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(54) AIR PURGE FOR GAS TURBINE ENGINE FUEL INJECTOR ASSEMBLY

(57) An assembly is provided for a gas turbine engine (20). This assembly includes an air swirler structure (66), an injector nozzle (114) and a nozzle guide (70). The air swirler structure (66) includes an inner bore (108) and an air swirler passage (102). The inner bore (108) extends axially along an axis (72) through the air swirler structure (66). The air swirler passage (102) extends radially into the air swirler structure (66) to the inner bore (108). The injector nozzle (114) projects axially into the inner bore (108). The nozzle guide (70) couples the injector nozzle (114) to the air swirler structure (66). The nozzle guide (70) includes a guide foot (146) and an air purge passage (144) radially outboard of the guide foot (146). The guide foot (146) is configured to radially engage the injector nozzle (114). The air purge passage (144) extends across the nozzle guide (70) and axially to the inner bore (108).

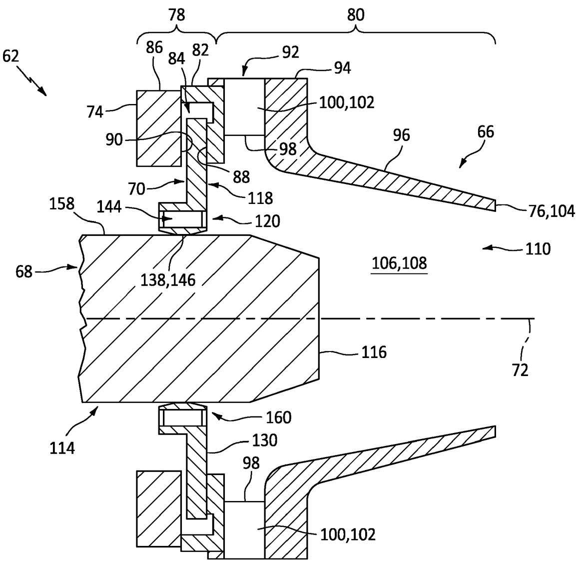

FIG. 3

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Description

BACKGROUND OF THE DISCLOSURE

1. Technical Field

[0001] This disclosure relates generally to a gas turbine engine and, more particularly, to a fuel injector assembly for the gas turbine engine.

2. Background Information

[0002] Various types and configurations of fuel injector assemblies are known in the art. Some of these known fuel injector assemblies include an air swirler mated with a fuel injector nozzle. While these known fuel injector assemblies have various advantages, there is still room in the art for improvement.

SUMMARY OF THE DISCLOSURE

[0003] According to an aspect of the present disclosure, an assembly is provided for a gas turbine engine. This assembly includes an air swirler structure, an injector nozzle and a nozzle guide. The air swirler structure includes an inner bore and an air swirler passage. The inner bore extends axially along an axis through the air swirler structure. The air swirler passage extends radially into the air swirler structure to the inner bore. The injector nozzle projects axially into the inner bore. The nozzle guide couples the injector nozzle to the air swirler structure. The nozzle guide includes a guide foot and an air purge passage radially outboard of the guide foot. The guide foot is configured to radially engage the injector nozzle. The air purge passage extends across the nozzle guide and axially to the inner bore.

[0004] According to another aspect of the present disclosure, another assembly is provided for a gas turbine engine. This assembly includes an air swirler structure, an injector nozzle and a nozzle guide. The air swirler structure includes an inner bore and an air swirler passage. The inner bore extends axially along an axis. The air swirler passage extends radially into the air swirler structure to the inner bore. The injector nozzle projects axially into the inner bore. The air swirler passage circumscribes the injector nozzle. The nozzle guide projects out from the injector nozzle to the air swirler structure. The nozzle guide includes an air purge passage that extends across the nozzle guide and axially to the inner bore. The air purge passage is configured to purge air from an interior corner between the nozzle guide and the injector nozzle. An outlet from the air swirler passage is arranged axially between a tip of the injector nozzle and an outlet from the air purge passage.

[0005] According to still another aspect of the present disclosure, another assembly is provided for a gas turbine engine. This assembly includes a fuel injector nozzle and a nozzle guide. The fuel injector nozzle extends axially along an axis. The nozzle guide circumscribes and is slidable axially along the fuel injector nozzle. The nozzle guide includes an air purge passage and a plurality of purge passage vanes. The air purge passage extends across the nozzle guide between an inlet to the air purge passage and an outlet from the air purge passage. The purge passage vanes are disposed within the air purge passage and are arranged circumferentially about the axis. Each of the purge passage vanes extends radially across the air purge passage.

[0006] The nozzle guide may also include a guide foot radially inboard of the outlet from the air purge passage. The guide foot may be configured to radially engage and move axially along the injector nozzle.

[0007] The nozzle guide may also include a plurality of purge passage vanes. The purge passage vanes may be arranged circumferentially around the axis. Each of the purge passage vanes may extend across the air purge passage.

[0008] The air purge passage may include a plurality of purge passage apertures and a purge passage groove. The purge passage apertures may be arranged circumferentially around the axis. Each of the purge passage apertures may extend into the nozzle guide to the purge passage groove. The purge passage groove may extend circumferentially around the axis within the nozzle guide. The purge passage groove may extend axially into the nozzle guide to the purge passage apertures.

[0009] The air purge passage may extend axially through the nozzle guide to the inner bore.

[0010] The nozzle guide may also include a plurality of purge passage vanes. The purge passage vanes may be arranged circumferentially about the axis. Each of the purge passage vanes may extend radially across the air purge passage.

[0011] A leading edge of a first of the purge passage vanes may be spaced an axial distance from an inlet to the air purge passage.

[0012] A trailing edge of a first of the purge passage vanes may be spaced an axial distance from an outlet from the air purge passage.

[0013] The air purge passage may include a plurality of purge passage apertures and a purge passage groove. The purge passage apertures may be arranged circumferentially about the axis. Each of the purge passage apertures may extend into the nozzle guide to the purge passage groove. The purge passage groove may extend circumferentially about the axis within the nozzle guide. The purge passage groove may extend axially into the nozzle guide, from the inner bore, to the purge passage apertures.

[0014] The purge passage groove may be an annular groove circumscribing the guide foot.

[0015] A first of the purge passage apertures may project radially into the nozzle guide to the purge passage groove.

[0016] The air swirler structure may also include a radial air swirler comprising the air swirler passage. The radial air swirler may be configured to direct a first quantity of air through the air swirler passage and radially into the inner bore. The nozzle guide may also include an axial air swirler comprising the air purge passage. The axial air swirler may be configured to direct a second quantity of air through the air purge passage and axially into the inner bore along a tip portion of the injector nozzle.

[0017] The radial air swirler may be configured to swirl the first quantity of air directed through the air swirler passage in a first direction about the axis. The axial air swirler may be configured to swirl the second quantity of air directed through the air purge passage in a second direction about the axis that is opposite the first direction.

[0018] The radial air swirler may be configured to swirl the first quantity of air directed through the air swirler passage in a first direction about the axis. The axial air swirler may be configured to swirl the second quantity of air directed through the air purge passage in the first direction about the axis.

[0019] The first quantity of air may be greater than the second quantity of air.

[0020] The air purge passage may be configured to purge air from an interior corner between the nozzle guide and the injector nozzle.

[0021] The air swirler passage may be a first air swirler passage. The air swirler structure may also include a second air swirler passage. The first air swirler passage may be axially between the second air swirler passage and the nozzle guide. The second air swirler passage may extend radially into the air swirler structure to the inner bore.

[0022] The air swirler passage may be a first air swirler passage. The air swirler structure may also include an annulus and a second air swirler passage. The annulus may be radially outboard from the inner bore. The annulus may extend circumferentially about and axially along the inner bore. The second air swirler passage may extend radially into the air swirler structure to the annulus.

[0023] The present disclosure may include any one or more of the individual features disclosed above and/or below alone or in any combination thereof.

[0024] The foregoing features and the operation of the invention will become more apparent in light of the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is a side cutaway illustration of a geared turbine engine.

FIG. 2 is a partial side sectional illustration of a combustor with a fuel injector assembly.

FIG. 3 is a partial side sectional illustration of the fuel injector assembly.

FIG. 4 is a cross-sectional illustration of a radial air swirler.

FIG. 5 is a partial side sectional illustration of the fuel injector assembly at a nozzle guide.

FIGS. 6A and 6B are partial perspective illustrations of the nozzle guide of FIG. 5.

FIGS. 7A-C are partial schematic illustrations of fuel injector nozzles injecting fuel along various trajectories.

FIG. 8 is a partial side sectional illustration of the fuel injector assembly with another nozzle guide.

FIGS. 9A and 9B are partial perspective illustrations of the nozzle guide of FIG. 8.

FIG. 10 is a partial side sectional illustration of the fuel injector assembly configured with one or more additional air swirlers.

DETAILED DESCRIPTION

[0026] FIG. 1 is a side cutaway illustration of a geared gas turbine engine 20. This gas turbine engine 20 extends along an axial centerline 22 between an upstream airflow inlet 24 and a downstream airflow exhaust 26. The gas turbine engine 20 includes a fan section 28, a compressor section 29, a combustor section 30 and a turbine section 31. The compressor section 29 includes a low pressure compressor (LPC) section 29A and a high pressure compressor (HPC) section 29B. The turbine section 31 includes a high pressure turbine (HPT) section 31A and a low pressure turbine (LPT) section 31B.

[0027] The engine sections 28-31B are arranged sequentially along the axial centerline 22 within an engine housing 34. This engine housing 34 includes an inner case 36 (e.g., a core case) and an outer case 38 (e.g., a fan case). The inner case 36 may house one or more of the engine sections 29A, 29B, 30, 31A and 31B; e.g., a core of the gas turbine engine 20. The outer case 38 may house at least the fan section 28.

[0028] Each of the engine sections 28, 29A, 29B, 31A and 31B includes a respective bladed rotor 40-44. Each of these bladed rotors 40-44 includes a plurality of rotor blades arranged circumferentially around and connected to one or more respective rotor disks and/or hubs. The rotor blades, for example, may be formed integral with or mechanically fastened, welded, brazed, adhered and/or otherwise attached to the respective rotor disk(s) and/or the respective hub(s).

