March 6, 1962 W. H. SANDERSON, JR 3,023,998

ROTOR BLADE RETAINING DEVICE

Filed March 13, 1959

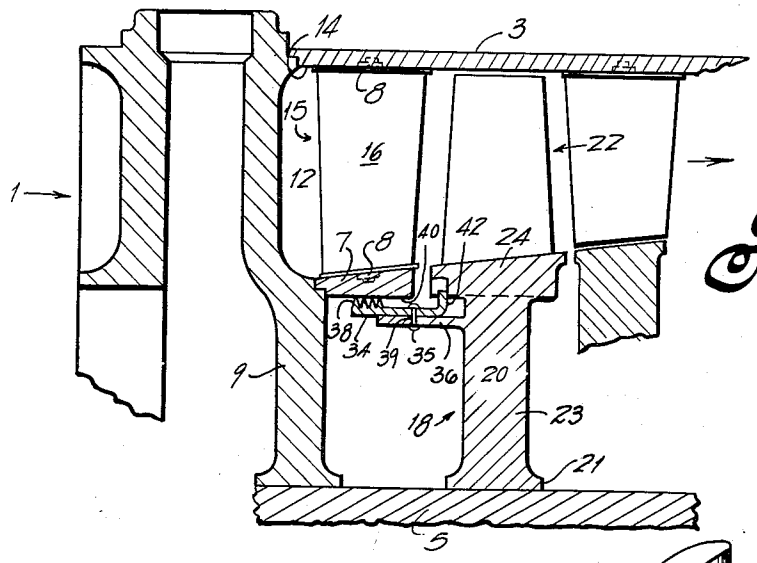


Fig 1

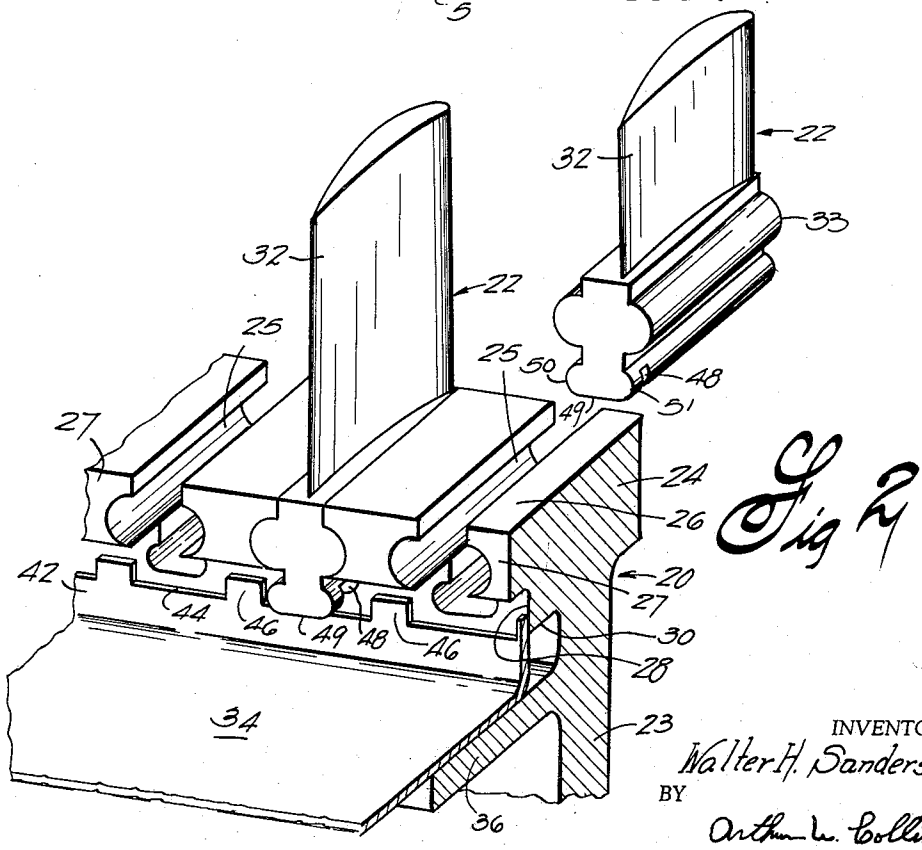


Fig 2

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United States Patent Office 3,023,998
Patented Mar. 6, 1962

3,023,998

ROTOR BLADE RETAINING DEVICE

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Filed Mar. 13, 1959, Ser. No. 799,392
2 Claims. (Cl. 253—39)

This invention relates to rotary, power converting machinery, such as a turbo-machine, and particularly to an improved means for locking the rotor blading in such machinery against axial movement.

