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[54] **TURBINE INTERSTAGE SEAL ASSEMBLY**

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[52] **U.S. Cl.** **415/113,** 415/171

[51] **Int. Cl.** **F01d 11/00,** F01d 11/10

[58] **Field of Search** 415/109, 110, 111, 115, 170, 415/171, 175, 176, 113; 277/198, 199

[56] **References Cited**

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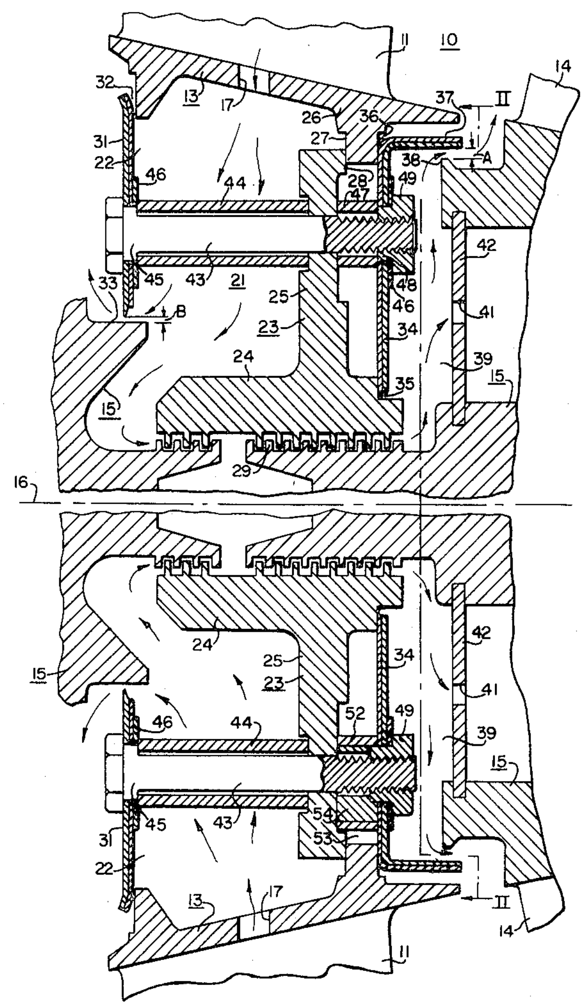
[57] **ABSTRACT**

Interstage leakage around the inner shrouds of the stationary vanes of a turbine is reduced by a seal assembly disposed in a space between turbine rotor wheels or discs. The members of the seal assembly are separated from the hot stator vanes and are supported by a seal housing cooled by air supplied through the hollow stator vanes. Thus, clearance between stationary members of the seal assembly and the rotor can be made smaller than in prior structures which had to allow for expansion of the members.

