

[54] SEGMENTED SEAL ASSEMBLY

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[58] Field of Search. 415/174, 171, 136, 199, 193,
415/217; 277/53, 96

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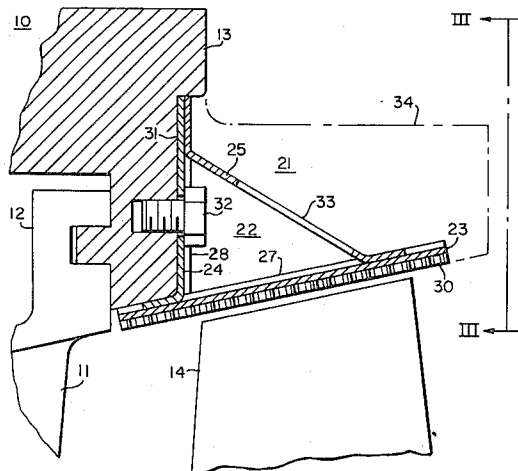
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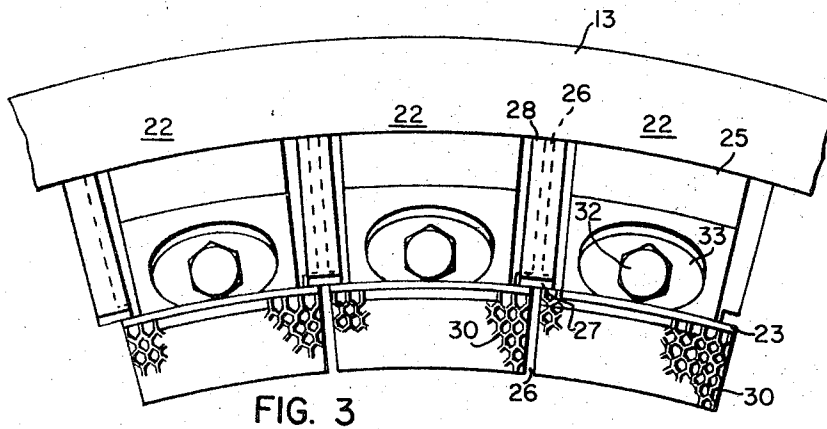
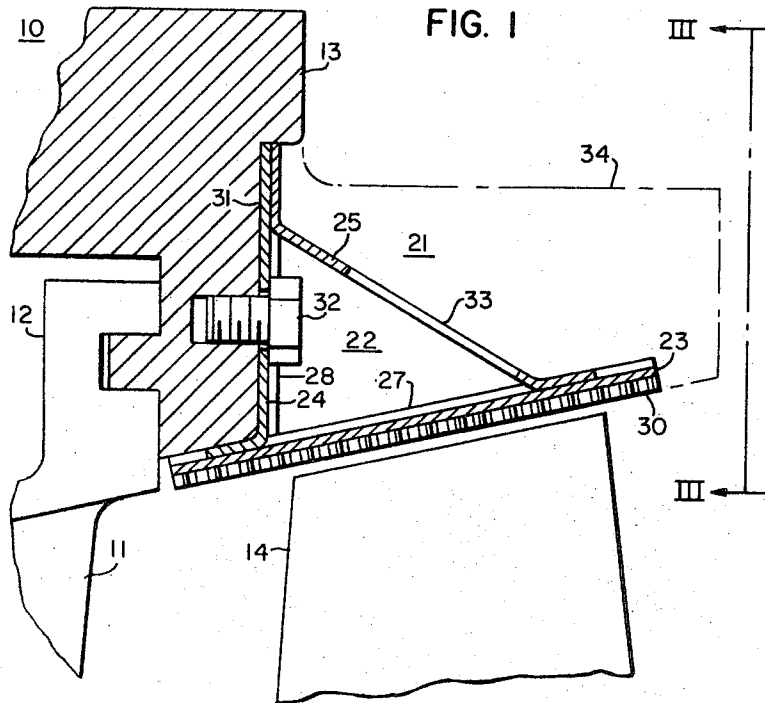
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ABSTRACT

