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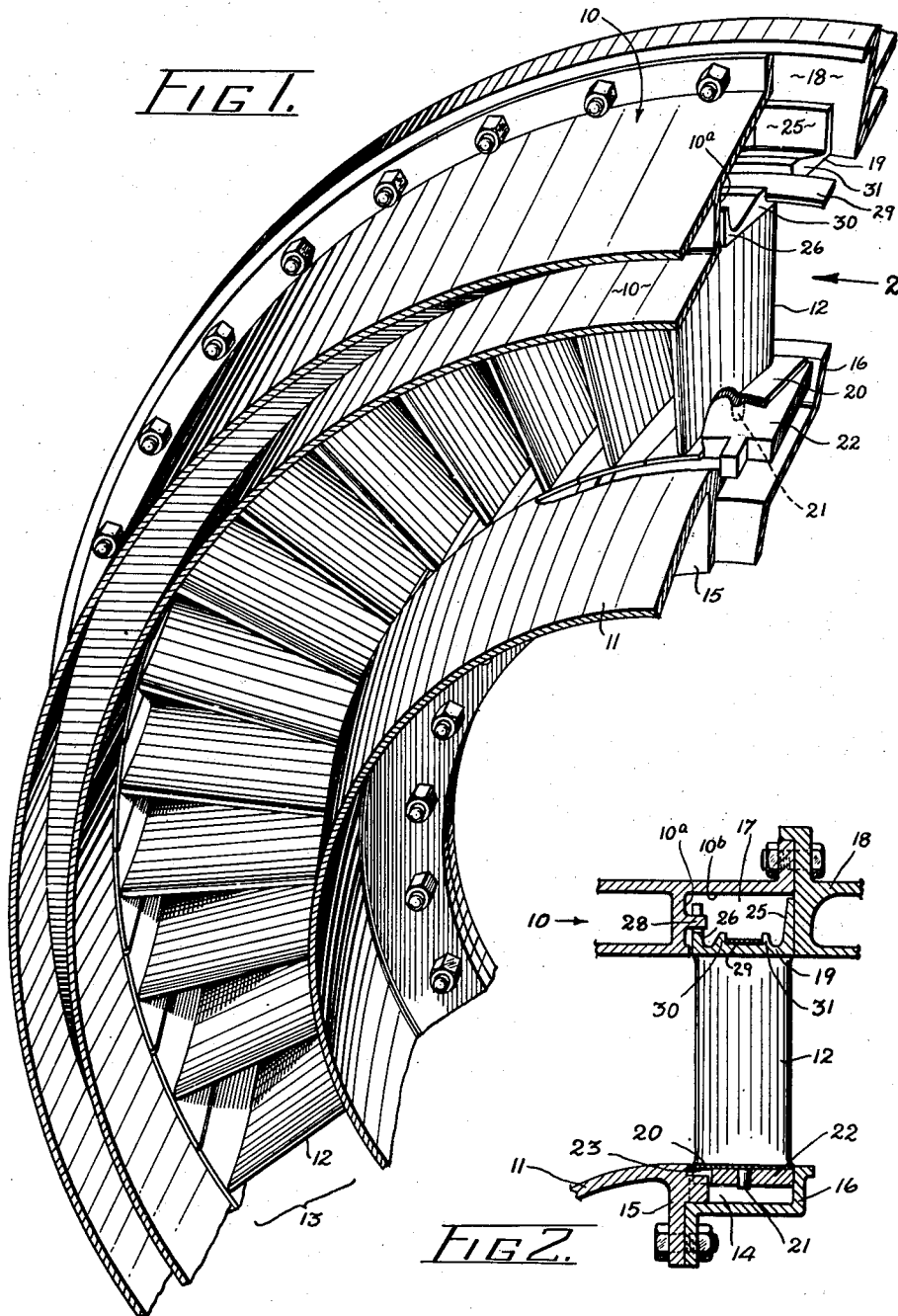
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TURBINE NOZZLE GUIDE VANE CONSTRUCTION

