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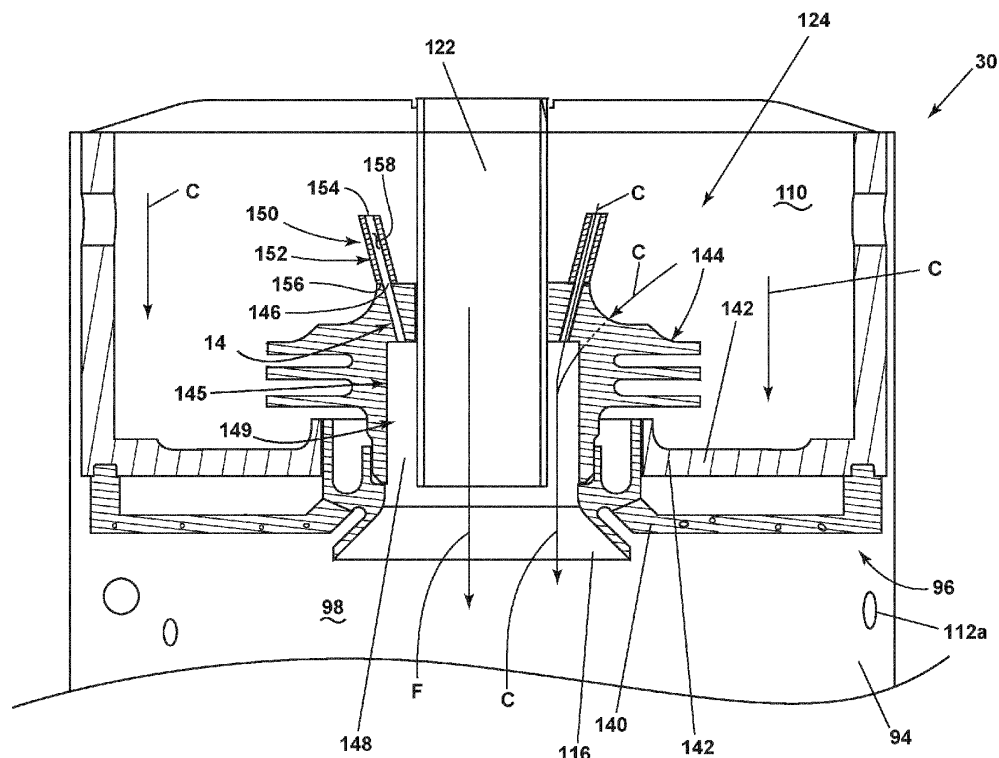
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(54) COMBUSTOR WITH RESONATOR

(57) A turbine engine (10) can include a compressor section (12), a combustion section (14, 29), and a turbine section (16) in serial flow arrangement. The combustion section (14, 29) can include a combustor (30) with a com-

bustion chamber (98), a compressed air passage (110) fluidly coupled to the combustion chamber (98), and a swirler (124, 224). At least one acoustic resonator (150, 152, 250, 252) can be provided in the combustor (30).

**FIG. 3****EP 4 198 397 A1**

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/291,539, filed December 20, 2021, and to U.S. Patent Application No. 17/672,946, filed February 16, 2022.

TECHNICAL FIELD

[0002] The present subject matter relates generally to a combustor having a resonator, and more specifically to a combustor having a set of acoustic resonators for damping.

BACKGROUND

[0003] Turbine engines are driven by a flow of combustion gases passing through the engine to rotate a multitude of turbine blades. A combustor can be provided within the turbine engine and is fluidly coupled with a turbine into which the combusted gases flow.

[0004] In a typical turbine engine, air and fuel are supplied to a combustion chamber, mixed, and then ignited to produce hot gas. The hot gas is then fed to a turbine where it rotates a turbine to generate power.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] In the drawings:

FIG. 1 is a schematic cross-sectional view of a turbine engine having a compressor, a combustor, and a turbine in accordance with various aspects described herein.

FIG. 2 is a cross-sectional view of the combustor in the turbine engine of FIG. 1 with a swirler in accordance with various aspects described herein.

FIG. 3 is a cross-sectional view of the swirler of FIG. 2 illustrating a ferrule assembly in accordance with various aspects described herein.

FIG. 4 is a cross-sectional view of the swirler of FIG. 2 illustrating another ferrule assembly in accordance with various aspects described herein.

DETAILED DESCRIPTION

[0006] Aspects of the disclosure described herein are directed to a combustor with a swirler. For purposes of illustration, the present disclosure will be described with respect to a turbine engine. It will be understood, however, that aspects of the disclosure described herein are not so limited and that a combustor as described herein can be implemented in engines, including but not limited to turbojet, turboprop, turboshaft, and turbofan engines. Aspects of the disclosure discussed herein may have general applicability within non-aircraft engines having a

combustor, such as other mobile applications and non-mobile industrial, commercial, and residential applications.

[0007] Turbine engine combustors typically introduce fuel that has been premixed with air and then combusted within the combustor to drive the turbine. Increases in efficiency and reduction in emissions have driven the need to use fuel that burns cleaner or at higher temperatures, such as utilizing hydrogen fuel. There is a need to improve durability of the combustor under these operating parameters, including reduction of selected acoustic dynamics within the combustor such as ringing, vibrational modes, or the like. The inventors' practice has proceeded in the manner of designing a combustor to meet durability requirements for increased engine temperatures and the use of hydrogen fuel.

[0008] The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other implementations. Additionally, unless specifically identified otherwise, all embodiments described herein should be considered exemplary.

[0009] As used herein, the terms "first", "second", and "third" may be used interchangeably to distinguish one component from another and are not intended to signify location or importance of the individual components.