In turbo machinery it is a general practice to individually attach rotor blading to a disk mounted on a shaft for rotation therewith. To restrain the blade against radial movement a tongue and groove, fir tree, or other joint is made between the rim of the disk and the roots of the blades. Staking, welding, locking tangs at the base of the blade root, and similar means fasten the blade against axial movement with respect to the disk.

It is also common to utilize labyrinth sealing rings concentric with and spaced from the rotor shaft in order to confine the driving fluid in an annular area containing the airfoil portion of the blading.

An object of this invention is the provision of a unitary locking means which secures all blading on a rotor disk against axial movement.

It is another object of this invention to provide a blade locking means which is an integral portion of a labyrinth seal ring by which all blading on a rotor disk are readily locked or unlocked at one time.

These are achieved according to my invention by the provision of a locking portion in the form of a flange on a seal ring having radially, outwardly extending tangs, each of which seats in a basal slot of a blade with a partial turn of the ring. Restriction of blade motion in an axial direction is obtained with securement of the seal ring to the rotor disk carrying the blading.

In the drawing:

FIG. 1 is a longitudinal section through a portion of a turbo-machine showing the invention applied to the blading on the compressor's first stage rotor;

FIG. 2 is a perspective view showing a rotor blade in spaced relation to a portion of a rotor disk with another blade and seal ring positioned for locking engagement.

Although not necessarily so restricted, the embodiment of the invention is shown and described as pertaining to the first stage rotor assembly of a compressor in a turbo jet engine.

In the drawing, 1 refers to the compressor of a turbine having a hollow, stationary structure or stator vane, outer shroud 3. Coaxially within the outer shroud 3 is a rotor shaft 5 which is rotatably supported by means not shown. Encompassing a forward portion of the shaft is another stationary structure or inner shroud 7. It is concentric with and radially spaced from both the rotor shaft and the outer shroud. Both the inner and outer shrouds are fixed at their forward ends to the inner side of the compressor's front frame 9 by wells (not shown) or other means utilizing the rabbit joints shown. An annular working fluid passage 12 is defined between the outer or fluid conducting surface of the inner shroud 7 and the inner surface 14 of outer shroud 3. Driving fluid enters the passage 12 through an opening (not shown) in the front frame of the compressor.

The first stage stator 15 has vanes, one of which is indicated at 16, arranged in an annular row in the fluid passage 12 that are rigidly secured at their ends to the outer and inner vane supporting shrouds 3 and 7 by some customary means such as shown at 8.

The first stage rotor 18 is disposed downstream of the stator 15 for operative cooperation therewith. It includes

a disk member 20 and a plurality of blades, 22, arranged in an annular row and attached to the rim 24 of the disk. The rotor is mounted for rotation with the shaft 5.

The disk 20 has a hub portion 21 for mounting the disk on the shaft 5, an annular rim 24 provided on its periphery 26 with an annular row of peripherally spaced, axially extending blade receiving recesses 25 (FIG. 2), and a web 23 which joins the rim to the hub. The rim extends axially and equally over both sides of the web. The recesses 25 may have the dove tail shape shown, a fir tree or any other preferable form, since it is immaterial for the purpose of the invention.

The rotor blades 22 include an airfoil portion 32 at their outermost ends and root portions 33 at their other ends that have forms suitable for introduction into the recesses 25 of the rim 24.

A hollow, cylindrical, labyrinth seal ring 34 is carried by the disk and encompasses the shaft portion between the disk and the downstream end of the inner shroud 7. A rivet 35 in a hole 39 secures the seal ring 34 to an annular lip 36 that extends upstream from the web of the disk. A peripheral portion on the forward end of the seal ring 34 telescopes into the inner shroud 7 and is provided with seal means on its outer surface such as the ridges 38 shown for sealing engagement with the inner surface 40 of a downstream peripheral portion of the inner shroud 7. The seal ring 34 thus provides a joint between the rotating rotor and the stationary shroud 7 and contains the fluid flow in the annular passage 12 downstream of the end of the inner shroud 7.

