Nov. 27, 1956 C. E. HOCKERT ET AL 2,772,069

SEGMENTED STATOR RING ASSEMBLY

Filed Oct. 31, 1951 2 Sheets-Sheet 1

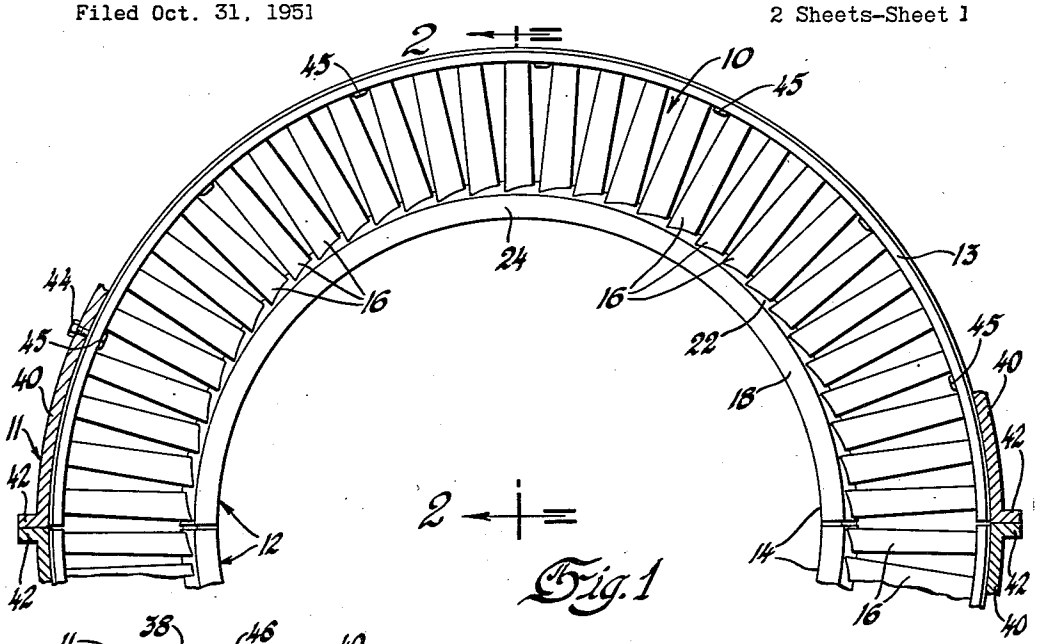

Fig. 1

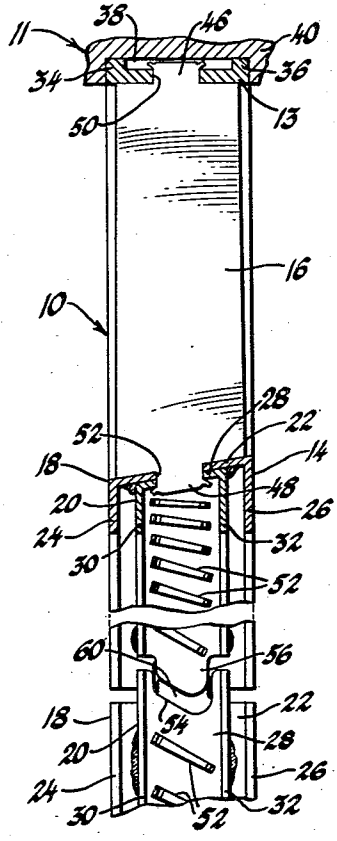

Fig. 2

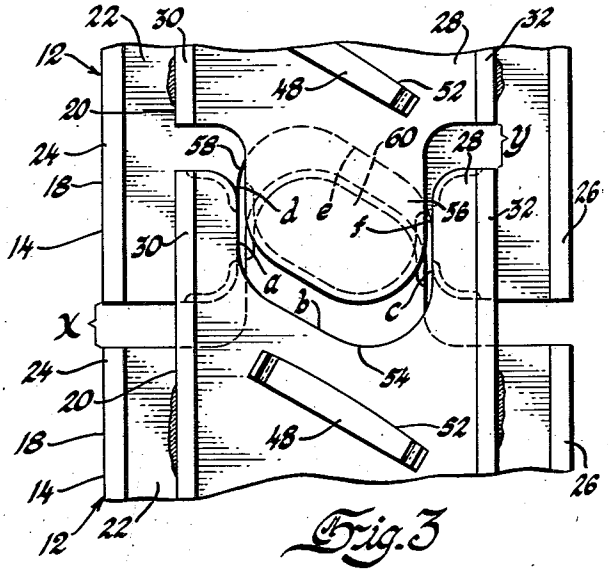

Fig. 3

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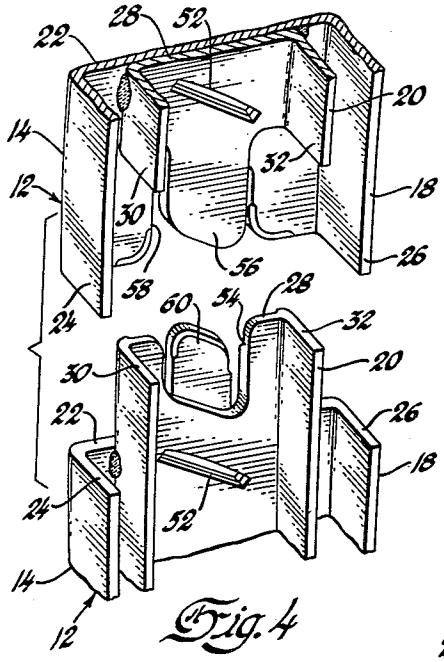

