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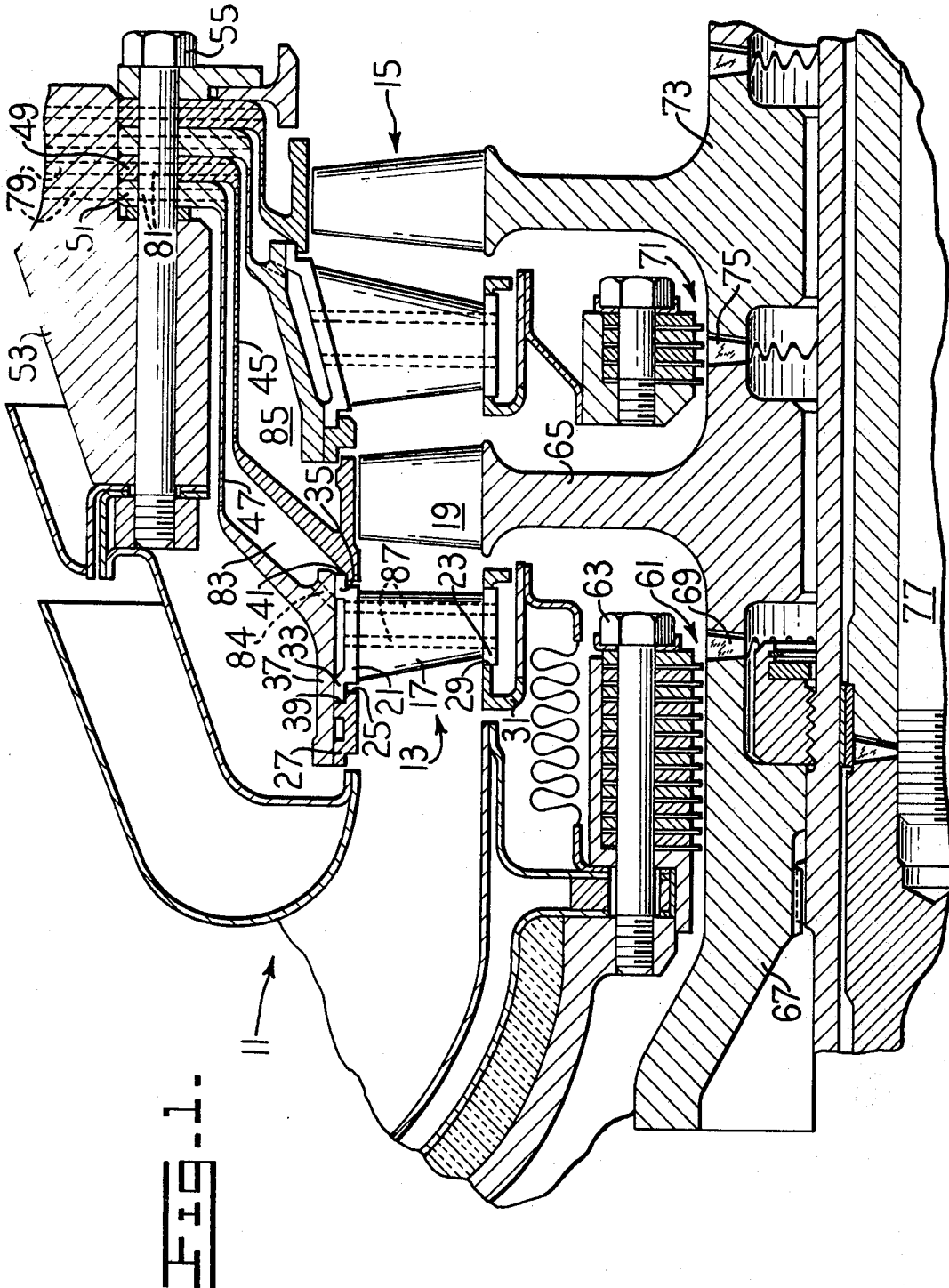
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TURBINE NOZZLE CONSTRUCTION