[0029] The fan rotor 40 is connected to a geartrain 46, for example, through a fan shaft 48. The geartrain 46 and the LPC rotor 41 are connected to and driven by the LPT rotor 44 through a low speed shaft 49. The HPC rotor 42 is connected to and driven by the HPT rotor 43 through a high speed shaft 50. The engine shafts 48-50 are rotatably supported by a plurality of bearings 52; e.g., rolling element and/or thrust bearings. Each of these bearings 52 is connected to the engine housing 34 by at least one stationary structure such as, for example, an annular support strut.

[0030] During engine operation, air enters the gas turbine engine 20 through the airflow inlet 24. This air is directed through the fan section 28 and into a core flowpath 54 and a bypass flowpath 56. The core flowpath 54 extends sequentially through the engine sections 29A-31B; e.g., the engine core. The air within the core flowpath 54 may be referred to as "core air". The bypass flowpath 56 extends through a bypass duct, and bypasses the engine core. The air within the bypass flowpath 56 may be referred to as "bypass air".

[0031] The core air is compressed by the LPC rotor 41 and the HPC rotor 42 and directed into a (e.g., annular) combustion chamber 58 of a (e.g., annular) combustor 60 in the combustor section 30. Fuel is injected into the combustion chamber 58 and mixed with the compressed core air to provide a fuel-air mixture. This fuel-air mixture is ignited and combustion products thereof flow through and sequentially cause the HPT rotor 43 and the LPT rotor 44 to rotate. The rotation of the HPT rotor 43 and the LPT rotor 44 respectively drive rotation of the HPC rotor 42 and the LPC rotor 41 and, thus, compression of the air received from an inlet to the core flowpath 54. The rotation of the LPT rotor 44 also drives rotation of the fan rotor 40, which propels bypass air through and out of the bypass flowpath 56. The propulsion of the bypass air may account for a majority of thrust generated by the gas turbine engine 20.

[0032] Referring to FIG. 2, the combustor section 30 includes a plurality of fuel injector assemblies 62 (one visible in FIG. 2) arranged circumferentially about the axial centerline 22 in a circular array. The fuel injector assemblies 62 are mounted to a (e.g., annular) bulkhead 64 of the combustor 60. The fuel injector assemblies 62 are configured to direct a mixture of fuel and compressed air into the combustion chamber 58 for combustion. Each fuel injector assembly 62 of FIG. 2 includes an outer air swirler structure 66 and a fuel injector 68. The fuel injector assembly 62 also includes a nozzle guide 70 (e.g., a guide plate, a slider, a nozzle mount, etc.) coupling the fuel injector 68 to the air swirler structure 66.

[0033] Referring to FIG. 3, the air swirler structure 66 extends circumferentially around an axis 72 (e.g., a centerline of the air swirler structure 66) providing the air swirler structure 66 with a full-hoop body. The air swirler structure 66 extends axially along the axis 72 from an upstream end 74 of the air swirler structure 66 to a downstream end 76 of the air swirler structure 66. The air swirler structure 66 of FIG. 3 includes a base section 78 and a swirler section 80.

[0034] The base section 78 is disposed at (e.g., on, adjacent or proximate) the structure upstream end 74. This base section 78 may be configured as or otherwise include a first swirler wall 82; e.g., an annular upstream swirler wall. The base section 78 may also be configured to form a receptacle 84 (e.g., a slot, a channel, etc.) for receiving the nozzle guide 70 at the structure upstream end 74. The base section 78 of FIG. 3, for example, also includes a mounting plate 86 axially abutted against and attached to the first swirler wall 82. The receptacle 84 is formed at an inner periphery of the base section 78, axially between a (e.g., annular) surface 88 of the first swirler wall 82 and a (e.g., annular) surface 90 of the mounting plate 86.

[0035] The swirler section 80 includes an outer air swirler 92 and a second swirler wall 94; e.g., an annular downstream swirler wall. The swirler section 80 of FIG. 3 also includes a swirler guide wall 96; e.g., a tubular funnel wall.

[0036] The air swirler 92 may be configured as a radial air swirler. The air swirler 92 of FIG. 3, for example, is arranged axially between and is connected to the first swirler wall 82 and the second swirler wall 94. The air swirler 92 of FIG. 4 includes a plurality of air swirler vanes 98. Each of these air swirler vanes 98 extends axially between and is connected to the first swirler wall 82 and the second swirler wall 94 (see FIG. 3). The air swirler vanes 98 are arranged circumferentially about the axis 72 in a circular array. Each of the air swirler vanes 98 is circumferentially separated from each circumferentially neighboring (e.g., adjacent) air swirler vane 98 by a respective air swirler channel 100; e.g., an air gap. Each air swirler channel 100 extends circumferentially between and to a respective circumferentially neighboring pair of the air swirler vanes 98. Each air swirler channel 100 extends axially between and to the first swirler wall 82 and the second swirler wall 94 (see FIG. 3). With this arrangement, the air swirler channels 100 collectively form an air swirler passage 102 radially through the air swirler 92, axially between the swirler walls 82 and 94 (see FIG. 3). The air swirler vanes 98 / the air swirler channels 100 are configured such that air passing through and out of the air swirler passage 102 is directed in a first circumferential direction (e.g., a clockwise direction, or alternatively a counterclockwise direction) about the axis 72. In other words, the air swirler vanes 98 / the air swirler channels 100 are operable to circumferentially swirl the air passing through the air swirler 92 in the first circumferential direction.

[0037] Referring to FIG. 3, the swirler guide wall 96 is disposed at the structure downstream end 76. The swirler guide wall 96 of FIG. 3, for example, is connected to (and cantilevered from) the second swirler wall 94 at an inner end of the air swirler 92. This swirler guide wall 96 projects out from the second swirler wall 94 and extends axially along the axis 72 to a (e.g., downstream) distal end 104 of the swirler guide wall 96 at the structure downstream end 76. As the swirler guide wall 96 extends towards (e.g., to) the structure downstream end 76, the swirler guide wall 96 may (e.g., continuously or incrementally) radially taper inwards towards the axis 72. The swirler guide wall 96 may thereby have a tubular frustoconical geometry with frustoconical inner and/or outer surfaces.

[0038] The air swirler structure 66 of FIG. 3 is further configured with an inner swirler passage 106. This inner swirler passage 106 is formed by an inner bore 108 of the air swirler structure 66, which inner bore 108 extend axially through the air swirler structure 66 between and to the structure upstream end 74 and the structure downstream end 76. An outer peripheral boundary of an upstream portion of the inner swirler passage 106, for example, may be formed by and radially within the base section 78 and its first swirler wall 82. An outer peripheral boundary of a downstream portion of the inner swirler passage 106 may be formed by and radially within the swirler section 80 and its swirler guide wall 96. The inner swirler passage 106 of FIG. 3 extends axially within the air swirler structure 66 from (or about) a side 130 of the nozzle guide 70 to an inner swirler outlet 110 (e.g., an outlet orifice) at the structure downstream end 76.

[0039] Referring to FIG. 2, the air swirler structure 66 may be mated with the combustor bulkhead 64. The swirler guide wall 96, for example, may project axially into or through a respective port in the combustor bulkhead 64. The air swirler structure 66 may also be mounted to the combustor bulkhead 64. For example, the swirler segment 80 (e.g., the second swirler wall 94 and/or the swirler guide wall 96 of FIG. 3) may be bonded (e.g., brazed or welded) and/or otherwise connected to the combustor bulkhead 64 and, more particularly, a shell 111 of the combustor bulkhead 64. However, various other techniques are known in the art for mounting an air swirler structure to a combustor bulkhead (or various other combustor components), and the present disclosure is not limited to any particular ones thereof.

[0040] The fuel injector 68 of FIG. 2 includes a fuel injector stem 112 and a fuel injector nozzle 114. The injector stem 112 is configured to support and route fuel to the injector nozzle 114. The injector nozzle 114 is cantilevered from the injector stem 112. The injector nozzle 114 projects along the axis 72 (e.g., a centerline of the injector nozzle 114) partially into the inner bore 108 of the air swirler structure 66. A tip 116 of the injector nozzle 114 is thereby disposed within the inner swirler passage 106. Here, the nozzle tip 116 is axially spaced from the inner swirler outlet 110 by an axial distance along the axis 72.

[0041] Referring to FIG. 5, the nozzle guide 70 includes a nozzle guide base 118 (e.g., an annular plate) and an air purge device 120 such as an inner air swirler. The nozzle guide 70 extends radially between and to an inner side 122 of the nozzle guide 70 and an outer side 124 of the nozzle guide 70. The nozzle guide 70 and each of its members 118 and 120 extends circumferentially about (e.g., completely around) the axis 72. The nozzle guide 70 may thereby be configured with a full-hoop annular body.

[0042] The guide base 118 projects radially outward (e.g., away from the axis 72) from the air purge device 120 to the guide outer side 124; e.g., a radial outer distal end of the guide base 118. The guide base 118 extends axially along the axis 72 between and to opposing axial sides 126 and 128 of the guide base 118. The base downstream side 128 may also form the downstream axial side 130 of the nozzle guide 70. The guide base 118 of FIG. 5 is disposed radially outboard of and circumscribes the air purge device 120.

[0043] The air purge device 120 is disposed at the guide inner side 122. The air purge device 120, for example, projects radially inward (e.g., towards the axis 72) from the guide base 118 to the guide inner side 122. The air purge device 120 extends axially between and to opposing axial sides 132 and 134 of the air purge device 120. The device downstream side 134 may be axially aligned with the base downstream side 128 and, thus, may also form the downstream axial side 130 of the nozzle guide 70. The device upstream side 132, however, may be axially offset from the base upstream side 126. The air purge device 120 of FIG. 5, for example, projects axially out from the guide base 118 to its device upstream side 132. The device upstream side 132 may also form an upstream axial side 136 of the nozzle guide 70. The air purge device 120 of FIG. 5 includes an (e.g., tubular) inner shroud 138, an (e.g., tubular) outer shroud 139 and a plurality of purge passage vanes 140.

[0044] The inner shroud 138 may be disposed at the guide inner side 122. This inner shroud 138 extends axially along the axis 72 between and to the opposing axial sides 136, 132 and 130, 134 of the nozzle guide 70 and its air purge device 120. The inner shroud 138 extends radially outward from the guide inner side 122 to an outer side 142 of the inner shroud 138. This inner shroud outer side 142 may form an inner radial peripheral boundary of an air purge passage 144 of the air purge device 120. The inner shroud 138 extends circumferentially about (e.g., completely) around the axis 72. This inner shroud 138 may be configured as a guide foot 146 (e.g., an annular slider) for the nozzle guide 70 as discussed below in further detail.