5 Claims, 3 Drawing Figures



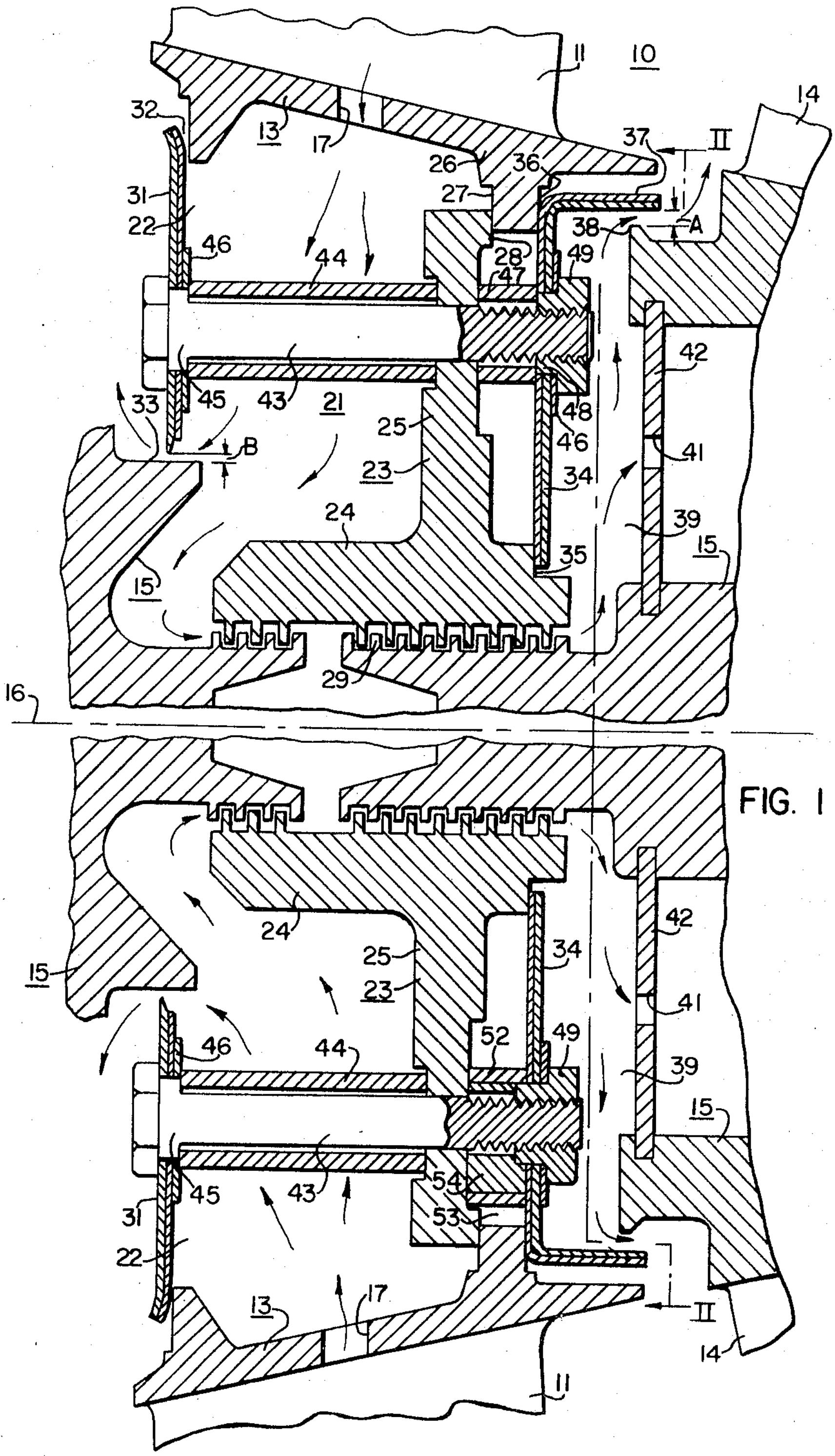

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FIG. 1

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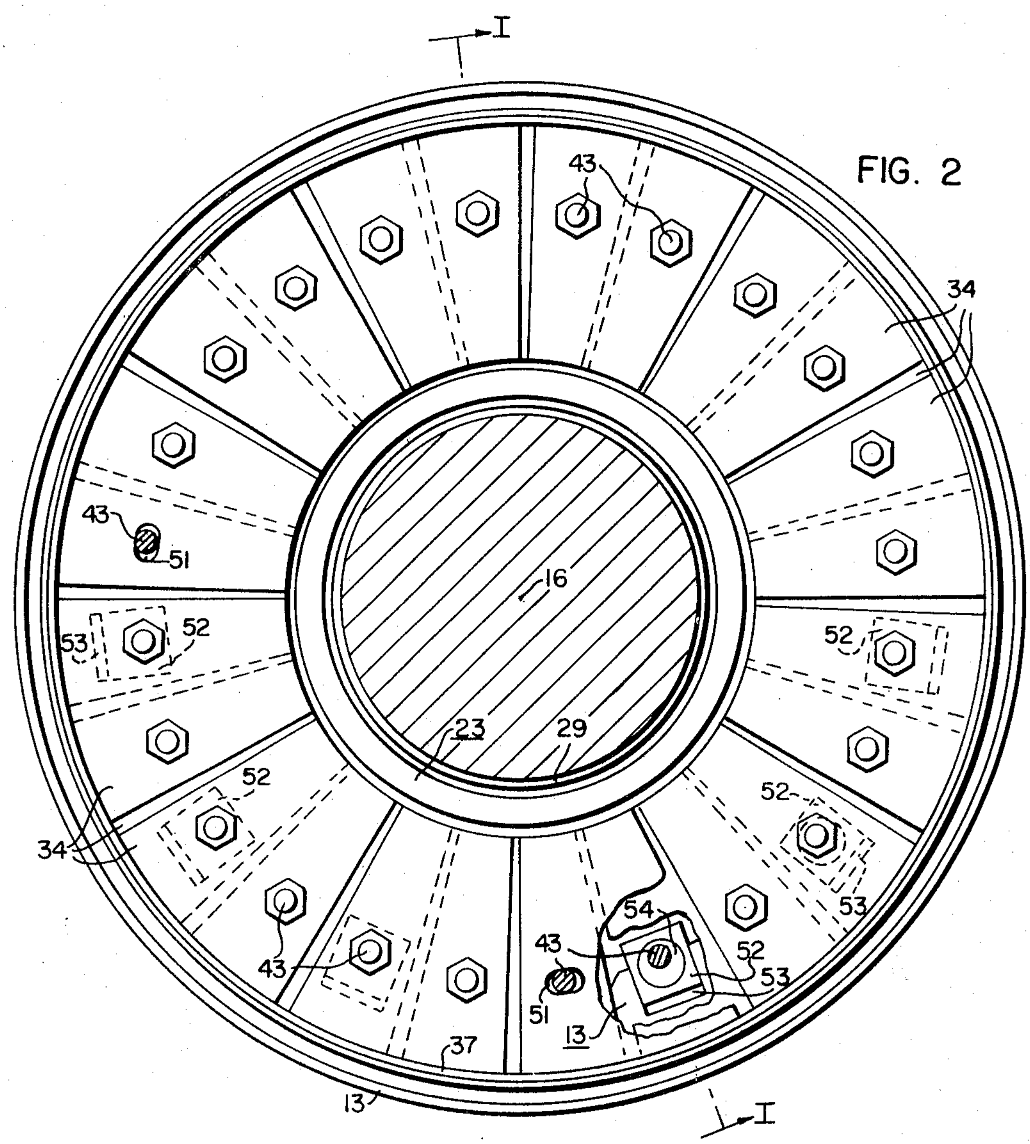

