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O-RING FOR GAS TURBINE ENGINE

Abstract

A seal arrangement of a gas turbine engine includes a first component and a second component abutting the first component. An O-ring is positioned in a gland volume defined between the first component and the second component. The O-ring has a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter. The ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width.

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Background/Summary

BACKGROUND

[0001] Exemplary embodiments of the present disclosure pertain to the art of gas turbine engines.

[0002] Traditional fluorocarbon O-rings, for use with engine oil, are limited to temperatures below

˜350 F. Some specially designed materials can be used at higher temperatures, up to 500 F, however the mechanical properties are those materials differ significantly from the existing standard fluorocarbon O-rings. Most notably, the thermal expansion of the new material is much greater.

[0003] O-rings using the new material must typically be used with a modified gland size to accommodate an increase in thermal expansion of the O-ring material. ie: the gland size must be larger. If a smaller size O-ring of the new material was defined to fit into an existing gland size, it would not meet the minimum pinch requirements of the O-ring.

BRIEF DESCRIPTION

[0004] In one exemplary embodiment, a seal arrangement of a gas turbine engine, includes a first component and a second component abutting the first component. An O-ring is positioned in a gland volume defined between the first component and the second component. The O-ring has a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter. The ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width.

[0005] Additionally or alternatively, in this or other embodiments the O-ring is configured to operate at temperatures greater than 350 degrees Fahrenheit.

[0006] Additionally or alternatively, in this or other embodiments the first component includes a seal groove at least partially defining the gland volume.

[0007] Additionally or alternatively, in this or other embodiments the ring inner diameter is in a range of 0.2-0.4 times the ring outer diameter.

[0008] Additionally or alternatively, in this or other embodiments the ring inner diameter is determined by Formula 1.

[0009] Additionally or alternatively, in this or other embodiments the first component and the second component are disposed at a bearing assembly of the gas turbine engine.

[0010] In another exemplary embodiment, a gas turbine engine includes a combustor, and at least one spool. The at least one spool includes at least one rotating component driven by products of the combustor, and a bearing assembly supportive of the at least one rotating component. The bearing assembly includes a seal arrangement including a first component, a second component abutting the first component, and an O-ring positioned in a gland volume defined between the first component and the second component. The O-ring has a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter. The ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width.

[0011] Additionally or alternatively, in this or other embodiments the O-ring is configured to operate at temperatures greater than 350 degrees Fahrenheit.

[0012] Additionally or alternatively, in this or other embodiments the first component includes a seal groove at least partially defining the gland volume.

[0013] Additionally or alternatively, in this or other embodiments the ring inner diameter is in a range of 0.2-0.4 times the ring outer diameter.

[0014] Additionally or alternatively, in this or other embodiments the ring inner diameter is determined by Formula 1.

[0015] In yet another exemplary embodiment, a method of assembling a seal arrangement of a gas turbine engine includes at least partially defining a gland volume at a first component the gas turbine engine, and installing a high-temperature O-ring into the gland volume. The high-temperature O-ring has a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter. The ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width. A second component of the gas turbine engine is installed over the high-temperature O-ring and the first component, to at least partially compress the high-temperature O-ring.

[0016] Additionally or alternatively, in this or other embodiments a fluorocarbon O-ring is removed from the first component before installing the high-temperature O-ring to the first component.

[0017] Additionally or alternatively, in this or other embodiments the high-temperature O-ring is configured to operate at temperatures greater than 350 degrees Fahrenheit.

[0018] Additionally or alternatively, in this or other embodiments a seal groove is formed in the first component to at least partially defining the gland volume.

[0019] Additionally or alternatively, in this or other embodiments the ring inner diameter is defined in a range of 0.2-0.4 times the ring outer diameter.

[0020] Additionally or alternatively, in this or other embodiments the ring inner diameter is defined by Formula 1.

[0021] Additionally or alternatively, in this or other embodiments the first component and the second component are located at a bearing assembly of the gas turbine engine.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0023] FIG. **1** is a partial cross-sectional view of an embodiment of a gas turbine engine;

[0024] FIG. **2** is a partial cross-sectional view of an embodiment of a sealing arrangement of a gas turbine engine; and

[0025] FIG. **3** is a cross-sectional illustration of an embodiment of an O-ring.

