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STATIC SEAL STRUCTURE

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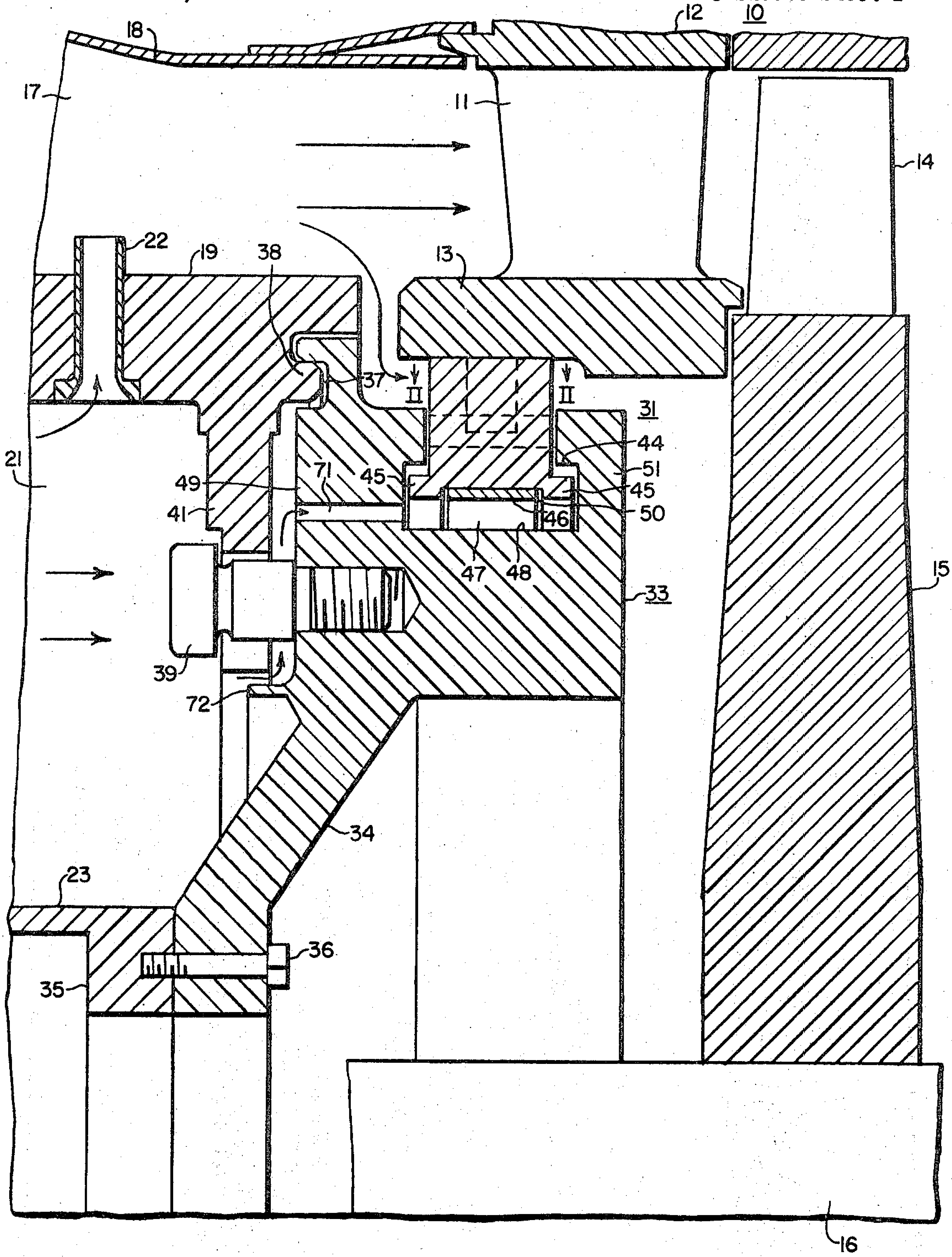

FIG. I.