FIG. 2

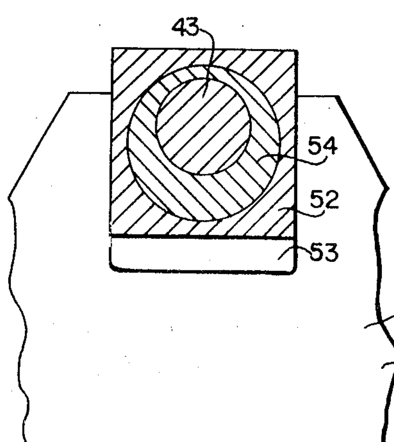

FIG. 3

TURBINE INTERSTAGE SEAL ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates, generally, to elastic fluid machines and, more particularly, to interstage seals for axial flow gas turbines.

In order to improve the performance of a multistage axial flow gas turbine it is desirable to control leakage between stages of the turbine. In prior turbines the clearances at certain points are necessarily large because the stationary members which control the clearances are integral with the stator vane segments and expand inwardly toward the rotor as the turbine comes up to operating temperature. Therefore, there is considerable leakage of the motive fluid past the stationary vanes of the turbine.

Furthermore, the operating temperatures of gas turbines are being increased to increase their output. The increase in operating temperature without exceeding the permissible temperature of the materials is attained by the introduction of a cooling fluid, such as air, into the turbine hot components such as the rotor blades and blade roots, and the stationary vane structure. It is desirable to conserve the cooling air and to direct its flow toward the hottest components of the turbine. Also, it is desirable to decrease the cost of a turbine by simplifying its structure.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, clearances between stationary members of a turbine interstage seal assembly and points on the turbine rotor are reduced by utilizing radially disposed layers of thin sheet metal segments which cooperate with an annular seal housing member encircling the rotor to define an annular chamber between the rotor and the stator vane inner shroud segments. The sheet metal segments are separated from the hot vanes and are supported by the housing member which is cooled by air supplied through the hollow stator vanes. The pressure in the chamber is maintained at a value slightly higher than the pressure ahead of the stage so that there will be a positive flow of relatively cool air through relatively narrow passages between the seal members and the rotor. Part of the air is directed toward the roots of the rotor blades. The metal segments are attached to the housing member by means of bolts and spacers and the housing member is held concentric with the rotor axis by means of radial keys on the lower half of the housing member. The keys are adjustable in radial slots in the shroud segments by means of eccentric bushings on certain of the bolts which attach the metal segments to the housing member.

