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(54) **Sealing assembly for gas turbine engines**

(57) A seal assembly (100) for a gas turbine engine (10) including a stationary stator member (102) and a rotating member (104). The seal assembly includes a primary seal assembly (106), and a secondary seal assembly (108), the primary seal assembly including a moveable stator member (110) including at least one keyed slot (118), and at least one biasing member (114) including at least one key (116) slidably coupled within the at least one keyed slot to facilitate aligning the primary seal assembly and the secondary seal assembly with respect to the gas turbine engine.

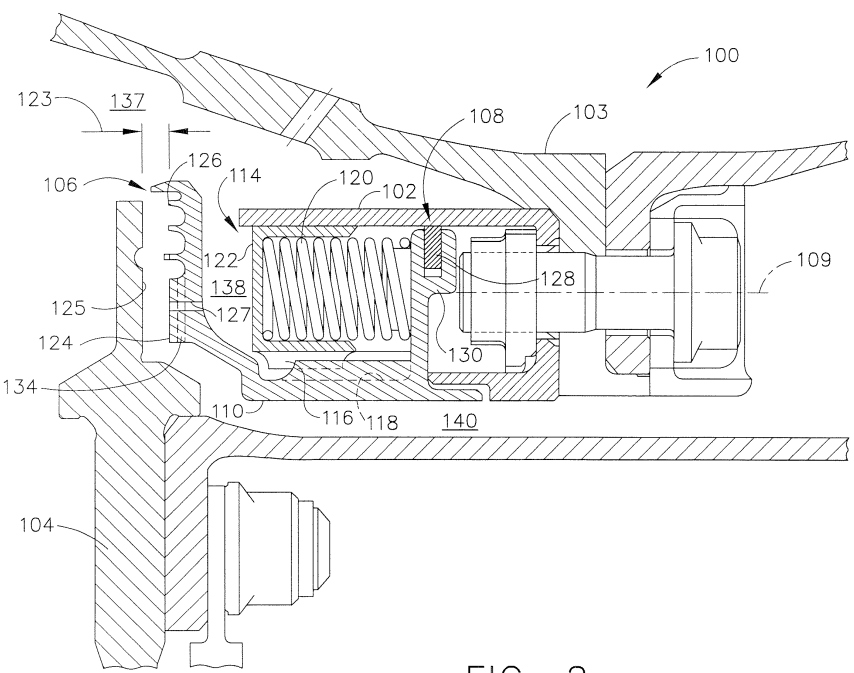

FIG. 2

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to gas turbine engines and more specifically to seal assemblies used with gas turbine engines.

[0002] At least some known gas turbine engines have large amounts of fluids flowing through the engine during operation. Seal assemblies control fluid leakage in the engine by restricting fluid flow from areas of higher pressure to areas of lower pressure. The seal assemblies may be positioned between an engine stationary member and a rotating member within the engine. In addition, seals facilitate compensating for transient variations that may exist in gaps defined between components.

[0003] Fluid leakage through gas turbine engine seal assemblies may significantly increase fuel consumption and adversely affect engine efficiency. Additionally, fluid leakage may cause damage to other components and/or increase overall engine maintenance costs. Because of the location of the seal assemblies, and/or the operating environment, at least some known seal assemblies may deteriorate over time.

[0004] To facilitate sealing gaps defined between regions of high and low pressure; at least some known seal assemblies, such as the seal assembly described in U.S. Patent No. 5,284,347, for example, use aspirating air to control leakage. The aspirating air prevents the rotating member from contacting the stationary member to facilitate accommodating transient variations in the gap defined between the rotating and stationary members with little or no deterioration of the seal over the life of the seal assembly. However, because of the number of seal assembly components, such seal assemblies may be complex to install in the engine, and the weight of such assemblies may adversely affect engine performance. Moreover, because of the number of seal assembly components, the operating efficiency of such seal assemblies may be contingent on the tolerances between the rotating and stationary members.

