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BLADE RETENTION

Filed Feb. 6, 1959

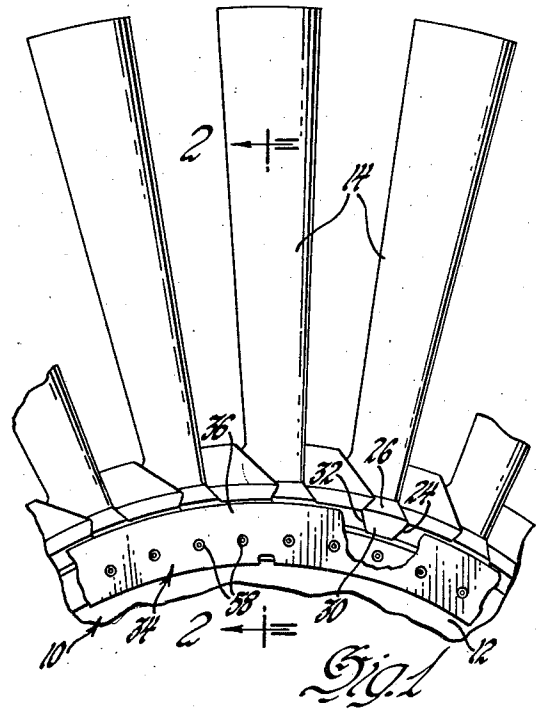


Fig. 1

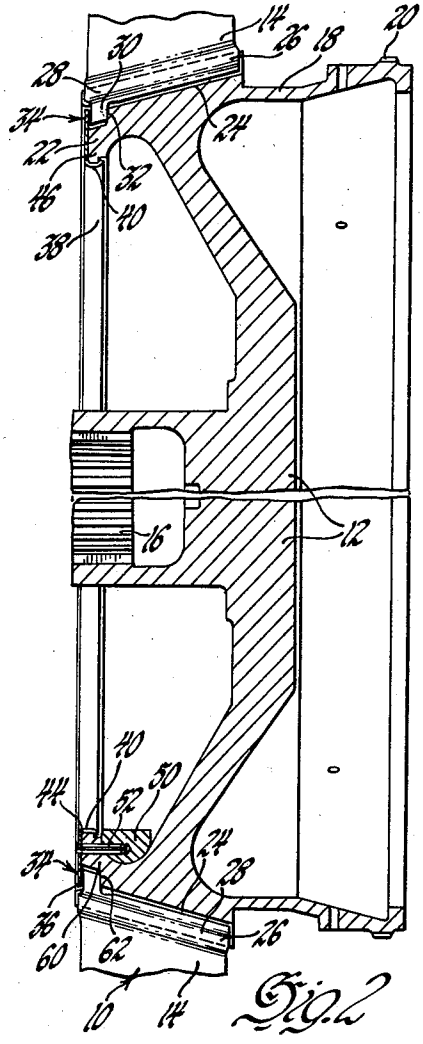


Fig. 2

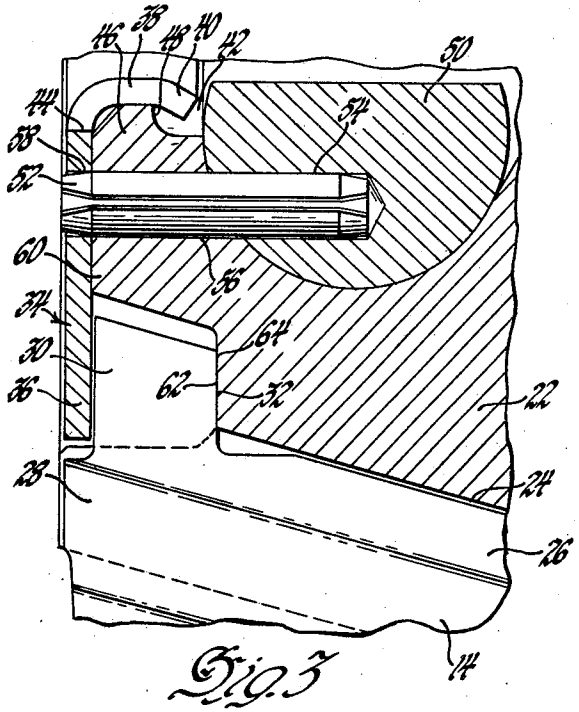


Fig. 3

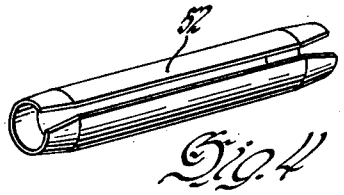


Fig. 4

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BLADE RETENTION

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This invention relates to a blade retaining means for use in a compressor or turbine rotor assembly wherein the blades are connected to the rotor wheel by an axial interfit, and means are provided to prevent axial movement of the blades.

More specifically, this invention relates to a blade-to-rotor wheel connection wherein the means to prevent axial movement therebetween comprises a flexible retaining ring adapted to be snapped over a portion of the wheel into a groove therein with another portion abutting each of the blades.

Therefore, it is an object of this invention to provide a flexible blade retaining ring to prevent relative axial movement between a blade and rotor wheel.

Other features, advantages and objects will become apparent by reference to the detailed description of the invention and to the drawings wherein there is shown the preferred embodiment of this invention.

In the drawings:

FIGURE 1 is a front elevational perspective view of a portion of a rotor assembly embodying this invention,

FIGURE 2 is a cross-sectional view on a reduced scale through the rotor assembly on a plane indicated by the lines 2—2 of FIGURE 1,

FIGURE 3 is an enlarged view of a detail of FIGURE 2, and

FIGURE 4 is a perspective view of a detail of FIGURE 3.

