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VANE RING ASSEMBLY

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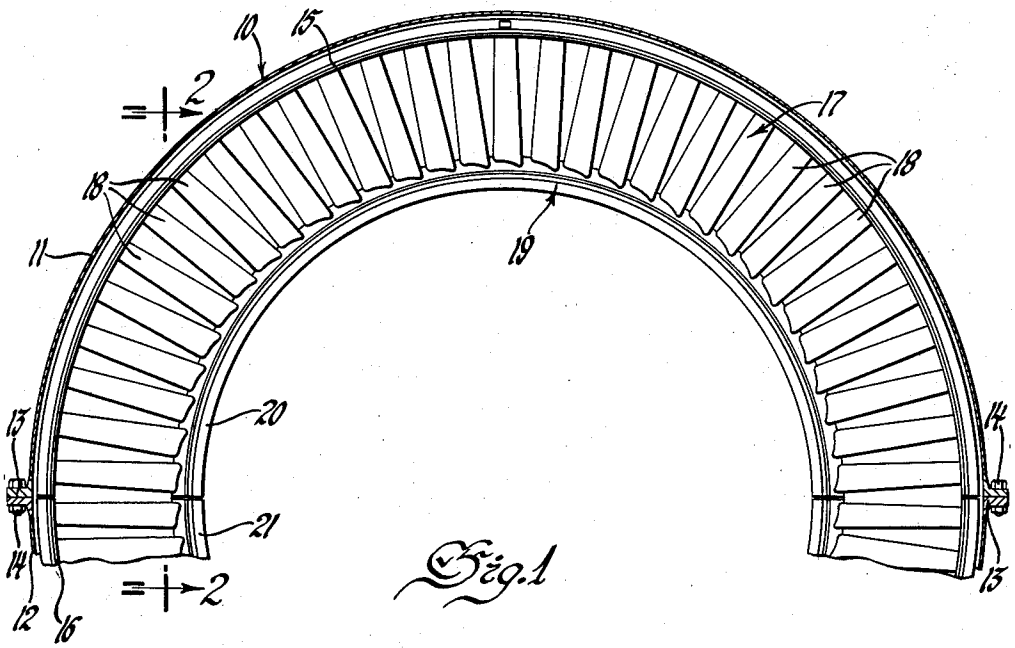


Fig. 1

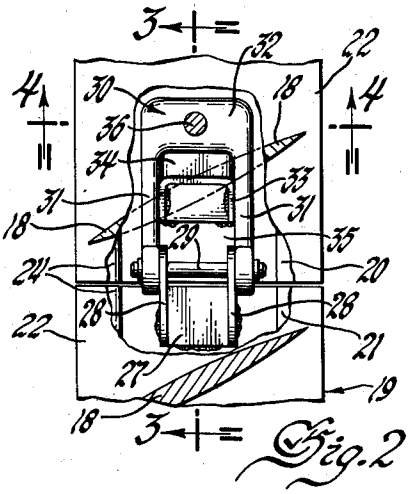


Fig. 2

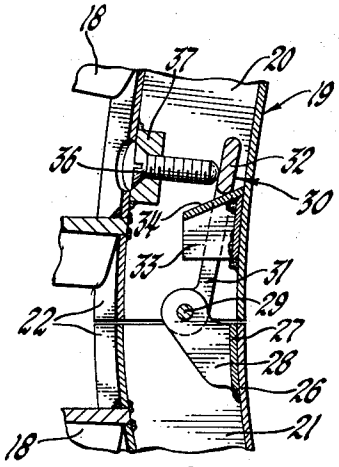


Fig. 3

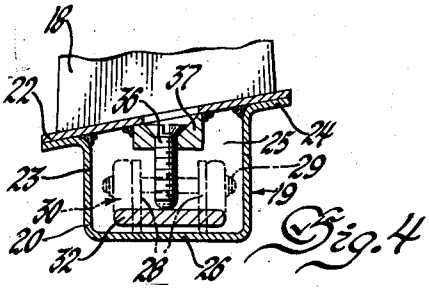


Fig. 4

INVENTOR.
Harvey W. Welsh
BY
Paul Fitzpatrick
ATTORNEY

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VANE RING ASSEMBLY

Harvey W. Welsh, Indianapolis, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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My invention relates to stator vane ring assemblies for axial-flow turbomachines and, more generally, to such axial-flow machines. It is particularly adapted to the requirements of axial-flow compressors such as are employed in aircraft gas turbines, but is not limited thereto.

