

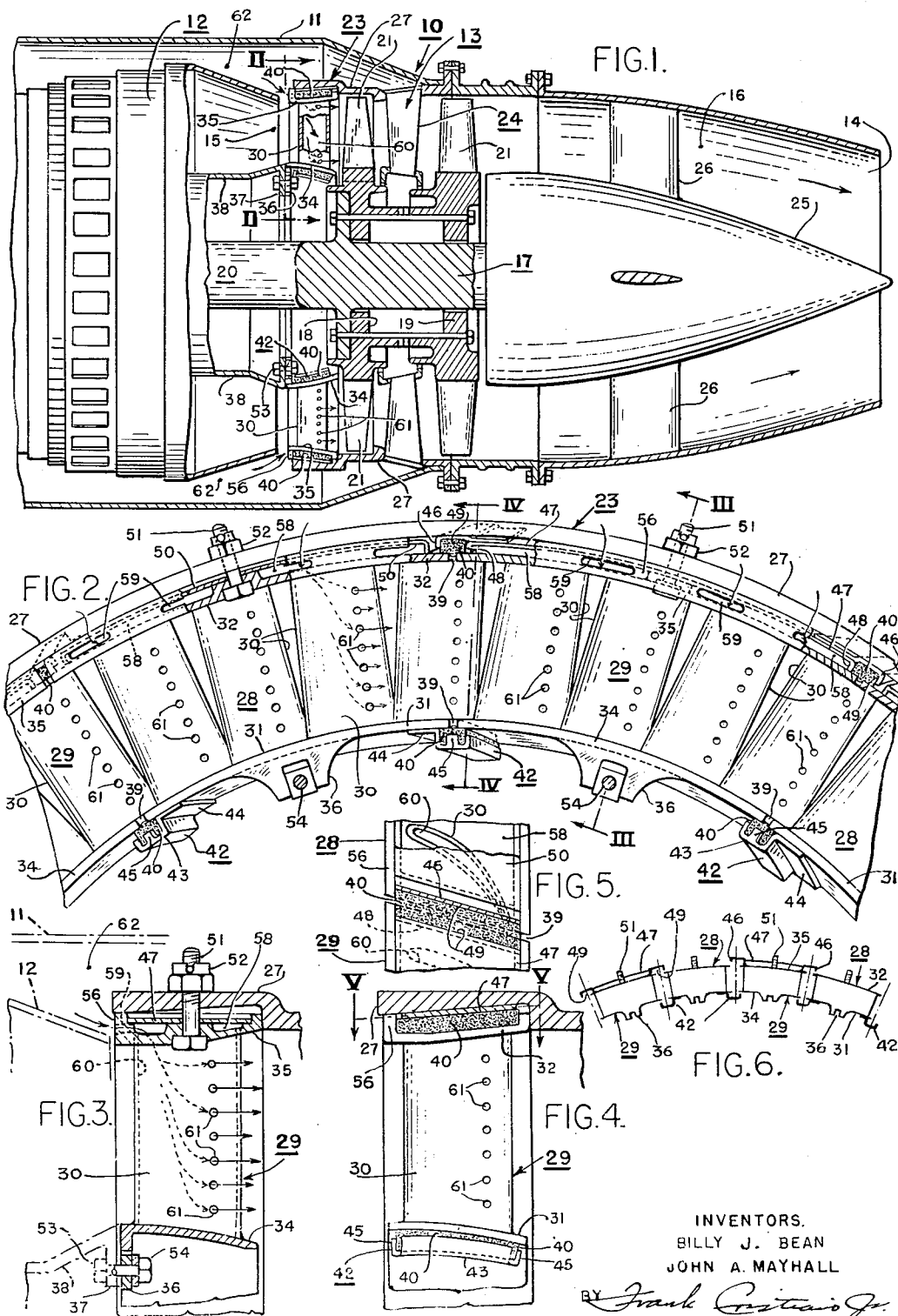
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STATOR STRUCTURE FOR AXIAL-FLOW FLUID MACHINE

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STATOR STRUCTURE FOR AXIAL-FLOW FLUID MACHINE

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This invention relates to fluid sealing apparatus, more particularly to fluid sealing apparatus for elastic fluid power conversion machines such as turbines and the like, and has for an object to provide a seal structure for sealing motive fluid from leaking out of the motive fluid passageway in a machine of the above type.