WITNESSES

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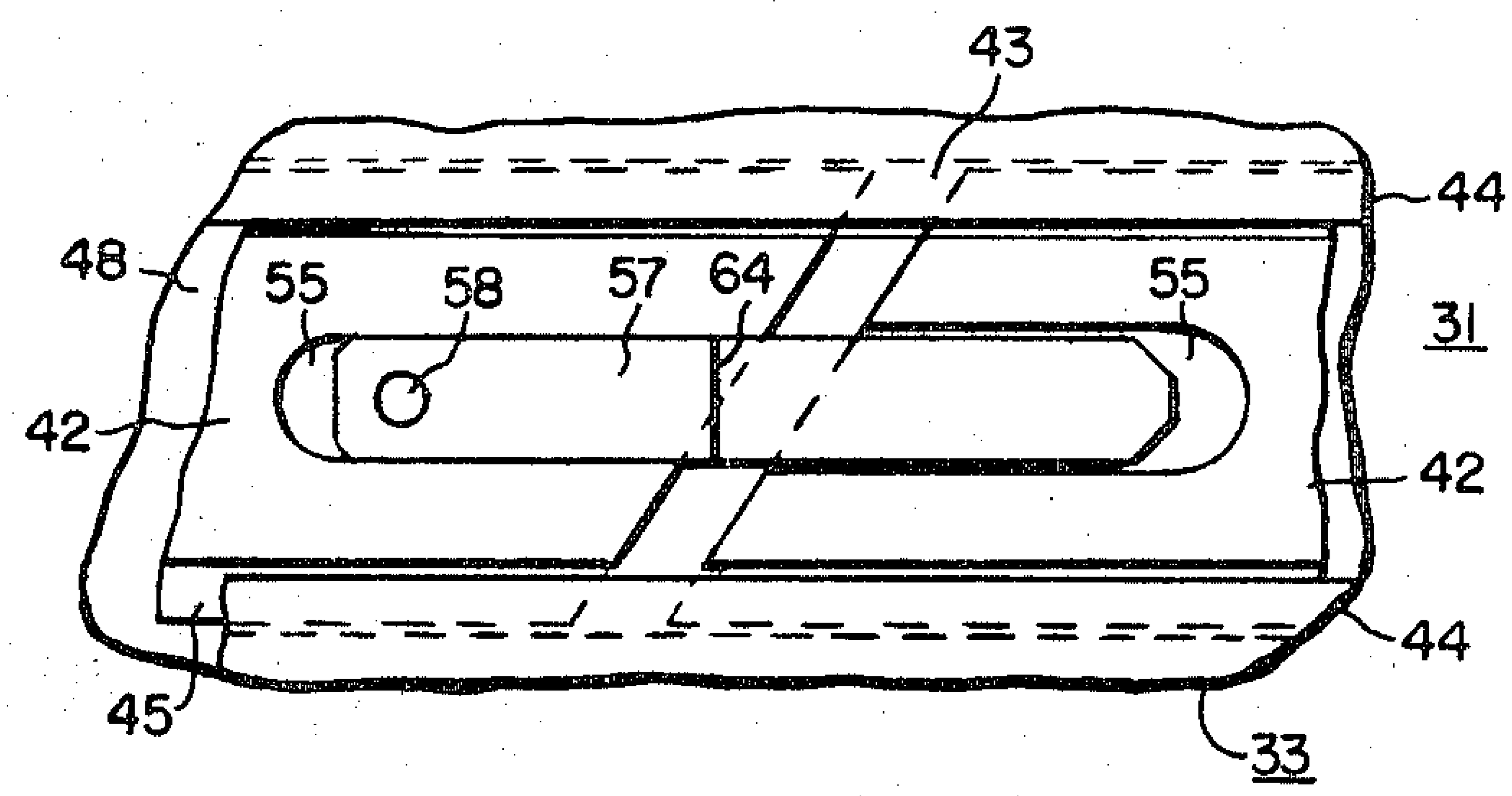

FIG. 2.