Fig. 4

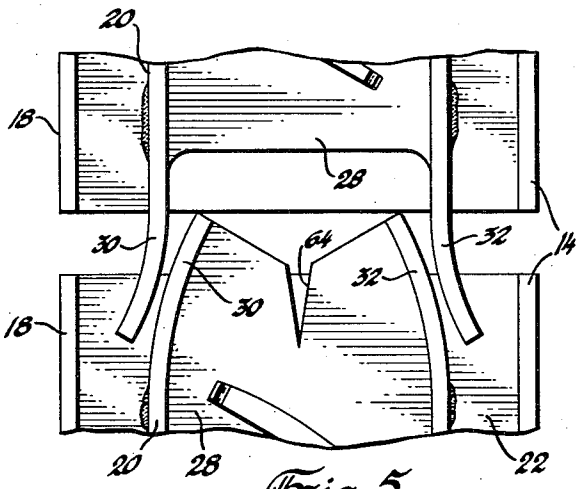

Fig. 5

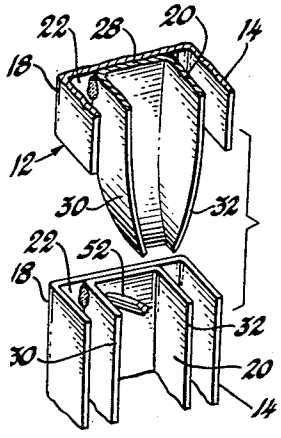

Fig. 6

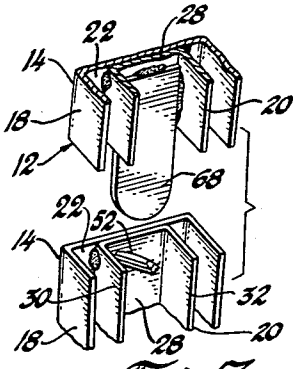

Fig. 7

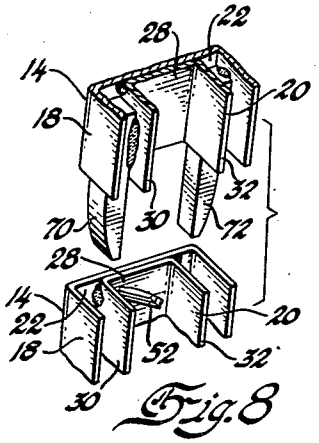

Fig. 8

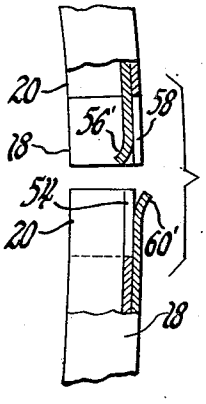

Fig. 4a

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SEGMENTED STATOR RING ASSEMBLY