In gas turbines of the axial flow type, it is desirable to form the nozzle block structure in segments, each of which has a group of nozzle vanes connected to inner and outer shroud segments. This arrangement has several advantages over the unitary nozzle block structure, since servicing is facilitated and, if only one nozzle vane is damaged, that segment may be removed and replaced instead of replacing the entire nozzle block structure. Further, since the gases flowing therethrough are exceedingly hot, expansion of the vanes and shrouding is permitted without the possibility of stressing the turbine housing and other related structure. However, while segmented nozzle block structures have the above as well as other advantages, they do have one disadvantage and this is the problem of sealing the spaces between the shroud segments of the segmented nozzle blocks. Various proposals have heretofore been made for sealing the above mentioned shroud spaces, but have met with varying degrees of success.

In view of the above, it is a further object to provide a sealing arrangement for sealing the gas flow through a segmented nozzle block arrangement, which arrangement is simple to manufacture, highly effective in operation regardless of temperature variations and which provides a reliable leakproof seal under all conditions of operation.

In accordance with the invention, there is provided a nozzle structure for an axial-flow elastic fluid power conversion machine, such as a turbine or the like, having a plurality of arcuate nozzle block segments disposed in an annular array with their inner and outer shroud members disposed in closely spaced end-to-end relation and having means for individually sealing the spaces between the ends of adjacent shroud segments.

Each of the sealing means includes a compacted resilient material, for example, a woven metallic filamentary member and a clip structure attached to one of the shroud segments and having a U-shaped channel portion for containing the seal member and maintaining the same in abutment with the shroud surface. The clip structure preferably is made of flexible sheet metal, so that it retains the seal member in biased abutment with the end portions of the shroud members, even though the nozzle block segments may move relative to each other under the influence of thermal expansion.

A further feature of the invention resides in providing a nozzle structure of the above type in which the clip structures are attached to the nozzle block segments in such a manner that half of the nozzle block segments are provided with two of the clips at the ends of the inner shroud segments while the others are provided with two of the clips at the ends of the outer shroud segments. The thus formed nozzle block segments are disposed in an alternating pattern. Hence, each of the spaces between inner and outer shroud segments is provided with a seal member, which seal member may be resiliently

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positioned by the nozzle block segments to provide the optimum seal against leakage of motive gases therethrough.

With the above arrangement, the resulting seal structure is effective during all conditions of operation to prevent flow of gases through the spaces between shroud segments, thereby preventing the gases from bypassing the nozzle vanes and flowing into the associated rotor blade row at an improper angle. This effect has heretofore resulted in considerable loss in efficiency in the extraction of the energy from the motive gases.

The foregoing and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

FIG. 1 is a longitudinal section of the aft end portion of an aviation turbojet engine including a gas turbine section incorporating the invention;

FIG. 2 is a transverse section, on a larger scale, taken on lines II—II of FIG. 1, with portions broken away for clarity;

FIG. 3 is a section taken on line III—III of FIG. 2;

FIG. 4 is a section taken on line IV—IV of FIG. 2;

FIG. 5 is a fragmentary section taken on line V—V of FIG. 4; and

FIG. 6 is a diagrammatic view showing some of the nozzle block segments in spaced relation with each other.

Referring to the drawing in detail, in FIG. 1, there is shown an aviation turbojet engine 10. Since the engine may be of any suitable type and forms no part of the invention, only the aft end thereof, wherein the invention is incorporated, has been shown. As well understood in the art, the engine 10 is provided with a tubular outer shell structure 11 having disposed therein a fuel combustion section 12 and a turbine section 13 and defining a rearwardly directed exhaust nozzle 14. In the fuel combustion section 12, fuel is ignited in the presence of air to form hot motive gases which are directed therefrom through a passageway 15 of annular shape to the turbine section 13 wherein they are partially expanded to energize the turbine. The gases are then directed through an exhaust passageway 16 in rearward direction to the ambient atmosphere through the exhaust nozzle 14 to provide a propulsive thrust to the engine in forward direction.

The turbine section 13, as illustrated, is of the two-stage type and includes a rotor structure 17 having mounted thereon a first rotor disc 18 and a second rotor disc 19 disposed downstream thereof. Both of the rotor discs 18 and 19 are bolted or otherwise attached to a drive shaft 20 and are further provided with an annular row of unshrouded blades 21. Immediately upstream of the first rotor blade row 21 there is provided an annular nozzle structure 23 for directing the motive gases from the fuel combustion section 12 to the first rotor blade row at the optimum angle.