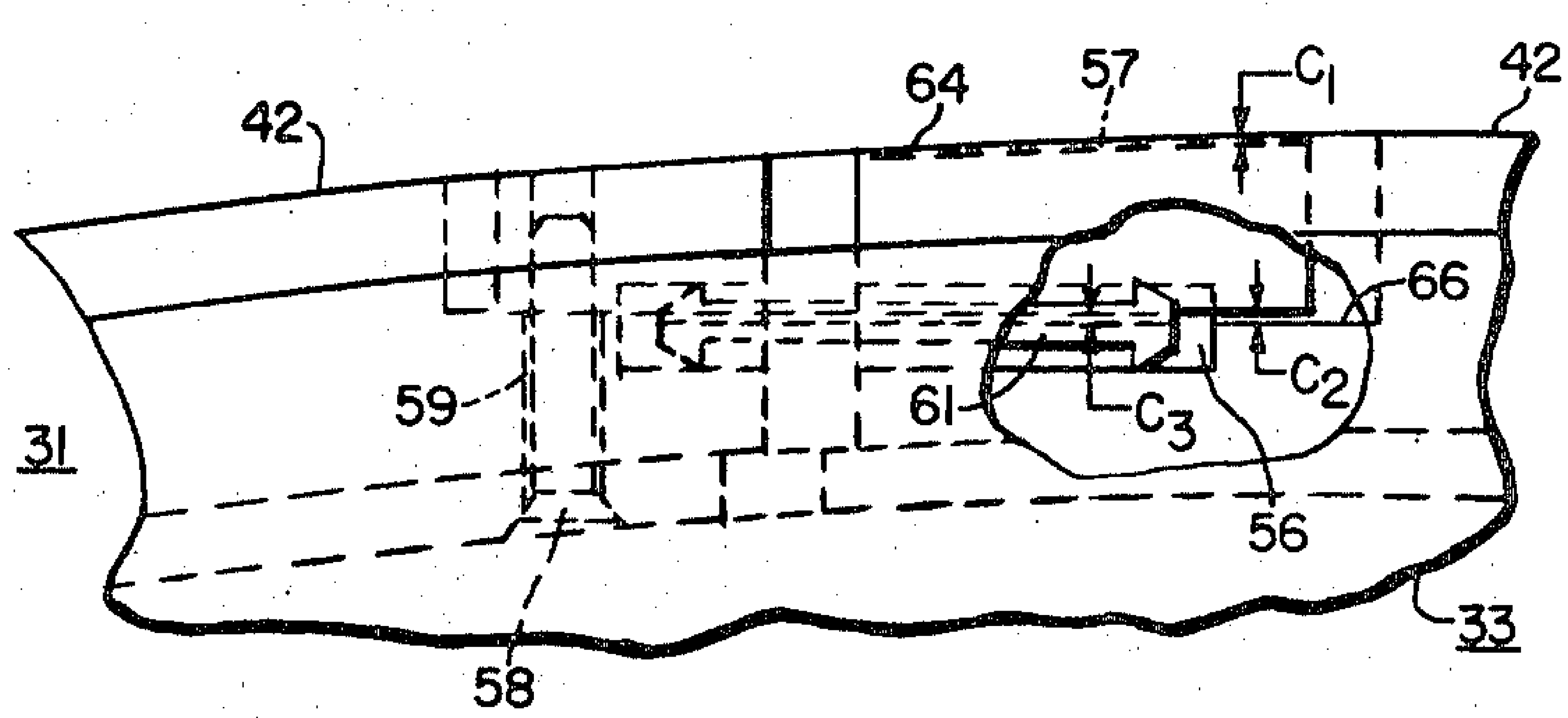

FIG. 3.

