



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.06.2023 Bulletin 2023/25

(51) International Patent Classification (IPC):
F23R 3/00 (2006.01)

(21) Application number: **22163562.6**

(52) Cooperative Patent Classification (CPC):
F23R 3/002; F23R 2900/00014; F23R 2900/03044

(22) Date of filing: **22.03.2022**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(30) Priority: **20.12.2021 US 202163291529 P**
17.02.2022 US 202217674351

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(54) **COMBUSTOR WITH RESONATOR**

(57) A turbine engine (10) comprises a compressor section (12), a combustion section (14) and a turbine section (16) in serial flow arrangement, with the combustion section (14) having a combustor (30) defining a longitudinal axis (LA). The combustor (30) comprises a combustor liner (94) at least partially defining a combustion chamber (98), a fuel passage (122) fluidly coupled to the combustion chamber (98), a compressed air passage

(110) fluidly coupling the compressor section (12) to the combustion chamber (98), a dome plate (142) separating the combustion chamber (98) from the compressed air passage (110) and having a set of apertures (146, 246, 346) fluidly coupled to the compressed air passage (110), and a set of resonator cavities (150, 250, 250a, 250b, 350, 350a-f) proximate the dome plate (142) and fluidly coupled to the set of apertures (146, 246, 346).

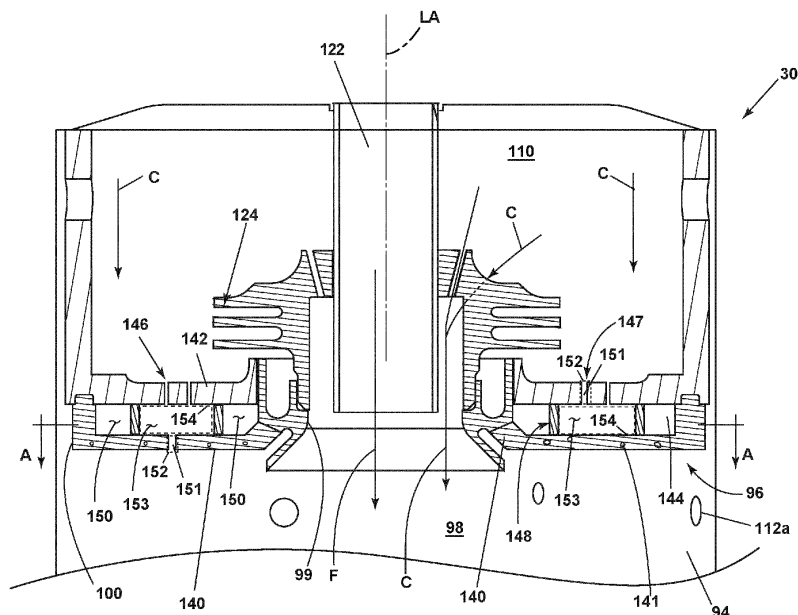


FIG. 3

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/291,529, filed December 20, 2021, and to U.S. Patent Application No. 17/674,351, filed February 17, 2022, which are incorporated herein by reference in their entirety.

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 dome assembly in accordance with various aspects described herein.

FIG. 3 is a cross-sectional view of the dome assembly of FIG. 2 illustrating a set of resonator cavities in accordance with various aspects described herein.

FIG. 4 is an axial view of the dome assembly and resonator cavities of FIG. 3.

FIG. 5 is an axial view of another dome assembly that can be utilized in the combustor of FIG. 1 in accordance with various aspects described herein.

FIG. 6 is an axial view of another dome assembly that can be utilized in the combustor of FIG. 1 in accordance with various aspects described herein.

DETAILED DESCRIPTION

[0006] Aspects of the disclosure described herein are directed to a combustor with a dome assembly. For purposes of illustration, the present disclosure will be de-

scribed 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] 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.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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.

[0013] 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, particularly 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 in-

licated. 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.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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 number of other components within the turbine section 16.

[0020] 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.

[0021] During operation of the turbine engine 10, ambient 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 combus-

tion 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.

[0022] 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, 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 passageway 110 can be defined at least in part by both combustor liner 94 and the casing 92. The compressed air passageway 110 can be fluidly coupled to the combustor inlet 135.

[0023] 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 passageway 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.

[0024] 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 hydrogen fuel in non-

limiting examples.

[0025] A fuel passageway 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.

[0026] 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.