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Application October 31, 1951, Serial No. 254,143

5 Claims. (Cl. 253—78)

This invention relates to a blade assembly for multistage fluid dynamic rotary machines and more particularly to engaging means for detachably interconnecting a shrouded blade assembly of the segmented ring variety.

From the standpoint of weight, simplicity of manufacture, and facility of assembly and disassembly, ring-like blade assemblies composed of a plurality of interconnected annular segments afford many advantages over the type of blade assembly commonly employed heretofore composed of a plurality of circumferentially spaced blades or vanes positioned between continuous outer and inner shroud rings. A shrouded blade assembly of the aforesaid segmented ring variety is illustrated and described in U. S. Patent 2,640,679, filed March 21, 1950, in the names of John B. Wheatley, Arthur W. Gaubatz, and Charles C. Anderson, and assigned to the present assignee, wherein there is shown a stator ring structure which comprises a pair of semi-circular ring vane assemblies each of which is constituted by outer and inner shroud bands between which are mounted a plurality of stator vanes. Each of the inner shroud bands comprises a pair of concentrically disposed channel members having superimposed webs and inwardly directed flanges which provide a fluid seal for reducing air leakage between the tips of the stator vanes and the rotor of a turbine or axial-flow compressor.

The present invention is directed to novel engaging means for detachably interconnecting adjacent arcuate segments of a double-channel inner shroud ring of a segmented stator ring structure. In accordance with a preferred embodiment of the present invention, a tongue and groove are integrally formed in one extremity of the outer and inner channel members, respectively, of each inner shroud band segment of a segmented stator ring structure. The tongue and groove slidably engage and mate with a complementary groove and tongue which are integrally formed in the adjacent or proximate ends of the outer and inner channel members, respectively, of an adjacent inner shroud band so as to be positively interconnected therewith.

Among the objects of the present invention are to provide simple and inexpensive engaging means for detachably interconnecting a segmented blade assembly so as to facilitate rapid assembly and disassembly thereof and to positively interlock the stator ring segments against movement in a direction substantially transverse to the plane of the blade assembly.

Other objects, features, and advantages of the present invention will appear more fully from a consideration of the following detailed description and drawings wherein;

Fig. 1 is a fragmentary transverse view of a segmented stator vane assembly utilizing an engaging means in accordance with the present invention;

Fig. 2 is a fragmentary sectional view taken in the plane indicated by the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary detail view of an engaging means in accordance with one embodiment of the invention;

Fig. 4 is a fragmentary axonometric view of the structure of Fig. 3;

Fig. 4*a* is a modification of Fig. 4.

Fig. 5 is a fragmentary view of another embodiment of the present invention; and

Figs. 6 to 8, inclusive, are fragmentary axonomertic views of still different embodiments of the present invention.

Referring to the drawings, Fig. 1 is a fragmentary transverse view of a segmented stator ring structure of a type suitable for use in an axial-flow compressor or turbine of a gas turbine engine and the like.