DETAILED DESCRIPTION

[0026] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0027] FIG. **1** schematically illustrates a gas turbine engine **10**. The gas turbine engine **10** is disclosed herein as a two-spool turbofan that generally incorporates a fan section **12**, a compressor section **14**, a combustor section **16** and a turbine section **18**. Alternative engines might include other systems or features. The fan section **12** drives air along a bypass flow path B in a bypass duct, while the compressor section **14** drives air along a core flow path C for compression and communication into the combustor section **16** then expansion through the turbine section **18**. Although depicted as a two-spool turbofan gas turbine engine in the disclosed non-limiting embodiment, it should be understood that the concepts described herein are not limited to use with two-spool turbofans as the teachings may be applied to other types of turbine engines including three-spool architectures.

[0028] The exemplary engine **10** generally includes a low speed spool **20** and a high speed spool **22** mounted for rotation about an engine central longitudinal axis A relative to an engine static structure **26**.

[0029] The low speed spool **20** generally includes an inner shaft **30** that interconnects a fan **32**, and a low pressure turbine **36**. The high speed spool **22** includes an outer shaft **40** that interconnects an impeller **42** and high pressure turbine **44**. A combustor **46** is arranged in exemplary gas turbine **10** between the impeller **42** and the high pressure turbine **44**. An engine static structure **36** is arranged generally between the high pressure turbine **44** and the low pressure turbine **36**. The inner shaft **30** and the outer shaft **40** are concentric and rotate about the engine central longitudinal axis A which is collinear with their longitudinal axes.

[0030] The core airflow is compressed by the impeller **42**, mixed and burned with fuel in the combustor **46**, then expanded over the high pressure turbine **44** and low pressure turbine **36**. The turbines **36**, **44** rotationally drive the respective low speed spool **20** and high speed spool **22** in response to the expansion. It will be appreciated that each of the positions of the fan section **12**, compressor section **14**, combustor section **16**, and turbine section **18**, may be varied. While the structure described herein is a two-spool gas turbine engine **10**, one skilled in the art will readily appreciate that the present disclosure may be similarly applied to a single spool or three or more spool gas turbine engine **10**.

[0031] The low speed spool **20** and the high speed spool **22** are supported by one or more bearing assemblies **48**. Referring now to FIG. **2**, to retain lubricant at the bearing assembly **48** and reduce undesired leakage of lubricant out of the bearing assembly **48**, seals such as O-rings **50** are utilized. The O-ring **50** is configured to seal between a first component **52** and a second component **54**. In some embodiments, the O-ring **50** is at least partially positioned in a seal groove **56** of the first component **52** and extends circumferentially about the engine central longitudinal axis A. When the second component **54** is installed to the first component **52**, the seal groove **56** and the second component **54** define a gland **58** in which the O-ring **50** is positioned. With the second component **54** installed to the first component **52** the O-ring **50** is at least partially compressed in the gland **58**. The gland **58** has a gland inner diameter defined at a seal groove base **60** of the first component **52**, and has a gland outer diameter defined by a radial inner surface **62** of the second component **54**. Additionally, the gland **58** has a gland width defined by an axial groove width **64** of the seal groove **56**.

[0032] It is desired to replace existing fluorocarbon O-rings on engines in service with newer higher temperature capability O-rings **50**, with no modifications to the first component **52** and the second component **54**. In some embodiments, due to differences in materials the thermal expansion of the O-ring **50** is greater than that of the fluorocarbon O-ring that the O-ring **50** is replacing. In some embodiments, the difference in thermal expansion is 2×, meaning that the O-ring **50** expands twice as much as the fluorocarbon O-ring at the operating temperature of the O-ring **50**. Thus, the O-ring **50** will need to be sized and configured to account for the difference in thermal expansion, while still ensuring that pinch requirements of the O-ring **50** are also met.

[0033] An embodiment of an exemplary O-ring **50** is illustrated in FIG. **3**. The O-ring **50** has a circular, hollow cross-sectional shape. The cross-sectional shape includes a ring outer diameter **66** and a ring inner diameter **68**, with the seal material disposed between the ring inner diameter **68** and the ring outer diameter **66**. A hollow portion **70** of the cross-sectional shape is defined radially inboard of the ring inner diameter **68** relative to a cross-sectional center **72** of the cross-sectional shape.