BRIEF DESCRIPTION OF THE INVENTION

[0005] In one aspect, a method of assembling a seal assembly within a gas turbine engine is provided. The method includes coupling a stationary stator member to a gas turbine engine comprising a rotating member, and coupling a primary seal assembly and a secondary seal assembly to the stationary stator member, wherein the primary seal assembly includes a moveable stator member including at least one keyed slot and at least one biasing member. The biasing member includes at least one key that is slidably coupled within the at least one keyed slot to facilitate aligning the primary seal assembly and the secondary seal assembly with respect to the gas turbine engine. The seal assembly facilitates sealing between the stationary stator member and the rotating member.

[0006] In another aspect, a seal assembly for a gas turbine engine including a stationary stator member and a rotating member is provided. The seal assembly includes a primary seal assembly and a secondary seal assembly. The primary seal assembly includes a moveable stator member including at least one keyed slot, and at least one biasing member. The biasing member includes at least one key slidably coupled within the at least one keyed slot to facilitate aligning the primary seal assembly and the secondary seal assembly with respect to the gas turbine engine.

[0007] In a further aspect, a gas turbine engine including a stationary stator member, a rotating member, and a seal assembly is provided. The seal assembly including a primary seal assembly and a secondary seal assembly. The primary seal assembly includes a moveable stator member including at least one keyed slot, and at least one biasing member. The biasing member includes at least one key. The at least one key is slidably coupled within the at least one keyed slot to facilitate aligning the primary seal assembly and the secondary seal assembly with respect to the gas turbine engine. The seal assembly facilitates sealing between the stationary stator member and the rotating member.

[0008] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of an exemplary gas turbine engine; and

Figure 2 is a cross-sectional view of an exemplary seal assembly that may be used with the gas turbine engine shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Although the invention is herein described and illustrated in association with a compressor to turbine interface for a gas turbine engine, it should be understood that the present invention may be used to facilitate controlling leakage of any fluid between any region of generally high pressure and any region of lower pressure within a gas turbine engine.

[0010] Figure 1 is a schematic illustration of a gas turbine engine 10 including a fan assembly 12, a compressor 14, and a combustor 16. In one embodiment, compressor 14 is a high-pressure compressor. Engine 10 also includes a high-pressure turbine 18, and a low-pressure turbine 20. In one embodiment, engine 10 is a CFM 56 engine commercially available from General Electric Company, Cincinnati, Ohio.

[0011] In operation, air flows through fan assembly 12 and compressed air is supplied to compressor 14. The compressed air is delivered to combustor 16. Airflow from combustor 16 drives turbines 18 and 20, and turbine 20 drives fan assembly 12.

[0012] Figure 2 is a cross-sectional view of an exemplary seal assembly 100 that may be used within gas turbine engine 10. In the exemplary embodiment, gas turbine engine 10 includes stationary stator member 102 coupled to frame 103 and a rotating member 104. Frame 103 is a stationary circumferential member positioned around an axis of rotation (not shown in Figure 2). In one embodiment, frame 103 is part of the casing of gas turbine engine 10. As air flows through engine 10, frame 103 is configured to help contain flowpath air. Additionally, stationary stator member 102 is a stationary circumferential member positioned around the axis of rotation of gas turbine engine 10. In one embodiment, stationary stator member 102 is bolted to frame 103. In one embodiment, rotating member 104 is a rotor that is rotatably coupled within engine 10 to rotate about the axis of rotation.

[0013] In the exemplary embodiment, seal assembly 100 includes a primary seal assembly 106 and a secondary seal assembly 108 that are each substantially concentrically aligned with respect to the axis of rotation of gas turbine engine 10. A moveable stator member 110 includes a primary seal assembly 106. Moveable stator member 110 also includes at least one keyed slot 118. In the exemplary embodiment, moveable stator member 110 includes at least three keyed slots 118. Moveable stator member 110 is also a circumferential member positioned around the axis of rotation of gas turbine engine 10. In the exemplary embodiment, moveable stator member 110 is positioned within stationary stator member 102. Primary seal assembly 106 also includes at least one biasing member 114. In the exemplary embodiment, primary seal assembly 106 includes at least three biasing members 114. Biasing member 114 includes at least one key 116, a biasing mechanism 120, and a housing 122. In the exemplary embodiment, housing 122 is bolted to stationary stator member 102 such that housing 122 is stationary. Additionally, in the exemplary embodiment, stationary stator member 102 includes at least three housings 122 spaced along the circumference of stationary stator member 102. Biasing mechanism 120 is contained within housing 122, and key 116 extends radially outward from housing 122. Key 116 is integrally formed with housing 122. In the exemplary embodiment, biasing mechanism 120 is a spring and housing 122 is a spring cartridge.