The stator ring structure 10 is contained within a cylindrical outer casing 11 composed of two half-sections to facilitate assembly and disassembly thereof. The stator ring structure 10 comprises a pair of semi-circular segments 12 that correspond to the halves of the casing 11. Each of the segments 12 is constituted by a semi-circular outer shroud band 13 and inner shroud band 14 between which are secured a plurality of stator vanes 16. Each of the inner shroud bands 14 comprises a pair of concentrically arranged channel members 18, 20 as shown in Fig. 2 and by the axonometric view of Fig. 4, for example. The channel members provide a fluid seal that materially reduce leakage of air around the stator vanes 16. The larger outer channels 18 comprise a base or web portion 22 and a pair of inwardly extending sealing flanges 24, 26, the web portions 22 thereof serving as inner shroud bands which may project axially beyond the leading and trailing edges of the stator vanes 16. Each of the smaller inner channels 20 also comprises a base or web portion 28 and a pair of inwardly extending sealing flanges 30, 32, the webs 22 of the larger channels 18 being superimposed or seated on the webs 28 of the smaller channels 20 and may be rigidly secured thereto as by spot welding, for example. The resultant series of axially spaced flanges 24, 30, 32, and 26 of the inner shroud band 14 are adapted to project into proximity to the surface of a rotor disk (not shown) as described in the aforementioned copending patent application, thereby providing an effective labyrinth seal. The sealing flanges can be of various lengths or shapes, depending on the contour of the rotor of the machine.

The outer shroud bands 13 and the channels 18 and 20 constituting the inner shroud bands 14 are preferably of rolled stock which possesses little weight and sufficient rigidity. The outer and inner channels 18 and 20 of the inner shroud bands are rigidly secured together before they are pierced to receive the tenons of the stator vanes and before their terminal portions are shaped or cut-off as will appear hereinafter. When assembled with the outer shroud bands 13 and the stator vanes, the outer and inner channel members of the inner shroud bands serve both as a reinforcing integral part of the stator ring structure and as a sealing device.

The outer shroud bands 13 extend circumferentially around the interior of the compressor or turbine casing 11 and may be formed with outwardly projecting peripheral flanges or rims 34, 36 which are seated in an annular groove 38 in the inner surface of the compressor or turbine casing. The casing 11 is constructed of two semi-cylindrical sections 40 which are fastened together by bolts (not shown) passing through the flanges 42 thereof. The rims 36, 38 of the outer shroud bands 13 engage the casing groove 38 (Fig. 2) and prevent axial movement of the ring structure and aid in the alignment of the stator vanes as well as increase the structural strength of the stator ring. The stator ring structure is supported from the interior of the split casing 11 by a plurality of spaced stud bolts 44 extending through the casing to engage threaded bosses 45 fixed in the outer shroud bands.

As illustrated in Fig. 2, the outboard and inboard ends of the stator vanes 16 are shaped to provide outer and inner projecting tangs or tenons 46, 48 which are received in radially aligned elongated apertures 50, 52 cir-

cumferentially spaced about the periphery of the outer shroud bands 13 and the channel members 18 and 20 of the inner shroud bands 14 respectively. The tenons 46, 48 are headed as illustrated by electric upsetting or other suitable means to rigidly secure the vanes 16 to the outer and inner shroud bands, and additionally fix the channels 18 and 20 together.

In accordance with a preferred embodiment of the present invention, the segments of the stator ring structure 10 are interconnected by tongue and groove connections integrally formed at both ends of each inner shroud band 14 included in each of the stator segments 12, as shown in Figs. 2, 3 and 4. As best illustrated in Fig. 4, the inner channel 20 of the inner shroud band 14 of one segment 12 projects peripherally beyond the flanges 24, 26 of the outer channel 18 and has a shallow groove or slot 54, defined by the surfaces *a, b, c,* of Fig. 3, formed in the web 28 of one extremity thereof. The groove 54 is adapted to receive a complementary mating tongue 56 in slidable engagement therewith, the tongue being integrally formed in the web 28 at the apposite extremity of the corresponding inner channel member 20 of the inner shroud band 14 of the adjacent ring segment 12. The outer channel 18 of the shroud band 14 of the said adjacent ring segment 12 extends or projects similarly beyond the flanges 30, 32 of the inner channel member 20 and has a groove or slot 58, defined by the surfaces *d, e, f* of Fig. 3, formed in the web 22 thereof so as to slidably receive a complementary mating tongue 60 formed in the web 22 at the apposite extremity of the outer channel member 18 of the first inner shroud band 14 of the first mentioned ring segment.

