This invention relates to axial-flow fluid machines such as turbines as employed in aircraft gas-turbine engines and is concerned more especially with stator constructions for such axial-flow fluid machines of the kind including plurality of guide vanes having inner and outer mounting platforms by which the vanes are mounted in stator structure.

This invention has for an object to provide an improved stator construction of the kind just specified which has advantages in operation of the machine and in assembly over known forms of such stator constructions.

According to the present invention, a stator construction of the kind specified comprises means to secure together the inner platforms in an annular assembly, said means comprising a pair of annular members clamped axially together and on to the inner platforms and interlocking with the upstream and downstream edges of the platforms, an outer casing around the vanes and in spaced relation to the outer platforms, interengaging radially-extending features on said outer platforms and on the outer casing to locate the outer platforms circumferentially with respect to one another, and an axially-extending annular member encircling the vanes between them and the casing, said axially-extending annular member being engaged by its upstream edge in an axially-facing annular groove in the casing and by its downstream edge in axially-facing grooves in the outer platforms adjacent their downstream edges. It is found that even though the inner platforms of a vane assembly of the kind specified are held together against relative displacement, there is a tendency for distortion of the vane assembly by the loads experienced in operation due to the fact that the outer ends of the vanes must be left free for relative expansion with respect to one another and to the engine casing. Provision of the axially-extending annular member in accordance with the present invention improves the resistance to distortion of the vane assembly.

Usually the axially-extending annular member will be of frusto-conical form with its larger diameter end in engagement with the outer casing and its smaller-diameter end engaging the outer platforms. The axially-extending annular member also gives rise to advantages in assembly where the downstream end of the outer casing is larger than the upstream end, since the vanes may be placed into position together with this member. In other words, the guide vanes and their associated structure may be assembled externally of the outer casing and then entered as a unit axially into the casing to bring the upstream edge of the axially-extending annular member into engagement with the groove in the outer casing.

Preferably one at least of the annular members which are clamped on to the inner platforms is of substantially greater radial dimension than the inner platforms so as to extend inwards of the casing gas path at an inner radius an element of a labyrinth seal to co-operate with adjacent rotating structure. Such an arrangement is especially suitable where the vanes, by reason that they are between two sets of rotating blades, can only be supported through the outer ends of the blades.

One embodiment of this invention will now be described with reference to the accompanying drawings in which:

Figure 1 is an axial section through part of a two-stage turbine which forms part of a gas-turbine engine for aircraft propulsion.

Figure 2 is a section on the line II—II of Figure 1.

Figure 3 is a section on the line III—III of Figure 2.

Figure 4 is a section on the line IV—IV of Figure 1 and Figure 5 is a section on the line V—V of Figure 1.

Referring to Figure 1, the turbine comprises two rows of rotor blading 10 and 11 carried on separate rotor discs 12 and 13 respectively. The high-pressure rotor blades are located just downstream of a nozzle-guide-vane assembly including a ring of vanes 14 by which hot gases from the engine combustion equipment 15 are directed on to the rotor blades 10 and there is also provided an intermediate nozzle-guide-vane assembly including stator vanes 16 which are in flow series between the high-pressure rotor blades 10 and the low-pressure rotor blades 11. The exhaust from the low-pressure rotor blades 11 flows into an exhaust assembly whereby the upstream end is indicated at 17. The engine also includes a backbone structure arranged within the combustion equipment 15 and the downstream end of the backbone structure is indicated at 18.

The vanes 14 of the high-pressure nozzle-guide-vane assembly are supported in the stationary structure in the following way.

Each vane 14 is provided at its inner end with a mounting platform 19 of small radial extent. The inner platforms 19 are secured in fixed relation to one another by means of a pair of annular members 20, 21 of which the member 20 is integral with the structure 18 and has an axially-flanged end to receive hoofted features 22 projecting from the inner surfaces of the inner platforms 19, and is provided with radial projections 23 to engage in notches in the inner platforms 19 at their downstream edges and with radial dogs 24 to engage notches in the upstream edges of the platforms 19. The other member 21 overlaps radially the upstream edges of the platforms 19 and the member 20 and is clamped by bolts 25 to the member 20 so retaining the hooked features 22 in engagement with the channel in the member 20.

