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TURBINE NOZZLE GUIDE VANE CONSTRUCTION

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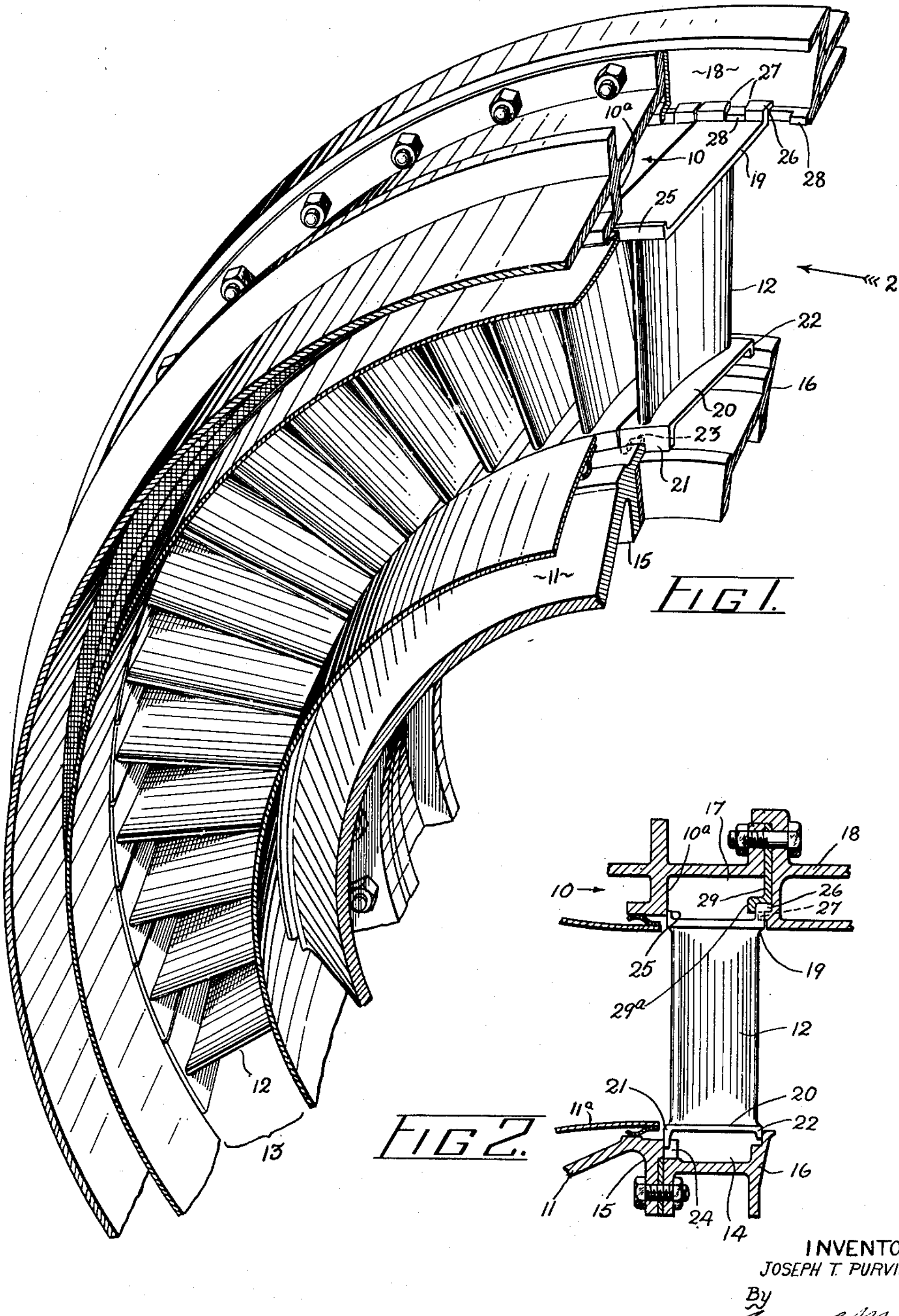

FIG 1.

FIG 2.

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TURBINE NOZZLE GUIDE VANE CONSTRUCTION

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This invention relates to turbines and other axial flow power conversion machines wherein the blading is subjected to a flow of fluid at relatively high temperatures. The invention more specifically relates to an improved mounting for turbine nozzle guide vanes.