When assembled in position the junction between the opposed ends of a pair of adjacent inner shroud bands is as illustrated in Fig. 3. The tongues and grooves may be lengthened where space permits. The peripheral separation X, Y between the ends of the outer and inner channel members of the respective inner shroud band segments allows for circumferential expansion, while the spacing between the edges of the respective tongues and their associated grooves prevents binding and aids assembly.

Preferably, each channel of each inner shroud band is formed with a tongue at one end of a groove at the other end, so that each segment 12 is identical with other segments.

In order to insure easy entry of the tongue 60 above tongue 56 and thereby obviate misalignment and possible bending of the ring, the entering edges of the tongues and grooves are preferably chamfered approximately one-half the stock thickness as shown in Figs. 3 and 4. The entering edges could be slightly curled in opposite directions in order to spread the tolerance and aid proper engagement, if desired as shown in Fig. 4*a*, for example, in which the web 56' of the interchannel member of one ring segment is oppositely curved to the web 60' of the outer channel member of the other adjacent ring segment.

The tongues and grooves can be stamped out as integral parts of the outer and inner channel members of the inner shroud ring segments, thereby eliminating any welding or riveting operations sometimes used for fastening segmented shroud bands. The interlocking means thus provided is not only simple and inexpensive to manufacture, but adds no weight to the stator ring structure.

It has been found that the segments of a segmented blade assembly incorporating the tongue and groove fastening method of the present invention are self-positioning and that the ring structure lends itself to circumferential expansion. The latter feature is particularly advantageous and desirable in a gas turbine engine wherein the high temperatures attained could cause buckling of a continuous ring assembly. Once the ring assembly is assembled, the interengaging means insure a positive interlock against relative axial movement and yet permit ready disassembly when necessary.

Figs. 5 to 8, inclusive, illustrate different embodiments of the invention. In Fig. 5, the web 28 of one end of the inner channel member 20 of the shroud band 14 is recessed or cut back to allow the flanges 30, 32 thereof to project peripherally beyond the end of the outer channel member 18. The projecting flanges 30, 32 are oppositely curved and flare outwardly as shown. The corresponding inner channel member 20 of the mating band 14 also projects beyond the end of the outer channel member 20 and has a notch 64 in the end of the web 28 thereof to permit the flanges 30, 32 thereof to be curved inwardly so as to fit within the flanges of the first inner channel member 20 and to be positively interlocked therewith when in the assembled position shown.

In the form of Fig. 6, one end only of the inner channel member 20 projects beyond the outer channel 18. The web 28 and flanges 30 and 32 of the projecting end are bent inwardly so as to fit within the unmodified end of the inner channel of the adjacent section.

In the form of Fig. 7, a projecting tab 68 welded or otherwise fixed to the web 28 of one inner channel member 20 slidably engages the inner surface of the web 28 between the flanges 30, 32 of the other inner channel member 20 and provides a positive interlock therebetween.

In the form of Fig. 8, a pair of projecting tabs or fingers 70, 72 having curved ends are welded to the outer surfaces of the flanges 30, 32 of the inner channel member 20 and/or to the inner surfaces of the flanges 24, 26 of the outer channel member so as to slidably engage between the outer surfaces of the flanges 30, 32, respectively, of the inner channel member 20 and the flanges of the outer channel of the inner shroud band of the adjacent segment.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised without departing from the spirit and scope of the invention.

We claim:

1. A blade ring assembly having a number of arcuate sections each comprising an outer ring segment, an inner ring segment spaced from and coaxial with said outer ring segment and a number of blades fixed in and extending radially between said outer and inner ring segments, adjacent sections of said blade ring assembly having an axially extending peripheral clearance space between their adjacent extremities to facilitate assembly and to permit differential thermal expansion thereof, each of said inner ring segments being of double channel construction with an outer channel member and an inner channel member having superimposed webs and axially spaced radially inwardly directed flanges, the adjacent extremities of adjacent inner ring segments having a tongue and groove connection for both of the said channel members of each of said segments permitting peripherally slidable movement and restraining relative axial movement of said ring sections, each of the said inner ring segments having the said inner channel member at one of the extremities thereof projecting beyond the end of the outer channel member thereof to overlap the said peripheral clearance space between that segment and an adjacent inner ring segment.