BRIEF DESCRIPTION OF THE DRAWINGS

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 drawings, in which:

FIG. 1 is a view, in axial section, taken along the line I—I in FIG. 2, of a portion of an axial flow gas turbine having an interstage seal assembly constructed in accordance with principles of the invention;

FIG. 2 is a reduced view, partly in elevation and partly in section, taken along the line II—II in FIG. 1, and

FIG. 3 is a detail view, in section, showing the key arrangement for holding the seal housing member concentric with the rotor axis.

DESCRIPTION OF THE PREFERRED EMBODIMENT

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 (not shown) and arcuate inner shroud segments 13. The outer shroud segments are mounted in a stator blade ring (not shown) 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 blades 11. The rotor blades 14 are suitably attached to the periphery of a rotor wheel 15 secured to a shaft having an axis 16 and rotatably mounted in the turbine casing. The stationary blades 11 and the rotor blades 14 constitute one stage of the turbine which may include other stationary and rotary blades similar to the ones shown, thereby providing a multistage 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 into the turbine through a suitable transition passageway (not shown) and then through the stationary vanes and the rotor blades of the stages of the turbine. The rotor 15 is driven by energy extracted from the hot elastic fluid in a manner well known in the art.

Compressed coolant fluid may be introduced into the turbine through the stationary vanes 11, which are of a hollow construction and thence through an opening 17 in the shroud segment 13. The coolant fluid, such as air, may be supplied from a suitable source such as a compressor (not shown).

In order to conserve the coolant fluid and also to minimize leakage of the hot motive fluid around the stationary vanes 11, a seal assembly 21 is provided in the space between rotor wheels or discs 15 of the turbine. The seal assembly 21 is so constructed that it defines a substantially enclosed annular chamber 22 between the rotor 15 and the stator vane inner shroud segments 13 for receiving the coolant fluid. The pressure of the coolant fluid inside the chamber 22 is maintained at a value slightly higher than the pressure of the motive fluid immediately upstream from the stationary vanes 11. Thus, the hot motive fluid is prevented from entering the chamber 22 and leakage of the hot motive fluid around the stationary vanes 11 is minimized.

In prior turbines, the clearance at points A and B has necessarily been large because the stationary members which control this clearance have been integral with the vane segments and expand inwardly toward the rotor as the turbine comes up to operating temperature. In the present structure, the clearance at points A and B can be much smaller because the members of the seal assembly 21 are separated from the hot vanes 11 and are supported by a seal housing member 23 which is cooled by the coolant fluid.

The annular seal housing member 23 has an axially extending portion 24 disposed in sealing relation with the rotor 15 and a radially extending flange 25 disposed in sealing relation with an inwardly extending projection 26 on the shroud segment 13. The projection 26 has a seal face 27 engaged by a seal face 28 on the flange 25. A labyrinth seal 29 may be provided between the portion 24 of the housing member 23 and the rotor 15.

Radially disposed relatively thin sheet metal segments 31 cooperate with the seal housing member 23 to define the substantially enclosed chamber 22 and to form a barrier to reduce loss of cooling air from the chamber. As shown, the segments 31 engage a seal surface 32 on the inner shroud segment 13 and the segments 31 are spaced a relatively small distance from an annular surface 33 on the rotor 15 to restrict the flow of cooling air through the annular passage at B. The segments 31 are disposed in two layers with expansion joints between segments staggered to prevent leakage between the ends of the segments. The gaps between the ends of the segments permit circumferential expansion of the segments due to rise in temperature.

Additional thin sheet metal segments 34 are disposed to engage a seal face 35 on the seal housing member 23 and a seal face 36 on the projection 26 on the shroud segment 13. As shown in FIG. 2, the segments 34 are disposed in two layers with expansion joints between layers staggered in the same manner as the segments 31. The segments 34 have an axially extending portion 37 spaced from a projection 38 on the rotor wheel 15 to maintain a relatively small clearance at point A.

Thus, the flow of coolant fluid which leaks through the labyrinth seal **29** into the space **39** is restricted at point A. In this manner coolant fluid is directed through an opening **41** in a sideplate **42** on the rotor wheel **15** to cool the root portions of the rotor blades **14** in a manner fully described in a copending application Ser. No. 739,274, filed June 24, 1968 by A. J. Scalzo and Andrew Zabrodsky and assigned to the Westinghouse Electric Corporation. The seal segments **34** also cooperate with the seal housing member **23** to prevent loss of cooling air from the chamber **22** at the seal surfaces **27** and **28**.