Each vane 14 is provided at its outer end with an outer mounting platform 26 and each mounting platform 26 has an external surface adjacent its upstream edge a radially-extending dog 27 which engages a notch 28 in a flange on the internal surface of an outer casing member 29, and is provided adjacent its downstream edge with a dog 30 which engages in a notch 31 in a second flange on the internal surface of the outer casing 29. The dogs 27 and 30 locate the associated blade mounting platform 26 circumferentially in the casing 29 but leave the mounting platform free both radially and axially.

Each outer mounting platform 26 is also provided adjacent its downstream edge with an axially-facing channel 32 which is engaged sideway by the thickened downstream edge of an annular frusto-conical member 33 whereof the upstream edge is engaged in a peripheral axially-facing channel 34 formed in the flange provided with the notches 28. The member 33 has its larger-diameter end disposed upstream of its narrower end. The member 33 acts to stiffen the vane assembly against distortion due to the gas loads experienced in operation, in particular against tilting of the vanes 14, and also acts as a sealing member to prevent interplatform leakage by.
passing the vanes. In assembly of the engine the member 33 also acts as a carrier for the vanes 14 which may be mounted on the downstream edge of the member 33 and then assembled as a whole into the casing 29 (which diverges in a downstream direction) by entering the assembly in an axial direction until the upstream edge of the member 33 engages the channel 34. Each mounting platform 26 is held against axial displacement in a direction to disengage them from the member 33 by means of arcuate members 35 which also serve as fixed shrouding for the high-pressure rotor blade 16. Each arcuate member 35 has at its upstream edge a T-section flange 36, the gap of which engages radially-outward-facing channels 26a in the downstream edges of the mounting platforms 26, and the outwardly-directed web of which is formed with lugs 37 to engage in circumferentially-extending channels 38 which interconnect the notches 31. All the members 35 are first placed in position with their lugs 37 aligned with the dogs 30, and they are then turned as a whole to carry the lugs 37 into the channels 38 so locking them axially and also locating the outer mounting platforms 26 against axial displacement whilst leaving them free for radial expansion. The upstream edges of members 35 are located radially with respect to the platforms 26 by means of tongues 36a (Figure 3).

The member 35 is otherwise of any convenient form and has its inner surface shaped appropriately to cooperate with the tip shrouds on the rotor blades 10.

The members 35 are locked circumferentially, as described below, by the mounting platforms of the vanes 16.

Each vane 16 is provided at its inner end with a mounting platform 39 of small radial extent and the mounting platforms are located with respect to one another by means of a pair of annular clamping members 40, 41, these members having a substantially greater radial extent than the mounting platforms 39. The member 41 has at its outer edge a peripheral flange 42 engaging channels in the upstream edges of the mounting platforms 39 so as to locate these edges radially and has dogs 43 co-operating with dogs 44 on the underside of the platforms 39 to locate them circumferentially. The member 41 has a peripheral flange 45 which engages axially-facing channels in the downstream edges of the mounting platforms 39. The members 40, 41 are held in appropriate spaced relation adjacent their mid radial dimension by means of spacer members 46 and the members 40, 41 are clamped together by setscrews 47 engaging threaded bosses on one of the members. At their radially-inner edges the members 40, 41 are axially flanged at 48 so that when they are clamped together they grip a radial flange 49 on the outer surface of a seal member 50 which co-operates with peripheral ribs on the downstream surface of the upstream rotor disc 12 and peripheral ribs on the upstream surface of the rotor disc 12 to provide a pair of labyrinth seals.

Each vane 16 is also provided with an outer mounting platform 51 by which the vane is positioned in the casing 29. Each mounting platform 51 has at its outer surface adjacent its upstream edge a radial dog 52 which engages a notch 53 in a third flange on the inner surface of the casing 29 so as to locate the mounting platform 51 circumferentially. The mounting platforms 51 are also provided at their upstream edges with circumferentially-extending axially-facing channels to receive the downstream edges of the shrouding members 35 and each shrouding member 35 is provided at this edge with a pair of upstanding nubs 54 which engage one on each side of a dog 52 to locate the shrouding member 35 circumferentially. Each outer mounting platform 51 also has a radially-extending dog 55 adjacent its downstream edge and the dogs 55 engage notches 56 in yet another flange on the inner surface of the casing 29.