Referring now to the drawings and more particularly to FIGURE 1, there is shown therein a portion or segment of a compressor rotor assembly **10**, although the rotor may be for use in either a compressor or turbine as a matter of choice without departing from the scope of the invention. The rotor assembly includes a wheel **12** having secured thereto at its outer periphery a plurality of blades **14** by means to be described, the wheel being internally splined at **16**, as seen in FIGURE 2, for driving a shaft (not shown). Wheel **12** is further provided with an axial flange **18** adapted to cooperate with a row of stator vanes (not shown), and a spline **20** adapted to mesh with a spline on the adjacent rotor wheel (not shown). The rim **22** of wheel **12** is provided with a number of transverse slots or notches **24** equally spaced around the circumference of the wheel as shown, these notches or slots each having a dove-tail shape as seen in FIG. 1 for cooperation with an oppositely formed mating root portion **26** integral with each of the blades **12**. Mating of the two portions by sliding each of the roots **26** into the slots **24** locates the blades radially with respect to the wheel by the wedging action therebetween preventing radial separation. While the roots and notches are shown as being dove-tailed to each other, it will be clear that a fir-tree type connection or any other similar axial interfit could be used without departing from the scope of the invention.

As shown in FIGURES 2 and 3, the blade roots **26** and rim **22** of wheel **12** are set at an angle relative to the rotor axis simulating the angle that would be found in the first stage of a multi-stage axial flow type compressor, for example, where a ramp effect is provided to both decrease the flow area across the stage and provide the most efficient path for the flow of air past the blading. Because of the axial interfit, and the angling of the roots and wheel rim, a centrifugal force will be exerted on the

blades **14** upon rotation of the rotor tending to urge the blades toward the right out of the notches **24**, which would be undesirable. Therefore, some means must be provided to prevent this movement.