[0014] Moveable stator member 110 includes a keyed slot 118. In the exemplary embodiment, keyed slot 118 is machined within moveable stator member 110. Additionally, in the exemplary embodiment, moveable stator member 110 includes a number of keyed slots 118 equal to the number of keys 116. Specifically, keyed slot 118 extends a distance and is sized to receive a portion of key 116 therein. More specifically, key 116 is slidably coupled within keyed slot 118 such that during operation, key 116, as will be described in more detail below, is moveable along a portion of the distance of keyed slot 118. Key 116 moves within keyed slot 118 allowing moveable stator member 110 to move. Moreover, key 116 facilitates aligning primary seal assembly 106 and secondary seal assembly 108 with respect to gas turbine engine 10.

[0015] Moveable stator member 110 also includes a sealing face 124 and a plurality of teeth 126 that extend outward from sealing face 124. In the exemplary embodiment, sealing face 124 is substantially parallel to a rotating member surface 125 of rotating member 104. More specifically, sealing face 124 is a distance 123 away from rotating member 104. Moveable stator member 110 also includes an opening 127 defined therein, and positioned within sealing face 124 such that opening 127 extends through sealing face 124. In the exemplary embodiment, opening 127 is oriented substantially perpendicular to rotating member surface 125. As described below in more detail, opening 127 facilitates preventing contact between plurality of teeth 126 and rotating member 104. Moveable stator member 110 further includes a plurality of radial openings 134 extending through moveable stator member 110. In the exemplary embodiment, radial openings 134 are substantially parallel to rotating member surface 125. Additionally, in the exemplary embodiment, radial openings 134 cross between openings 127.

[0016] Moveable stator member 110 also includes a yoke 130 that is sized to receive at least a portion of secondary seal assembly 108 therein. More specifically, secondary seal assembly 108 includes a seal 128 that is received within yoke 130. In the exemplary embodiment, seal 128 is a piston ring seal. In an alternative embodiment, seal 128 may be retained by stationary stator member 102.

[0017] During operation, cooling air and/or fluids flow through gas turbine engine 10. When engine 10 is in operation, high pressure air flows forward to aft through engine 10. A portion of the highly compressed air discharged from high pressure compressor 14 is directed towards seal assembly 100 for use as cooling fluid. Seal assembly 100 facilitates substantially controlling fluid flow from a region of higher pressure 137 to a region of lower pressure 140 within gas turbine engine 10. The pressure differential between higher pressure region 137 and lower pressure region 140 initiates flow through seal assembly 100.

[0018] Biasing mechanism 120 biases moveable stator member 110 away from rotating member 104. Moveable stator member 110 slides forward and aft relative to housing 122, stationary stator member 102, and frame 103. During operation of gas turbine engine 10, a portion of the high pressure air will flow into a region 138 defined between stationary stator member 102 and moveable stator member 110. The high pressure air exerts a pressure on moveable stator member 110 causing moveable stator member 110 to move, against and to overcome biasing force exerted by biasing mechanism 120, within keyed slot 118, and towards rotating member 104. Specifically, during operation, key 116 translates within keyed slot 118 such that keyed slot 118 limits the amount of travel of moveable stator member 110 and prevents rotational, circumferential and/or radial, movement of moveable stator member 110 with respect to stationary stator member 102, housing 122, and frame 103. Keyed slot 118 also facilitates aligning primary seal and secondary seal assemblies 106 and 108 with respect to gas turbine engine 10.

[0019] Additionally, during operation, a portion of the high pressure air flows through opening 127. In the exemplary embodiment, opening 127 is a plurality of feed openings. Opening 127 forms a high pressure film or air bearing between opening 127 and rotating member surface 125. The air bearing prevents moveable stator member 110 from contacting rotating member 104.