[0010] The terms "forward" and "aft" refer to relative positions within a gas turbine engine or vehicle, and refer to the normal operational attitude of the gas turbine engine or vehicle. For example, with regard to a gas turbine engine, forward refers to a position closer to an engine inlet and aft refers to a position closer to an engine nozzle or exhaust.

[0011] As used herein, the term "upstream" refers to a direction that is opposite the fluid flow direction, and the term "downstream" refers to a direction that is in the same direction as the fluid flow. The term "fore" or "forward" means in front of something and "aft" or "rearward" means behind something. For example, when used in terms of fluid flow, fore/forward can mean upstream and aft/rearward can mean downstream.

[0012] The term "fluid" may be a gas or a liquid. The term "fluid communication" means that a fluid is capable of making the connection between the areas specified.

[0013] Additionally, as used herein, the terms "radial" or "radially" refer to a direction away from a common center. For example, in the overall context of a turbine engine, radial refers to a direction along a ray extending between a center longitudinal axis of the engine and an outer engine circumference.

[0014] All directional references (e.g., radial, axial, proximal, distal, upper, lower, upward, downward, left, right, lateral, front, back, top, bottom, above, below, vertical, horizontal, clockwise, counterclockwise, upstream, downstream, forward, aft, etc.) are only used for identification purposes to aid the reader's understanding of the present disclosure, and do not create limitations, partic-

ularly as to the position, orientation, or use of aspects of the disclosure described herein. Connection references (e.g., attached, coupled, connected, and joined) are to be construed broadly and can include intermediate structural elements between a collection of elements and relative movement between elements unless otherwise indicated. As such, connection references do not necessarily infer that two elements are directly connected and in fixed relation to one another. The exemplary drawings are for purposes of illustration only and the dimensions, positions, order and relative sizes reflected in the drawings attached hereto can vary.

[0015] The singular forms "a", "an", and "the" include plural references unless the context clearly dictates otherwise. Furthermore, as used herein, the term "set" or a "set" of elements can be any number of elements, including only one.

[0016] Approximating language, as used herein throughout the specification and claims, is applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as "about", "approximately", "generally", and "substantially", are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or machines for constructing or manufacturing the components and/or systems. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or machines for constructing or manufacturing the components and/or systems. For example, the approximating language may refer to being within a 1, 2, 4, 5, 10, 15, or 20 percent margin in either individual values, range(s) of values and/or endpoints defining range(s) of values. Here and throughout the specification and claims, range limitations are combined and interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise. For example, all ranges disclosed herein are inclusive of the endpoints, and the endpoints are independently combinable with each other.

[0017] FIG. 1 is a schematic view of a turbine engine 10. As a non-limiting example, the turbine engine 10 can be used within an aircraft. The turbine engine 10 can include, at least, a compressor section 12, a combustion section 14, and a turbine section 16. A drive shaft 18 rotationally couples the compressor section 12 and turbine section 16, such that rotation of one affects the rotation of the other, and defines a rotational axis 20 for the turbine engine 10.

[0018] The compressor section 12 can include a low-pressure (LP) compressor 22, and a high-pressure (HP) compressor 24 serially fluidly coupled to one another. The turbine section 16 can include an HP turbine 26, and an LP turbine 28 serially fluidly coupled to one another.

The drive shaft 18 can operatively couple the LP compressor 22, the HP compressor 24, the HP turbine 26 and the LP turbine 28 together. Alternatively, the drive shaft 18 can include an LP drive shaft (not illustrated) and an HP drive shaft (not illustrated). The LP drive shaft can couple the LP compressor 22 to the LP turbine 28, and the HP drive shaft can couple the HP compressor 24 to the HP turbine 26. An LP spool can be defined as the combination of the LP compressor 22, the LP turbine 28, and the LP drive shaft such that the rotation of the LP turbine 28 can apply a driving force to the LP drive shaft, which in turn can rotate the LP compressor 22. An HP spool can be defined as the combination of the HP compressor 24, the HP turbine 26, and the HP drive shaft such that the rotation of the HP turbine 26 can apply a driving force to the HP drive shaft which in turn can rotate the HP compressor 24.

[0019] The compressor section 12 can include a plurality of axially spaced stages. Each stage includes a set of circumferentially-spaced rotating blades and a set of circumferentially-spaced stationary vanes. The compressor blades for a stage of the compressor section 12 can be mounted to a disk, which is mounted to the drive shaft 18. Each set of blades for a given stage can have its own disk. The vanes of the compressor section 12 can be mounted to a casing which can extend circumferentially about the turbine engine 10. It will be appreciated that the representation of the compressor section 12 is merely schematic and that there can be any number of blades, vanes and stages. Further, it is contemplated that there can be any number of other components within the compressor section 12.

[0020] Similar to the compressor section 12, the turbine section 16 can include a plurality of axially spaced stages, with each stage having a set of circumferentially-spaced, rotating blades and a set of circumferentially-spaced, stationary vanes. The turbine blades for a stage of the turbine section 16 can be mounted to a disk which is mounted to the drive shaft 18. Each set of blades for a given stage can have its own disk. The vanes of the turbine section can be mounted to the casing in a circumferential manner. It is noted that there can be any number of blades, vanes and turbine stages as the illustrated turbine section is merely a schematic representation. Further, it is contemplated, that there can be any other number of components within the turbine section 16.

[0021] The combustion section 14 can be provided serially between the compressor section 12 and the turbine section 16. The combustion section 14 can be fluidly coupled to at least a portion of the compressor section 12 and the turbine section 16 such that the combustion section 14 at least partially fluidly couples the compressor section 12 to the turbine section 16. As a non-limiting example, the combustion section 14 can be fluidly coupled to the HP compressor 24 at an upstream end of the combustion section 14 and to the HP turbine 26 at a downstream end of the combustion section 14.