The structure thus far described is known and according to my invention it is improved by the provision of a rotor blade locking flange 42 on the seal ring 34 and the modification of the disk rim and blade roots whereby the flange may be keyed to the blades against axial movement.

The flange 42 is annular and extends outwardly from one end of the seal ring 34. At spaced intervals, the peripheral edge of the flange 42 is cut out as at 44 to form a plurality of radially extending keys or tangs 46 corresponding with the number of blade members to be carried by the rotor disk. Each blade root 33 has a locking slot or keyway 48 suitable for receiving a tang 46. Each slot 48 is formed in the basal surface 49 of the root substantially adjacent its upstream end and penetrates both side walls 50 and 51 of the root. The wall forming the bottoms of the slots 48 are obviously by necessity disposed on a larger periphery than that of the tangs 46.

To provide the tangs with access to the blade slots 48, the upstream wall 27 of the rim has an annular groove 28 on its radially inward portion which includes a portion of the wall forming the bottom of the recesses 25 and the inner wall 30 of the rim.

In use, the roots of the rotor blade 22 are axially slid into the disk rim recesses 25 and positioned so that the slots 48 are in an annular row. The seal ring 34, being disposed on the rotor shaft 5, is then moved axially downstream so that the tangs 46 are positioned between the blades 22 (FIG. 2) and are in the same annular row with the slots 48. The seal ring 34 is then partially rotated until the tangs enter the blade slots 48, thus keying them to the seal ring. Holes 39 in the seal ring 34 and lip 36, if not made before hand, are then drilled and the rivet 35 fixed into place. The blades 22 are readily removable, since to do so merely requires a reversal of the steps outlined for their assembly.

The construction described is obviously subject to many variations without departing from the principle of the invention. It is, therefore, to be understood that the scope of the invention is defined by the appended claims otherwise than as specifically described.

What I claim is:

1. In a rotary fluid machine having a hollow cylindrical inner shroud, a stator mounted on said shroud, a rotor mounted in said machine for operative cooperation with said stator, a disk mounted on said shaft for rotation therewith having a web and rim with portions extending over the end faces of said web, said rim being provided with a plurality of circumferentially spaced recesses penetrating its outer periphery and end faces and having axially undercut sidewalls, a plurality of spaced blades secured at their roots in said rim against centrifugal forces and being free to move axially relative said disk, each blade including a root with ridges shaped to conform with said undercut sidewalls and adapted for insertion into said rim recess by sliding movement axially toward an end face on said rim, support means extending from said disk toward said stator, and a hollow cylindrical sealing ring secured at one end portion to said support means on said disk and in sealing engagement at its other end portion with said shroud, the improvement for securing said blades against axial movement comprising locking means including a plurality of circumferentially spaced tangs extending radially outwardly from said one end portion of sealing ring, said blade roots being provided with basal slots each adapted to receive a tang, and said disk being provided with an opening giving said tangs an access to said slots and engagement of said blades with rotation of said sealing ring.

2. A rotary fluid machine comprising a rotatable shaft, a disk mounted on said shaft for rotation therewith having a web and a rim with portions extending over the end faces of said web, said rim being provided with a plurality of circumferentially spaced axial recesses penetrating its outer periphery and end faces and having axially undercut sidewalls for holding a blade against radial forces but permitting free axial movement, a plurality of blades each including a root with ridges shaped to conform with said undercut sidewalls for mounting thereby into a disk recess by sliding movement axially toward a rim end face and having a lower portion with a basal slot penetrating the bottom and side walls of said root, said rim having an annular opening on its end face and radially inward periphery penetrating said rim recesses and exposing said basal slots, a hollow cylindrical seal ring enclosing said shaft, a flange extending radially outwardly from one end of said seal ring, and a plurality of said circumferentially spaced tangs radially extending from said flange, said tangs being adapted for introduction into said blade basal slots through said rim opening upon partial rotation of said seal ring, and means for securing said ring to said disk.

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