[0027] 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.

[0028] During operation, compressed air (C) can flow from the compressor section 12 to the combustor 30 through the compressed air passageway 110. At least a portion of the compressed air (C) can pass from the compressed air passageway 110 to the combustion chamber 98 by way of the set of dilution openings 112a, with the portion defining a dilution airflow (D).

[0029] 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.

[0030] It should be understood that passages and passageways illustrated herein, including the compressed air passageway 110, fuel passageway 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 or passageway extends into or out of the plane of the exemplary cross-sectional view such that the passage is not actually blocked.

[0031] Turning to FIG. 3, a portion of the combustor 30 is shown proximate the dome assembly 96. The set of

dilution openings 112a in the combustor liner 94 is also shown. The compressed air (C) is shown within the compressed air passageway 110. The fuel (F) is illustrated moving through the fuel passageway 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 passageway 122 in some examples.

[0032] The dome assembly 96 can include a deflector 140 spaced from a dome plate 142 to define a plenum 144 therebetween. The deflector 140 can include a radially inner surface 99 and a radially outer surface 100 as shown. In addition, a set of apertures 146 can be provided in the dome plate 142 as shown. In some examples, the set of apertures 146 can form a set of impingement holes though this need not be the case. The plenum 144 can be fluidly coupled to the compressed air passageway 110 by way of the set of apertures 146. During operation, compressed air (C) can enter the plenum 144 through the set of apertures 146. In a non-limiting example, the compressed air (C) can impinge the deflector 140, such as for cooling the deflector 140. In some examples, the deflector 140 can also include a set of deflector apertures 141 fluidly coupling the plenum 144 to the combustion chamber 98. In such a case, compressed air (C) can move from the plenum 144 into the combustion chamber 98 and at least partially form the dilution airflow (D) (FIG. 2).

[0033] A set of interior walls 148 can be provided within the plenum 144. The set of interior walls 148 can extend at least in a direction parallel to the longitudinal axis LA between the deflector 140 and the dome plate 142. In some examples, the set of interior walls 148 can couple to either or both of the deflector 140 or the dome plate 142. The set of interior walls 148 can also extend in any suitable direction, including axially or parallel to the longitudinal axis LA, radially, circumferentially, or combinations thereof. The set of interior walls 148 can be distributed symmetrically or asymmetrically about the plenum 144. Any number of interior walls can be provided in the set of interior walls 148, including only one, or two or more.

[0034] The set of interior walls 148 can at least partially form at least one resonator cavity 150 within the plenum 144. For example, the set of interior walls 148 can divide the plenum 144 into one or more resonator cavities 150. The resonator cavity 150 can at least partially form an acoustic resonator within the combustor 30. The resonator cavity 150 can have any suitable form including a Helmholtz resonator, a quarter-wave resonator, or a half-wave resonator, in non-limiting examples. In one non-limiting example with the resonator cavity 150 forming a Helmholtz resonator, the resonator cavity 150 can include a neck 151 formed by an aperture 147 in the set of apertures 146 and defining a neck volume 152. The chamber volume 154 can be fluidly coupled to the combustion chamber 98 in some examples. In another non-limiting example with the resonator cavity 150 forming a Helmholtz resonator, the resonator cavity 150 can in-

clude neck 151 formed by a deflector aperture 141 in the deflector 140 and defining neck volume 152. The resonator cavity 150 can include a chamber 153 formed within the plenum 144 fluidly coupled to the neck 151 and defining a chamber volume 154. Any suitable geometric profile can be utilized for the resonator cavity 150, including round, curved, conical, asymmetric, or irregular geometric profiles.

[0035] In another non-limiting example, the resonator cavity 150 can define an open acoustic chamber as is known in the art. In such a case, the aperture 147 in the set of apertures 146 can form a first opening at a first end of the resonator cavity 150, and the deflector aperture 141 in the deflector 140 can form a second opening at a second end of the resonator cavity 150 opposite the first end.