Filed April 10, 1968

3 Sheets-Sheet 1



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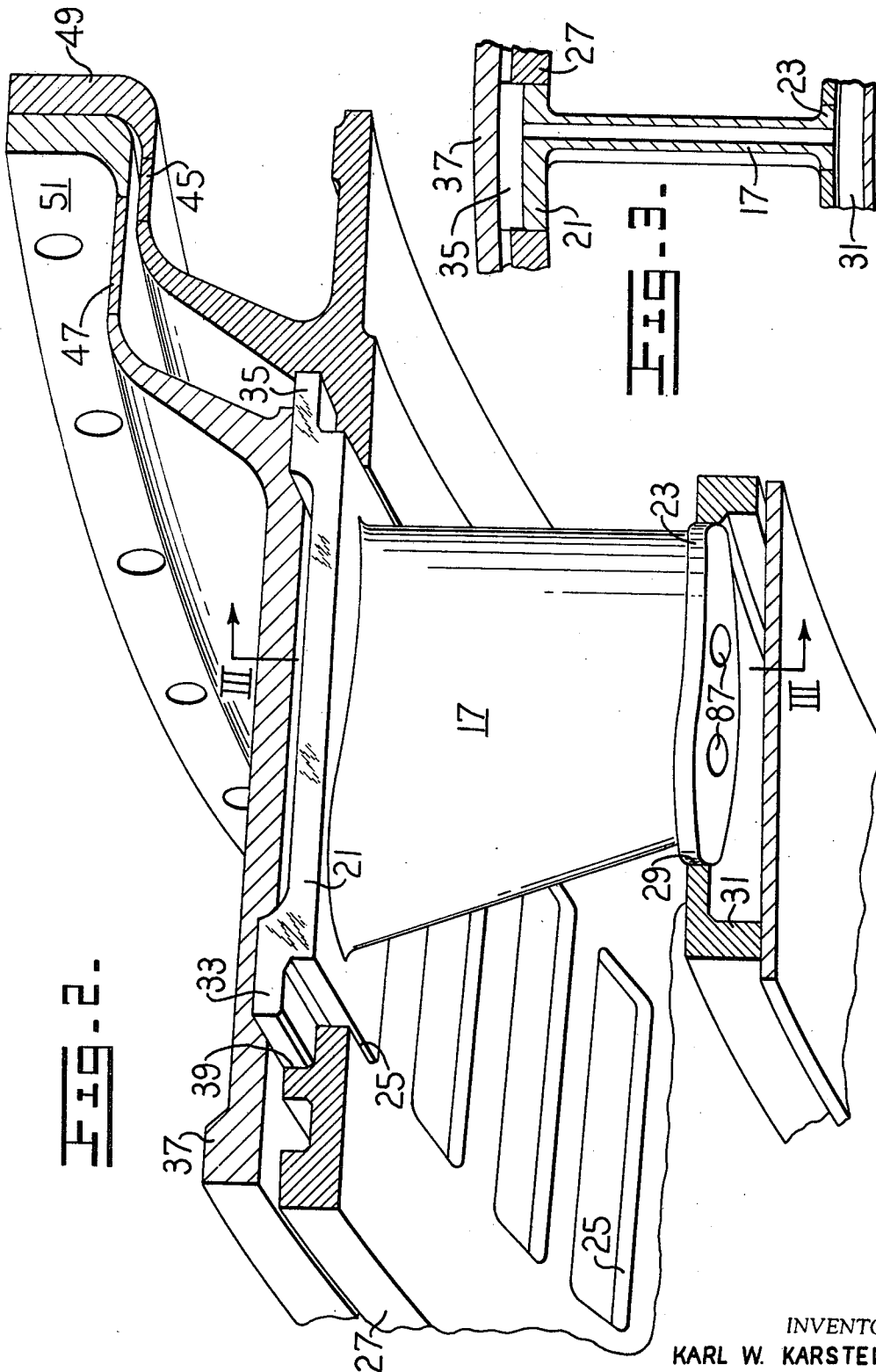
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TURBINE NOZZLE CONSTRUCTION