[0022] During operation of the turbine engine 10, am-

bient or atmospheric air is drawn into the compressor section 12 via a fan (not illustrated) upstream of the compressor section 12, where the air is compressed defining a pressurized air. The pressurized air can then flow into the combustion section 14 where the pressurized air is mixed with fuel and ignited, thereby generating combustion gases. Some work is extracted from these combustion gases by the HP turbine 26, which drives the HP compressor 24. The combustion gases are discharged into the LP turbine 28, which extracts additional work to drive the LP compressor 22, and the exhaust gas is ultimately discharged from the turbine engine 10 via an exhaust section (not illustrated) downstream of the turbine section 16. The driving of the LP turbine 28 drives the LP spool to rotate the fan (not illustrated) and the LP compressor 22. The pressurized airflow and the combustion gases can together define a working airflow that flows through the fan, compressor section 12, combustion section 14, and turbine section 16 of the turbine engine 10.

[0023] Turning to FIG. 2, a generic combustion section 29, suitable for use as the combustion section 14 of FIG. 1, is illustrated in further detail. The combustion section 29 can include a combustor 30. The combustor 30 can include a combustor inlet 135 fluidly coupled to the compressor section 12 and a combustor outlet 136 fluidly coupled to the turbine section 16. The combustion section 29 can include an annular arrangement of fuel injectors 90 each connected to the combustor 30. It should be appreciated that the annular arrangement of fuel injectors 90 can be one or multiple fuel injectors 90, and that one or more of the fuel injectors 90 can have different characteristics (e.g. geometric arrangement or profile, or supply different fuel types, or the like). It will also be understood that the fuel injector 90 shown is for illustrative purposes only and is not intended to be limiting. The combustor 30 can have a can, can-annular, or annular arrangement depending on the type of engine in which the combustor 30 is located. In a non-limiting example, an annular arrangement is illustrated and disposed within a casing 92. The combustor 30 can include an annular combustor liner 94 and a dome assembly 96 that at least partially defines a combustion chamber 98 about a longitudinal axis (LA). A compressed air passage 110 can be defined at least in part by both combustor liner 94 and the casing 92. The compressed air passage 110 can be fluidly coupled to the combustor inlet 135.

[0024] At least one fuel injector 90 can be fluidly coupled to the combustion chamber 98. At least one passage 112 can fluidly connect the compressed air passage 110 and the combustor 30. The at least one passage 112 can, in some examples, be formed by a set of dilution openings 112a in the combustor liner 94. Any number of dilution openings can be provided in the set of dilution openings 112a. The set of dilution openings 112a can have any geometric profile, size, pattern, arrangement, or the like, including combinations of varying geometric profiles, sizes, patterns, or arrangements, on or over the combustor liner 94

[0025] The fuel injector 90 can be coupled to and disposed within the dome assembly 96 upstream of a flare cone 114 to define a fuel outlet 116. The fuel injector 90 can include a fuel inlet 118 that can be adapted to receive a flow of fuel (F). The fuel (F) can include any suitable fuel, including hydrocarbon fuel or fuel blend, or hydrogen fuel or fuel blend, in non-limiting examples.

[0026] A fuel passage 122 can extend between the fuel inlet 118 and the fuel outlet 116. A swirler 124 can be provided and configured to swirl incoming air in proximity to fuel (F) exiting the fuel injector 90. In some examples, the swirler 124 can be provided at a dome inlet 120 though this need not be the case. The swirler 124 can also be configured to provide a homogeneous mixture of air and fuel entering the combustor 30 in some examples.

[0027] The combustor liner 94 can include a liner wall 126 having an outer surface 128 and an inner surface 130 at least partially defining the combustion chamber 98. In some examples, the liner wall 126 can be made of one continuous portion, including one continuous monolithic portion. In some examples, the liner wall 126 can include multiple portions assembled together to define the combustor liner 94. By way of non-limiting example, the outer surface 128 can define a first piece of the liner wall 126 while the inner surface 130 can define a second piece of the liner wall 126 that when assembled together form the combustor liner 94. In addition, the combustor liner 94 can have any suitable form including, but not limited to, a double-walled liner or a tile liner.

[0028] An igniter 132 can be coupled to the liner wall 126 and fluidly coupled to the combustion chamber 98. The igniter 132 can be provided at any suitable location including, but not limited to, between adjacent dilution openings in the set of dilution openings 112a.

[0029] During operation, compressed air (C) can flow from the compressor section 12 to the combustor 30 through the compressed air passage 110. At least a portion of the compressed air (C) can pass from the compressed air passage 110 to the combustion chamber 98 by way of the set of dilution openings 112a, with the portion defining a dilution airflow (D).

[0030] Some compressed air (C) can be mixed with the fuel (F) and upon entering the combustor 30 the mixture is ignited within the combustion chamber 98 by one or more igniters 132 to generate combustion gas (G). The dilution airflow (D) can be supplied through at least the set of dilution openings 112a and mixed into the combustion gas (G) within the combustion chamber 98, after which the combustion gas (G) can flow through combustor outlet 136 and into the turbine section 16.

[0031] It should be understood that passages illustrated herein, including the compressed air passage 110, fuel passage 122, passage 112, and the like, may be shown with components that visually appear to block the passage in the exemplary cross-sectional view shown without actually blocking the passage. For example, an internal wall, strut, or the like may be present in the plane of the exemplary cross-sectional view while the passage

extends into or out of the plane of the exemplary cross-sectional view such that the passage is not actually blocked.

[0032] Turning to FIG. 3, a portion of the combustor 30 is shown proximate the dome assembly 96 and swirler 124. The set of dilution openings 112a in the combustor liner 94 is also shown. Compressed air (C) is shown within the compressed air passage 110. The fuel (F) is illustrated moving through the fuel passage 122 and entering the combustion chamber 98. It will be understood that compressed air (C) can also be mixed with fuel (F) within the fuel passage 122 in some examples.