[0045] The outer shroud 139 may be disposed at a radial outer side 148 of the air purge device 120; e.g., radially adjacent the guide base 118. The outer shroud 139 extends axially along the axis 72 between and to the opposing axial sides 136, 132 and 130, 134 of the nozzle guide 70 and its air purge device 120. The outer shroud 139 extends radially inward from the device outer side 148 to an inner side 150 of the outer shroud 139. This outer shroud inner side 150 may form an outer radial peripheral boundary of the air purge passage 144. The outer shroud 139 extends circumferentially about (e.g., completely) around the axis 72.

[0046] The outer shroud 139 axially overlaps the inner shroud 138. The outer shroud 139 is spaced radially outboard for the inner shroud 138. The outer shroud 139 circumscribes the inner shroud 138. With this arrangement, the air purge passage 144 is disposed radially between and formed by the inner shroud 138 and the outer shroud 139. This air purge passage 144 extends circumferentially about (e.g., completely around) the axis 72 within the air purge device 120. The air purge passage 144 may thereby be configured with an annular geometry. The air purge passage 144 extends across the nozzle guide 70 and its air purge device 120 between and to an (e.g., annular) inlet 152 to the air purge passage 144 and an (e.g., annular) outlet 154 from the air purge passage

144. The air purge passage 144 of FIG. 5, for example, extends axially through the nozzle guide 70 and its air purge device 120 from the purge passage inlet 152 at the side 132, 136 to the purge passage outlet 154 at the side 130, 134.

[0047] Each of the purge passage vanes 140 extends radially between the inner shroud 138 and the outer shroud 139. Each of the purge passage vanes 140 is connected to the inner shroud 138 and the outer shroud 139. Each of the purge passage vanes 140 may thereby extend radially across the air purge passage 144. Each of the purge passage vanes 140 extends longitudinally (e.g., axially) between and to a leading edge of the respective purge passage vane 140 and a trailing edge of the respective purge passage vane 140. The vane leading edge may be axially recessed from (e.g., axially spaced from) the purge passage inlet 152 by a (e.g., non-zero) axial distance. The vane trailing edge may be axially recessed from (e.g., axially spaced from) the purge passage outlet 154 by a (e.g., non-zero) axial distance. The present disclosure, however, is not limited to such a spatial arrangement. For example, the vane leading edge may alternatively be axially aligned with the purge passage inlet 152 and/or the vane trailing edge may alternatively be axially aligned with the purge passage outlet 154.

[0048] Referring to FIGS. 6A and 6B, the purge passage vanes 140 are arranged circumferentially about the axis 72 in a circular array. This array of purge passage vanes 140 circumscribes the inner shroud 138, and the outer shroud 139 circumscribes the array of purge passage vanes 140. Within the array, each of the purge passage vanes 140 is circumferentially separated from each circumferentially neighboring (e.g., adjacent) purge passage vane 140 by a respective purge passage channel 156; e.g., an air gap. Each purge passage channel 156 extends circumferentially between and to a respective circumferentially neighboring pair of the purge passage vanes 140. Each purge passage channel 156 extends radially between and to the inner shroud 138 and the outer shroud 139 (see also FIG. 5). With this arrangement, the purge passage channels 156 collectively form at least a (e.g., intermediate) portion of the air purge passage 144 (see also FIG. 5).

[0049] The purge passage vanes 140 / the purge passage channels 156 may be configured such that air passing through and out of the air purge passage 144 is directed in the first circumferential direction (e.g., the clockwise direction, or alternatively the counterclockwise direction) about the axis 72. In other words, the purge passage vanes 140 / the purge passage channels 156 may be operable to circumferentially swirl the air passing through the purge passage device in the first circumferential direction - the same direction of the air swirler 92 of FIG. 4. However, in other embodiments, the purge passage vanes 140 / the purge passage channels 156 may be configured such that air passing through and out of the air purge passage 144 is directed in a second circumferential direction (e.g., the counterclockwise direction, or alternatively the clockwise direction) about the axis 72. In other words, the purge passage vanes 140 / the purge passage channels 156 may be operable to circumferentially swirl the air passing through the air purge device 120 in the second circumferential direction opposite the first circumferential direction.

[0050] Referring to FIG. 3, the nozzle guide 70 is configured to couple the injector nozzle 114 to the air swirler structure 66 and, thus, the bulkhead 64 (see FIG. 2). The nozzle guide 70 and its guide base 118, for example, may project radially into the receptacle 84, where the nozzle guide 70 and its guide base 118 may (e.g., loosely) capture the nozzle guide 70 and its guide base 118 axially between the first swirler wall 82 and the mounting plate 86. This capturing of the nozzle guide 70 between the first swirler wall 82 and the mounting plate 86 may facilitate the nozzle guide 70 and its guide base 118 to radially float (e.g., shift) within the receptacle 84. This floating may in turn accommodate (e.g., slight) radial shifting between the air swirler structure 66 and the fuel injector 68 and its injector nozzle 114 during gas turbine engine operation.

[0051] The injector nozzle 114 is mated with the nozzle guide 70. The injector nozzle 114, for example, projects axially through an inner bore of the inner shroud 138. The inner shroud 138 thereby extends axially along and circumscribes the injector nozzle 114. The inner shroud 138 / the guide foot 146 is configured to radially engage (e.g., contact) an outer cylindrical land surface 158 of the injector nozzle 114. The inner shroud 138 / the guide foot 146 is further configured to move (e.g., slide, translate, etc.) axially along the injector nozzle 114 and its land surface 158. This relative movement between the inner shroud 138 / the guide foot 146 and the injector nozzle 114 and its land surface 158 may in turn accommodate (e.g., slight) axial shifting between the air swirler structure 66 and the fuel injector 68 and its injector nozzle 114 during gas turbine engine operation.

[0052] During operation of the fuel injector assembly 62 of FIG. 3, a first quantity / stream of air (e.g., the compressed core air from the HPC section 29B of FIG. 1) is directed into the air swirler passage 102. This first air stream flows radially through the air swirler passage 102 and is directed radially into the inner swirler passage 106; e.g., a portion of the inner bore 108 downstream of the nozzle guide 70. As the first air stream passes through the air swirler 92 and its air swirler passage 102, the first air stream is swirled in the first circumferential direction (see FIG. 4). The first air stream directed through the air swirler 92 into the inner swirler passage 106 is therefore (or otherwise includes) swirled air. This swirled air is then directed axially through the inner swirler passage 106 and is discharged from the air swirler structure 66 through the inner swirler outlet 110.

[0053] A second quantity / stream of air (e.g., the compressed core air from the HPC section 29B of FIG. 1) is directed into the air purge passage 144, which second quantity of air may be less than (e.g., less than 1/2, 1/3 or 1/4 of) the first quantity of air injected by the air swirler 92. This second air stream flows axially through the air purge passage 144 and is directed axially into the inner swirler passage 106 axially along and adjacent the injector nozzle 114. As the second air stream passes through the air purge device 120 and its air purge passage 144, the second air stream is swirled in the first circumferential direction (see FIGS. 6A and 6B). The second air stream directed through the air purge device 120 into the inner swirler passage 106 is therefore (or otherwise) includes swirled air, which is coflowing with the first air stream. Of course, in other embodiments, the second air stream may be counterflowing to the first air stream. The swirled air is then directed axially through the inner swirler passage 106 and is discharged from the air swirler structure 66 through the inner swirler outlet 110.

[0054] As the second air stream is directed into the inner swirler passage 106 (e.g., the inner bore 108), the second air stream flows through a region at an interior corner 160 between the nozzle guide 70 and the injector nozzle 114. The second air stream may thereby purge (e.g., recirculating) air that may otherwise be trapped at the corner 160 by the first air stream from the air swirler 92. Directing of the second air stream into the inner swirler passage 106 at the corner 160 may also mitigate effects of (e.g., potential future wear related) leakage air through an interface between the inner shroud 138 / the guide foot 146 and the injector nozzle 114. Directing the axial second air stream along the injector nozzle 114 may tune (e.g., modify) fuel spray from the injector nozzle 114. The second air stream, for example, may push fuel sprayed into the inner swirler passage 106 from the injector nozzle 114 further downstream to facilitate further axial fuel penetration. Furthermore, the second air stream may work with the first air stream within the inner swirler passage 106 to modify (e.g., increase) swirling velocity within the inner swirler passage 106 to enhance fuel atomization and combustor performance.

[0055] The fuel injected by the injector nozzle 114 for mixing with the first and the second air streams may be a hydrocarbon fuel and/or a non-hydrocarbon fuel such as hydrogen fuel (e.g., H_2 gas). Referring to FIG. 7A, the fuel may be directed out of the injector nozzle 114 in a substantially radial direction (e.g., see line 162A) from one or more fuel nozzle outlets. Referring to FIG. 7B, the fuel may alternatively (or also) be directed out of the injector nozzle 114 in a substantially axial direction (e.g., see line 162B) from one or more fuel nozzle outlets. Referring to FIG. 7C, the fuel may alternatively (or also) be directed out of the injector nozzle 114 in a canted (e.g., axial and radial; diagonal) direction (e.g., see line 162C) from one or more fuel nozzle outlets. The present disclosure, however, is not limited to the foregoing exemplary injector nozzle configurations.

[0056] In some embodiments, referring to FIGS. 5, 6A and 6B, the purge passage channels 156 may be formed by the purge passage vanes 140. In other embodiments, referring to FIG. 8 and 9A and 9B, the purge passage channels 156 may be respectively formed by a plurality of purge passage apertures 164. The air purge device 120 of FIGS. 8, 9A and 9B, for example, includes the purge passage apertures 164 and a (e.g., annular) purge passage groove 166, which passage members 164 and 166 collectively form the air purge passage 144 across the nozzle guide 70 and its air purge device 120. In particular, the air purge device 120 of FIGS. 8, 9A and 9B includes the inner shroud 138 which forms the guide foot 146, the outer shroud 139 and an (e.g., annular) endwall 168. Here, the inner shroud 138 of FIG. 8 projects axially beyond both opposing axial sides 126 and 128 of the guide base 118. The outer shroud 139 projects axially out from the guide base 118 to the device upstream side 132. The endwall 168 is disposed at the device upstream side 132, and extends radially between and to the inner shroud 138 and the outer shroud 139. The purge passage apertures 164 are arranged circumferentially about the axis 72 in a circular array; see also FIGS. 9A and 9B. Each of the purge passage apertures 164 extends radially into the air purge device 120 (e.g., radially through the outer shroud 139) to an upstream end portion of the purge passage groove 166. The purge passage groove 166 extends circumferentially about (e.g., completely around) the axis 72 within the air purge device 120. The purge passage groove 166 may thereby circumscribe the inner shroud 138 / the guide foot 146. The purge passage groove 166 extends axially into the air purge device 120 to outlets of the purge passage apertures 164 and/or to the endwall 168.