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2 Sheets-Sheet 1



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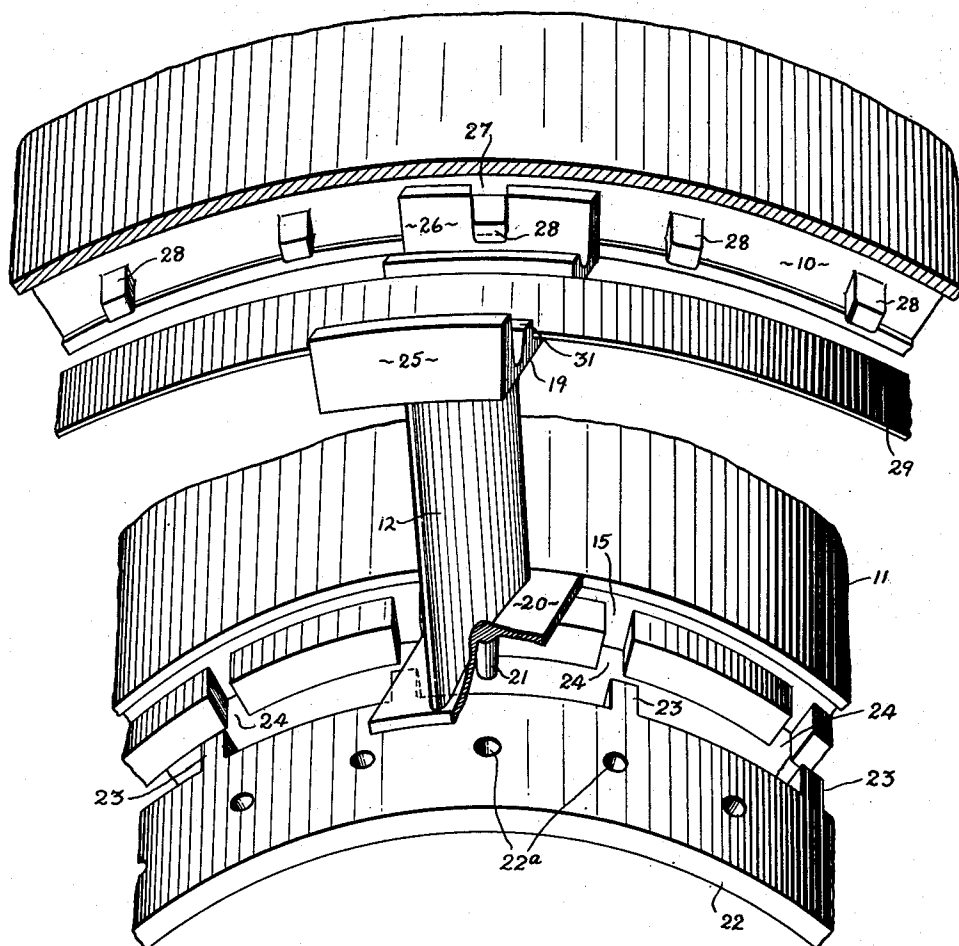


FIG. 3.

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TURBINE NOZZLE GUIDE VANE
CONSTRUCTION

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1

This invention relates to turbine 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 a mounting for turbine nozzle guide vanes.

An 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 but permits ample relative movement between the blading and the adjacent structures in response to 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 system of 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.

A still further object of the invention is to provide a system of guide vane mounting that permits the ready removal and replacement of worn or damaged 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 casing structure and 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;

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; and

Fig. 3 is a fragmentary perspective view showing one of the turbine nozzle guide vanes in spaced relationship with the vane mounting ring, as observed when viewed in a sense opposite to that of the fluid flow.

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

2

the usual nozzle box (not shown) into the turbine. Suitable means are provided to hold the casing and the inner structure in spaced relationship. (The words "inner" and "outer" as used herein refer to the senses radial to the engine and the words "front" and "rear" are used in reference to the direction of the flow of the stream of gases passing through the engine, "front" denoting the upstream or inlet side and "rear" denoting the downstream or outlet side.)