[0034] When replacing a fluorocarbon O-ring with the O-ring **50** formed from a high temperature material in the structure, the ring outer diameter **66** of the O-ring **50** is the same as that of the fluorocarbon O-ring that it replaces. This is done in order for the O-ring **50** to fit within the existing gland **58** space and the ring inner diameter **68** is thus sized to provide a desired hollow portion **70** size so the O-ring **50** meets the pinch requirements and/or other performance characteristics of the O-ring **50**. In some embodiments, the ring inner diameter **68** is sized via the following Formula 1:

[00001] $$\text{ORingInnerDiameterMin} = 2 \times \sqrt{\left(\left(\frac{\text{GlandOD - GlandID}}{2}\right) \times (\text{GlandWidth}) \times 0.05\right) /}$$

[0035] The ring inner diameter **68**, which defines the hollow portion **70**, is a function of the gland outer diameter, the gland inner diameter, and the gland width, as previously defined herein. In some embodiments, the resultant ring inner diameter **68** is in a range of 0.2-0.4 times the ring outer diameter **66**. The formula is based on a nominal 75% fill ratio, where fill ratio is defined as a ratio of O-ring cross-sectional area to gland cross-sectional area. Additionally, in some embodiments the high temperature material is defined as one having a coefficient of thermal expansion equal to or greater than 0.00022 in/in/degF.

[0036] By way of example, in one embodiment it is desired to replace an O-ring having an outer diameter of 0.103″ with an O-ring **50** having a hollow cross-section. At this location, the gland outer diameter is 1.44125″, the gland inner diameter is 1.276″ and the gland width is 0.140″. Using Formula 1, the desired ring inner diameter **68** for the O-ring **50** is 0.027″. The resulting O-ring **50** has a hollow, circular cross-sectional shape with a ring outer diameter **66** of **103**″ and a ring inner diameter **68** of 0.027″. The resultant O-ring **50** formed from the high-temperature capable material seals the gland **58** while meeting the pinch requirement and other performance requirements of the O-ring **50**.

[0037] The term “about” is intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, “about” can include a range of +8% or 5%, or 2% of a given value.

[0038] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, element components, and/or groups thereof.

[0039] While the present disclosure has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the claims.

Claims

1. A seal arrangement of a gas turbine engine, comprising: a first component; a second component abutting the first component; and an O-ring disposed in a gland volume defined between the first component and the second component, the O-ring having a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter; wherein the ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width.

2. The seal arrangement of claim 1, wherein the O-ring is configured to operate at temperatures greater than 350 degrees Fahrenheit.

3. The seal arrangement of claim 1, wherein the first component includes a seal groove at least partially defining the gland volume.

4. The seal arrangement of claim 1, wherein the ring inner diameter is in a range of 0.2-0.4 times the ring outer diameter.

5. The seal arrangement of claim 1, wherein the ring inner diameter is determined by Formula 1.

6. The seal arrangement of claim 1, wherein the first component and the second component are disposed at a bearing assembly of the gas turbine engine.

7. A gas turbine engine, comprising: a combustor; and at least one spool, the at least one spool including: at least one rotating component driven by products of the combustor; and a bearing assembly supportive of the at least one rotating component, the bearing assembly including a seal arrangement including: a first component; a second component abutting the first component; and an O-ring disposed in a gland volume defined between the first component and the second component, the O-ring having a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter; wherein the ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width.

8. The gas turbine engine of claim 7, wherein the O-ring is configured to operate at temperatures

greater than 350 degrees Fahrenheit.
9. The gas turbine engine of claim 7, wherein the first component includes a seal groove at least partially defining the gland volume.
10. The gas turbine engine of claim 7, wherein the ring inner diameter is in a range of 0.2-0.4 times the ring outer diameter.
11. The gas turbine engine of claim 7, wherein the ring inner diameter is determined by Formula 1.
12. A method of assembling a seal arrangement of a gas turbine engine, comprising: at least partially defining a gland volume at a first component the gas turbine engine; installing a high-temperature O-ring into the gland volume, the high-temperature O-ring having a hollow circular cross-sectional shape including a ring inner diameter and a ring outer diameter, with a hollow portion defined by the ring inner diameter; wherein the ring inner diameter of the cross-sectional shape is defined as a function of a gland outer diameter, a gland inner diameter and a gland width; and installing a second component of the gas turbine engine over the high-temperature O-ring and the first component, to at least partially compress the high-temperature O-ring.
13. The method of claim 12, further comprising removing a fluorocarbon O-ring from the first component before installing the high-temperature O-ring to the first component.
14. The method of claim 12, wherein the high-temperature O-ring is configured to operate at temperatures greater than 350 degrees Fahrenheit.
15. The method of claim 12, further comprising forming a seal groove in the first component to at least partially defining the gland volume.
16. The method of claim 12, further comprising defining the ring inner diameter in a range of 0.2-0.4 times the ring outer diameter.
17. The method of claim 12, further comprising defining the ring inner by Formula 1.
18. The method of claim 12, wherein the first component and the second component are disposed at a bearing assembly of the gas turbine engine.