[0057] One or more or all of the purge passage apertures 164 may be canted to impart swirl to the air flowing therethrough. One or more or all of the purge passage apertures 164 may alternatively be perpendicular to the shroud(s) 138, 139 to flow air therethrough without imparting (or with imparting little) swirl.

[0058] In some embodiments, referring to FIG. 3, the air swirler structure 66 may be configured with a single air swirler 92. In other embodiments, referring to FIG. 10, the air swirler may alternatively be one of a plurality of air swirlers 92A-C (generally referred to as "92"). In the embodiment of FIG. 10, the first air swirler 92A and the second air swirler 92B are each configured to direct (counter or co) swirled air radially into the inner bore 108 and its inner swirler passage 106. The second air swirler 92B may be configured similar to the first air swirler 92A, except positioned axially downstream of the first air swirler 92A. The first air swirler 92A, for example, may be arranged axially between (a) the nozzle guide 70 and its purge passage outlet 154 and (b) the second air swirler 92B. The first air swirler 92A may also be axially aligned with (e.g., axially overlap) the injector nozzle 114; e.g., axially arranged between (a) the nozzle guide 70 and its purge passage outlet 154 and (b) the nozzle tip 116. The third air swirler 92C, on the other hand, may be configured to direct swirled air into an outer swirler passage 170 (e.g., an annulus within the air swirler structure 66) that circumscribes and extends along the swirler guide wall 96. This third air swirler 92C may swirl a third stream of air in the first circumferential direction (e.g., a common direction as the first air swirler 92A and/or the second air swirler 92B and/or the air purge device 120), or in the second circumferential direction about the axis 72 that is opposite the first circumferential direction. The present disclosure, however, is not limited to such an exemplary multi-air swirler configuration. For example, in other embodiments, the air swirler structure 66 may include one or more additional radial and/or axial flow air swirlers. In still other embodiments, the second air swirler 92B or the third air swirler 92C may be omitted.

[0059] The fuel injector assembly(ies) 62 may be included in various turbine engines other than the one described above. The fuel injector assembly(ies) 62, for example, may be included in a geared turbine engine where a geartrain connects one or more shafts to one or more rotors in a fan section, a compressor section and/or any other engine section. Alternatively, the fuel injector assembly(ies) 62 may be included in a direct drive turbine engine configured without a geartrain. The fuel injector assembly(ies) 62 may be included in a turbine engine configured with a single spool, with two spools (e.g., see FIG. 1), or with more than two spools. The turbine engine may be configured as a turbofan engine, a turbojet engine, a turboprop engine, a turboshaft engine, a propfan engine, a pusher fan engine or any other type of turbine engine. The turbine engine may alternatively be configured as an auxiliary power unit (APU) or an industrial gas turbine engine. The present disclosure therefore is not limited to any particular types or configurations of turbine engines.

[0060] While various embodiments of the present disclosure have been described, it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible within the scope of the disclosure. For example, the present disclosure as described herein includes several aspects and embodiments that include particular features. Although these features may be described individually, it is within the scope of the present disclosure that some or all of these features may be combined with any one of the aspects and remain within the scope of the disclosure. Accordingly, the present disclosure is not to be restricted except in light of the attached claims and their equivalents.

Claims

1. An assembly for a gas turbine engine (20), comprising:

   an air swirler structure (66) including an inner bore (108) and an air swirler passage (102), the inner bore (108) extending axially along an axis (72) through the air swirler structure (66), and the air swirler passage (102) extending radially into the air swirler structure (66) to the inner bore (108);

   an injector nozzle (114) projecting axially into the inner bore (108); and

   a nozzle guide (70) coupling the injector nozzle (114) to the air swirler structure (66), the nozzle guide (70) including a guide foot (146) and an air purge passage (144) radially outboard of the guide foot (146), the guide foot (146) configured to radially engage the injector nozzle (114), and the air purge passage (144) extending across the nozzle guide (70) and axially to the inner bore (108).

2. The assembly of claim 1, wherein the air purge passage (144) extends axially through the nozzle guide (70) to the inner bore (108).

3. The assembly of claim 1 or 2, wherein

   the nozzle guide (70) further includes a plurality of purge passage vanes (140); and

   the plurality of purge passage vanes (140) are arranged circumferentially about the axis (72), and each of the plurality of purge passage vanes (140) extends radially across the air purge passage (144).

4. The assembly of claim 3, wherein:

   a leading edge of a first of the plurality of purge passage vanes (140) is spaced an axial distance from an inlet (152) to the air purge passage (144); and/or

   a trailing edge of a first of the plurality of purge passage vanes (140) is spaced an axial distance from an outlet (154) from the air purge passage (144).

5. The assembly of any preceding claim, wherein

   the air purge passage (144) includes a plurality of purge passage apertures (164) and a purge passage groove (166);

   the plurality of purge passage apertures (164) are arranged circumferentially about the axis (72), and each of the plurality of purge passage apertures (164) extends into the nozzle guide (70) to the purge passage groove (166); and

   the purge passage groove (166) extends circumferentially about the axis (72) within the nozzle guide (70), and the purge passage groove (166) extends axially into the nozzle guide (70), from the inner bore (108), to the plurality of purge passage apertures (164), optionally wherein:

      the purge passage groove (166) is an annular groove circumscribing the guide foot

(146); and/or

a first of the plurality of purge passage apertures (164) projects radially into the nozzle guide (70) to the purge passage groove (166).

6. The assembly of any preceding claim, wherein

the air swirler structure (66) further includes a radial air swirler comprising the air swirler passage (102), and the radial air swirler is configured to direct a first quantity of air through the air swirler passage (102) and radially into the inner bore (108); and

the nozzle guide (70) further includes an axial air swirler comprising the air purge passage (144), and the axial air swirler is configured to direct a second quantity of air through the air purge passage (144) and axially into the inner bore (108) along a tip portion (116) of the injector nozzle (114), optionally wherein the first quantity of air is greater than the second quantity of air.

7. The assembly of claim 6, wherein

the radial air swirler is configured to swirl the first quantity of air directed through the air swirler passage (102) in a first direction about the axis (72); and

the axial air swirler is configured to swirl the second quantity of air directed through the air purge passage (144) in a second direction about the axis (72) that is opposite the first direction.

8. The assembly of claim 6, wherein

the radial air swirler is configured to swirl the first quantity of air directed through the air swirler passage (102) in a first direction about the axis (72); and

the axial air swirler is configured to swirl the second quantity of air directed through the air purge passage (144) in the first direction about the axis (72).

9. The assembly of any preceding claim, wherein the air purge passage (144) is configured to purge air from an interior corner (160) between the nozzle guide (70) and the injector nozzle (114).

10. The assembly of any preceding claim, wherein

the air swirler passage (102) is a first air swirler passage (102), and the air swirler structure (66) further includes a second air swirler passage (102);

the first air swirler passage (102) is axially between the second air swirler passage (102) and the nozzle guide (70); and

the second air swirler passage (102) extends radially into the air swirler structure (66) to the inner bore (108).

11. The assembly of any of claims 1 to 9, wherein

the air swirler passage (102) is a first air swirler passage (102), and the air swirler structure (66) further includes an annulus (170) and a second air swirler passage (102);

the annulus (170) is radially outboard from the inner bore (108), and the annulus (170) extends circumferentially about and axially along the inner bore (108); and

the second air swirler passage (102) extends radially into the air swirler structure (66) to the annulus (170).

12. An assembly for a gas turbine engine (20), comprising:

an air swirler structure (66) including an inner bore (108) and an air swirler passage (102), the inner bore (108) extending axially along an axis (72), and the air swirler passage (102) extending radially into the air swirler structure (66) to the inner bore (108);

an injector nozzle (114) projecting axially into the inner bore (108), the air swirler passage (102) circumscribing the injector nozzle (114); and

a nozzle guide (70) projecting out from the injector nozzle (114) to the air swirler structure (66), the nozzle guide (70) including an air purge passage (144) that extends across the nozzle guide (70) and axially to the inner bore (108), the air purge passage (144) configured to purge air from an interior corner (160) between the nozzle guide (70) and the injector nozzle (114), and an outlet (154) from the air swirler passage (102) arranged axially between a tip (116) of the injector nozzle (114) and an outlet (154) from the air purge passage (144).

13. The assembly of claim 12, wherein the nozzle guide (70) further includes:

a guide foot (146) radially inboard of the outlet (154) from the air purge passage (144), the guide foot (146) configured to radially engage and move axially along the injector nozzle (114); and/or

a plurality of purge passage vanes (140), the plurality of purge passage vanes (140) arranged circumferentially around the axis (72), each of the plurality of purge passage vanes (140) extending across the air purge passage (144).

14. The assembly of claim 12 or 13, wherein

the air purge passage (144) includes a plurality of purge passage apertures (164) and a purge passage groove (166);
the plurality of purge passage apertures (164) are arranged circumferentially around the axis (72), and each of the plurality of purge passage apertures (164) extends into the nozzle guide (70) to the purge passage groove (166); and
the purge passage groove (166) extends circumferentially around the axis (72) within the nozzle guide (70), and the purge passage groove (166) extends axially into the nozzle guide (70) to the plurality of purge passage apertures (164).

15. An assembly for a gas turbine engine (20), comprising:

a fuel injector nozzle (114) extending axially along an axis (72); and
a nozzle guide (70) circumscribing and slidable axially along the fuel injector nozzle (114), the nozzle guide (70) including an air purge passage (144) and a plurality of purge passage vanes (140), the air purge passage (144) extending across the nozzle guide (70) between an inlet (152) to the air purge passage (144) and an outlet (154) from the air purge passage (144), the plurality of purge passage vanes (140) disposed within the air purge passage (144) and arranged circumferentially about the axis (72), and each of the plurality of purge passage vanes (140) extending radially across the air purge passage (144).