By way of explanation and background, it is well known that most axial-flow compressors and turbines have alternating annular rows of fixed and moving blades. A ring of fixed blades may be referred to as a stator ring. In most cases, the stator ring comprises an outer shroud, an inner shroud, and vanes extending radially between and fixed to the shrouds. The outer shroud is fixed to the compressor case and the inner shroud ordinarily provides or supports a labyrinth seal acting against the rotor. In order to assemble the compressor, that is, to mount the rotor in the stator structure, the compressor case ordinarily is split along a plane containing the axis of the compressor into two segments, or halves, which are fixed together at what is called the split line on each side of the case. The stator vane rings likewise are made in 180 degree sectors, or halves. The stator vane ring halves are fixed to the halves of the compressor case. After the rotor has been mounted in one half of the case, the other half is placed over the rotor and the two halves of the case are bolted together or otherwise joined at the split lines.

One purpose of the inner shroud is to increase the strength and stiffness of the stator vane structure. However, the usual practice of dividing the inner shroud into two sections greatly reduces the strength of the inner shroud and the restraint it places on the deflection of the vanes. It also increases local stresses in the shroud and vanes. Since the vane ring is deflected axially of the compressor by the load put on the vanes by air flow, a rigid structure which minimizes this deflection is highly desirable because it makes it possible to reduce stage clearances in the compressor and reduce distortion of the seal between the inner shroud and the rotor.

My invention substantially eliminates the defects of the previous split vane ring assemblies by providing a strong mechanical attachment between the adjoining ends of the sections of the inner shroud so that the inner shroud becomes a mechanical equivalent of a continuous ring. This is effected by a coupling device which may be readily applied to fasten the two halves of the inner shroud together. Preferably, although not necessarily, the attachment is such as to put the inner shroud rings in tension. Thus, if a small clearance is provided between the shroud sections and the coupling pulls these together, the inner shroud and the vanes will be put in tension by the coupling and the outer shroud will receive a compressive load.

By this means, a vane assembly is provided which may be taken apart for assembly and disassembly of the compressor but which has mechanical strength substantially equivalent to a continuous 360 degree vane assembly. The rigidity of the structure is high, and distortions with the undesirable effects referred to above are minimized.

A further advantage of a structure according to the invention and a further feature of the invention is that the rigid fixing together of the halves of the vane ring assembly makes it unnecessary to provide a rigid attachment between the outer shroud and the case.

In the succeeding description of the preferred embodiments of the invention, a structure is shown in which the case and vane rings are in two sections. Three or more

sections could be provided if desired, but two sections are sufficient to provide for assembly of the compressor. For conciseness, the term "shroud" or "ring" will be applied to the arcuate sections thereof as well as to the assembled 360 degree shroud or ring.

The nature of the invention and the advantages thereof will be more clearly apparent from the succeeding detailed description of the preferred embodiments of the invention and the accompanying drawings thereof.

FIGURE 1 is a partial transverse sectional view of a stator vane assembly,

FIGURE 2 is a fragmentary view of a shroud coupling taken on the plane indicated by the line 2—2 in FIGURE 1, with parts cut away.

FIGURE 3 is a sectional view taken on the plane indicated by the line 3—3 in FIGURE 2, and

FIGURE 4 is a sectional view taken on the plane indicated by the line 4—4 in FIGURE 2.

Referring now to the drawings and more particularly to FIGURE 1, there is shown therein a compressor case 10 consisting of two semicylindrical sections or halves 11 and 12 having flanges 13 at their edges joined together by suitable bolts 14.

Suitably mounted to the case 10 by means not shown are two semicylindrical outer shroud sections 15 and 16 of a stator vane ring assembly 17 having a number of vanes 18 fixed thereto and to an inner shroud ring 19 comprising two sections 20 and 21.

The manner in which the inner shroud sections are connected together is the subject of this invention.

Referring now to FIGURES 2 to 4 as well as FIGURE 1, each inner shroud section 20 or 21 comprises an outer frusto-conical band 22 and an inner hat-section ring 23, these being spot-welded together at their abutting margins 24, thus forming a hollow box-like chamber 25. The vanes 18 are suitably attached as, for example, by brazing to the inner shroud 19.

Secured within the hollow chamber 25 of shroud section 21 to the inner wall 26 of the hat section, as by spot-welding, is a bracket 27 with two upstanding flanges or ears 28 extending to the split line between the shroud sections 20 and 21. Pivotally mounted on the ends of the ears 28 by means of a pivot pin 29 is a yoke 30 having two arms 31 and a cross piece 32. The yoke 31 is received within the shroud section 20 when the two shroud sections 20 and 21 are placed adjacent each other for joining the two together.