A light weight seal assembly divided into arcuate segments surrounds the tips of an annular row of rotating blades of an axial flow gas turbine. Each segment comprises formed sheet metal members brazed together and attached to the blade ring in the turbine casing. Leakage through expansion gaps between segments is prevented by sealing strips which bridge the gaps. Heat is transferred from the light weight seal structure into the relatively massive blade ring which is cooled by an external air supply. A soft wearable liner is brazed to the inside of the segment to insulate against heat transfer from the gas stream into the blade ring.

5 Claims, 4 Drawing Figures





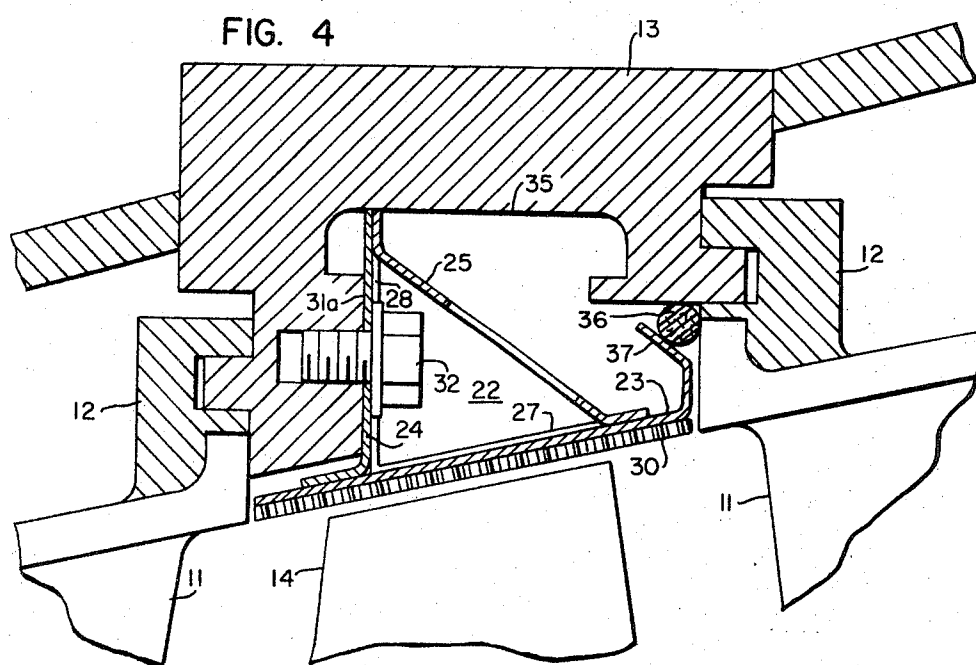
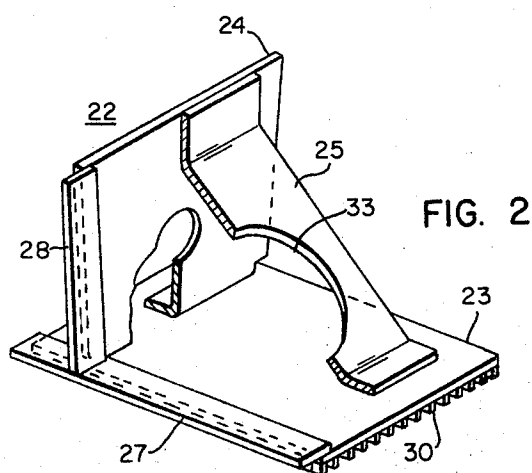
WITNESSES

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SEGMENTED SEAL ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates, generally, to elastic fluid machines and, more particularly, to a segmented seal assembly for axial flow gas turbines.