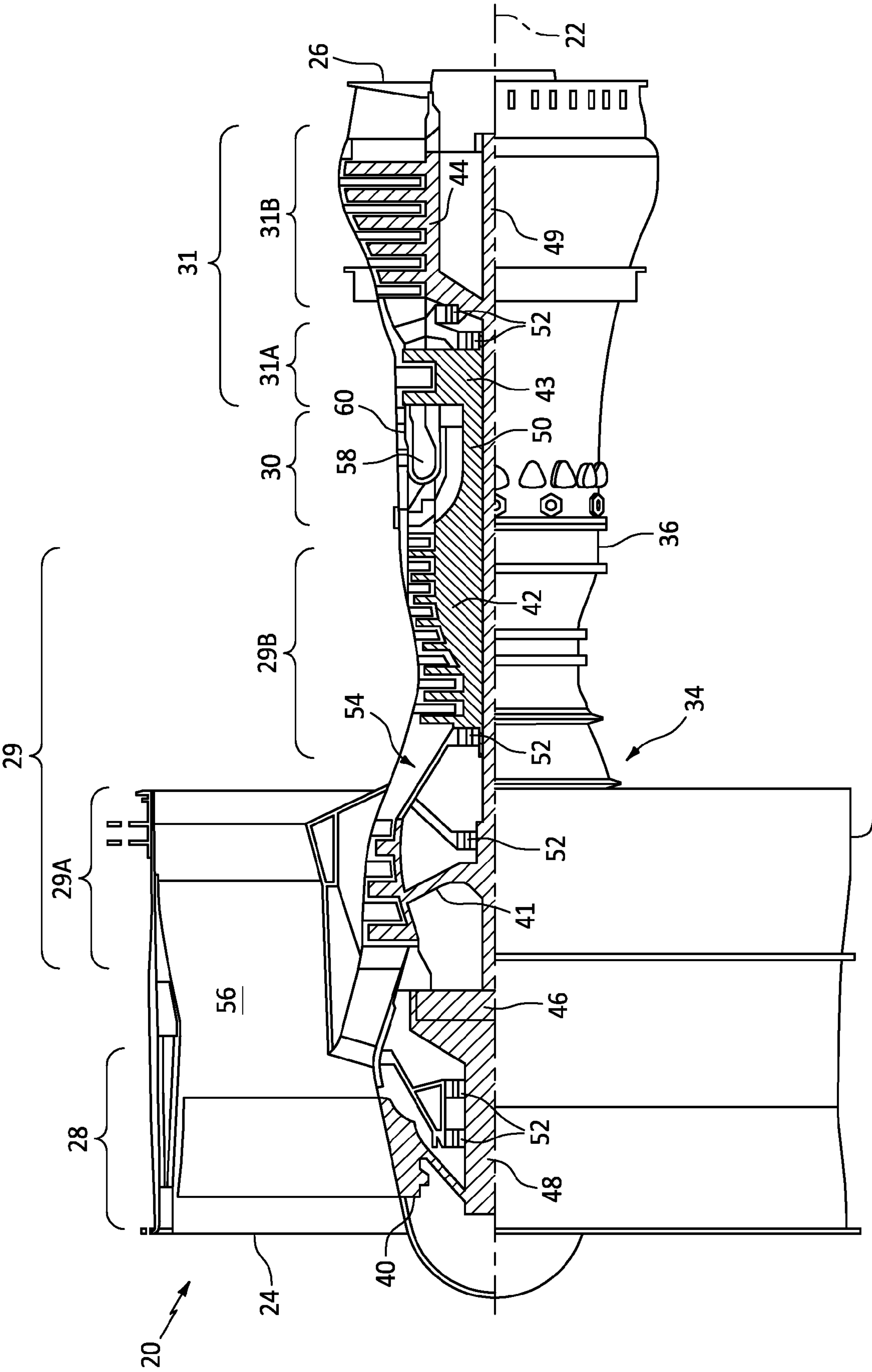
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FIG. 1

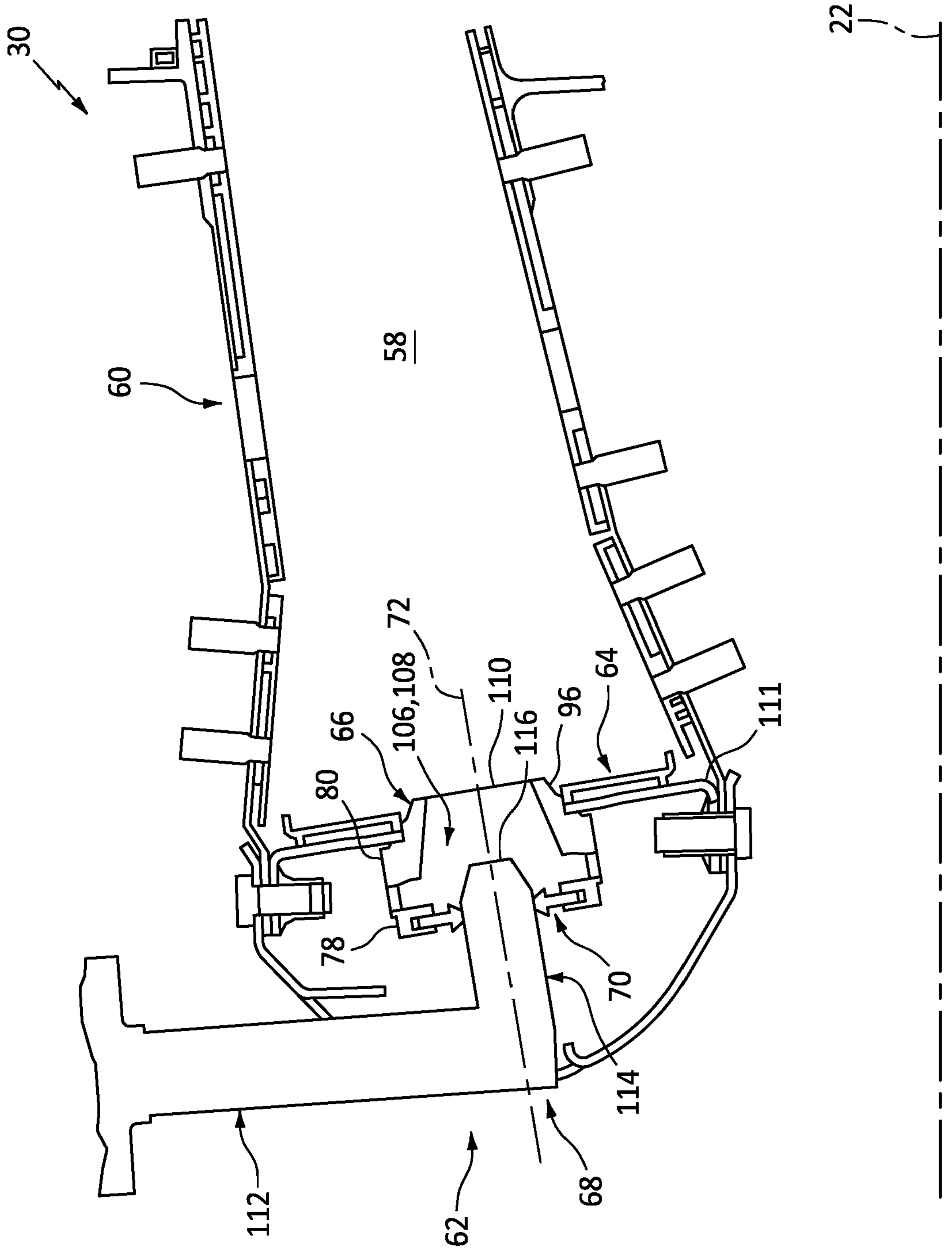
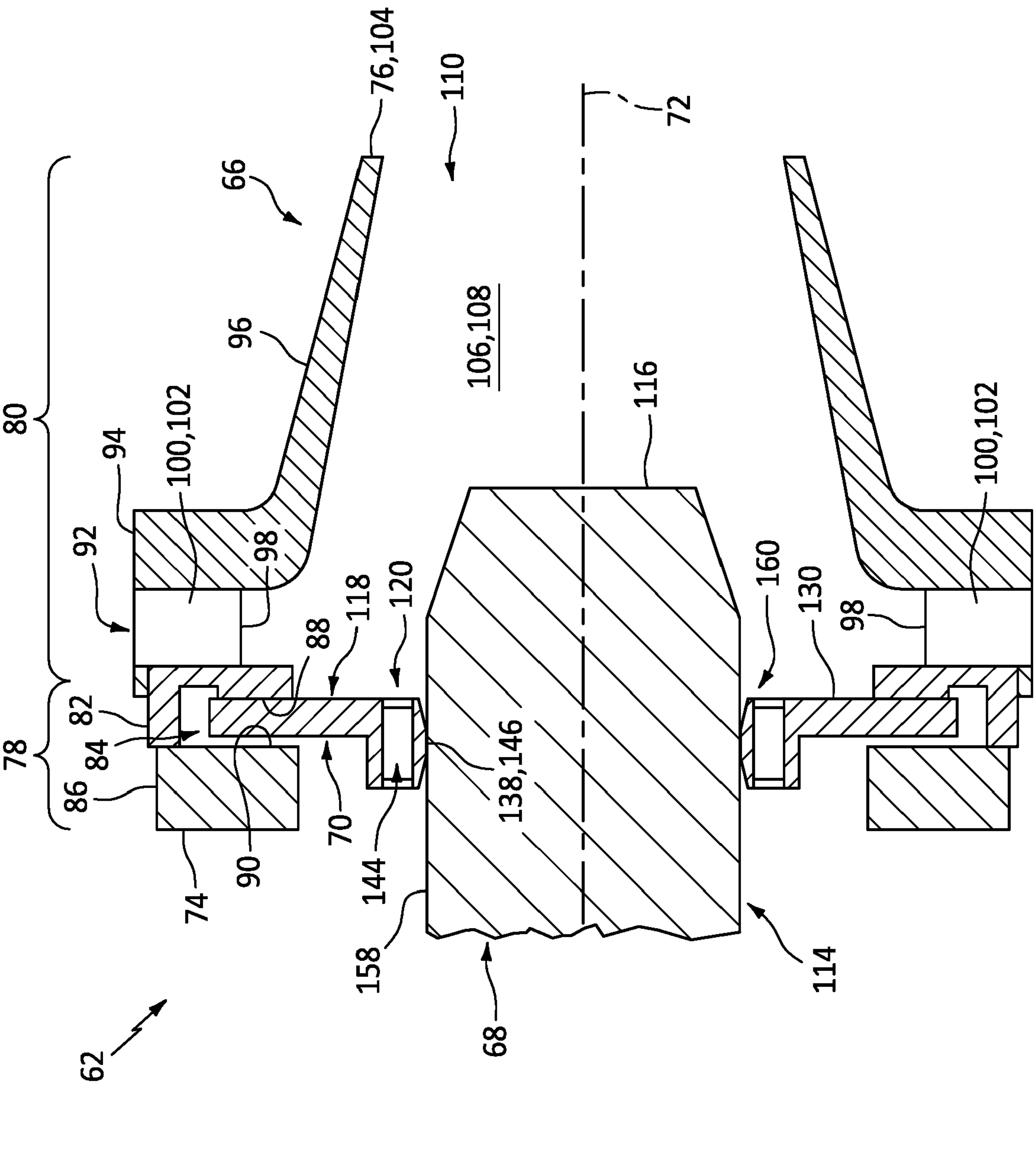