[0033] In the illustrated example, the dome assembly 96 can include a deflector 140 and a dome plate 142 though this need not be the case. The swirler 124 can be positioned upstream of the dome assembly 96 within the compressed air passage 110. The swirler 124 can include a ferrule assembly 144 at least partially surrounding the fuel passage 122 as shown. The ferrule assembly 144 can include at least one internal fluid passage 145 having an inlet 146 fluidly coupled to the compressed air passage 110 and an outlet 148 fluidly coupled to the fuel outlet 116. In the non-limiting example shown, the internal fluid passage 145 can include a first passage 147 extending through a wall of the ferrule assembly 144, and a plenum 149 at least partially surrounding the fuel passage 122. The first passage 147 can be fluidly coupled to the inlet 146, and the plenum 149 can be fluidly coupled to the outlet 148. Any number of internal fluid passages 145 can be provided. The internal fluid passages 145 can have any suitable geometric profile, arrangement, or positioning. In addition, a single internal fluid passage 145 can have a single inlet 146, multiple inlets 146, a single outlet 148, or multiple outlets 148. During operation, compressed air (C) can flow through the internal fluid passage 145 of the ferrule assembly 144 and enter the combustion chamber 98.

[0034] At least one acoustic resonator 150 can be provided with the swirler 124. Any number of acoustic resonators 150 can be provided. The acoustic resonator 150 can have any suitable form, arrangement, geometric profile, size, or the like. In some examples, the acoustic resonator 150 can include a Helmholtz resonator, a quarter-wave resonator, or a half-wave resonator, or the like, or combinations thereof.

[0035] In the example of FIG. 3, the at least one acoustic resonator 150 includes a set of quarter-wave resonators 152 coupled to the inlet 146 of the internal fluid passage 145 as shown. Any number of acoustic resonators 150 can be provided, including only one, or two or more. In addition, the set of quarter-wave resonators 152 can include any number of quarter-wave resonators, including only one, or two or more. In the illustrated example, each quarter-wave resonator of the set of quarter-wave resonators 152 includes a resonator inlet 154 fluidly coupled to the compressed air passage 110 and a resonator outlet 156 fluidly coupled to the inlet 146 of the internal fluid passage 145. A resonator chamber 158 can be de-

fined between the resonator inlet 154 and resonator outlet 156. Any suitable geometric profile can be utilized for the resonator chamber 158, including round, curved, conical, asymmetric, or irregular geometric profiles. In addition, a length of each quarter-wave resonator of the set of quarter-wave resonators 152 can be defined between the resonator inlet 154 and resonator outlet 156. In some examples, a first quarter-wave resonator can have a first length and a second quarter-wave resonator can have a second length. The second length can be the same as the first length, or smaller than the first length, or larger than the first length. It is also contemplated that an inner diameter of a quarter-wave resonator of the set of quarter-wave resonators 152 can be variable, or the set of quarter-wave resonators 152 can include a first quarter-wave resonator having a smaller inner diameter compared to a second quarter-wave resonator, in non-limiting examples.

[0036] The size of the resonator chamber 158 can be selected or designed to attenuate a particular frequency or range of frequencies of acoustic waves, including sound waves or pressure waves, flowing through the combustor 30. The at least one acoustic resonator 150 can attenuate frequencies between 2000 Hz and 5000 Hz, or between 4000 Hz and 5000 Hz, in non-limiting examples. In some examples, multiple acoustic resonators can be provided wherein a first acoustic resonator can attenuate frequencies over a first frequency range and a second acoustic resonator can attenuate frequencies over a second frequency range. In a non-limiting example, a first acoustic resonator can have a first chamber volume attenuating frequencies between 2000 Hz and 2500 Hz in a first portion of the combustor, and a second acoustic resonator can have a second chamber volume attenuating frequencies between 3500 Hz and 4000 Hz in a second portion of the combustor. During operation, acoustic waves within the combustor 30 can pass through the ferrule assembly 144 and cause resonance within the at least one acoustic resonators 150, thereby damping at least one acoustic frequency and reducing noise, vibrations, or the like.

[0037] Referring now to FIG. 4, another swirler 224 is illustrated that can be utilized with the combustor 30 (FIG. 2). The swirler 224 is similar to the swirler 124; therefore, like parts will be identified with like numerals increased by 100, with it being understood that the description of like parts of the swirler 124 applies to the swirler 224, except where noted.

[0038] The swirler 224 can be positioned within the combustor 30 upstream of the dome assembly 96 within the compressed air passage 110. The swirler 224 can include a ferrule assembly 244 similar to the ferrule assembly 144 (FIG. 3). The ferrule assembly 244 can at least partially surround the fuel passage 122 as shown. The ferrule assembly 244 can include an internal fluid passage 245 having an inlet 246 fluidly coupled to the compressed air passage 110 and an outlet 248 fluidly coupled to the fuel outlet 116. During operation, com-

pressed air (C) can flow through the internal fluid passage 245 of the ferrule assembly 244 and enter the combustion chamber 98.

[0039] At least one acoustic resonator 250 can be provided with the swirler 224. One difference compared to the acoustic resonator 150 of FIG. 3 is that the acoustic resonator 250 can include a Helmholtz resonator 252 having a resonator inlet 254, a resonator outlet 256, and a resonator chamber 258. The resonator outlet 256 can be fluidly coupled to the inlet 246 of the internal fluid passage 245. The Helmholtz resonator 252 can also include a neck 253 formed by the resonator inlet 254 and defining a neck volume 255. The resonator chamber 258 can include a chamber fluidly coupled to the neck and defining a chamber volume.