According to the invention, a plurality of nozzle guide vanes 12 extend 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 10^a 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 (see Fig. 3).

The inner platform 20 has an inwardly projecting mounting dowel 21 that engages in a hole 22^a in a vane mounting ring 22 located in the channel 14. The mounting ring 22 is prevented from rotating with respect to the inner structure 11 by means of teeth 23 that engage symmetrically spaced radial slots 24 provided in flange 15 of the inner structure 11. The engagement of the teeth 23 in slots 24 also maintains the concentricity of the mounting ring 22 with respect to the inner structure 11 regardless of relative expansion or contraction of the ring 22 and of the inner structure 11.

The outer platform 19 of each of the guide vanes 12 is located in the channel 17 and has at the rear thereof an outwardly projecting flange 25, the outer extremity of which is sufficiently spaced from the inner surface 10^b of the outer casing 10 in channel 17 to provide clearance for

the maximum outward expansion of guide vane 12 and mounting ring 22. The clearance thus provided is however, less than the length of dowel 21 on the inner platform 20, for reasons which will subsequently appear.

At the front of the outer platform 19 there is provided an outwardly projecting flange 26 which has a slot 27 engaging with one of a series of evenly spaced teeth 28 provided on the outer casing 10, whereby tangential displacement of the vane 12 is prevented while permitting radial displacement caused by relative expansion or contraction of the vane and outer casing. As in the case of rear flange 25, the dimensions of the front flange 26 are arranged to provide sufficient clearance for such radial displacement.

A clamping band 29 of relatively thin flat material having suitable standard means to adjust its tension encircles all of the outer platforms of the guide vanes and is held in place by ridges 30 and 31 provided on the outer platforms 19. On first assembly of the engine, the band 29 is adjusted so that it fits snugly under light tension. As the machine warms up, the mounting ring 22 and the guide vanes 12 expand outwardly against the clamping band 29, stretching the latter beyond its yield point and causing plastic yielding of the band. The tension in the band keeps all the guide vanes in firm contact with the mounting ring and ensures that they remain concentrically disposed about the axis of the machine. On cooling down the clamping band 29 is no longer tight, and the vanes on the under side of the engine are prevented from falling out of place by the rear flange 25 on the outer platform 19; the clearances are such that the outer tips of the rear flanges will then engage the inner surface 10^b of the outer casing 10, and prevent the dowel 21 from being withdrawn from hole 22^a in the mounting ring 22.

When the machine is run again and warms to operating temperature, the guide vanes expand until they take up the slack in the clamping band 29 and further expansion will result in the vanes on the under side of the engine being restored to their original positions by the outward expansion of the blades on the upper side. Thus the entire guide vane assembly resumes its concentric disposition about the axis of the machine, the outer platforms of the blades being mutually supporting against radially outward displacement, through the medium of the band which surrounds them all. Although the band acquires a permanent stretch during the initial operation of the engine, it retains some elastic properties about its newly acquired length and is still capable of supporting the vanes radially, so that their outer flanges 25 are clear of the outer casing 10, when they have attained their operational temperature on successive subsequent occasions.

Small tangential clearances are provided between the platforms 19 and 20 of adjacent blades when the machine is cold. The clearances disappear when the machine warms up so that a smooth-contoured passage through the annular gap between the inner structure 11 and the outer casing 10 are presented to the flow of working fluid.

The loads on the vanes imposed by the working fluid may be resolved into axial and tangential components. At the inner end of each vane, both of these components are carried by the mounting dowel 21. At the outer end of each vane, the axial loading is carried by the reac-

tion of the turbine shroud ring 18 against the rear extension 25 of the outer platform 19. The tangential loading is carried by the tangential reaction of the tooth 28 against the slot 27.

One of the advantages of the invention may be better understood by considering the couples acting on the outer vane platform 19 and resolving these about the point of contact between the tooth 28 and the slot 27, it will be seen that the turning moment induced by the resultant of the gas loads on the vane must be balanced by the moment of an axial reaction between the turbine shroud ring 18 and the rear flange 25 of the outer platform 19. Because of the tangential displacement of the rear flange 25 in relation to the front flange 26, the reaction force against the rear flange 25 that produces the balancing couple tends to be distributed uniformly across the width of the rear flange.