As shown in the figures, each of the blade roots is formed at one edge **28** with a radially depending lug **30** of dove-tail shape to conform to the general shape of the root as seen in FIGURE 1, and is adapted to be received within mating dove-tail notches or grooves **32** provided in one edge of the wheel rim **22**, the number of notches being equal in number to the number of depending lugs **30** and being equally spaced around the circumference of the wheel rim **22**. The radial interfit of each of the lugs and notches therefore prevents axial movement of the blades relative to the wheel in one direction upon rotation of the assembly. When the rotor is not turning, however, and therefore no centrifugal force is acting on the blades, some means must be provided to prevent the blades from sliding out of the notches **24** to the left as seen in FIG. 2 due to the effect of gravity on the blade and root masses.

As shown in FIGURE 2 and more specifically in FIGURE 3, this latter means comprises a retaining ring or disc **34** having one portion **36** adapted to abut the outer face portion of the lugs **30**, while another portion **38** is yieldingly secured to a portion of the wheel in a manner to be described. More specifically, rig **34** has a radially extending portion **36** with an inner portion **38** bent into an axially directed flange having a lip **40** bent in a combined axial and radial direction as shown to form a hook adapted to extend into an annular groove **42** milled in the wheel. The ring is relieved or slotted at four equally spaced points **44** to permit bending of the flange **38** into the shape shown. The milling of groove **42** in the wheel provides an annular depending ridge or flange **46** adapted to cooperate with flange **38**. The major portion of flange **38** is of a dimension so that it will normally slide over the ridge **46**. However, the radially outward bend of the lip **40** provides an interference fit between the shoulder **48** of the wheel and the lip and therefore constitute an axial stop to prevent any tendency of relative axial movement between the rotor and ring.

The relief slots **44** therefore divide the flange **38** into four flexible portions which are deflected radially inwardly to ride over or clear the rib **46** upon axial movement of the ring to abut the radial portion **36** against the end of depending blade lugs **30**. Therefore, as soon as lip flanges **40** have cleared rib **46**, the resiliency of the lip will cause it to be snapped back to its undeflected or original shape to enter groove **42** and thereby provide the interference fit between shoulder **48** and the lip preventing disengagement of the two parts. Thus, the blades are prevented from moving to the left relative to the rotor as seen in FIGURE 2.

As shown in FIGURES 2 and 3, the rotor is provided with at least one balance weight **50** having an arcuate shape corresponding to the shape of the wheel cut-out within which it is secured, and is secured in position in the wheel by a spring-type pin **52** (FIGURE 4) inserted within a groove **54** in the balance weight and aperture **56** in the rotor. While a spring-type pin **52** is shown, a staked solid pin could be used without departing from the scope of the invention. The retaining ring **34** is also provided with a large number of holes **58** equally spaced around the circumference of the retaining ring and arranged radially and circumferentially so as to align some of the holes with the holes in the wheel so that the pins can be inserted therethrough or removed easily to add or change a balance weight without disassembling the wheel assembly. The surplus number of holes in the ring is merely for convenience in lining up a set of retaining ring, rotor and balance weight holes so as to reduce the assem-

bly problems in assembling the retaining ring to the wheel. Additionally, of course, the holes serve to lighten the retaining ring.

While the balance weights are shown in connection with the first stage wheel, they are provided primarily for balancing the entire rotor assembly and not the individual rotor stages per se since the individual stages generally have been balanced prior to assembly. As a rule, in an installation of the axial flow type, the rotor balance weights are attached to both the first and last stage wheels, with the particular number of pins and balance weights being as required to balance the particular rotor assembly.

While the assembly and operation of this blade retaining means is believed to be clear from a consideration of the drawings, a brief description of the same will however be given. Initially, each of the dove-tailed blade roots is positioned at one edge **60** of the wheel and slid axially through the dove-tail shaped notch **24** until face **62** of lug **30** is seated against face **64** of notch **32**. The blade is thus radially positioned in both directions and axially positioned in one direction. The retaining ring **34** is then axially aligned with the wheel and abutted against the wheel ridge **46** so that upon further axial movement of the ring, the axial flange portions **38** will be cammed or deflected inwardly to permit the lip portions **40** to ride over ridge **46** and be snapped into position in the groove **42**. The retaining ring **34** is thus secured to the rotor by the hooking of the axial flange **38** around the ridge **46**, with the radial flange **36** abutting the depending lugs **30**. Each of the blades is therefore restrained from axial movement relative to the rotor towards the left as seen in FIGURE 2.