As shown more clearly in FIGS. **1** and **2**, the seal segments **31** and **34** are attached to the flange **25** by two bolts **43** per segment. The segments **31** are spaced from the flange **25** by pipe spacing members **44** which engage a shoulder **45** at the head of each bolt. Resilient means, such as a Belleville spring washer **46**, is disposed around the shoulder **45** between the end of the pipe spacer **44** and the segments **31** to control the clamping action on the metal segments **31**. In this manner the loading on the segments is limited so that the segments can slide under the boltheads without danger of buckling.

The seal segments **34** are spaced from the flange **25** by means of pipe spacers **47** disposed between the flange **25** and a shoulder **48** on a nut **49** threaded onto each bolt **43**. A Belleville washer **46** is disposed around the shoulder **48** to control the pressure applied on the segments **34** in the manner hereinbefore described. As shown more clearly in FIG. **2**, elongated holes **51** are provided in the segments **34** for the bolts **43** to allow for circumferential growth while retaining positive positioning of the segments in a radial direction. Likewise, elongated holes **51** are provided in the segments **31** for the bolts **43**.

As shown more clearly in FIGS. **2** and **3**, the seal housing member **23** is held concentric with the rotor axis **16** by means of **6** radial keys **52** disposed in radial slots **53** in the projections **26** on the shroud segments **13**. The keys **52** are provided in the lower half only of the seal housing member **23**. The keys **52** are adjustable by means of eccentric bushings **54** on the bolts **43**, thereby assuring proper alignment of the seal housing member **23**. The keys **52** and eccentric bushings **54** take the place of the pipe spacers **47** on the bolts on which the keys are mounted. In this manner the seal segments **34** are maintained in spaced relation with the seal housing member **25**, and the desired pressure on the seal segments is maintained. As previously stated, the keys **52** are provided in only the lower half of the seal housing member **23** and the key may be spaced in the manner shown in FIG. **2**. The bolts **43** and pipe spacers **47** are provided between the keys **52** in the lower half of the seal housing member **23**.

Another feature of the present seal arrangement is that the flexible nature of the seal segment plates **31** permits an initial cold spring pressure between surfaces at **32**, thereby assuring that the joint between the seal segments **31** and the shroud segment **13** stays tight. As previously explained, the segments **34** cooperate with the seal housing member **23** and the shroud segment **13** to prevent leakage of the cooling air through the joint between seal surfaces **27** and **28**.

From the foregoing description it is apparent that the invention provides a seal assembly which makes it possible to reduce clearances between stationary and rotating parts of a turbine since the members of the seal assembly are separated from hot portions of the turbine and they are supported on a member which is cooled by cooling air introduced into the turbine. The seal assembly conserves the cooling air and directs its flow in a manner to cool otherwise hot portions of the turbine. Furthermore, the seal assembly minimizes leakage of the hot motive fluid around the stationary vanes of the turbine.

We claim as our invention:

1. In a seal assembly for an axial flow machine utilizing a hot pressurized motive fluid,
   - a stator having an annular array of stator vanes with inner shroud segments secured to the vanes,
   - a rotor having an annular row of rotor blades disposed downstream from the stator vanes,
   - an annular seal housing member encircling the rotor upstream from the rotor blades,
   - radially disposed metal segments cooperating with the housing member to define a substantially enclosed annular chamber between the rotor and the stator vane inner shroud segments to prevent leakage of the motive fluid around the stator vanes,
   - said housing member having an axially extending portion disposed in sealing relation with said rotor and a radially extending flange disposed in sealing relation with said inner shroud segments, and
   - means for attaching said metal segments to the radially extending flange on said housing member in axially spaced relation.
2. The seal assembly defined in claim **1**, wherein
   - the attaching means includes bolts extending through said flange and spacing members disposed between the metal segments and the flange to apply a clamping action on the segments.
3. The seal assembly defined in claim **2**, wherein
   - the metal segments are disposed in layers with staggered expansion joints between segments.
4. The seal assembly defined in claim **3**, including
   - resilient means for controlling the clamping action on the metal segments.
5. The seal assembly defined in claim **2**, including
   - inwardly extending projections on the shroud segments having radial slots therein, radial keys on the lower half of the housing member and disposed in certain of said slots for holding the housing member concentric with the rotor axis, and eccentric bushings on certain of said bolts for adjusting said keys in said slots.

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