[0040] Another difference is that the at least one acoustic resonator 250 can include a variable chamber volume within the resonator chamber 258. In some examples, a single resonator chamber 258 can be provided having a wall 260 with a thickness that is variable in a circumferential direction about the combustor 30. In some examples, multiple internal, circumferentially-arranged dividing walls 261 can be provided to form multiple circumferentially-arranged acoustic resonators 250 with corresponding resonator chambers 258. In some examples, a first resonator chamber 258A can have a first chamber volume 259A and a second resonator chamber 258B can have a second chamber volume 259B smaller than the first chamber volume 259A. It should be understood that the first resonator chamber 258A extends behind the fuel passage 122 in the illustrated example. In other examples, the resonator chamber 258 can include walls with constant thickness, an increasing or decreasing spacing between adjacent walls, a variable geometric profile along a predetermined axis, or the like, or combinations thereof. The set of acoustic resonators 250 can attenuate frequencies between 1000 Hz and 5000 Hz, in some non-limiting examples.

[0041] Benefits of the present disclosure include the ability to attenuate one or more acoustic waves, including pressure waves, high-frequency waves, flow disturbances, or other flow dynamics that may be present within the combustor. In some examples, multiple frequencies can be attenuated simultaneously by selection of chamber volumes formed by the ferrule assembly with integrated acoustic resonators. The use of variable chamber volumes of can additionally provide for selective frequency attenuation in different regions of the combustor. Attenuation of undesirable acoustic waves can provide for increased engine efficiency and increased component part life.

[0042] While described with respect to a turbine engine, it should be appreciated that aspects of the disclosure can have general applicability to any combustor. Aspects of the disclosure described herein can also be applicable to engines with propeller sections, fan and booster sections, turbojet engines, or turboshaft engines, in non-limiting examples.

[0043] To the extent not already described, the different features and structures of the various embodiments can be used in combination, or in substitution with each other as desired. That one feature is not illustrated in all of the embodiments is not meant to be construed that it cannot be so illustrated, but is done for brevity of description. Thus, the various features of the different embodiments can be mixed and matched as desired to form new embodiments, whether or not the new embodiments are expressly described. All combinations or permutations of features described herein are covered by this disclosure.

[0044] Further aspects of the disclosure are provided by the subject matter of the following clauses:

[0045] A turbine engine, comprising a compressor section, a combustion section, and a turbine section in serial flow arrangement, and the combustion section having a combustor comprising a combustor liner at least partially defining a combustion chamber, a compressed air passage fluidly coupled to the compressor section and the combustion chamber, a fuel passage fluidly coupled to the combustion chamber, and a swirler at least partially surrounding the fuel passage, the swirler comprising an internal fluid passage having an inlet fluidly coupled to the compressed air passage and an outlet fluidly coupled to the fuel passage, and an acoustic resonator having a resonator chamber fluidly coupled to the inlet of the internal fluid passage.

[0046] The turbine engine of any preceding clause, wherein the swirler comprises a ferrule assembly at least partially surrounding the fuel passage.

[0047] The turbine engine of any preceding clause, further comprising a first passage extending through a wall of the ferrule assembly, and also comprising a plenum at least partially surrounding the fuel passage.

[0048] The turbine engine of any preceding clause, wherein the first passage and the plenum at least partially define the internal fluid passage.

[0049] The turbine engine of any preceding clause, wherein the acoustic resonator comprises one of a quarter-wave resonator, a half-wave resonator, or a Helmholtz resonator.

[0050] The turbine engine of any preceding clause, wherein the acoustic resonator comprises a quarter-wave resonator coupled to the inlet of the internal fluid passage and extending into the compressed air passage.

[0051] The turbine engine of any preceding clause, wherein the acoustic resonator comprises an outer wall bounding the resonator chamber.

[0052] The turbine engine of any preceding clause, wherein the outer wall comprises a resonator inlet fluidly coupled to the compressed air passage and a resonator outlet fluidly coupled to the inlet of the internal fluid passage.

[0053] The turbine engine of any preceding clause, wherein the resonator chamber comprises a first chamber volume, and further comprising a second resonator chamber having a second chamber volume smaller than

the first chamber volume.

[0054] The turbine engine of any preceding clause, wherein the fuel passage is configured to supply hydrogen fuel to the combustion chamber.

[0055] A combustor for a turbine engine, comprising a combustor liner at least partially defining a combustion chamber, a compressed air passage fluidly coupling a source of compressed air and the combustion chamber, a fuel passage fluidly coupled to the combustion chamber, and a swirler at least partially surrounding the fuel passage, the swirler comprising an internal fluid passage having an inlet fluidly coupled to the compressed air passage and an outlet fluidly coupled to the fuel passage, and an acoustic resonator having a resonator chamber fluidly coupled to the inlet of the internal fluid passage.

[0056] The combustor of any preceding clause, wherein the swirler comprises a ferrule assembly at least partially surrounding the fuel passage.

[0057] The combustor of any preceding clause, further comprising a first passage extending through a wall of the ferrule assembly, and also comprising a plenum at least partially surrounding the fuel passage.

[0058] The combustor of any preceding clause, wherein the first passage and the plenum at least partially define the internal fluid passage.

[0059] The combustor of any preceding clause, wherein the acoustic resonator comprises one of a quarter-wave resonator, a half-wave resonator, or a Helmholtz resonator.

[0060] The combustor of any preceding clause, wherein the acoustic resonator comprises a quarter-wave resonator coupled to the inlet of the internal fluid passage and extending into the compressed air passage.

[0061] The combustor of any preceding clause, wherein the acoustic resonator comprises an outer wall bounding the resonator chamber.

[0062] The combustor of any preceding clause, wherein the outer wall comprises a resonator inlet fluidly coupled to the compressed air passage and a resonator outlet fluidly coupled to the inlet of the internal fluid passage.