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3 Sheets-Sheet 2



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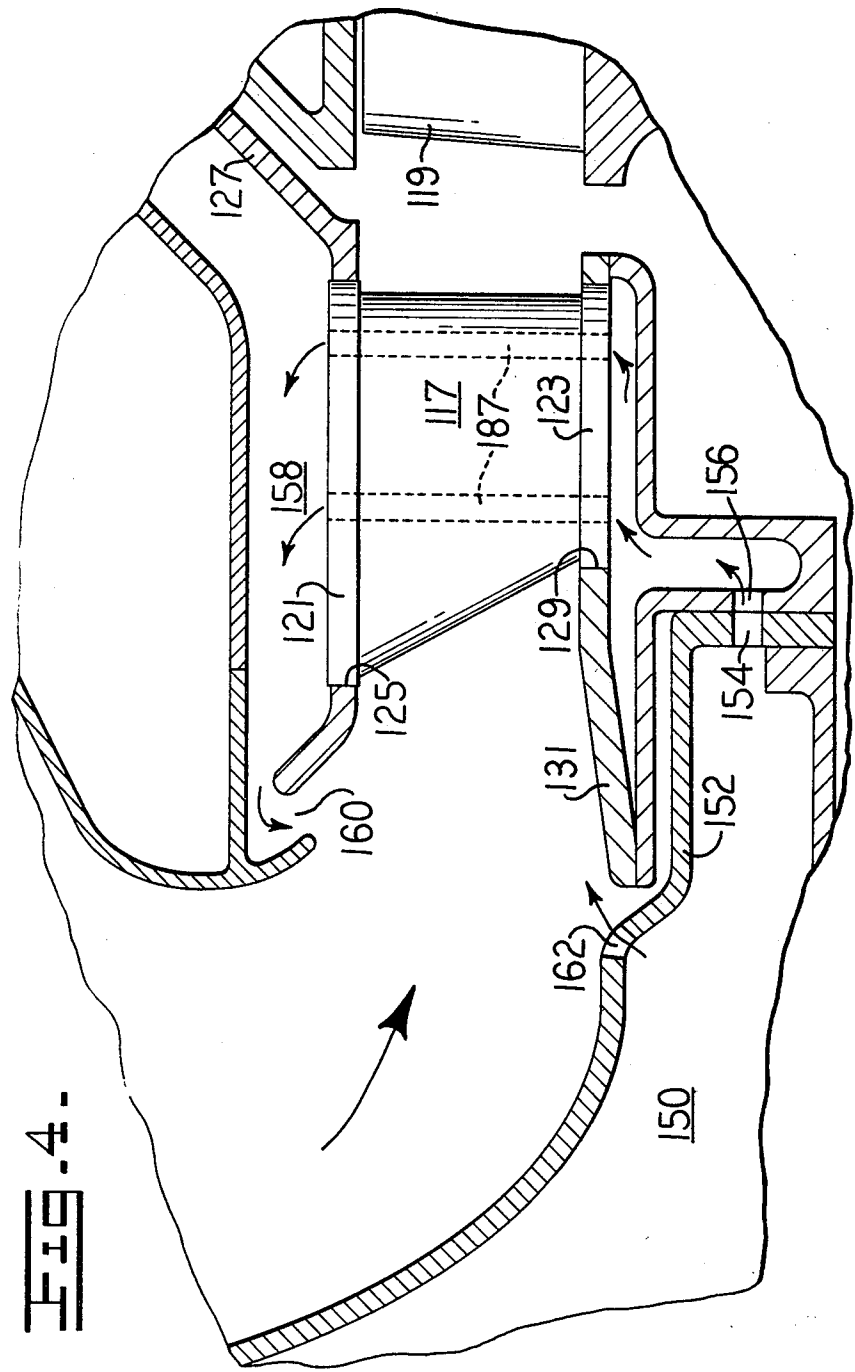


Fig. 4.

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TURBINE NOZZLE CONSTRUCTION

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4 Claims

ABSTRACT OF THE DISCLOSURE

A turbine nozzle construction having separately cast turbine vanes with machined footings. One footing is fastened in one shroud and the other footing radially floats in slots in the other shroud.

Present turbine nozzles in which the vanes are cast in one piece and rigidly connected to the inner and outer shrouds have proven to be susceptible to cracking due to thermal strain.

On the other hand, while fabricated nozzles avoid or appreciably reduce such stress cracking problems, it is difficult to keep the gas passage area constant between the vanes of these nozzles due to casting variations and the difficulty of jiggling during brazing. These problems result in a loose fit of the cast surface in the shroud slots because of clearance requirements. Also, use of these nozzles often produces unequal thermal growth during transient modes of engine operation. This results in undesirable nozzle and shroud support problems as well as turbine rotor tip clearance problems.

It is therefore an object of the present invention to provide a turbine nozzle in which the vanes are not susceptible to cracking due to thermal strain.

It is also an object of the present invention to provide such a nozzle in which the gas passage area between vanes is constant.

It is also an object of the present invention to provide such a nozzle wherein gas leakage between the vane footings and the shrouds is minimized.