2. A blade ring assembly having a number of arcuate sections each comprising an outer ring segment, an inner ring segment spaced from and coaxial with said outer ring segment and a number of blades fixed in and extending radially between said outer and inner ring segments, adjacent sections of said blade ring assembly having an axially extending peripheral clearance space between their adjacent extremities to facilitate assembly and to permit differential thermal expansion thereof, each of said inner ring segments being of double channel con-

struction with an outer channel member and an inner channel member having superimposed webs and axially spaced radially inwardly directed flanges, each of the said inner ring segments having a tongue and groove integrally formed on one extremity of the outer and inner channel members, respectively, thereof mating with a complementary oppositely formed groove and tongue integrally formed on the adjacent extremity of the corresponding outer and inner channel members, respectively, of an adjacent inner ring segment.

3. A blade ring assembly having a number of arcuate sections each comprising an outer ring segment, an inner ring segment spaced from and coaxial with said outer ring segment and a number of blades fixed in and extending radially between said outer and inner ring segments, adjacent sections of said blade ring assembly having an axially extending peripheral clearance space between their adjacent extremities to facilitate assembly and to permit differential thermal expansion thereof, each of said inner ring segments being of double channel construction with an outer channel member and an inner channel member having superimposed webs and axially spaced radially inwardly directed flanges, each of the said inner ring segments having a tongue and groove integrally formed on one extremity of the outer and inner channel members, respectively, thereof mating with a complementary oppositely formed groove and tongue integrally formed on the adjacent extremity of the corresponding outer and inner channel members, respectively, of an adjacent inner ring segment, each of the said inner ring segments having the said inner channel member at one of the extremities thereof projecting beyond the end of the outer channel member thereof to overlap the said clearance space between that segment and an adjacent inner ring segment.

4. A blade ring assembly having a number of arcuate sections each comprising an outer ring segment, an inner ring segment spaced from and coaxial with said outer ring segment and a number of blades fixed in and extending radially between said outer and inner ring segment, adjacent sections of said blade ring assembly having an axially extending peripheral clearance space between their adjacent extremities to facilitate assembly and to permit differential thermal expansion thereof, each of said inner ring segments being of double channel construction with an outer channel member and an inner channel member having superimposed webs and axially spaced radially inwardly directed flanges, each of the said inner ring segments having a tongue and groove

integrally formed on one extremity of the outer and inner channel members, respectively, thereof mating with a complementary oppositely formed groove and tongue integrally formed on the adjacent extremity of the corresponding outer and inner channel members, respectively, of an adjacent inner ring segment, the entering edges of the tongues at the adjacent ends of adjacent inner ring segments being curled in opposite directions to facilitate interengagement thereof.

5. A blade ring assembly having a number of arcuate sections each comprising an outer ring segment, an inner ring segment spaced from and coaxial with said outer ring segment and a number of blades fixed in and extending radially between said outer and inner ring segment, adjacent sections of said blade ring assembly having an axially extending peripheral clearance space between their adjacent extremities to facilitate assembly and to permit differential thermal expansion thereof, each of said inner ring segments being of double channel construction with an outer channel member and an inner channel member having superimposed webs and axially spaced radially inwardly directed flanges, each of the said inner ring segments having a tongue and groove integrally formed on one extremity of the outer and inner channel members, respectively, thereof mating with a complemetary oppositely formed groove and tongue integrally formed on the adjacent extremity of the corresponding outer and inner channel members, respectively, of an adjacent inner ring segment, the entering edges of the tongues at the adjacent ends of adjacent inner ring segments being curled in opposite directions to facilitate interengagement thereof, each of the said inner ring segments having the said inner channel member at one of the extremities thereof projecting beyond the end of the outer channel member thereof to overlap the said clearance space between that segment and an adjacent inner ring segment.

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