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VANE RING ASSEMBLY

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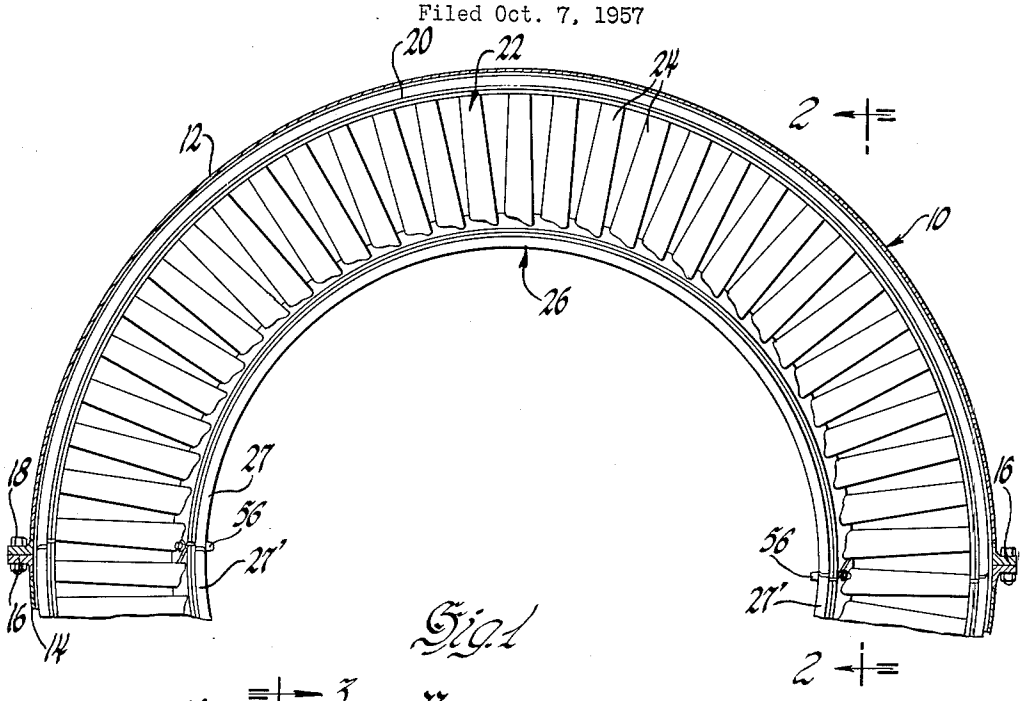