It is also an object of this invention to provide a nozzle having equal thermal growth in all vanes during transient modes of engine operation.

Another object of this invention is to provide an improved vane mounting construction for the nozzle vanes of an axial flow engine which allows the easy removal and replacement of individual vanes.

It is also an object of this invention to provide a turbine nozzle having a relatively cool and stable support casing which serves as a common pilot for the turbine nozzle and rotor tip shrouds.

It is further object of the invention to provide such a nozzle having long flexible cylindrical elements supporting the shrouds so as to control concentricity relative to the engine axis and reduce thermal stress at operating temperatures.

It is a further object of the invention to provide such a nozzle having machined slots in the shrouds so as to accurately position the vanes for control of the exit area and to capture the vanes in correct radial position.

It is a still further object of this invention to provide such a nozzle wherein the outer shroud has passages for delivering cooling air to the vanes while controlling thermal growth of the shrouds.

It is also an object of this invention to provide such a nozzle wherein the inner shroud has passages for delivering cooling air to the vanes and controlling thermal growth of the shrouds.

Other objects of the invention will be apparent from the accompanying drawings and the following description.

Referring now to the drawings:

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FIG. 1 shows a fragmentary sectional view of a gas turbine engine utilizing the instant invention;

FIG. 2 shows a cut-away portion of the nozzle of the present invention which illustrates the manner utilized for capturing a vane in the nozzle;

FIG. 3 shows a view of the vane illustrated in FIG. 2 taken along a line III—III in FIG. 2; and

FIG. 4 shows an alternate embodiment of that portion of the invention utilized in capturing a vane in the nozzle.

In FIG. 1, there is generally illustrated a turbine 11, utilizing one embodiment of the invention. The turbine contains a first stage expansion system 13 and a second stage expansion system 15. Although the engine is illustrated as having two stages of expansion, it should be realized that a greater number of stages utilizing similar structure may be installed, if desired. The subsequent description which will, in general, be limited to the first stage 13, is applicable to all succeeding stages with obvious differences in dimensions, displacement, etc.

As the gases enter stage 13, turbine guide vanes 17 direct the gases so as to provide a motive force against turbine blades 19. The vanes 17 are cast with integral footings 21 and 23 and each inner footing 23 is cam-ground to a specific profile positioned with respect to the vane air foil. This will insure less variation in the gas passage areas even if there are casting variations.

The vanes will all be in the same position relative to their footings after machining. Each of the footings 21 fits within a slot 25 in the upper shroud 27 and the footings 23 fit within slots 29 in the inner shroud 31. Slots 25 and 29 may be machined by any process which will insure extremely close fit—as, for example, an electrochemical or electro-discharged process. Footing 21 is radially positioned within the shroud 27 by a pair of flanges 33 and 35 which are held against shroud 27 by a locking shroud 37. Footing 21 is axially positioned by a pair of shoulders 39 and 41 in shroud 27. By machining shoulders 39 and 41 to controlled dimensional tolerances, each vane is caused to be properly axially positioned when it is inserted into its slot 25.

Footing 23 is allowed to float radially in slipfit cooperation with slot 29 in shroud 31.

Outer shroud 27 and locking shroud 37 are suitably fixed as by welding to cylindrical support members 45 and 47, respectively. Support members 45 and 47 are, in turn, suitably attached to bolt flanges 49 and 51, respectively, and the flanges are fastened to housing 53 of the turbine by a series of bolts 55.

When the engine is in operation, each shroud will tend to expand in direct relation to its proximity to the combustion chamber and the vanes. In other words, the outer shroud and the locking shroud will tend to expand to a greater extent near blades 17 and outer footings 21 than at the outer edge of their conical supporting sections. In turn, those sections will tend to expand to a greater extent than their respective support members 45 and 47. Due to the rigidity of such a turbine nozzle structure, this relative expansion will cause the conical supporting sections to assume a slightly greater degree of taper when the engine is in operation than when cold and the conical support members 45 and 47, being of very thin cross-section, will take on a very shallow S-shaped wave (in longitudinal cross-section) extending throughout the greater part of their lengths and completely around the circumferences thereof. Thus, a high degree of flexibility is provided so as to avoid cracking due to thermal stress, while maintaining the individually replaceable vanes in an axially fixed position.

