered surface and containing a mating slot for receiving said blade foot, said blade having a component

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of centrifugal force exerted thereon due to the taper of said rotor surface tending to urge said blade out of said slot during rotation of said rotor member, means for retaining said blade against movement in said slot comprising a pin inserted from said rotor member to engage a transverse recess in said blade foot, said recess being located near the end of said blade toward which the blade is urged by said component of centrifugal force, said pin being more resistant to shear fracture than a portion of the blade foot on one side of said recess whereby the said portion of said blade foot may be readily broken off to free said blade of said pin for removal of the blade.

4. In combination, a blade having a frangible foot having axially extending sides and transversely extending ends with an undercut portion thereon adjacent one end thereof, a blade carrying member having a slot therein receiving said blade foot and a relatively infrangible pin inserted from said blade carrying member to engage the said undercut portion of said blade foot in said slot.

5. In combination, a footed blade having an undercut bottom portion forming a narrow lip with a part of the blade foot on one side of the undercut portion thereof, the thickness of said lip measured in a generally axial direction of the blade being several times less than that of the part of said blade foot on the other side of said undercut portion, a blade carrying member having a slot therein for receiving said blade foot and a pin inserted from said blade carrying member to engage the said undercut portion of said blade foot for retaining said blade in said slot.

6. In combination, a rotor blade having an enlarged foot thereon and containing an aperture therein, a support member having a slot therein for receiving the foot of said blade, and a pin-like member carried by said support member and engaging the aperture in said blade foot to retain said blade in said slot, the aperture in said blade foot being displaced from the center of the blade toward one end of the blade foot and slot and the pin-like member being of higher resistance to shear fracture than the part of said blade foot between the aperture and the end of the blade foot adjacent said aperture, whereby the blade can be destructively released from said support member by sliding the blade longitudinally of the slot thereby causing the pin to shear the said part of the blade foot.

References Cited in the file of this patent

UNITED STATES PATENTS

741,776	Dodge	Oct. 20, 1903
1,095,587	McIntosh	May 5, 1914
1,535,417	Huff	Apr. 28, 1925
1,959,220	Robinson	May 15, 1934
2,483,610	Baumann	Oct. 4, 1949