FIG. 2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144
74
158
114
68
62

FIG. 3

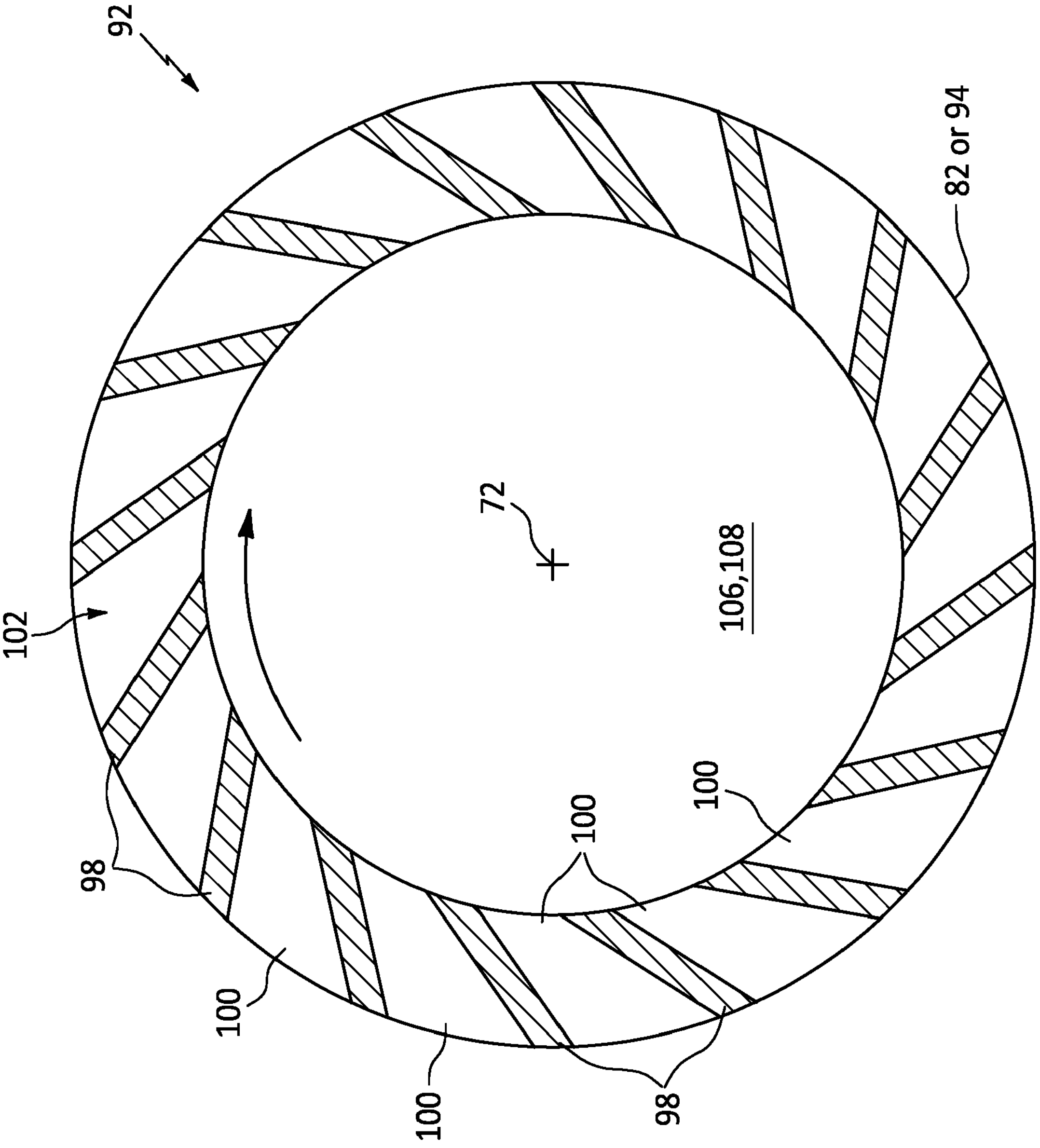
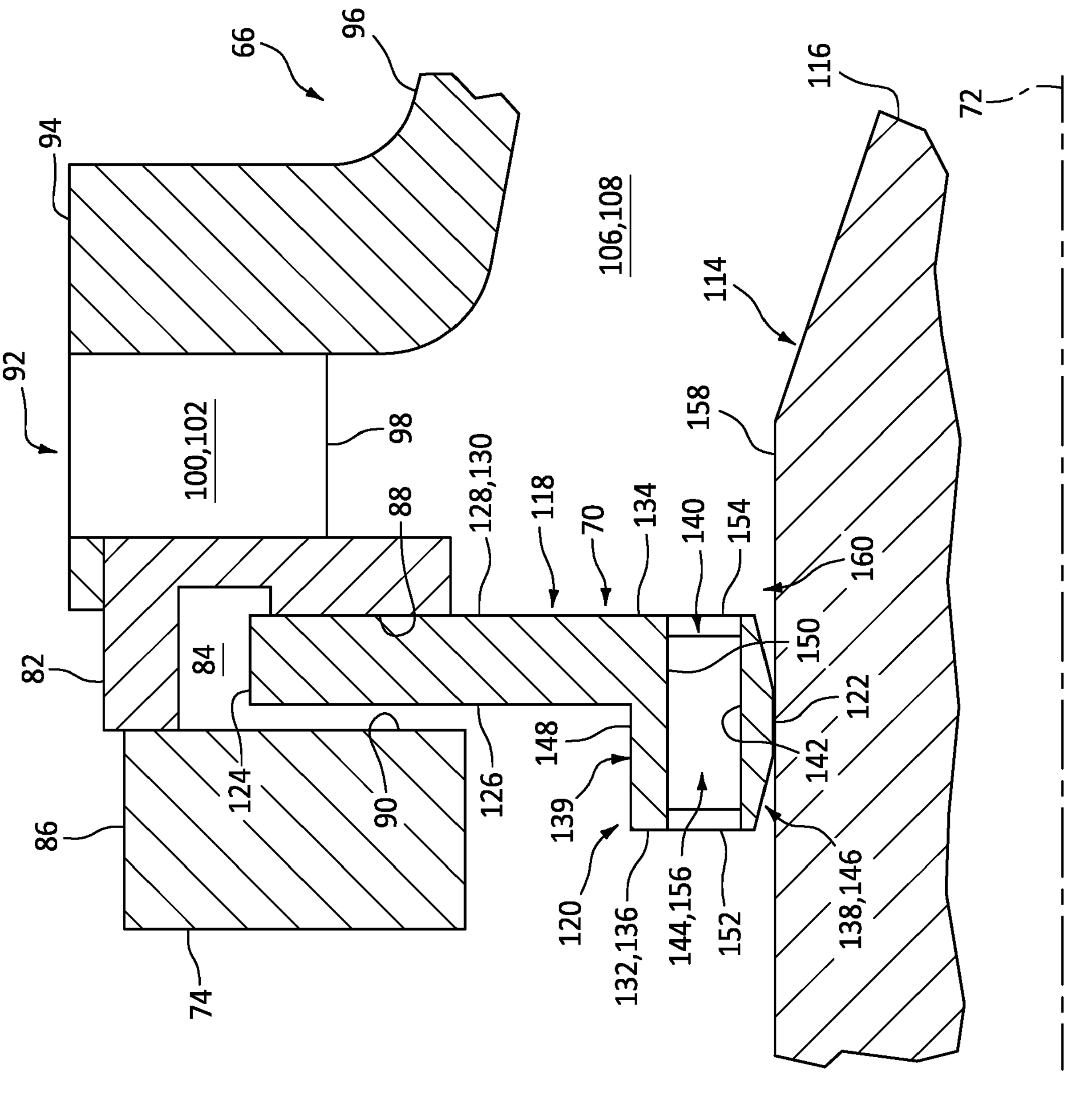