[0020] After air flows through opening 127, the air exits to the region of lower pressure 140. Also, a portion of air may leak past seal teeth 126. Air that leaks past seal teeth 126 and air that has exited opening 127 flows through radial openings 134 to the region of lower pressure 140. Moreover, secondary seal assembly 108 creates a second seal to prevent leakage of high pressure air between moveable stator member 110 and stationary stator member 102.

[0021] When gas turbine engine 10 is not in operation, the biasing force of biasing mechanism 120 pushes against moveable stator member 110 moving moveable stator member 110 and holding moveable stator member 110 away from rotating member 104 to prevent contact between members 104 and 110.

[0022] During assembly of gas turbine engine 10, stationary stator member 102 is coupled to frame 103 of gas turbine engine 10 near rotating member 104. Housing 122 is coupled to stationary stator member 102. Moveable stator member 110 is coupled to and positioned within stationary stator member 102. Keyed slot 118 is positioned at least partially within key 116 and moves within keyed slot 118. Biasing mechanism 120 is coupled and positioned within housing 122.

[0023] The above-described seal assembly includes a primary seal assembly that includes a moveable stator member and a secondary seal assembly. The moveable stator member facilitates reducing leakage between the rotating member and the stationary engine frame. As a result, the engine operates more efficiently. Furthermore, the above-described seal assembly includes significantly fewer components than some known seal assemblies. With fewer components, such a seal is less expensive to install, is easier to produce than known seal assemblies, reduces the amount and cost of maintenance, is more reliable than known seal assemblies, and is lighter weight. Weight of seal assemblies may adversely affect engine performance.

[0024] Exemplary embodiments of a seal assembly are described above in detail. The seal assembly is not limited to use with the specific embodiments described herein, but rather, the seal assembly can be utilized independently and separately from other components described herein. Moreover, the invention is not limited to the embodiments of the seal assembly described above in detail. Rather, other variations of a seal assembly may be utilized within the spirit and scope of the claims.

[0025] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

Claims

1. A seal assembly (100) for a gas turbine engine (10) comprising a stationary stator member (102) and a rotating member (104), said seal assembly comprising:

    a primary seal assembly (106); and
    a secondary seal assembly (108), said primary seal assembly comprising:

        a moveable stator member (110) comprising at least one keyed slot (118); and
        at least one biasing member (114) comprising at least one key (116) slidably coupled within said at least one keyed slot to facilitate aligning said primary seal assembly and said secondary seal assembly with respect to the gas turbine engine.

2. A seal assembly (100) in accordance with Claim 1 wherein said primary seal assembly (106) further comprises at least three biasing members (114), said at least three biasing members each further comprise a biasing mechanism (120) and a housing (122), said biasing mechanism is contained within said housing.

3. A seal assembly (100) in accordance with Claim 2 wherein said at least one key (116) extends substantially radially outward from said housing (122), said at least one key facilitates rotational alignment between said primary and secondary seal assemblies (106, 108).

4. A seal assembly (100) in accordance with Claim 1 wherein said seal assembly facilitates sealing between said stationary stator member (102) and said rotating member (104).

5. A seal assembly (100) in accordance with Claim 1 wherein said moveable stator member (110) further comprises at least three keyed slots (118), said at least three keyed slots facilitate limiting axial and rotational movement of said moveable stator member with respect to the stationary stator member (102).

6. A seal assembly (100) in accordance with Claim 1 wherein said moveable stator member (110) further

comprises a sealing face (124) comprising a plurality of teeth (126) extending outward from said sealing face, and said sealing face further comprises an opening (127) extending therethrough, said opening facilitates preventing contact between said moveable stator member and the rotating member (104).

7. A seal assembly (100) in accordance with Claim 1 wherein said secondary seal assembly (108) comprises a piston ring seal (128), said moveable stator member comprises a yoke (130), said yoke sized to receive said piston ring seal therein.

8. A gas turbine engine (10) comprising:

a stationary stator member (102);
a rotating member (104); and
a seal assembly (100) comprising a primary seal assembly (106) and a secondary seal assembly (108), said primary seal assembly comprising:

a moveable stator member (110) comprising at least one keyed slot (118); and
at least one biasing member (114) comprising at least one key (116), wherein said at least one key is slidably coupled within said at least one keyed slot to facilitate aligning said primary seal assembly and said secondary seal assembly with respect to said gas turbine engine, said seal assembly facilitates sealing between said stationary stator member and said rotating member.