[0063] The combustor of any preceding clause, wherein the resonator chamber comprises a first chamber volume, and further comprising a second resonator chamber having a second chamber volume smaller than the first chamber volume.

[0064] The combustor of any preceding clause, wherein the fuel passage is configured to supply hydrogen fuel to the combustion chamber.

[0065] There is further provided a combustor, as substantially shown and described herein. There is also provided a swirler for a combustor, as substantially shown and described herein.

Claims

1. A turbine engine (10), comprising:
a compressor section (12), a combustion section (14,

29), and a turbine section (16) in serial flow arrangement, and the combustion section (14, 29) having a combustor (30) comprising:

a combustor liner (94) at least partially defining a combustion chamber (98);
a compressed air passage (110) fluidly coupled to the compressor section (12) and the combustion chamber (98);
a fuel passage (122) fluidly coupled to the combustion chamber (98); and
a swirler (124, 224) at least partially surrounding the fuel passage (122), the swirler (124, 224) comprising:

an internal fluid passage (145, 245) having an inlet (146, 246) fluidly coupled to the compressed air passage (110) and an outlet (148, 248) fluidly coupled to the fuel passage (122); and
an acoustic resonator (150, 152, 250, 252) having a resonator chamber (158, 258) fluidly coupled to the inlet of the internal fluid passage (145, 245).

2. The turbine engine (10) of claim 1, wherein the swirler (124, 224) comprises a ferrule assembly (144, 244) at least partially surrounding the fuel passage (122).

3. The turbine engine (10) of claim 2, further comprising a first passage (147) extending through a wall of the ferrule assembly (144, 244) and also comprising a plenum (149) at least partially surrounding the fuel passage (122).

4. The turbine engine (10) of any of claims 1-3, wherein the first passage (147) and the plenum (149) at least partially define the internal fluid passage (145, 245).

5. The turbine engine (10) of any of claims 1-4, wherein the acoustic resonator (150, 152, 250, 252) comprises one of a quarter-wave resonator, a half-wave resonator, or a Helmholtz resonator (252).

6. The turbine engine (10) of claim 1, wherein the acoustic resonator (150, 152, 250, 252) comprises a quarter-wave resonator (152) coupled to the inlet of the internal fluid passage (145, 245) and extending into the compressed air passage (110).

7. The turbine engine (10) of claim 1, wherein the acoustic resonator (150, 152, 250, 252) comprises an outer wall (260) bounding the resonator chamber (158, 258).

8. The turbine engine (10) of claim 7, wherein the outer wall (260) comprises a resonator inlet (254) fluidly

coupled to the compressed air passage (110) and a resonator outlet (256) fluidly coupled to the inlet (246) of the internal fluid passage (245).

9. The turbine engine (10) of any of claims 1-8, wherein the resonator chamber (158, 258) comprises a variable cross-sectional area in a circumferential direction about the combustor (30). 5
10. The turbine engine (10) of any of claims 1-9, wherein the fuel passage (122) is configured to supply hydrogen fuel to the combustion chamber (98). 10

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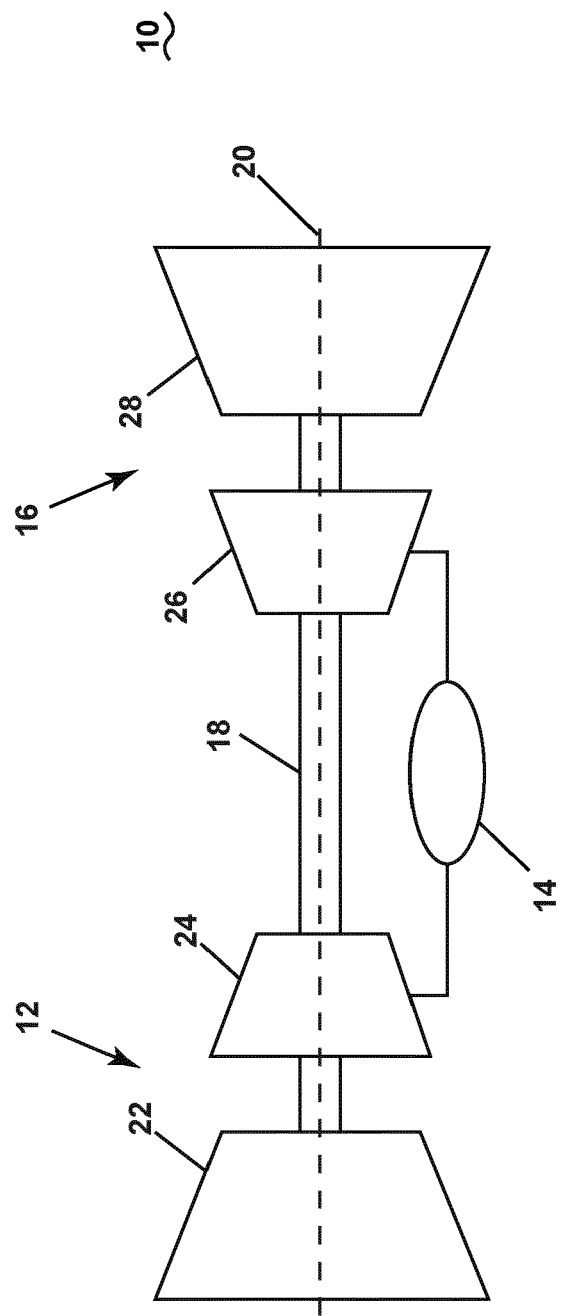