Suitably secured to the bottom wall 26 of the hat section 23 of section 20 as by welding is an upstanding projection or U-shaped member 33 having a combined radially and circumferentially inclined wall or ramp 34 adapted to cooperate with the cross-piece 32. This projection 33 with its ramp 34 is adapted to be positioned within the open portion 35 defined by the arms 31 of the yoke 30 so that the ramp 34 and cross-piece 32 cooperate to form a fastening means for circumferentially and axially securing the two shroud sections 20 and 21 together.

To move or cam the yoke 30 along the ramp or incline 34 to thereby cause relative circumferential movement of shroud section 21 with respect to section 20 to lock the two members securely together, a radially movable camming screw 36 is provided cooperating with an annular threaded lug or guide 37 spot-welded to the underside of the outer band 22 of shroud section 20.

The operation of this shroud coupling will be obvious by reference to the several figures wherein it will be seen that initially the two shroud sections are placed together with the yoke 30 telescoped into the box-like section of shroud section 20 and being slipped over the U-shaped member 33 so that the cross-piece 32 will slide on the ramp 34 to initially provide a friction connection between the two shrouds. Upon threading of

the screw **36** into the boss **37** so as to bear against the cross-piece **32**, tightening of the screw will forcibly cause the yoke **30** to be cammed or moved downwardly along the ramp **34**, thereby circumferentially moving the shroud section **21** into abutting relationship with the shroud section **20**, and providing a secure connection between the two. A very strong and rigid attachment between the stator rings or shrouds is thus provided and the inner shroud is put in tension.

As will be apparent, both of the couplings at the two split lines may be identical. Both brackets **27** may be on one section, or one may be on one end of each section. The screw **36** may be reached by a suitable tool to tighten or release the coupling through the clearances between the stages or through a hole (not shown) in the outer shroud before the top half of the case is assembled onto the lower half.

From the foregoing it will be seen that this invention provides a rigid coupling for securing the inner shroud sections together to prevent circumferential and axial movement thereof. It will be understood that the invention can be modified beyond the illustrated embodiments, and therefore, any limitations to be imposed are those set forth in the following claims.

I claim:

1. Connecting means for joining a plurality of relatively movable arcuate hollow sections together comprising yoke means pivotally connected to one of said sections and extending into the hollow portion of another of said sections, means secured to said other section and extending through said yoke means, said latter means having an inclined portion abutting an end portion of said yoke means, and radially adjustable means secured to said other section and bearing against said end portion of said yoke means for securing said sections together, adjustment of said means pivotally moving said end portion along said inclined portion causing relative movement of said sections until said sections abut each other.

2. Blade ring connecting means comprising a plurality of bladed arcuate sections to be joined, means pivotally mounted on one of said sections and having an opening therein, means mounted on another of said sections and extending through said opening, said latter means having a cam surface, and camming means mounted on said other section for movement in a radial direction and bearing against said pivotally mounted means, movement of said camming means causing camming of said pivotally mounted means along said cam surface to join said sections together.

3. A vaned ring assembly comprising a plurality of arcuate sections to be joined to form a ring-like member, said sections each comprising an outer shroud, an inner shroud, and vanes connected between said shrouds, and means on said inner shrouds for connecting said sections, said means including pivotally mounted means secured to one of said sections, ramp means secured to an adjacent section to be joined and having a surface adapted to be engaged by said pivotally movable means, and radially adjustable means mounted on said adjacent section and bearing against said pivotally mounted means, adjustment of said adjustable means in one direction moving said pivotally mounted means against said ramp means surface joining said sections together.

4. A vaned ring assembly comprising a plurality of arcuate sections to be joined, each of said sections including an outer shroud, an inner shroud, and vanes connecting said shrouds, and means on said inner shrouds for joining said sections, said means including a plurality of upstanding ears mounted on one of said sections, a plurality of arms pivotally connected at one end to said ears, means secured to another of said sections and projecting therefrom and having a surface inclined with respect to the direction of curvature of said arcuate sections, means connecting said arms to each other at their opposite ends and adapted to slidingly abut said inclined surface, and securing means adjustably mounted on said other section and bearing against said arm connecting means slidably abutting said arm connecting means and the inclined surface for securing said sections together.

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