[0036] Any number or arrangement of apertures in the set of apertures 146 can be provided in the dome plate 142, including one or more. Any number or arrangement of deflector apertures 141 can be provided in the deflector 140, including zero, or one or more. In some examples, a single resonator cavity 150 can be fluidly coupled to multiple apertures in the set of apertures 146 in the dome plate 142, or to multiple deflector apertures 141 in the deflector 140, or combinations thereof. In some examples, a first radial distance R1 between a first deflector aperture 141A and the longitudinal axis LA can be larger than a second radial distance R2 between a second deflector aperture 141B and the longitudinal axis LA. The relative sizes of the chamber volume 154 and neck volume 152 for each resonator cavity 150 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 resonator cavities 150 can attenuate frequencies between 500 Hz and 5000 Hz, in some non-limiting examples. During operation, acoustic waves within the combustor 30 can pass over the dome assembly 96 and cause resonance within the at least one resonator cavity 150, thereby damping at least one acoustic frequency and reducing noise, vibrations, or the like.

[0037] Turning to FIG. 4, the dome assembly 96 is illustrated in a schematic cross-sectional view along line A-A of FIG. 3. It should be understood that the dome plate 142 (FIG. 3) is not shown in this view, and that the set of interior walls 148 can extend in a direction along the longitudinal axis LA between the dome plate 142 (FIG. 3) and the deflector 140.

[0038] In the exemplary configuration shown in FIG. 4, the set of interior walls 148 includes two interior walls extending circumferentially about the combustor 30. The set of interior walls 148 can at least partially define three resonator cavities 150 circumscribing one another as shown. Some exemplary deflector apertures 141 are illustrated over the deflector 140. It will be understood that any number of deflector apertures 141 can be provided, and the deflector apertures 141 can have any suitable size, shape, spacing, patterning, or the like. In addition,

some of the resonator cavities 150 of the illustrated example are fluidly coupled to multiple deflector apertures 141 though this need not be the case.

[0039] Referring now to FIG. 5, another exemplary configuration of a dome assembly 196 is shown that can be utilized in the combustor 30 (FIG. 2). The dome assembly 196 is illustrated generally along the same direction as the dome assembly 96 (FIG. 4). The dome assembly 196 is similar to the dome assembly 96 (FIG. 4); therefore, like parts will be identified with like numerals increased by 100, with it being understood that the description of the like parts of the dome assembly 96 applies to the dome assembly 196, except where noted.

[0040] The dome assembly 196 includes a deflector 240 and a set of interior walls 248. The deflector 240 can include a radially inner surface 199 and radially outer surface 200. While not shown in FIG. 5 for clarity, it will be understood that the dome assembly 196 can also include a dome plate similar to the dome plate 142 and a plenum similar to the plenum 144 (FIG. 3). The set of interior walls 248 can couple to the deflector 240 and at least partially form a set of resonator cavities 250. In addition, some exemplary deflector apertures 241 are illustrated over the deflector 240. It will be understood that any number of deflector apertures 241 can be provided, and the deflector apertures 241 can have any suitable size, shape, spacing, patterning, or the like.

[0041] One difference compared to the set of interior walls 148 of FIG. 3 is that the set of interior walls 248 includes interior walls that extend parallel to a radial direction without intersecting the longitudinal axis LA. Put another way, the set of interior walls 248 can extend in a generally radial direction and also be offset from the longitudinal axis LA. In the illustrated example, the set of interior walls 248 at least partially defines four resonator cavities 250 distributed at least annularly about the combustor 30 as shown. The resonator cavities 250 in the illustrated example have unequal chamber volumes, though this need not be the case. In this manner, the resonator cavities 250 can be tuned to attenuate particular frequencies, including simultaneous attenuation of multiple frequencies, along different portions of the combustor 30. In a non-limiting example, a first resonator cavity 250a can attenuate frequencies between 1500 Hz and 2500 Hz in a first portion of the combustor 30, and a second resonator cavity 250b can attenuate frequencies between 3000 Hz and 4000 Hz in a second portion of the combustor 30.

[0042] Referring now to FIG. 6, another exemplary configuration of a dome assembly 296 is shown that can be utilized in the combustor 30 (FIG. 2). The dome assembly 296 is illustrated generally along the same direction as the dome assembly 96 (FIG. 4). The dome assembly 296 is similar to the dome assembly 96, 196; therefore, like parts will be identified with like numerals further increased by 100, with it being understood that the description of the like parts of the dome assembly 96, 196 applies to the dome assembly 296, except where

noted.