It is customary, in the mounting of turbine nozzle guide vanes for axial flow turbines, to secure the said vanes by their inner platforms or extremities to a diaphragm surrounding the turbine shaft, and to make provision for expansion in the attachment of the outer extremities of the vanes to the surrounding engine casing. Although this arrangement has some advantages of assembly, in that the vanes can be installed before the outer casing is assembled, it suffers from the disadvantage that the engine must be very extensively dismantled if it is found necessary to replace individual guide vanes which may become burnt or otherwise damaged in service. Furthermore the operating temperatures of the inner attachment points are relatively indeterminable and not readily measurable on test, whereas a close and accurate control can be exercised over the temperatures of the engine casing and the outer attachment points of the vanes which this casing provides.

The principal object of this invention is to provide a mounting for turbine nozzle guide vanes which will enable the position of the vanes under operating conditions to be predetermined with some accuracy and at the same time will facilitate the replacement of vanes which become damaged in service.

Another object of the invention is to provide a mounting for turbine nozzle guide vanes which provides firm support against the loads imposed by the working fluid and makes provision for relative movement between the blading and the adjacent structures caused by temperature variations.

Another object of the invention is to provide a mounting that permits each guide vane to expand or contract independently in relation to the adjoining guide vanes.

Another object of the invention is to provide a guide vane mounting wherein the loads imposed by the working fluid tend to hold the guide vanes firmly against their mountings thereby helping to support the guide vanes and minimizing the leakage of working fluid through the interstices between the base portions of the guide vanes and between the base portions and adjacent members.

Another object of the invention is to provide a

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guide vane mounting that permits the ready removal and replacement of worn or damaged parts.

A still further object of the invention is to provide a guide vane mounting arrangement consisting of the smallest possible number of parts.

Other objects and advantages will become apparent during the course of the following description.

In the drawings accompanying and forming a part of this specification, in which like reference characters are used to designate like parts throughout the several views, Fig. 1 is a fragmentary perspective view of a turbine structure in which are included turbine nozzle guide vanes constructed according to the invention, as observed when viewed in a direction parallel to the axis of the turbine and in the same sense as the fluid flow; and Fig. 2 is a fragmentary sectional view taken on a radial plane through the casing structure and viewed in the direction of the arrow 2 in Fig. 1.

Referring to the drawings, a typical turbine comprises a fixed outer casing 10 and a fixed inner structure 11 spaced from the said casing and providing a passage for the flow of fluid from the usual nozzle box 11a rearwardly into the turbine. Suitable means are provided to hold the casing and the inner structure in spaced relationship. (The words "inner" and "outer" are used herein in reference to the senses radial to the engine).

According to the invention, each of a plurality of nozzle guide vanes 12 extends radially across an annular gap 13, located between the fixed inner structure 11 and the fixed outer casing 10. A circumferential channel 14 is provided in the inner structure 11, the sides of the said channel being defined by an annular flange 15 on the inner structure 11 and a flanged retaining ring 16 attached thereto. At the outer side of the annular gap 13 there is similarly provided a circumferential channel 17 lying between the rear face 10a of the outer casing 10 and a turbine shroud ring 18 secured to the outer casing.

Each guide vane has an outer base member or platform 19 and an inner base member or platform 20, which provide means for mounting the vanes in the channels 17 and 14. Since the vanes 12 curve away from the axial direction at a considerable angle and adjacent vanes must be spaced relatively closely together, the inner and outer vane platforms 20 and 19 are skewed so that the rear edge of each vane platform is not in axial alignment with the front edge but is displaced tangentially to the turbine in the direction of curvature of the guide vanes.

The inner platform 20 of each of the guide vanes 12 has an inwardly projecting flange 21 at the forward edge of the platform and a smaller inwardly projecting flange 22 at the rear edge of the platform. The flange 21 is provided with a radial slot 23 which engages with one of a series of evenly spaced rearwardly projecting teeth 24 carried by the flange 15 on the inner structure 11. The smaller flange 22 on the rear edge of inner platform 20 is just long enough radially to make contact with the retaining ring 16 on the inner structure 11 when the guide vanes are in extreme contracted position relative to the inner structure 11 and the outer casing 10. Sufficient clearance for radially inward expansion of the guide vanes 12 is provided at the inner extremities of flanges 21 and 22.

The outer platform 19 of each of the guide vanes 12 is located in channel 17 and has a relatively small outwardly projecting flange 25 at the forward edge of the platform and an outwardly and rearwardly projecting right-angled flange 26 at the rear edge of the platform. The right-angled flange 26 is provided with a radial slot 27 engaging with one of a series of evenly spaced forwardly projecting teeth 28 on the forward face of turbine shroud ring 18. A clamping plate 29 is removably attached to the shroud ring 18 and has an annular shoulder 29^a at the inward end, which receives the outermost edge of the right-angled flange 26 on each of the outer platforms 19 and clamps the said flanges in position against shroud ring 18. The smaller flange 25 on the outer platform 19 is just long enough radially to rest against the rear face 10^a of the outer casing 10 when the guide vanes 12 are in extreme contracted position relative to the inner structure 11 and the outer casing 10.