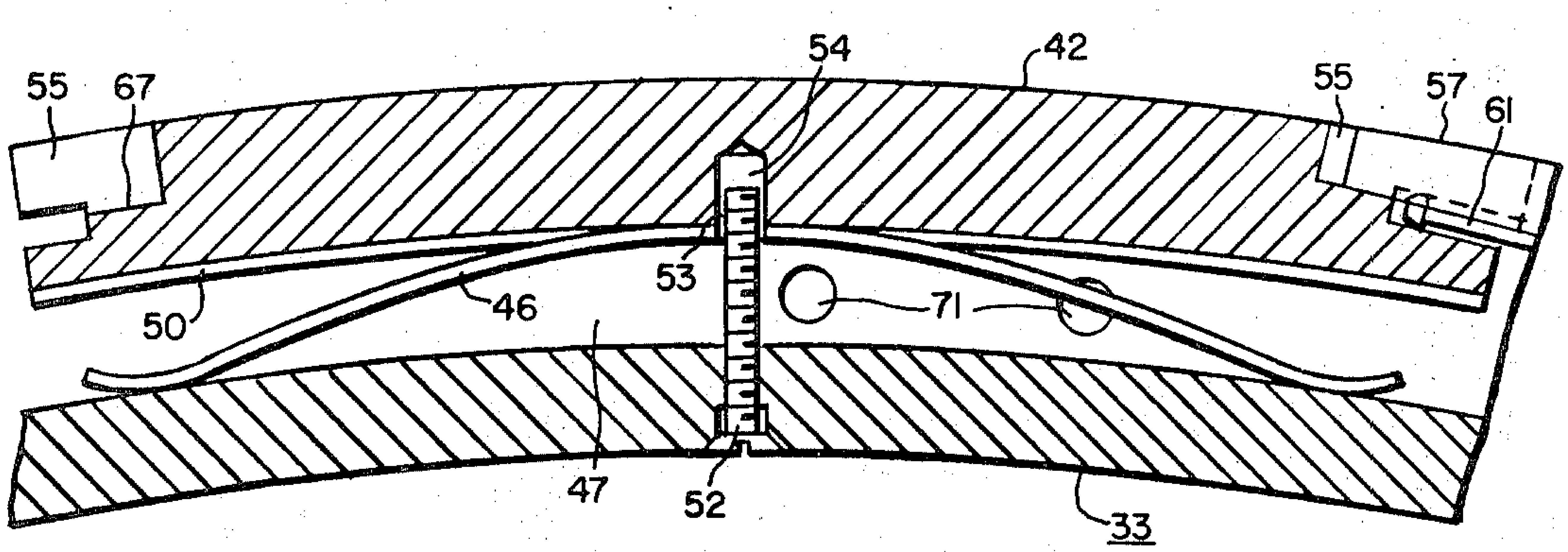

FIG. 4.