[0043] The dome assembly 296 can include a deflector 340 and a set of interior walls 348. The deflector 340 can include a radially inner surface 299 and radially outer surface 300. While not shown in FIG. 6 for clarity, it will be understood that the dome assembly 296 can also include a dome plate similar to the dome plate 142 and a plenum similar to the plenum 144 (FIG. 3). The set of interior walls 348 can couple to the deflector 340 and at least partially form a set of resonator cavities 350. In addition, some exemplary deflector apertures 341 are illustrated over the deflector 340. It will be understood that any number of deflector apertures 341 can be provided, and the deflector apertures 341 can have any suitable size, shape, spacing, patterning, or the like.

[0044] One difference compared to the set of interior walls 148, 248 is that the set of interior walls 348 includes interior walls that have nonlinear portions. In some examples the set of interior walls 348 includes an overall wall curvature extending across the combustor 30. In some examples, the set of interior walls 348 can include local wall curvatures over a small portion of the combustor 30. In the illustrated example, the set of interior walls 348 at least partially defines six resonator cavities, with a first resonator cavity 350a arranged to surround the fuel passageway 122 and five additional resonator cavities 350b-350f distributed at least annularly about the first resonator cavity 350a. In this manner, the set of resonator cavities 350 can include a central resonator cavity (e.g. first resonator cavity 350a) and a group of outer resonator cavities (e.g. the five resonator cavities 350b, 350c, 350d, 350e, 350f) distributed annularly about the central resonator cavity. In addition, while the resonator cavities 350a-350f in the illustrated example are shown with unequal chamber volumes, this need not be the case and any suitable size or arrangement of chamber volumes is contemplated.

[0045] 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 interior walls between the deflector and dome plate. Such attenuation can provide for increased engine efficiency and increased component part life.

[0046] 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.

[0047] 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.

[0048] Further aspects of the disclosure are provided by the subject matter of the following clauses:

[0049] A turbine engine, comprising a compressor section, a combustion section, and a turbine section in serial flow arrangement, with the combustion section having a combustor defining a longitudinal axis and comprising a combustor liner at least partially defining a combustion chamber, a fuel passage fluidly coupled to the combustion chamber, a compressed air passage fluidly coupling the compressor section to the combustion chamber, a dome plate separating the combustion chamber from the compressed air passage, the dome having a set of apertures fluidly coupled to the compressed air passage, and a set of resonator cavities proximate the dome plate and fluidly coupled to the set of apertures.

[0050] The turbine engine of any preceding clause, further comprising a deflector spaced from the dome plate and having a set of deflector apertures fluidly coupled to the combustion chamber.

[0051] The turbine engine of any preceding clause, further comprising a set of interior walls extending between the deflector and the dome plate and at least partially defining the set of resonator cavities.

[0052] The turbine engine of any preceding clause, wherein a resonator cavity in the set of resonator cavities comprises a neck formed by an impingement aperture in the set of apertures and a chamber at least partially formed by the set of interior walls.

[0053] The turbine engine of any preceding clause, wherein the set of interior walls extend radially with respect to the longitudinal axis to form at least two annularly-arranged resonator cavities in the set of resonator cavities.

[0054] The turbine engine of any preceding clause, wherein the set of resonator cavities includes a central resonator cavity and a group of outer resonator cavities distributed annularly about the central resonator cavity.

[0055] The turbine engine of any preceding clause, wherein the set of interior walls includes at least one of an overall wall curvature, a local wall curvature, or a linear wall.

[0056] The turbine engine of any preceding clause, wherein the set of apertures in the dome plate comprise impingement holes configured to impinge air from the compressed air passage onto the deflector.

[0057] The turbine engine of any preceding clause, wherein the set of resonator cavities comprises a Helmholtz resonator.

[0058] The turbine engine of any preceding clause, wherein the set of resonator cavities comprises a first

annular resonator cavity surrounding the fuel passage about the longitudinal axis, and a second annular resonator cavity surrounding the first annular resonator cavity.

5 **[0059]** The turbine engine of any preceding clause, wherein at least one of the first annular resonator cavity or the second annular resonator cavity is fluidly coupled to multiple apertures in the set of apertures.

10 **[0060]** A combustor for a turbine engine, the combustor extending along a longitudinal axis and comprising a combustor liner at least partially defining a combustion chamber, a fuel passage fluidly coupled to the combustion chamber, a compressed air passage fluidly coupled to the combustion chamber, a dome plate separating the combustion chamber from the compressed air passage, the dome plate having a set of apertures fluidly coupled to the compressed air passage, and a set of resonator cavities proximate the dome plate and fluidly coupled to the set of apertures.