In a similar manner, immediately upstream of the second rotor blade row 21 there is provided a second annular nozzle structure 24 for redirecting at the optimum angle the motive gases received from the first rotor blade row 21 to the second blade row 21. Hence, in a manner well known in the art, as the motive gases flow through the turbine section 13, they are partially expanded therein to rotate the rotor structure 17 and provide power at the shaft 20 for operating the other engine components (not shown). The gases are then ejected through the exhaust nozzle 14 with sufficiently remaining energy to provide the forward propulsion to the engine.

In addition thereto, within the exhaust nozzle 14 there is conventionally provided a generally conical fairing member 25 supported within the exhaust nozzle 14 by a plurality of suitable struts 26, thereby to permit flow of

the gases through the nozzle in a smooth and efficient manner.

The turbine section 13 is enclosed in a tubular outer housing 27 which supports the nozzle structures 23 and 24 and defines the outer periphery of the annular flow passageway through the turbine for the motive gases.

In accordance with the invention, the first nozzle structure 23 includes a plurality of nozzle block segments 28 and 29 disposed in an alternating annular array, each having one or more nozzle or guide vanes 30 for directing the gas flow therethrough.

The nozzle block segments 28 are provided with inner and outer arcuate shroud segments 31 and 32 disposed in radially spaced relation with each other and having the vanes 30 connected thereto.

In a similar manner, the nozzle block segments 29 are provided with inner and outer arcuate shroud segments 34 and 35 disposed in radially spaced relation with each other and having the vanes 30 connected thereto.

The inner shroud segments 31 and 34 are provided with radially inwardly directed slotted tangs 36 disposed at their upstream edge portions. The nozzle block segments 28 and 29 are received in the turbine housing 27 and are bolted at their tangs 36 to mating tangs 37 provided in a tubular fairing member 38 which is rigidly connected to the engine (in a manner not shown) and forms the inner periphery of the gas flow passageway 15 from the fuel combustion section, as best shown in FIG. 1.

The thus formed nozzle block segments 28 and 29 are disposed in an alternating sequence with their shroud segments disposed in spaced end-to-end relation with each other to form spaces 39 extending from the upstream edges of the shroud members to the downstream edges thereof, as best shown in FIG. 5. The spaces 39 are individually sealed against leakage of motive gases therethrough by a resilient member 40 disposed in abutment with the outer surfaces of the ends of adjacent shroud segments.

Although the specific material utilized in forming the resilient members 40 does not form a part of the invention, it is desirable to form them of a highly heat resistant material which is flexible or resilient, thereby to permit relative motion between adjacent shroud segments while still maintaining the seal. One of the materials found highly suitable for this application is a woven or braided filamentary material wherein the filaments are made of a metal capable of withstanding the hot motive gases without deterioration.

The nozzle block segments 28 are provided with a pair of clip members 42 disposed at the opposite ends of the inner shroud segments and having U-shaped channel-shaped portions 43 for retaining the seal members 40 and tang portions 44 for attachment to the concave inner face of the shroud segment. The channel portions 43 may further be provided with tabs 45 to maintain the seal members in the channel portions.

The nozzle block segments 29 on the other hand, are provided with seal member retaining structure including a pair of opposed L-shaped members 46 of flexible sheet metal attached to an elongated sheet metal member 47 of arcuate shape with inturned ends 48 disposed in abutment with and overlying the convex outer surface of the outer shroud segment 35 adjacent the end portions thereof. The end portions 48 and the members 46 jointly define a U-shaped channel 49 in which is received the resilient seal member 40. The elongated member 47 and the members 46 are interposed between the turbine housing 27 and the shroud segments 35, as best seen in FIG. 2.

The nozzle block segments 28 are also provided with elongated sheet metal members 50, similar in shape to the members 47. The members 50 are interposed between the nozzle block segments 28 and the turbine housing 27.

The nozzle block segments 28 and 29 are individually attached to the turbine housing 27 by bolts 51 extending through aligned apertures in the outer shrouds, the mem-

bers 47 and 50, and the turbine housing. The bolts 51 are retained by nuts 52. With this arrangement, the nozzle block segments 28 and 29 may be positioned radially within the housing 27, as required to compress the seal members, and then clamped by tightening the nuts and bolts 53, 54 which engage the tangs 36, 37. This feature is schematically shown in FIG. 6.