STATIC SEAL STRUCTURE

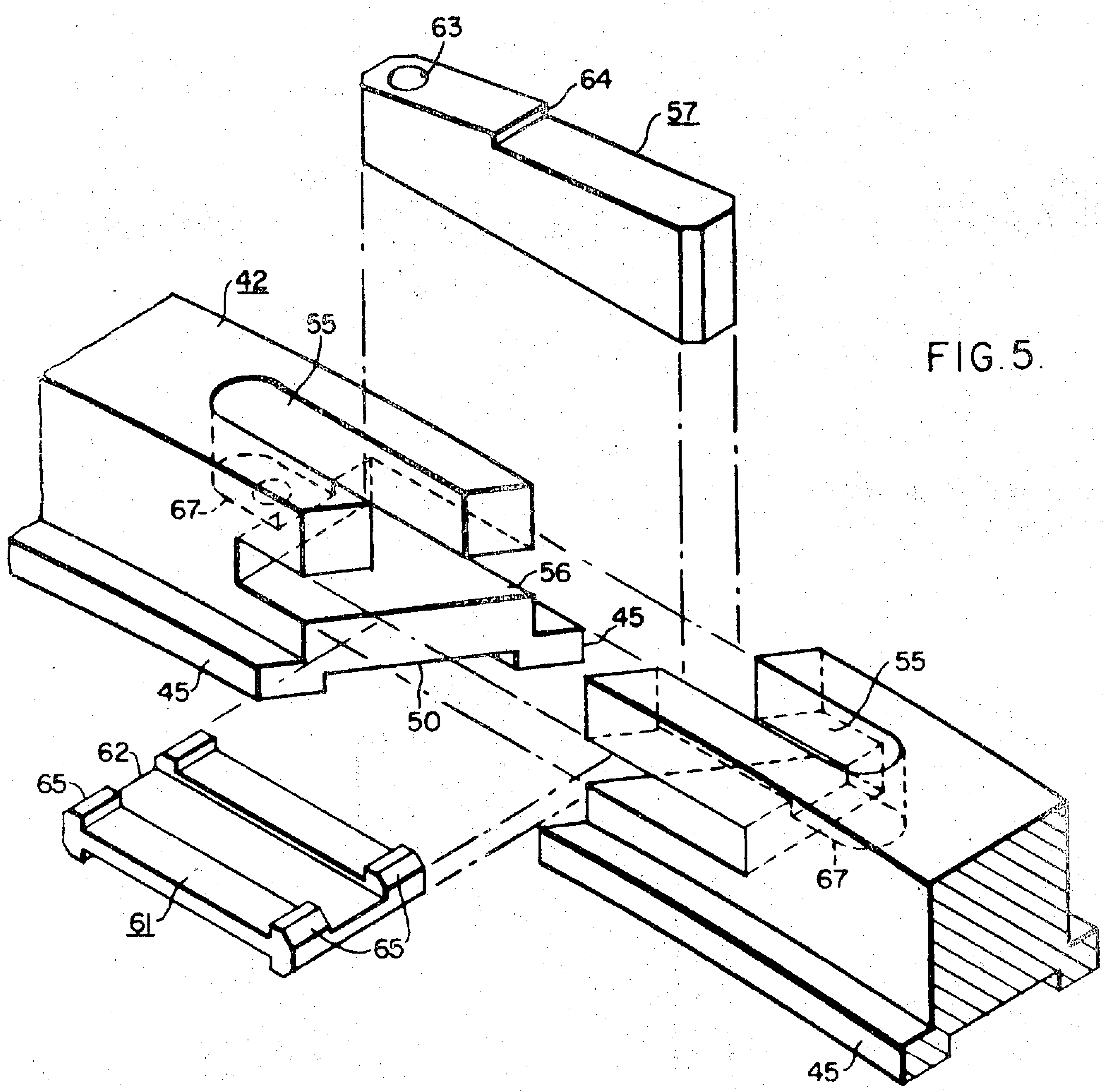

FIG. 5

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STATIC SEAL STRUCTURE

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U.S. Cl. 415—180 10 Claims

ABSTRACT OF THE DISCLOSURE

An annular static seal structure is provided at the entrance to the stator of an axial flow turbine to minimize by-pass leakage around the first stage nozzle or stator vanes. The seal structure includes a plurality of arcuate ring segments mounted end-to-end in an annular seal housing and pressure loaded against the inner shroud of the first stage stator vanes. At the gaps between segments, one end of each segment is interconnected with one end of the adjacent segment by a radial link and a transverse key. The radial link prevents axial leakage and the transverse key prevents radial leakage which would otherwise by-pass the radial link.

BACKGROUND OF THE INVENTION

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

Present high efficiency gas turbines which produce more work per stage result in a higher pressure drop across the first stage nozzle or stator vanes. To maintain high first stage efficiency, it is important to minimize by-pass leakage around the first stage stator vanes.

The first row vanes are usually manufactured in groups of 3 or 4 vanes, with clearance between each group for expansion. Due to unequal heating in the combustion system and hot spots in the vanes, each group may have a different radial expansion. Previous seal arrangements used on machines with lower pressure drops had gaps permitting axial leakage past the inner shroud on the stator vanes.

An object of this invention is to provide an effective sealing system for preventing by-pass leakage under the inner shroud of stator vanes in a turbine.

Another object of the invention is to provide a sealing system which prevents axial as well as radial leakage and has the ability to follow radial movement of each group of stator vanes without distorting the system in general.

Other objects of the invention will be explained more fully hereinafter or will be apparent to those skilled in the art.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, a plurality of arcuate ring segments are slidably mounted end-to-end in a generally channel-shaped annular seal housing. The segments are spring biased radially outwardly against the inner shroud of the first row of stator vanes in an axial flow gas turbine. At the gaps between segments, the ends of adjacent segments are interconnected by radial links and keys extending transversely to the links and disposed in intersecting grooves in the segments. The clearances between members of the seal assembly are such that the seal segments can follow radial movement of an individual group of stator vanes.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature and objects 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, of a portion of an axial flow gas turbine with an annular seal structure constructed in accordance with principles of the present invention;

FIG. 2 is a view, in plan, of a portion of the seal structure, looking in the direction of arrows II—II in FIG. 1;

FIG. 3 is a view, in elevation, of the portion of the seal structure shown in FIG. 2;

FIG. 4 is a fragmentary view, partly in section and partly in side elevation, showing one of the seal segments utilized in the seal structure; and

FIG. 5 is an exploded view of the end portions of a pair of the seal segments and their associated seal link and seal key.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, particularly to FIG. 1, there is shown therein 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 **13**. The outer shroud segments **12** 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 array of rotor blades **14** is disposed immediately down stream from the stationary blades **11**. The rotor blades **14** are suitably attached to the periphery of a rotor wheel secured to a shaft **16** rotatably mounted in the turbine casing. The stationary blades **11** and the rotor blades **14** constitute the first stage of the turbine which may include other stationary and rotary blades disposed down stream from the blades **14**, thereby increasing the number of stages in the 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 to the blades **11** through a transition passageway **17** disposed between a transition cover plate **18** and an annular wall **19** of an air box or chamber **21**. The rotor **15** and the shaft **16** are driven by the energy extracted from the hot elastic fluid, in a manner well known in the art.