Fig. 1

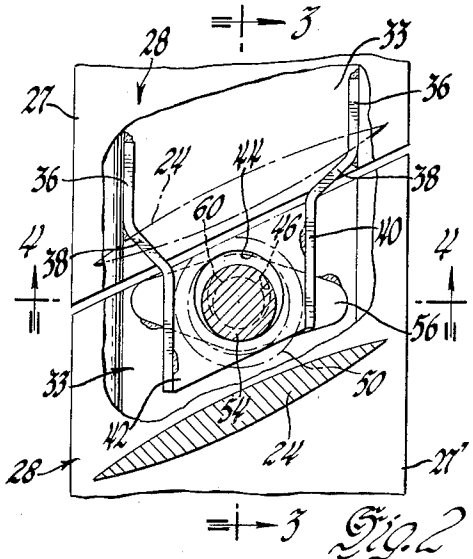


Fig. 2

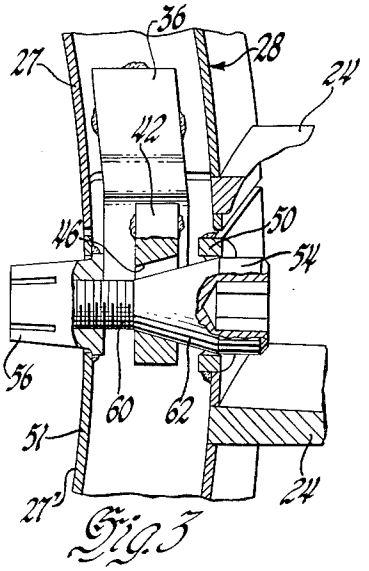


Fig. 3

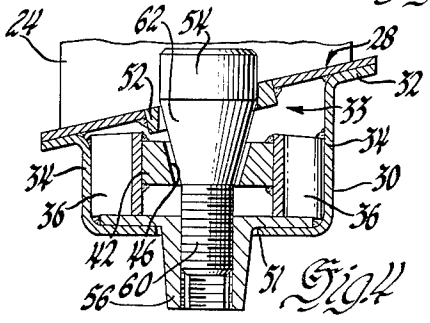


Fig. 4

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 asemblies 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 embodiment 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 semi-cylindrical sections or halves **12** and **14** having flanges **16** formed at their edges and joined together by suitable bolts **18**.

Suitably mounted within the case **10** by means not shown are two semi-cylindrical outer shroud sections **20** of a stator vane ring assembly **22** having a number of vanes **24** fixed thereto and to an inner shroud ring **26**. The mounting of the vane ring assembly in the case may be as described in my application Serial Number 677,933, filed August 13, 1957, and issued as Patent No. 3,026,087.

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 **27**, **27'** comprises an outer frusto-conical band **28** and an inner hat-section ring **30**, these being spot-welded together at their abutting margins **32**, thus forming a hollow box-like chamber **33**. The vanes **24** are suitably attached as, for example, by brazing to the outer band **28**.

Secured within chamber **33** to each of the radial walls **34** of the hat-section ring **30** at one end of each shroud section or both ends of section **27** are circumferentially extending flanges **36** having converging portions **38** and end or tongue portions **40** extending beyond the end of the shroud section **27** and adapted to be received within the adjacent inner shroud section **27'**.

Suitably connecting the ends **40** and welded thereto is a cross member or plate **42** in the shape of a parallelogram and having an annular opening or hole **44** provided with tapered or inclined walls **46** providing a wedging surface or ramp for a purpose to be presently described. It will be noted that the shroud section split line and the cross-piece **42** are skewed with respect to the axis of the compressor so as to not interfere with the mounting of the blades or vanes **24**.

Secured to the other inner shroud **27'** is an annular guide member **50** having an opening **52** for slidably receiving a bolt or conical wedge **54**. Spot-welded to the bottom wall **51** of the hat-section **30** of shroud section **27'** is a nut **56** having threads adapted to cooperate with the threads **60** on the radially movable bolt **54**. The bolt **54** is tapered at **62** for cooperation with the ramp or wedging surface **46** provided on the member **42**, the bolt **54** and nut **56** together constituting a fastening means.

The operation of this device will be obvious by reference to the figures wherein it will be seen that placing the shroud sections **27** and **27'** adjacent each other will telescope the cross-piece **42** within chamber **33** so as to be positioned in alignment with the guide member **50** and the nut **56**. Thereafter, insertion of the bolt **54** into the guide **50**, cross-piece **42**, and nut **56**, and tightening of the same in the nut will cause radial movement of the tapered

portion **62** of the bolt to engage the cam surface **46** of the hole in cross-piece **42** to cam the section **27** circumferentially into abutting engagement with section **27'**. A very strong and rigid attachment between the stator rings 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. The bolt **54** 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. A vane ring assembly comprising a plurality of circumferentially arranged arcuate sections together forming a ring-like body, each of said sections comprising an outer shroud, an inner hollow shroud, and vanes between said shrouds; and means connecting the arcuate sections of said inner shrouds, said means comprising tongues fixed within said hollow member on one of said sections and extending circumferentially therebeyond, the hollow member

of an adjacent section telescopically receiving said tongues a part rigidly fixed to said tongues at their ends and having a tapered hole therein extending radially of the ring, mutually coaxial guide means and fastening means on said adjacent section, and a tapered pin progressively movable radially of the ring into and through said guide means and hole into engagement with said fastening means for connecting said sections together, said hole being slightly offset relative to the axis of the guide means and fastening means, said pin having a conical surface for contact with the said part upon radial movement of said pin for circumferentially moving said connecting means and one section towards the other section.

2. An assembly as recited in claim 1 in which the said pin and fastening means are threaded together, rotation of the pin thus moving the pin into the hole.

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