In order to maintain high first stage efficiency, static seal structures have been provided to minimize by-pass leakage of the motive fluid around the first stage stator vanes of an axial flow gas turbine. In order to improve the efficiency of any other stage of an axial flow turbine, it is desirable to decrease leakage of the motive fluid past the tips of the rotor blades for that stage. This is accomplished by reducing the tip clearance by providing a light weight segmented annular seal assembly around the rotor blades.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, an annular seal assembly divided into a plurality of arcuate segments surrounds a row of rotating blades of an axial flow turbine. Each segment comprises an axially extending member and a radially extending member of formed sheet metal brazed together and attached to the blade ring in the stator casing of the turbine. A honeycombed liner composed of a relatively soft wearable material is secured on the inner surface of each segment to insulate against heat transfer from the motive fluid into the blade ring. Leakage through expansion gaps between segments is prevented by sealing strips which bridge the gaps. Heat is transferred from the light weight seal structure into the relatively massive blade ring which is cooled by an external air supply.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the nature of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a view, partly in axial section and partly in elevation, of a portion of an axial flow gas turbine with a segmented seal assembly constructed in accordance with principles of the present invention;

FIG. 2 is an isometric view of one arcuate segment of the seal assembly;

FIG. 3 is a view, in elevation taken along line III—III in FIG. 1, showing an expansion gap between adjacent seal segments; and

FIG. 4 is a view, similar to FIG. 1, of a modified seal assembly.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, particularly to FIG. 1, the structure shown therein comprises a portion of an axial flow gas turbine 10 which includes an annular array of circumferentially spaced stationary blades or vanes 11 secured between arcuate outer shroud segments 12 and arcuate inner shroud segments (not shown). The outer shroud segments 12 are mounted in a stator blade ring 13 disposed inside a turbine casing (not shown) which is generally circular in cross section.

An annular row of rotor blades 14 is disposed immediately downstream from the stationary vanes 11. The rotor blades 14 are suitably attached to the periphery of a rotor wheel (not shown) secured to a shaft (not shown) rotatably mounted in the turbine casing in a manner well known in the art. In the arrangement shown in FIG. 1, the stationary blades 11 and the rotor blades 14 constitute the last stage of the turbine which includes other stationary and rotary blades disposed upstream from the blades 14, thereby providing a multi-stage turbine.

A hot motive gas is supplied to the turbine from suitable combustion chambers (not shown). The hot motive gas flows from the combustion chambers through the stationary vanes and the rotating blades, thereby driving the turbine shaft by energy extracted from the hot motive fluid in a manner well known in the art.

In order to minimize the leakage of the motive fluid around the rotating blades 14, an annular seal assembly 21 surrounds the row of rotating blades 14. The seal assembly 21 is divided into a plurality of arcuate segments 22 which are disposed end-to-end around the rotating blades 14. The segments 22 are supported by the blade ring 13 in a manner which will be described more fully hereinafter.

As shown more clearly in FIGS. 2 and 3, each segment 22 comprises a generally axially disposed member 23 and a radially disposed member 24 which are preferably formed from relatively light weight sheet metal and brazed together. An angularly disposed brace member 25, also formed from sheet metal, may be secured to the members 23 and 24 to maintain the members in the desired angular relation.

Expansion gaps 26 are provided between adjacent segments to permit circumferential expansion due to heating of the segments. Leakage through the expansion gaps is prevented by sealing strips 27 which bridge the gaps between the members 23. Sealing strips 28 bridge the gaps between the radially extending members 24. The strips 27 and 28 may be secured to the members 23 and 24, respectively, as by brazing.

A honeycombed soft wearable liner 30 is secured to the inside of each arcuate member 23. The liner 30 is preferably composed of a metal which is softer than the metal of which the blades 14 are composed, thereby permitting the liner to wear away if it is rubbed by the rotating blades. In this manner the turbine may be constructed with relatively small cold tip clearance between the tips of the blades and the liner which provides a more efficient stage and more horsepower output from the turbine. The wearable material, which is secured to the member 23, as by brazing, will wear clear if rubbing occurs, thus permitting minimum possible tip clearance.