Compressed coolant fluid may, if desired, be introduced into the passageway **17** through a plurality of circumferentially spaced tubular shaped nozzle **22** extending through the annular wall **19** of the chamber **21** which is adapted to receive a flow of pressurized fluid, such as air, from a suitable source, such as a compressor (not shown). In the structure shown, the chamber **21** is of annular shape and is formed between the wall **19** and a tubular wall **23** of a tube housing through which the shaft **16** extends.

In order to minimize the leakage of the elastic fluid around the stationary vanes or blades **11**, a static seal structure **31** is provided to cooperte with the inner shroud segments **13** of the stator structure. As shown in FIGS. 1, 2, and 3, the static seal structure **31** comprises an annular housing **33** which is generally channel-shaped in cross section and has an integrally formed disc-like portion **34** attached to a flange **35** on the tube wall **23** by means of a plurality of bolts **36**. The housing **33** is supported inside the inner shroud segments **13**, and the surface of an outer wall **49** of the housing has an annular groove **37** therein receiving an annular projection **38** on the end of the air chamber wall **19**. Thus, the housing **33** is in sealing relation with the wall **19**, and the housing **33** with its integral disc portion **34** form a portion of the enclosure for the air chamber **21**. Indexing bolts **39** which extend through circumferentially spaced projections **41** on the chamber wall **19** are threaded into the housing 33, thereby locating the position of the wall 19 relative to the housing 33.

As shown more clearly in FIGS. 2 and 3, the seal structure 31 includes a plurality of arcuate seal ring segments 42 mounted end-to-end in the housing 33 with gaps 43 between adjacent ends of the ring segments. As shown in FIG. 1, internal shoulders 44 are provided on the inside walls of the housing 33 and projections 45 are provided on the segments 42, thereby slidably retaining the segments 42 between the walls of the housing 33 which is preferably made in two semi-circular portions.

As shown in FIGS. 1 and 4, each ring segment 42 is biased radially outwardly into contact with an inner shroud segment 13 by means of a leaf spring 46 disposed in a cavity 47 defined between the bottom 47 and side walls 49 and 51 of the channel shaped housing 33. As shown in FIG. 4, each spring 46 is retained in position in the cavity 47 and in a groove 50 in the segment 42 by means of a screw 52 which extends through the bottom of the housing 33, and through an opening 53 in the spring into a hole 54 in the segment 42. The opening 53 and the hole 54 are slightly larger in diameter than the diameter of the screw 52 which is threaded into the housing 33. Also, the hole 54 extends in depth beyond the end of the screw 52. Thus, the segment 42 is free to move radially in the housing 33 within the limits defined by the shoulders 44 and projections 45.

As shown in FIG. 5, each end of each ring segment 42 has a radial groove 55 in its periphery and an intersecting groove 56 extending transversely there to across the bottom of the groove 55. As shown in FIGS. 2 and 3, a radial link 57 is disposed in a pair of grooves 55 in the adjacent ends of the two ring segments 42 and extends across the gap 43 between the ends of the segments. The link 57 is retained in position by means of a screw 58 which is threaded into one end of the link 57 through an opening 59 in one end of each segment 42. A transverse key 61 is disposed in the transverse groove 56 with the lower edge of the link 57 disposed in a slot 62 in the key 61. The key 61 also bridges the gap 43 between the adjacent ends of two ring segments 42. Thus, each segment is interconnected with the adjacent segment by the link 57 and the key 61. The link 57 is effective to obstruct axial leakage and the key 61 is effective to obstruct radial leakage which would otherwise by-pass the link 57.