The outer shroud segments 32 and 35 may further be provided with radially outwardly directed flanges 56 at their leading edges and the turbine housing 27 may be provided with an annular recess to receive the annular shroud segments 32 and 35. Accordingly, the members 50 and 47 and their associated shrouds 32 and 35 jointly define arcuate passageways 58 substantially encompassing the nozzle structure 23, as best shown in FIGS. 2 and 3. If desired, the members 50 and 47 may be brazed or otherwise attached to the shroud segments 32 and 35. The flanges 56 may further be provided with a series of spaced apertures 59 communicating with the passageways 58. In conjunction therewith, the nozzle vanes 30 in the nozzle structure 23 may be formed of hollow shape to define radial flow passages 60 and provided with a plurality of orifices 61 for coolant air flow and the outer shroud segments may be provided with suitable openings to receive the vanes. Thus, coolant air from the diluent air passageway 62 may be delivered through the apertures 59 to the passages 60 of the hollow vanes 30 and then directed radially inwardly therethrough and ejected by the orifices 61 into the motive gas passageway for utilization in the turbine.

It will now be seen that the invention provides a simple yet highly effective sealing arrangement for sealing the spaces between associated nozzle block segments in a segmented nozzle block structure for an axial-flow turbine or other fluid power conversion machine.

With this arrangement, the sealing problem, heretofore one of the main disadvantages of the segmented nozzle block structure, is substantially eliminated, thereby rendering the segmented nozzle block structure considerably more desirable than heretofore.

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What is claimed is:

1. An annular stator structure for an axial-flow elastic fluid power conversion machine comprising inner and outer shroud structure of annular shape concentrically spaced from each other and having mutually facing surfaces defining an annular fluid flow passageway, an annular array of guide vanes extending generally radially between said inner and outer shroud structure and connected thereto, said outer shroud structure comprising a plurality of arcuate segments having radially outer convex surfaces and being disposed in closely spaced end-to-end relation, said inner shroud structure comprising a plurality of arcuate segments having radially inner concave surfaces and being disposed in closely spaced end-to-end relation, means for sealing the spaces between adjacent outer shroud segments including a resilient member disposed in abutment with said convex surfaces and a first channel shaped clip member having an end portion connected to the convex surface of one of said outer shroud segments, and means for sealing the spaces between adjacent inner shroud segments including a resilient member disposed in abutment with said concave surfaces and a second channel shaped clip member having an end portion connected to the concave surface of one of said inner shroud segments.

2. An annular stator structure for an axial-flow elastic fluid power conversion machine comprising inner and outer shroud structure of annular shape concentrically spaced from each other and having mutually facing surfaces defining an annular fluid flow passageway, an annular array of guide vanes extending generally radially

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between said inner and outer shroud structure and connected thereto, said outer shroud structure comprising a plurality of arcuate segments having radially outer convex surfaces and being disposed in closely spaced end-to-end relation, said inner shroud structure comprising a plurality of arcuate segments having radially inner concave surfaces and being disposed in closely spaced end-to-end relation, said inner shroud segments being equal in number to and in substantially radial alignment with said outer shroud segments, means for individually sealing the spaces between each pair of adjacent outer shroud segments including a woven metallic filamentary member disposed in abutment with the adjacent end portions of said convex surfaces and a clip member having a channel shaped end portion supporting said woven member and an opposed end portion connected to one of said outer shroud segments, and means for individually sealing the spaces between each pair of adjacent inner shroud segments including a second woven metallic filamentary member disposed in abutment with the adjacent end portions said concave surfaces and a second clip member having an end portion connected to one of said inner shroud segments and an oppositely disposed channel shaped end portion supporting said second woven member.

3. An annular stator structure for an axial-flow elastic fluid power conversion machine comprising inner and outer shroud structure of annular shape concentrically spaced from each other and having mutually facing surfaces defining an annular fluid flow passageway, an annular array of guide vanes extending generally radially between said inner and outer shroud structure and con-

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nected thereto, said outer shroud structure comprising at least three arcuate segments including a central segment and a pair of outermost segments each having radially outer convex surfaces, said segments being disposed in closely spaced end-to-end relation, said inner shroud structure comprising at least three arcuate segments including a pair of outermost segments and a central segment each having radially inner concave surfaces, said segments being disposed in closely spaced end-to-end relation, means for individually sealing the spaces between adjacent outer shroud segments including a pair of sheet metal clips attached to the convex surface of said central outer shroud segment and a resilient member carried by each of said clips and disposed in abutment with said convex surfaces adjacent said spaces, means for individually sealing the spaces between adjacent inner shroud segments including a pair of sheet metal clips attached to the concave surface of said outermost shroud segments and a resilient member carried by said last mentioned clips and disposed in abutment with said concave surfaces adjacent said spaces, and means for radially positioning said central outer and inner shroud segments relative to said outermost outer and inner segments.

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