FIG. 4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152
138,146

FIG. 5

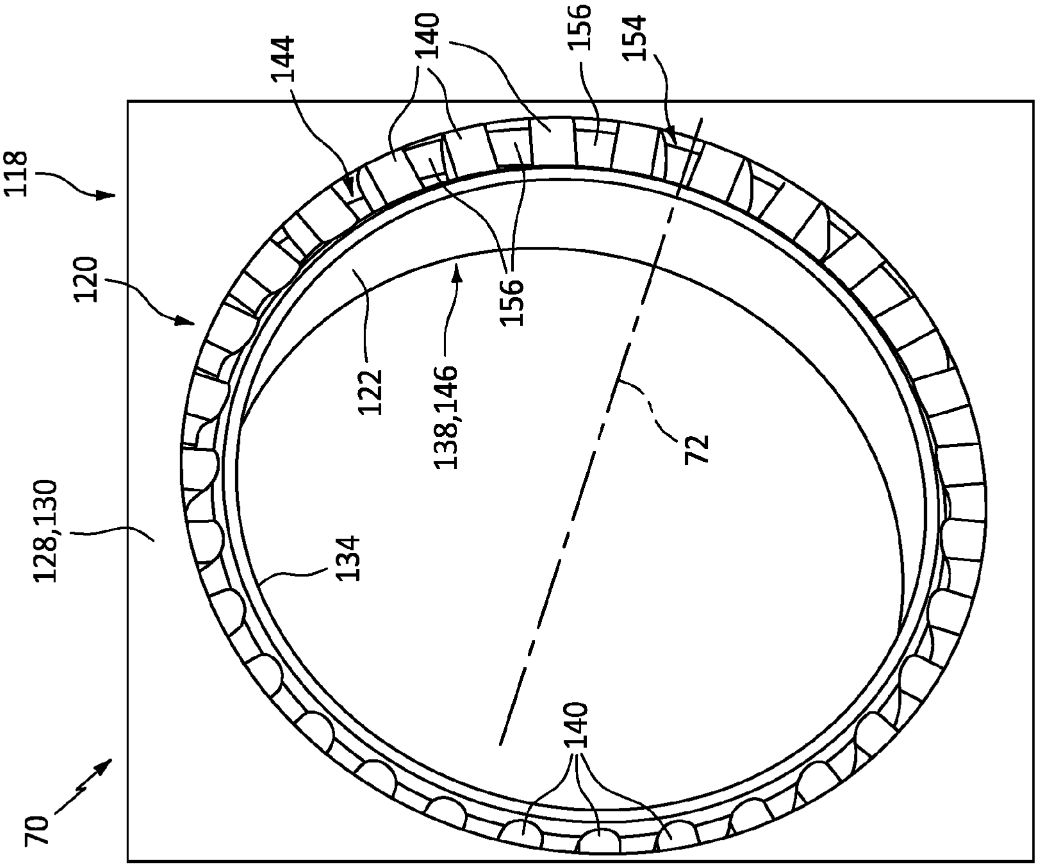
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FIG. 6B

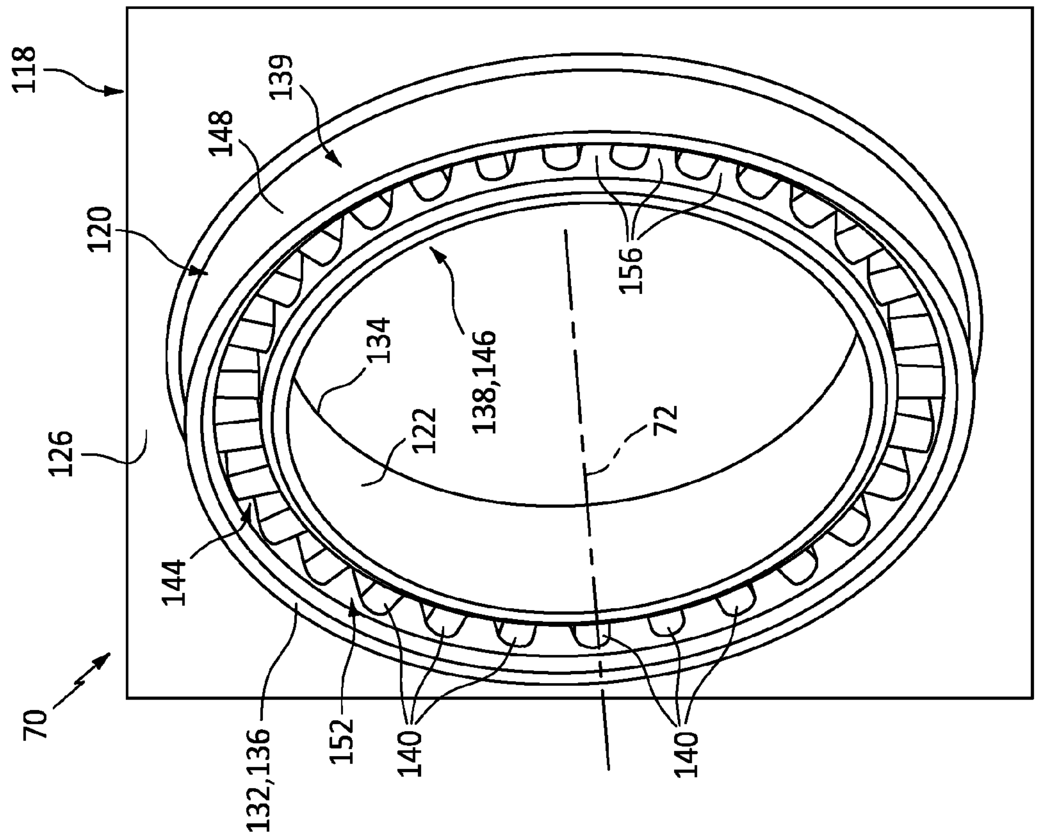
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FIG. 6A

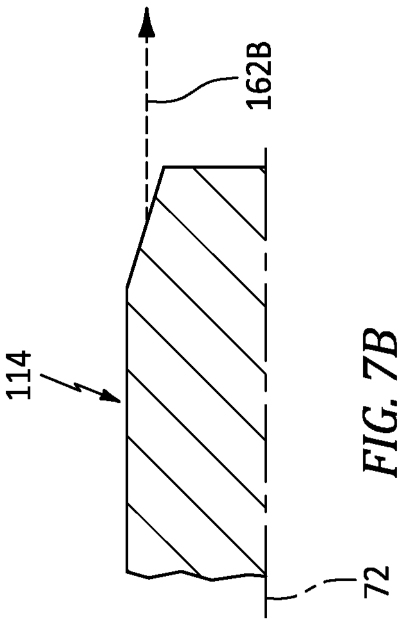

FIG. 7B

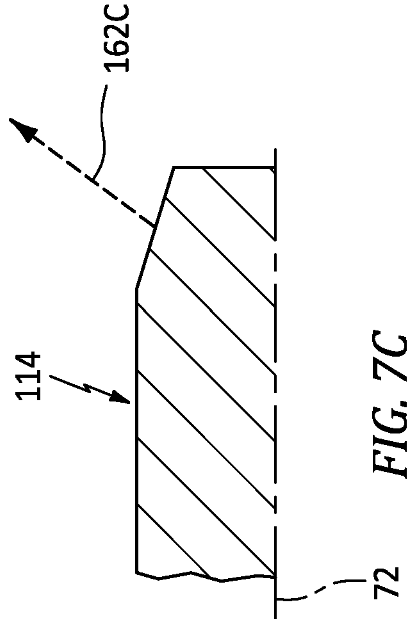

FIG. 7C

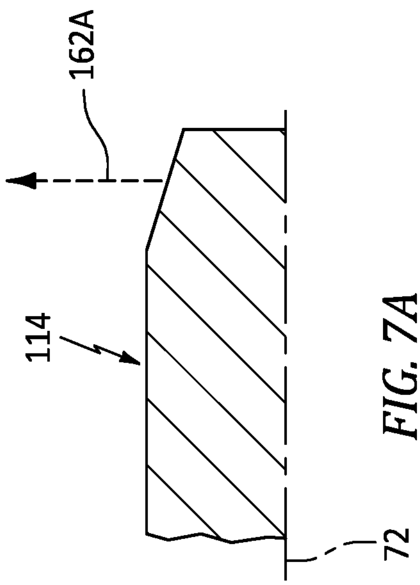

FIG. 7A

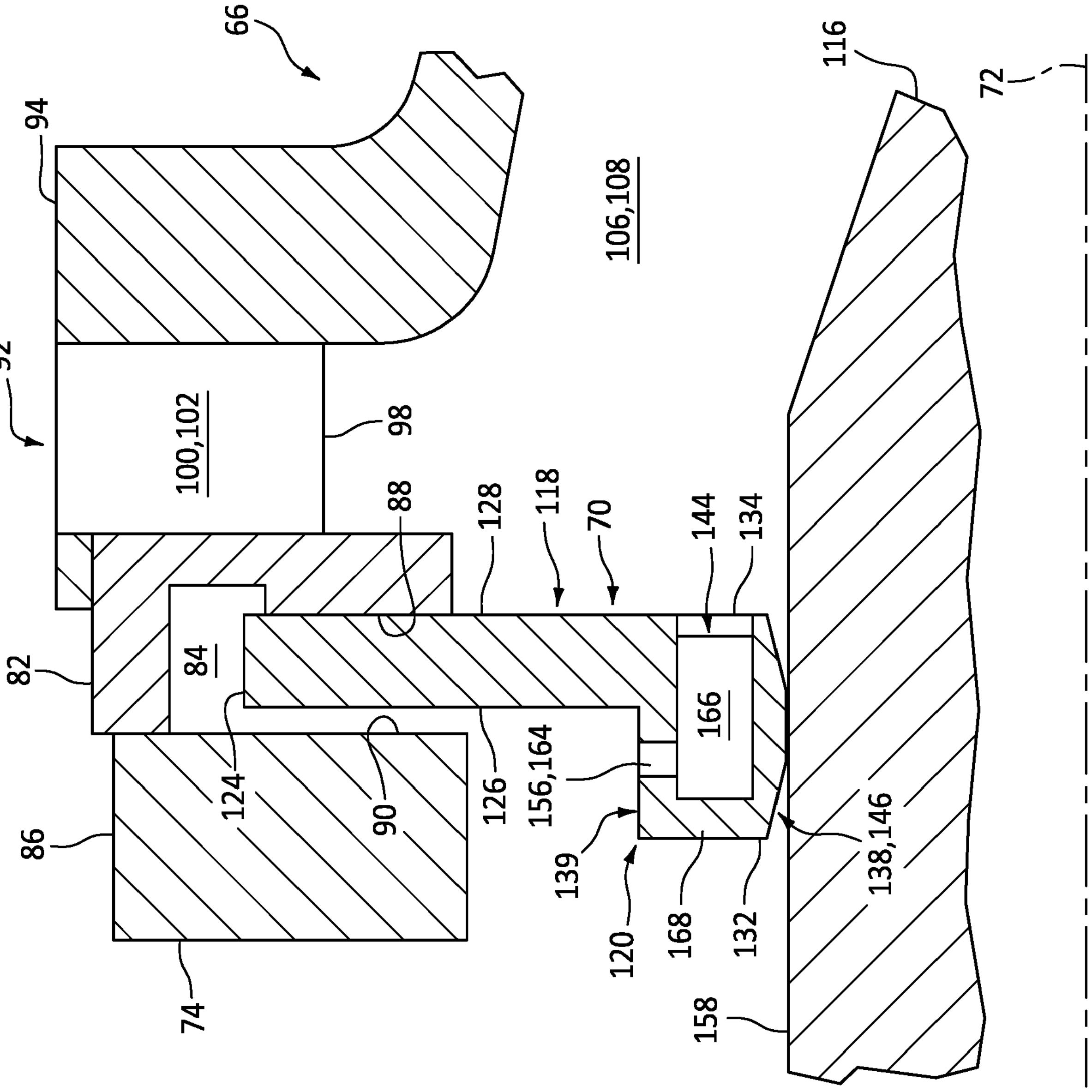
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FIG. 8