Furthermore, the honeycomb material insulates against heat transfer from the gas stream into the blade ring, thereby increasing the efficiency of the turbine. Heat is transferred from the light weight seal structure into the relatively massive blade ring to reduce expansion of the seal members. The blade ring 13 may be cooled by an external cool air supply in a manner known in the art, for example as disclosed in U.S. Pat. No. 3,427,000, issued Feb. 11, 1969, to A. J. Scalzo and assigned to Westinghouse Electric Corporation, to decrease expansion of the blade ring during transient conditions.

By way of example, the annular seal assembly 21 may consist of 36 segments 22. The radially extending member 24 of each segment may be attached to a radially extending face 31 on the end of the blade ring 13 by means of a bolt 32 which is threaded into the blade ring 13. An opening 33 is provided in the brace member 25 to permit access to the head of the bolt 32.

Another advantage of the seal arrangement shown in FIG. 1 is that several inches of material have been removed from the rear end of the blade ring 13 as shown by the dot-dash line 34 which shows the prior contour of the blade ring. The removal of this material results in a lighter and less costly blade ring.

As explained hereinbefore, the seal mounting arrangement shown in FIG. 1 is suitable for use with the last stage of a multi-stage turbine. The seal mounting arrangement shown in FIG. 4 is suitable for use with an intermediate stage of a multi-stage turbine. As shown in FIG. 4, an annular recess 35 is provided in the blade ring 13 to provide a radially extending face 31a on the blade ring to which the radially extending member 24 of each seal segment 22 is attached by means of a bolt 32. In this manner the annular seal assembly may be utilized with an intermediate stage of the turbine without interfering with the mounting of the stationary vanes in the blade ring of the turbine.

A seal ring 36 is retained in position by an outwardly extending extension 37 on the member 23 to prevent leakage through the joint between members 12 and 13. The ring 36 may be an O-ring divided into several sections. Thus, the annular seal assembly may be utilized with the rotary blades of an intermediate stage as well as with the rotary blades of the last stage of a multi-stage turbine.

From the foregoing description, it is apparent that the invention provides a light weight seal assembly for use with the rotating blades of a turbine which makes it possible to maintain minimum tip clearance for the blades, thereby reducing leakage of the motive fluid around the turbine blades and increasing the efficiency of the turbine. Heat is transferred from the light weight seal structure into the relatively massive blade ring which supports the seal structure. Also, heat losses from the hot motive fluid are reduced by the honeycombed structure of the wearable liner utilized in the seal assembly.

We claim:

1. In an axial flow turbine, in combination,
a relatively massive stator blade ring having an annular array of stationary vanes mounted therein,
an annular row of metal rotor blades disposed immediately downstream from the stationary vanes,
an annular seal assembly divided into a plurality of arcuate segments surrounding the row of rotor blades,
each segment comprising a generally axially disposed member and a radially disposed member secured together,
an angularly disposed brace member secured to said axially and radially disposed members,
said segments being spaced circumferentially to provide expansion gaps between segments, and having sealing strips bridging said gaps,
said blade ring having a radially disposed face thereon, and

threaded screw means attaching the radially disposed members to said face.

2. The combination defined in claim 1 wherein said members are formed of sheet metal and are of relatively lighter construction than said blade ring.

3. The combination defined in claim 2, including a liner composed of a relatively soft wearable material secured on the inner surface of the axially disposed member.

4. The combination defined in claim 1 wherein the rotor blades are in the last stage of a multi-stage turbine, the radial face is on the end of the blade ring, and the seal assembly extends axially from the blade ring face in a cantilever fashion.

5. The combination defined in claim 1, wherein the rotor blades are in an intermediate stage of a multi-stage turbine,
the blade ring has a second annular array of stationary vanes mounted thereto and forming a part of a succeeding stage,
the blade ring has an annular recess between said arrays of vanes providing said face,
the axially disposed member has an outwardly extending extension thereon, and
a seal ring retained in sealing position by said extension.

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