FIG. 1

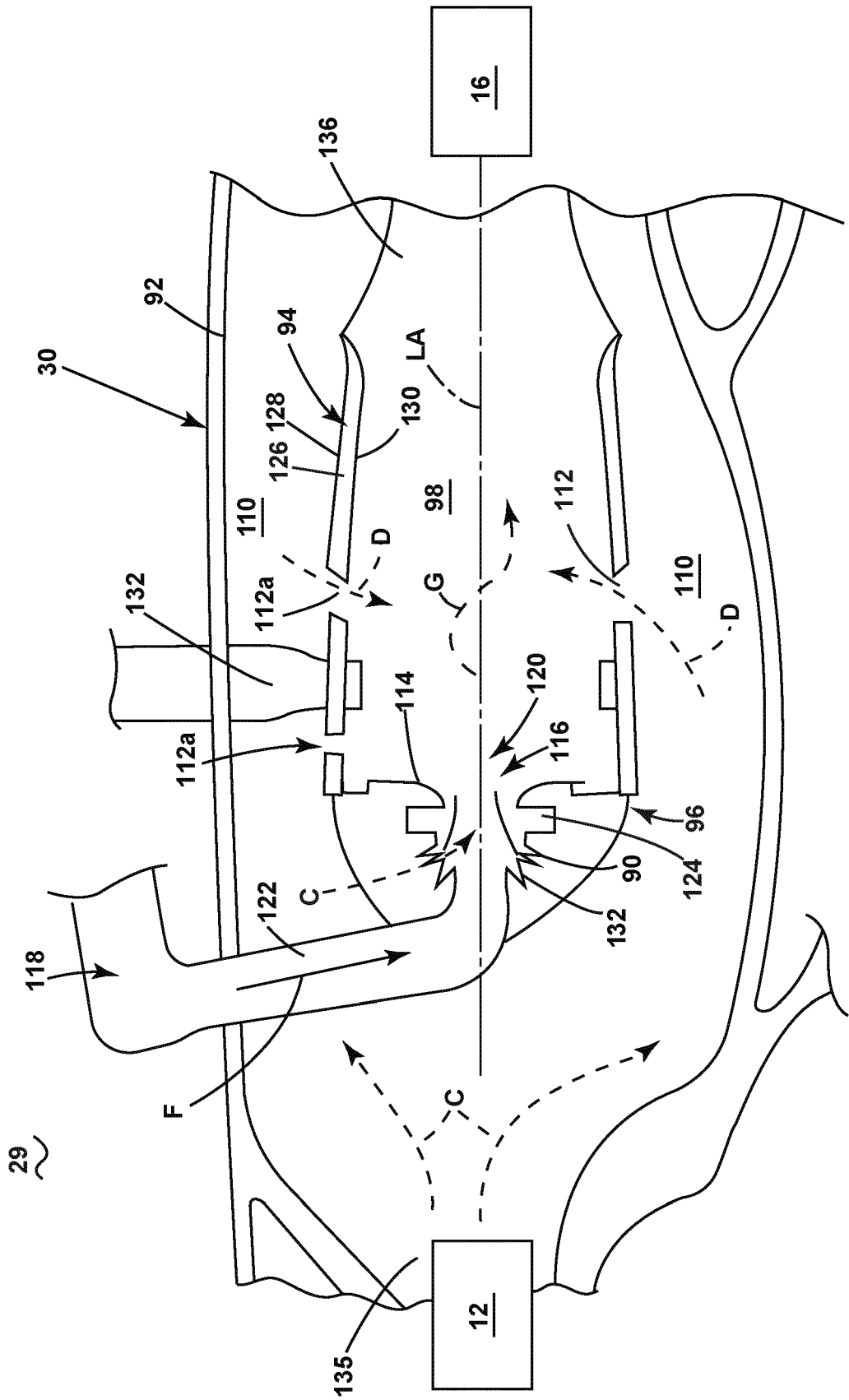
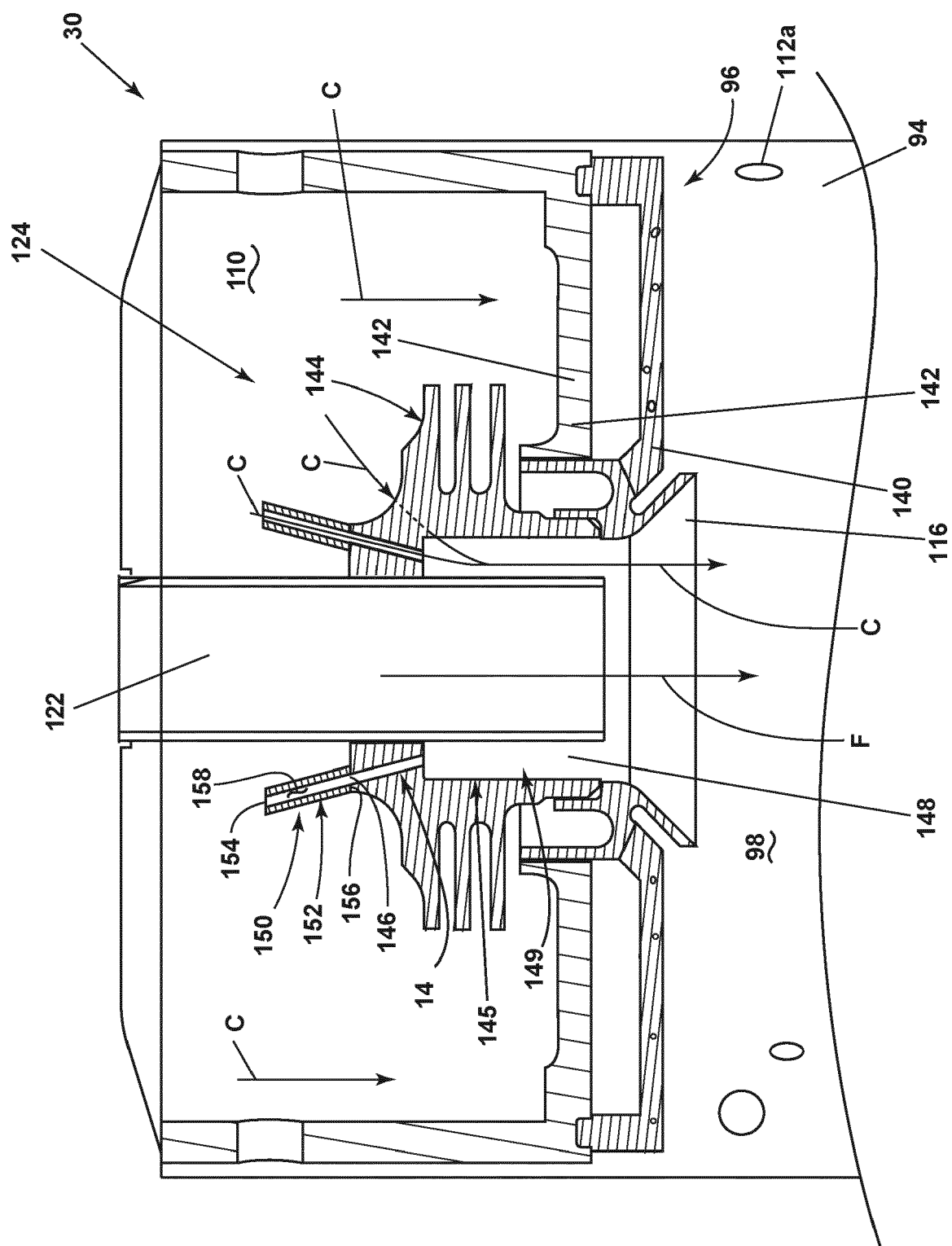