If so desired, thermal insulation 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 that such 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 the 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 we claim as our invention is:

1. In an axial flow elastic fluid power conversion machine comprising a fixed outer casing structure and a fixed inner structure spaced from said casing structure and defining therewith an annular passage for the flow of fluid, a plurality of guide vanes extending generally radially between the inner structure and the outer casing structure, and having inner and outer platforms, a pin and socket connection between each of the inner platforms of the guide vanes and the inner structure, the pin being radially slidable in the socket, and the blades thereby being free for radial movement relative to the inner structure, the said connections spacing said inner platforms angularly about the axis of the machine, platform-engaging means connecting the outer platforms of the guide vanes to the outer casing structure, said platform-engaging means permitting radial expansion and contraction of the guide vanes and restraining tangential and axial displacement thereof, and an elastic clamping band resiliently encircling all the outer platforms and rendering the platforms mutually supporting against radially outward displacement when the machine is at its operating temperature.

2. In an axial flow elastic fluid power conversion machine comprising a fixed outer casing structure and a fixed inner structure spaced from said casing and defining therewith an annular passage for the flow of fluid, a plurality of guide vanes extending generally radially between the fixed inner structure and the fixed outer casing structure and having inner and outer platforms, a ring member in rotation-preventing engagement with the fixed inner structure, a pin and socket connection between each of the inner platforms of the guide vanes and the inner structure, the pin being radially slidable in the socket and the blades thereby being free for radial movement relative to the inner structure, platform-engaging means connecting the outer platforms of the guide vanes to the outer casing structure, said platform-engaging means permitting radial

5

expansion and contraction of the guide vanes and preventing tangential and axial displacement thereof, and an elastic clamping band of relatively thin material resiliently encircling all the said outer platforms and rendering the platforms mutually supporting against radially outward displacement when the machine is at its operating temperature.

3. In an axial flow elastic fluid power conversion machine comprising a fixed outer casing structure and a fixed inner structure with a rim portion having a plurality of radial slots formed therein, said outer and inner structures defining a passage for the flow of fluid, a plurality of guide vanes extending between the fixed inner structure and the fixed outer casing structure, inner and outer platforms on the guide vanes, a mounting ring having a plurality of holes and having in one edge a plurality of teeth in engagement with the radial slots in the fixed inner structure, dowels secured to the inner platforms of the guide vanes and extending into the holes in the ring member, said ring member engaging the inner platforms to limit radially inward displacement of the guide vanes the fixed outer casing having a channel in which the outer platforms of the guide vanes are secured axially, teeth in the side of the channel, and means in the outer platform for engaging the teeth and securing the outer platforms tangentially, and a clamping band encircling all the outer platforms and rendering the platforms mutually supporting against radially outward displacement when the machine is at its operating temperature.

4. In an axial flow elastic fluid power conversion machine comprising a fixed outer casing structure and a fixed inner structure with a rim structure having a plurality of radial slots

6

formed therein, said outer and inner structures defining a passage for the flow of fluid from the front to the rear of the passage, a plurality of guide vanes extending between the fixed inner structure and the fixed outer casing structure, inner and outer platforms on the guide vanes, a front flange and a rear flange on each of the outer platforms, the front flanges having notches therein, a mounting ring having a plurality of holes and having in one edge a plurality of teeth in engagement with the radial slots in the fixed inner structure, dowels secured to the inner platforms of the guide vanes and extending into the holes in the ring member, said ring member engaging the inner platforms to limit radially inward displacement of the guide vanes the fixed outer casing having a channel into which the front flanges and rear flanges on the outer platforms extend, teeth in the side of the channel engaging the notches in the front flanges, and a clamping band encircling all the outer platforms and rendering the platforms mutually supporting against radially outward displacement when the machine is at its operating temperature.

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