9. A gas turbine engine (10) in accordance with Claim 8 wherein said moveable stator member (110) further comprises a sealing face (124) and a plurality of teeth (126) extending outward from said sealing face.

10. A gas turbine engine (10) in accordance with Claim 8 wherein said moveable stator member (110) comprises an opening (127) extending therethrough, said opening facilitates preventing contact between said rotating member (104) and said stationary stator member (102).

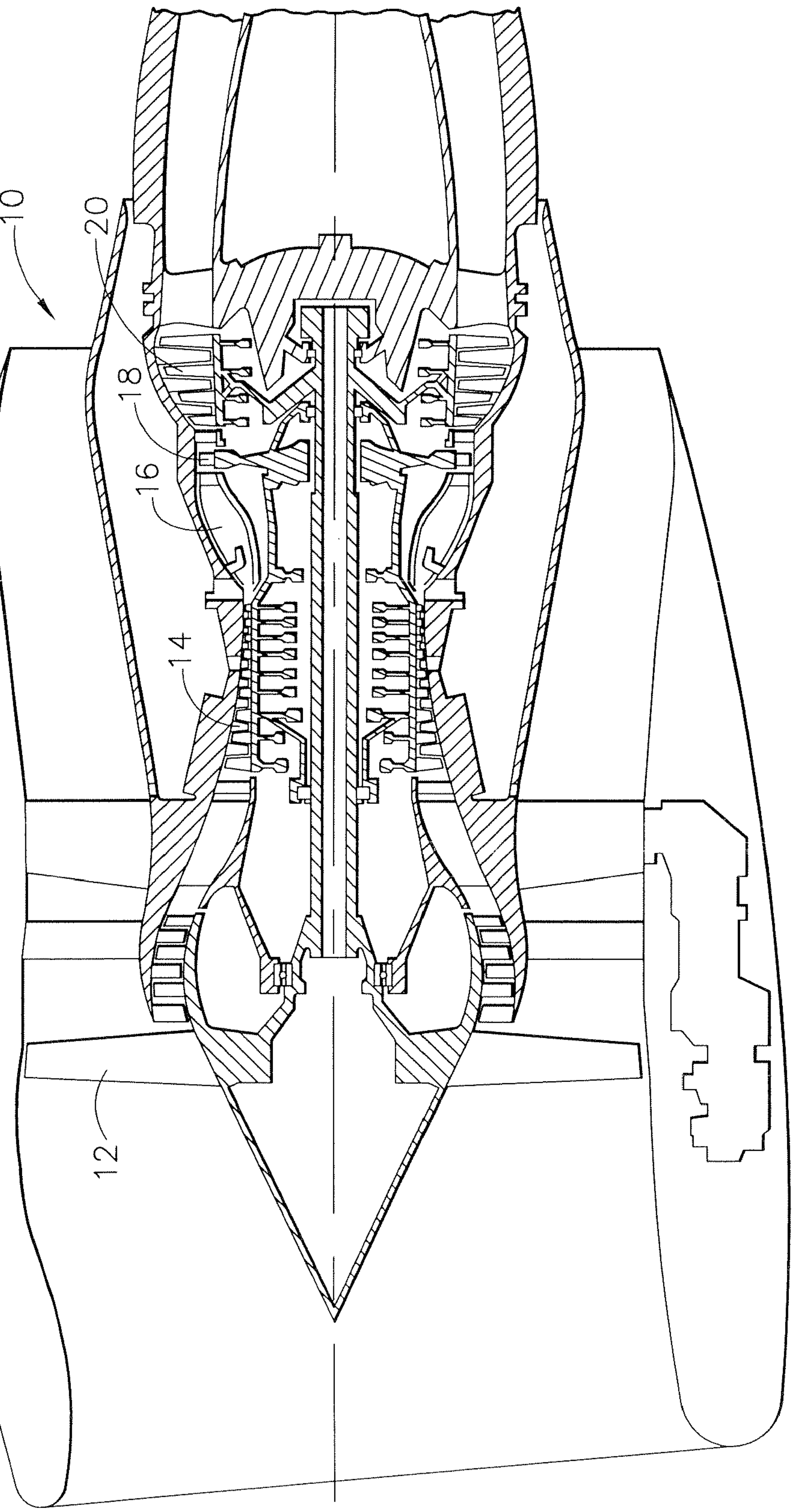

FIG. 1

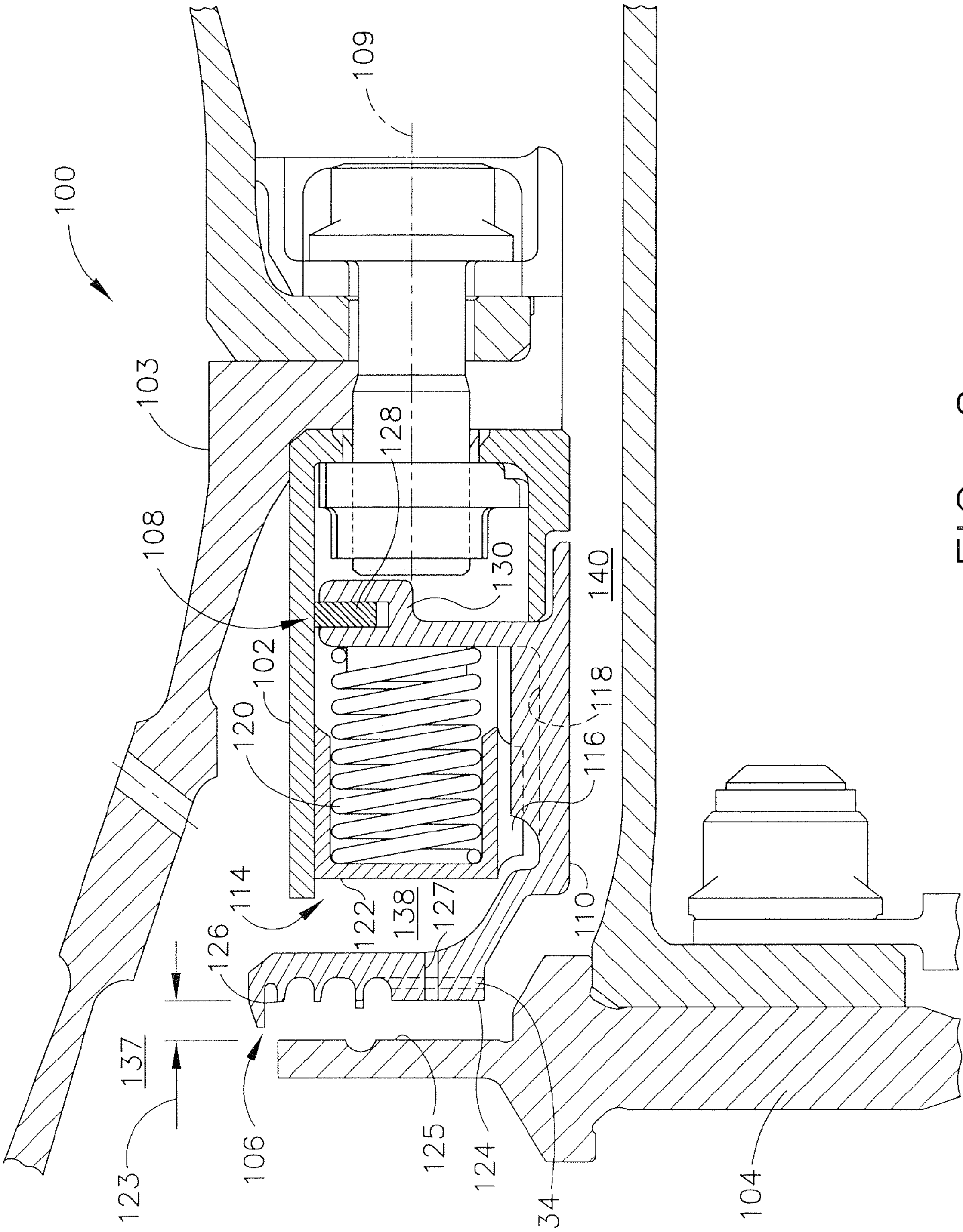
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FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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