In the complete assembly, the guide vanes 12 are fixed with respect to the outer casing 10 by means of the clamping plate 29 and the engagement of teeth 28 with the slots 27, while the vanes are free to expand and contract relative to the inner structure 11 because relative radial movement is possible between the teeth 24 and the slots 23. The axial gas loads acting on the vanes are carried by the forward reaction of the turbine shroud ring 18 against the read edges of the right-angled flanges 26 at the rear of outer platforms 19 and by the forward reaction of the retaining ring 16 against the flanges 22 at the rear of inner platforms 20. The tangential gas loads are carried by the tangential reactions of teeth 24 and 28, against the sides of the radial slots 23 and 27 respectively.

From the foregoing description it will be apparent that the guide vanes are positively located with respect to the shroud ring 18 and the outer casing 10, and are independent of the radial expansion and contraction of the inner structure 11. The operating temperatures of the shroud ring and the outer casing are well understood and can be easily controlled by insulation and other means so that the position of the guide vanes under operating conditions can be accurately predetermined; this is a point of some importance since the relationship between the guide vanes and the turbine rotor blades has a marked effect upon the performance of the engine. Moreover, vanes which become damaged in service can be readily replaced by the removal of the shroud ring 18 and the clamping plate 29, enabling the damaged vanes to be withdrawn from their inner mountings without the necessity of removing the turbine rotor and other major dismantling operations. (It is, of course, important that the engine should be mounted with its longitudinal axis in a vertical position during this operation, so that the vanes will rest on their flanges 25; otherwise many of them will fall out when the clamping plate is removed.)

Thermal insulating material may be placed in the channels 14 and 17, in order to prevent excessive loss of heat from the guide vanes and also to prevent the damage to other parts which escaping heat might cause.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same and that various changes in shape, size and arrangement of the parts may be resorted to without departing from the spirit of the invention or the scope of the claims.

What I claim as my invention is:

1. In an axial flow elastic fluid power conversion machine, a fixed annular outer casing, a fixed generally cylindrical inner structure within and radially spaced from the casing and defining therewith an annular passage for the flow of fluid, the inner structure having an encircling surface provided with a series of circumferentially spaced surface interruptions having radially and axially disposed faces, said inner structure having a radially protruding annular surface downstream of the said first-mentioned surface and facing upstream of the flow, a plurality of guide vanes traversing the annular passage, each of the guide vanes having an outer platform adjacent the outer casing and an inner platform adjacent the inner structure, clamping means on the outer casing securing the outer platforms to the outer casing, each of the guide vane inner platforms having at its upstream side a radially inwardly extending projection, the projections being in radially and axially slidable engagement with the interruptions on the said first-mentioned surface to permit radial and downstream axial movement and to prevent circumferential movement of the guide vanes with respect to the inner structure, the downstream side of each of the guide vane inner platforms abutting the said protruding annular surface to permit relative radial and circumferential movement but to prevent downstream axial movement of the guide vanes with respect to the inner structure.

2. In an axial flow elastic fluid power conversion machine, a fixed annular outer casing, a fixed generally cylindrical inner structure within and radially spaced from the casing and defining therewith an annular passage for the flow of fluid, the inner structure having a circumferential channel, the channel having upstream and downstream mutually facing annular side wall surfaces, the said upstream surface being provided with a series of circumferentially spaced teeth projecting axially from the said surface and having radially and axially disposed faces, a plurality of guide vanes traversing the annular passage, each of the guide vanes having an outer platform adjacent the outer casing and an inner platform adjacent the inner structure, means on the outer casing securing the outer platforms to the outer casing, each of the guide vane inner platforms having at its upstream side a radially inwardly extending projection, the projections being in radially and axially slidable engagement with the teeth to permit radial and downstream axial movement and to prevent circumferential movement of the guide vanes with respect to the inner structure, the downstream side of each of the guide vane inner platforms

abutting the said downstream annular surface to permit relative radial and circumferential movement but to prevent downstream axial movement of the guide vanes with respect to the inner structure.

3. In an axial flow power conversion machine, the combination as claimed in claim 2 in which the radially inwardly extending projections on each of the guide vane inner platforms has a generally radially disposed slot extending radially inwardly from the extreme radial outward end of the projection providing radially and axially disposed side surfaces, the said slots slidably receiving the teeth in the channel in the inner structure.

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