The seal members, as indicated in the exploded view in FIG. 5, may be assembled in the following manner: A transverse key 61 is slid into the groove 56 in one of the segments 42 with the slot 62 in the key disposed in registry with the groove 55. A radial link 57 is then installed in the groove 55 in the segment with its lower portion keyed in the slot 62 and is held in position by means of the screw 58. Another segment 42 is then installed in the housing 33 with the seal members entering the mating grooves 55 and 56 in the end of that segment. The process is then repeated for another pair of seal ring segments.

The link is generally trapezoidal in shape and has a threaded hole 63 at the narrow end for receiving the screw 58. The sloping surface between the wide end of the link and the narrow end is stepped at 64 for a purpose which will be explained more fully hereinafter.

The detail structure of the key 61, as more clearly shown in FIG. 5, is generally of a dumbbell-shape having enlarged beveled end portions 65. The beveled end portions permit the key 61 to rock in the ring segments 42, thereby permitting relative radial movement between adjacent ring segments without binding.

The ability of the seal structure to follow the radial movement of an individual stator group of vanes is insured by clearances C_1, C_2 and C_3 as shown in FIG. 3. The clearance C_1 between the top of the link 57 and the outer peripheral surface of the ring segment 42 is provided by the step 64 in the sloping surface of the link 57. The clearance C_2 is provided between the bottom edge of the link 57 and the bottom 66 of the vertical groove 55 in one end of each ring segment 42. The bottom 67 of the groove 55 in the other end of each segment is slightly higher than bottom 66. The clearance C_3 between the bottom edge of the link 57 and the top of the key 61 is provided by the slot 62 in the key 61.

In order to still further improve the effectiveness of the seal structure 31, a plurality of openings 71 are provided in the wall 49 of the channel-shaped housing 33, as shown in FIGS. 1 and 4. The openings 71 connect the air pressure chamber 21 with the cavity 47 underneath the seal ring segments 42. Thus, a fluid pressure is maintained in the cavity 47. The pressurized fluid is directed into the openings 71 by an annular flange 72 on the housing 33 and by the seal members 37 and 38 on the walls 49 and 19 previously described. The pressurized fluid in the cavity 47 functions to prevent the hot motive fluid from bypassing the seal segments 42 through the cavity 47, thereby improving the efficiency of the seal structure.

From the foregoing description, it is apparent that the invention provides a seal structure which is particularly suitable for utilization in conjunction with the first row of stator vane segments in a gas turbine. However, the present seal structure is not limited in its application to gas turbines, but may be utilized in elastic fluid machines of other types. The seal structure is relatively simple to construct and assemble and is efficient in operation.

Since numerous changes may be made in the above described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all subject matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. In a machine utilizing hot pressurized elastic fluid, in combination,
   a stator having an annular array of stationary vanes with inner shroud segments secured to the vanes,
   an annular housing disposed inside the inner shroud segments,
   a plurality of arcuate seal ring segments mounted end-to-end in said housing gaps between adjacent ends of the ring segments,
   resilient means biasing said ring segments radially outwardly into contact with the inner shroud segments, and
   radial links and transverse keys interconnecting adjacent ends of the ring segments to prevent fluid leakage through the gaps.

2. The combination defined in claim 1, wherein
   each end of each ring segment has a pair of intersecting grooves therein receiving an interconnecting link and a cooperating key.

3. The combination defined in claim 1, wherein
   the annular housing is generally channel-shaped in cross section with the ring segments slidably disposed in the housing channel.

4. The combination defined in claim 3, including
   internal shoulders on the side walls of the channel, and
   projections on the ring segments cooperating with the shoulders to limit outward movement of the ring segments.

5. The combination defined in claim 3, wherein
   said channel-shaped housing has a cavity between the ring segments and the bottom wall of the channel, and
   the resilient means includes leaf springs disposed in said cavity.

6. The combination defined in claim 5, wherein
   the housing has openings in a side wall thereof admitting pressurized fluid into said cavity.

7. The combination defined in claim 6, including
   means directing the flow of fluid into said openings.

8. The combination defined in claim 2, wherein each key has a slot therein receiving a cooperating link.

9. The combination defined in claim 2, wherein each key is generally of a dumbbell-shape having rounded end portions permitting radial movement of the seal ring segments.

10. The combination defined in claim 8, wherein one end of each link is attached to one of the ring segments with clearances between the link and the cooperating key and the interconnected ring segment permitting radial movement of the ring segments.

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