Referring to FIG. 1, it is seen that the stator and rotor shrouds of the second expansion stage are fixed similarly to those of the first stage. Since the second stage cylin-

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dricol support members are shorter than those in the first stage, less expansion take-up will occur in them, but since the structure is necessarily cooler in the second stage, due to the lowering of the gas temperature by its expansion, less expansion will occur and the results will continue to be satisfactory. This will also hold true if additional expansion stages are stacked in the manner shown.

In assembling the engine, the nozzles are installed in a stacked manner alternating with the rotors and, as previously stated, as many expansion stages desired may be so stacked. Bolt flanges 49 and 51 of the first stage shrouds are fitted against housing 53 and a labyrinth seal, generally shown at 61, is installed and held in place by bolts 63. A first stage rotor 65 carrying turbine blades 19 is then stacked upon a drive flange 67 by means of a Curvic coupling 69. The bolt flanges of the shrouds of the second stage 15 and any succeeding stages are then assembled against flanges 49 and 51 and bolts 55 are inserted through housing 53 to hold the flanges against the housing. A second labyrinth seal indicated generally at 71 is then installed and a second stage rotor 73 is stacked on the first stage rotor by means of a second Curvic coupling 75.

A series of other well known parts (not shown) are then stacked against the rotors and a flange (also not shown) and tie bolt 77 secure them in place.

If it is desired to cool the vanes, air may be forced through a plurality of passages 79 in housing 53 to a corresponding set of passages 81 in the respective bolt flanges. This air will be forced into chambers 83 and 85. The air in chamber 83 is then passed through holes 84 in the locking shroud and holes 87 in vanes 17, through the inner shroud, and into the inner edge of the gas flow path on blades 19. The air in chamber 85 will pass between shroud 27 of the first stage and the outer shroud of the second stage and enter the gas flow path at the outer edge of the path.

Referring now to FIG. 4, there is shown an alternate embodiment of the stator vane holding structure wherein vanes 117, utilized to direct the gases against the rotor blades 119, have outer footings 121 and inner footings 123. An upper shroud 127 having machined slots 125 allows the footing 121 of each vane to float radially in slip fit cooperation with the slot. Inner footing 123 is fixed, as by brazing, within a slot 129 in the inner shroud 131.

Cooling air can enter the nozzle area in a different manner than that described relative to the first embodiment, if desired. A passage 150 just forward of the plenum wall 152 transfers air through openings 154 and 156 in the plenum wall and lower shroud respectively. It is then directed upwardly through passages 187 in the vane, through chamber 158 and opening 160 and into the outer edge of the gas flow. If necessary, it can also enter the inner edge of the flow via holes 162 in the inner shroud.

This embodiment could, if desired, be mounted within a turbine in the same fashion shown in the embodiment described relative to FIGS. 1 and 2. In order to enable the reader to more clearly understand how this would be accomplished, it is pointed out, whenever possible, that identical identification labels have been utilized in both embodiments, except that the labels in the embodiment

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of FIG. 4 are preceded by the numeral "1," so that, for example, vane 17 becomes vane 117, etc.

Thus application has provided a relatively cool and stable support casing acting as a pilot for both the rotor and the nozzle tip shrouds which shrouds comprise long, flexible cylindrical elements controlling the vane concentricity with the engine axis, even when operating temperatures create thermal stress. Changes in structure and dimension of the illustrated embodiments of the invention may be made without exceeding the purview of the following claims.

What is claimed is:

1. In a turbine stator

an inner shroud fixed within the turbine housing and having

at least one aperture therein for receiving a stator vane footing,

an outer shroud fixed within the turbine housing in radial spacing from said inner shroud and having

at least one aperture therein for receiving a stator vane footing,

a recessed section in one face of one of said shrouds about said at least one aperture therein,

a locking shroud fixed within the turbine in relatively close radial spacing from one of said shrouds, and

at least one vane extending between said inner and outer shrouds and having

an inner footing slidably received in said at least one aperture in said inner shroud,

an outer footing slidably received in said at least one aperture in said outer shroud, and

a flange means on said vane and extending about one of said footings, slidably received within said recessed section in said one of said shrouds, and closely adjacent said locking shroud such that said vane is held in place by said locking shroud.

2. The turbine stator of claim 1 including means for removably attaching said locking shroud and said closely spaced shroud to a turbine housing at a single point in the housing.

3. The turbine stator of claim 2 including thin flexible members between said locking shroud and the housing and between said closely spaced shroud and said housing.

4. The turbine stator of claim 1 wherein said closely spaced shroud is said outer shroud and said locking shroud is radially outward thereof.

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