The blades are therefore restrained from axial movement in the direction of the normal operating forces towards the right as seen in FIGURE 2 by the abutment of the depending lugs **30** against the face **64** of notch **32**, and in the opposite direction by the abutment of ring **34** against the lugs. In the event of a reversal in direction of operating forces or other unusual occurrences wherein the application of forces is caused to be applied against the radial flange **36** in a direction towards the left as seen in FIGURE 2, the forces will merely cause the ring **34** to tighten in the wheel and work as a spring to resist movement of the blades by the tighter engagement of lip portions **40** in the groove **42** and the springing of the axial flange portions **38** in a somewhat radial direction. The blades are thus maintained axially from movement regardless of the direction of operating forces.

From the foregoing it will be seen, therefore, that this invention minimizes assembly problems by simplifying the method of retaining the blades against axial movement, whether the rotor is turning or not. Furthermore, this invention permits removal of the blades without disassembly of the rotor. While the invention has been illustrated in its preferred form in FIGURES 1–4 in connection with a compressor rotor, it will be clear to those skilled in the arts to which this invention pertains that many modifications can be made thereto without departing from the scope of the invention.

I claim:

1. A rotor assembly including a rotor, a plurality of blade means extending radially outwardly of and secured to said rotor for a substantially axial slidable movement therebetween, and retaining means preventing said movement, said retaining means including a flat washer-like disc in operative position located flat against substantially contiguous radial face portions of one side of said rotor and portions of all of the blade means, said rotor having a projection adjacent said rotor radial face portion extending radially inwardly, the inner peripheral portion of said disc having a springable fingerlike clamping means extending axially from said disc and abutting said rotor projection, the axial movement of said disc and clamping means into operative position effecting the springing movement of said clamping means by said projection inwardly over the end of said projection into clamping engagement with said projection to securely fasten said disc and rotor together preventing axial sliding movement of said blade means past said disc.

2. A rotor assembly including a rotor, a plurality of blade means extending radially outwardly of and secured to said rotor for a substantially axial slidable movement therebetween, and retaining means preventing said movement, said retaining means including a flat washer-like disc in operative position located flat against substantially contiguous radial face portions of one side of said rotor and portions of all of the blade means, said rotor having a projection adjacent said rotor radial face portion extending radially inwardly, the inner peripheral portion of said disc having a springable fingerlike flange extending axially from said disc and abutting said rotor projection, the edge of said flange having a hook shape in cross section, the axial movement of said disc and flange into operative position effecting the springing movement of said flange by said projection inwardly over the end of said projection interengaging the hook shaped edge of said flange and said projection securely fastening said disc and rotor together preventing axial sliding movement of said blade means past said disc.

3. A rotor assembly including a rotor, a plurality of blade means extending radially outwardly of and secured to said rotor for a substantially axial slidable movement therebetween, and retaining means preventing said movement, said retaining means including a flat washer-like disc in operative position located flat against substantially contiguous radial face portions of one side of said rotor and portions of all of the blade means, said rotor having a projection adjacent said rotor radial face portion extending radially inwardly, the inner peripheral portion of said disc having an annular flange-like clamping means extending axially from said disc and abutting said rotor projection, said clamping means comprising a plurality of circumferentially arranged and separated springable arcuate clamping portions, the axial movement of said disc and flange-like means into operative position effecting the springing movement of said clamping portions by said projection inwardly over the end of said projection into clamping engagement with said projection to securely fasten said disc and rotor together preventing axial sliding movement of said blade means past said disc.

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