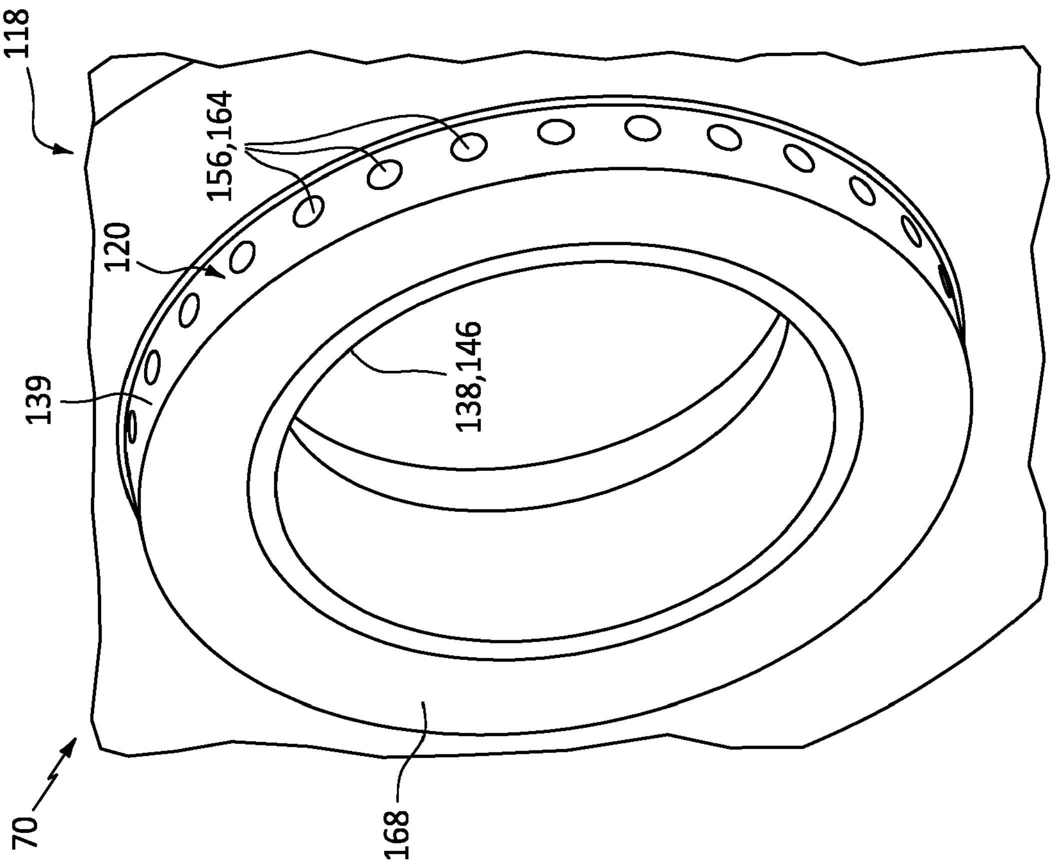
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FIG. 9B

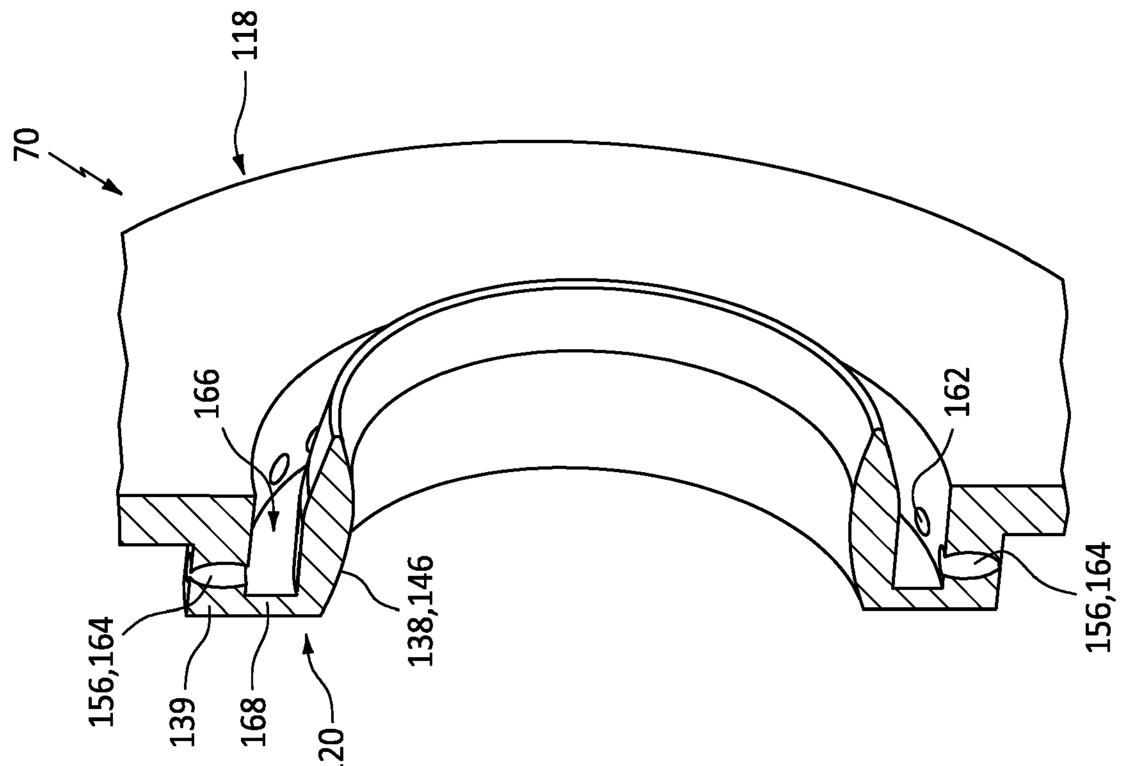
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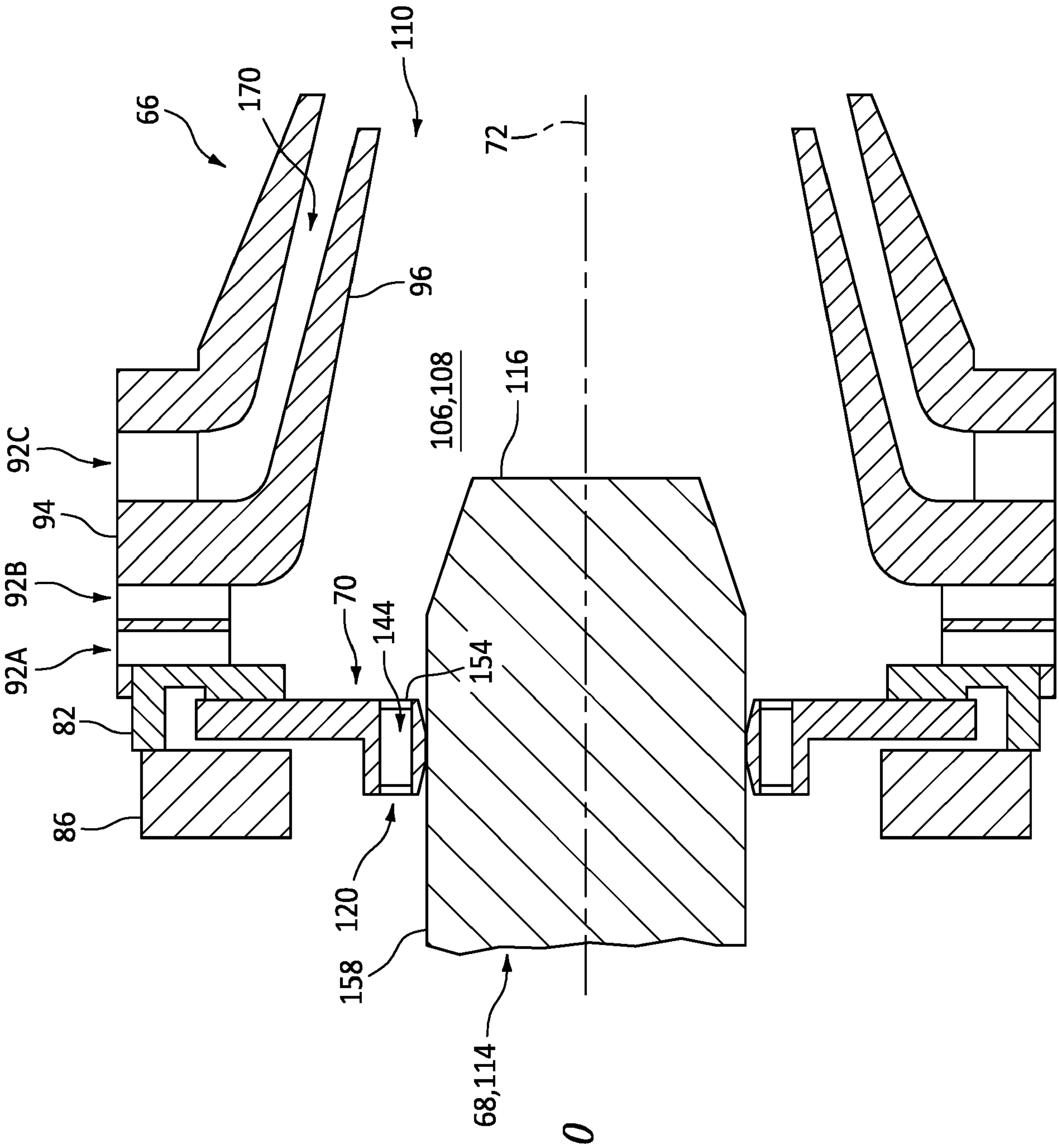
FIG. 9A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94
92B
70
144
154
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68,114

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 24 15 5110

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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	24 April 2024	Mootz, Frank

CATEGORY OF CITED DOCUMENTS

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