Each outer mounting platform 51 is also provided adjacent its downstream end with a circumferentially-extending axially-facing channel 57 to receive the downstream thickened edge of an annular member 58 whereof the thickened upstream edge engages axially-facing channels 59 in the flange having the notches 53. The member 58 serves the same purpose for the vanes 16 as the member 33 serves for the vanes 14. The member 58 also serves to assist in centralising the seal member 50. Each platform 51 is also provided at its downstream edge with a radially-outward-facing channel 61 to receive an inwardly-directed flange 62 on an arcuate shrouding member 69 which is also provided with outwardly-directed lugs 63, corresponding to the lugs 37 of the shrouding members 35, and the lugs 63 engage in circumferential channels 64 extending between the notches 56, thereby to locate the shroud member axially.

The shrouding members 60 are also provided with outwardly- and axially-directed lugs 65 which engage in an axially-facing groove in the rear face of the flange having the notches 56, to locate the shroud member radially adjacent its forward end, and with similar outwardly and axially-directed lugs 67 which engage in a further axially-facing groove in the casing 29 at its downstream end, to locate the shroud member 60 radially adjacent its downstream end. The lugs 67 also afford notches between them which are engaged by axially-facing dogs 66 formed on the outer casing 68 of the exhaust assembly which is secured to the downstream end of the casing member 29, so as to locate the shrouding members 60 circumferentially.

In assembling the turbine, the casing member 29 will normally be disposed with its axis vertical and first the assembly comprising nozzle guide vanes 14 and the annular member 33 will be placed in position, followed by the rotor shrouding elements 35 and the high-pressure rotor 12. Next the low-pressure nozzle guide vanes 16 and their associated annular member 58 will be positioned, followed by the shrouding members 60 and the low-pressure rotor disc. The member 41 is then provided with its exhaust assembly in position and the dogs 66 on its outer casing 68 engage with the notches between lugs 67.

We claim:

1. A stator construction for an axial-flow fluid machine comprising a plurality of guide vanes having separately mounting platforms at their radially inner and radially outer ends, means to secure together the inner platforms in an annular assembly, said means comprising a pair of annular members clamped axially together and on to the inner platforms and interlocking with the upstream and downstream edges of the platforms, a one-piece outer casing surrounding the vanes and spaced radially outwards from the outer platforms axially extending axially-facing annular grooves in the outer platforms adjacent their downstream edges, the maximum diameter of the annular member being less than the minimum internal diameter of the casing between the groove therein and the downstream end of the casing.

2. A stator construction as claimed in claim 1, wherein one at least of the annular members which are clamped on to the inner platforms, is of substantially greater radial dimension that the inner platforms, extends radially inwards from these platforms and carries at an inner radius an element of a labyrinth seal to co-operate with adjacent rotating structure.

3. A stator construction as claimed in claim 1, wherein one of said pair of annular members comprises an axial flange radially within the inner platforms, the axial flange having at one edge an axially-facing channel to be engaged by hooked features on the adjacent edge of the inner
platforms and having adjacent each edge radial projections engaging corresponding notches on the inner platforms, and the other of the annular members radially overlaps and bears on the inner platform to retain the hooked features in engagement with the channel.

4. A stator construction as claimed in claim 1, wherein the inner platforms have upstream-facing and downstream-facing channels in their upstream and downstream edges respectively and each of the pair of annular members has a peripheral flange, the one to engage the upstream-facing channels and the other to engage the downstream-facing channels, whereby when the annular members are clamped together the platforms are retained axially and radially with respect to one another, and wherein cooperating dogs are provided on the inner platforms and on one at least of the pair of annular members to locate the platforms circumferentially.

5. A stator construction for an axial-flow fluid machine comprising a plurality of separate guide vanes, each vane having individual mounting platforms at its radially inner and radially outer ends, means to secure together the inner platforms in an annular assembly, said means comprising a pair of annular members clamped axially together and onto the inner platforms and interlocking with the upstream and downstream edges of the platforms, a one-piece outer casing surrounding the vanes and spaced radially outwards from the outer platforms of the vanes, interengaging radially-extending features on said outer platforms and the outer casing to locate the outer platforms circumferentially with respect to one another and with respect to the outer casing, and an axially-extending frusto-conical member encircling the vanes radially outside the outer platforms and radially within the casing, said axially-extending frusto-conical member having its larger diameter end upstream and engaging an axially-facing annular groove in the outer casing and having its smaller diameter end engaging axially-facing grooves provided in the outer platforms adjacent their downstream edges, and the frusto-conical member having a maximum diameter less than the minimum diameter of the outer casing between the groove in the casing and its downstream end.

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