FIG. 2



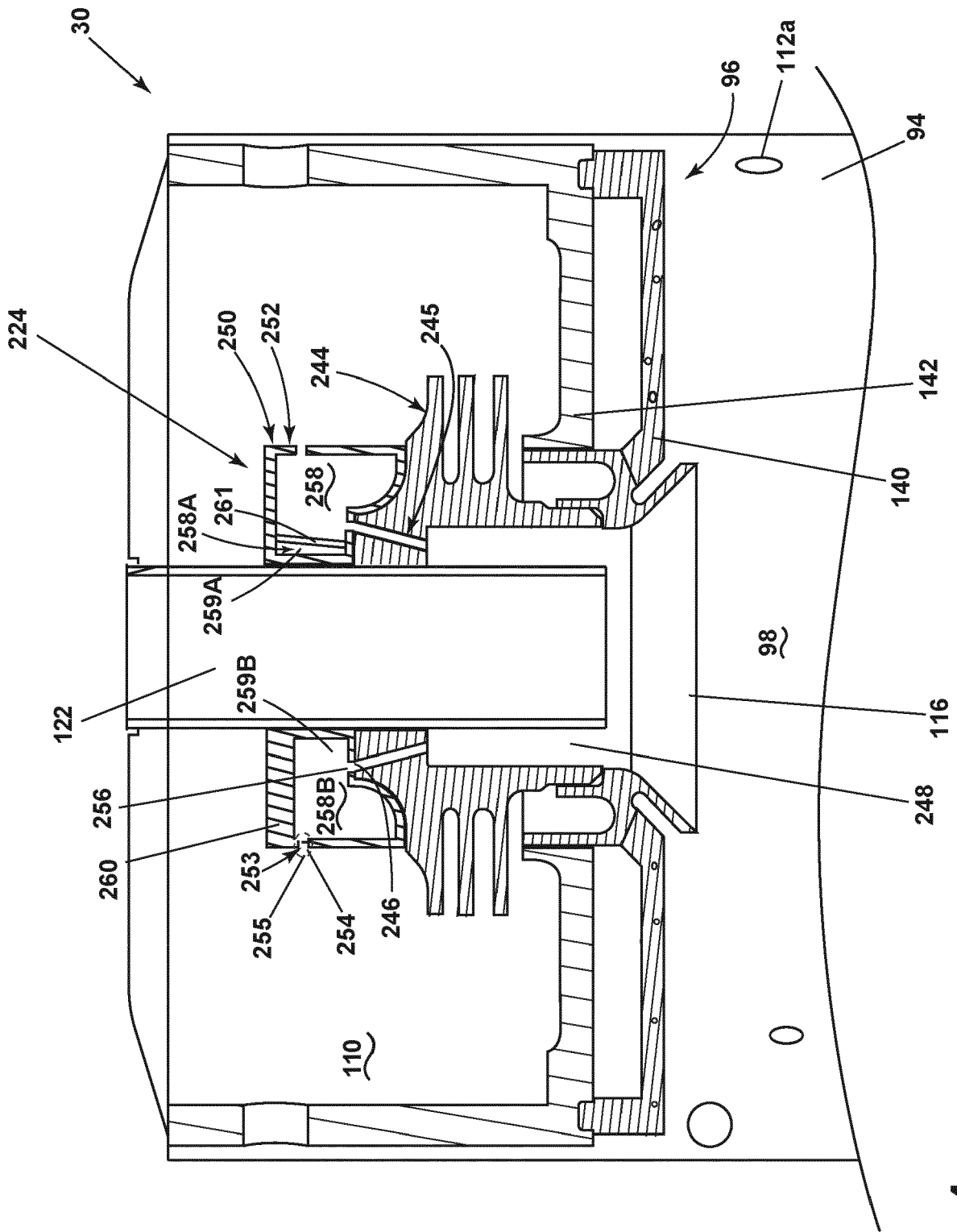


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 4988

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	* paragraph [0005]; figure 1 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F23R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		9 September 2022	Mougey, Maurice
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09-09-2022

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