20 **[0061]** The combustor of any preceding clause, further comprising a deflector spaced from the dome plate and having a set of deflector apertures fluidly coupled to the combustion chamber.

25 **[0062]** The combustor of any preceding clause, further comprising a set of interior walls coupled between the deflector and the dome plate and at least partially defining the set of resonator cavities.

30 **[0063]** The combustor of any preceding clause, wherein the set of interior walls extend radially with respect to the longitudinal axis to form at least two annularly-arranged resonator cavities in the set of resonator cavities.

35 **[0064]** The combustor of any preceding clause, wherein the set of apertures in the dome comprise impingement holes configured to impinge air from the compressed air passage onto the deflector.

[0065] The combustor of any preceding clause, wherein the set of resonator cavities comprises a Helmholtz resonator.

40 **[0066]** The turbine engine of any preceding clause, wherein the set of resonator cavities comprises a first annular resonator cavity surrounding the fuel passage about the longitudinal axis, and a second annular resonator cavity surrounding the first annular resonator cavity.

45 **[0067]** The combustor of any preceding clause, wherein at least one of the first annular resonator cavity or the second annular resonator cavity is fluidly coupled to multiple apertures in the set of apertures.

50 **[0068]** The combustor of any preceding clause, wherein the set of resonator cavities includes a central resonator cavity and a group of outer resonator cavities distributed annularly about the central resonator cavity.

[0069] There is further provided a combustor, as substantially shown and described herein.

55 **[0070]** There is further provided a dome assembly for a combustor, as substantially shown and described herein.

Claims

1. A turbine engine (10), comprising:
 - a compressor section (12), a combustion section (14), and a turbine section (16) in serial flow arrangement, with the combustion section (14) having a combustor (30) defining a longitudinal axis (LA) and comprising:
 - a combustor liner (94) at least partially defining a combustion chamber (98);
 - a fuel passage (122) fluidly coupled to the combustion chamber (98);
 - a compressed air passage (110) fluidly coupling the compressor section (12) to the combustion chamber (98);
 - a dome plate (142) separating the combustion chamber (98) from the compressed air passage (110), the dome plate (142) having a set of apertures (146, 246, 346) fluidly coupled to the compressed air passage (110); and
 - a set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) proximate the dome plate (142) and fluidly coupled to the set of apertures (146, 246, 346).
2. The turbine engine (10) of claim 1, further comprising a deflector (140, 240, 340) spaced from the dome plate (142) and having a set of deflector apertures (141, 241, 341) fluidly coupled to the combustion chamber (98).
3. The turbine engine (10) of any of claims 1-2, further comprising a set of interior walls (148, 248, 348) extending between the deflector (140, 240, 340) and the dome plate (142) and at least partially defining the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f).
4. The turbine engine (10) of any of claims 1-3, wherein a resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) in the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) comprises a neck (151) formed by an impingement aperture (146, 147, 246, 346) in the set of apertures (146, 246, 346) and a chamber (153) at least partially formed by the set of interior walls (148, 248, 348).
5. The turbine engine (10) of any of claims 1-4, wherein the set of interior walls (148, 248, 348) extend radially with respect to the longitudinal axis (LA) to form at least two annularly-arranged resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) in the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f).
6. The turbine engine (10) of any of claims 1-4, wherein the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) includes a central resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) and a group of outer resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) distributed annularly about the central resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f).
7. The turbine engine (10) of any of claims 1-6, wherein the set of interior walls (148, 248, 348) includes at least one of an overall wall curvature, a local wall curvature, or a linear wall.
8. The turbine engine (10) of any of claims 1-7, wherein the set of apertures in the dome plate comprise impingement holes configured to impinge air from the compressed air passage (110) onto the deflector (140, 240, 340).
9. The turbine engine (10) of any of claims 1-8, wherein the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) comprises a Helmholtz resonator.
10. The turbine engine (10) of any of claims 1-9, wherein the set of resonator cavities (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) comprises a first annular resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) surrounding the fuel passage (122) about the longitudinal axis (LA), and a second annular resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) surrounding the first annular resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f).
11. The turbine engine (10) of claim 10, wherein at least one of the first annular resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) or the second annular resonator cavity (150, 250, 250a, 250b, 350, 350a, 350b, 350c, 350d, 350e, 350f) is fluidly coupled to multiple apertures in the set of apertures (146, 246, 346).

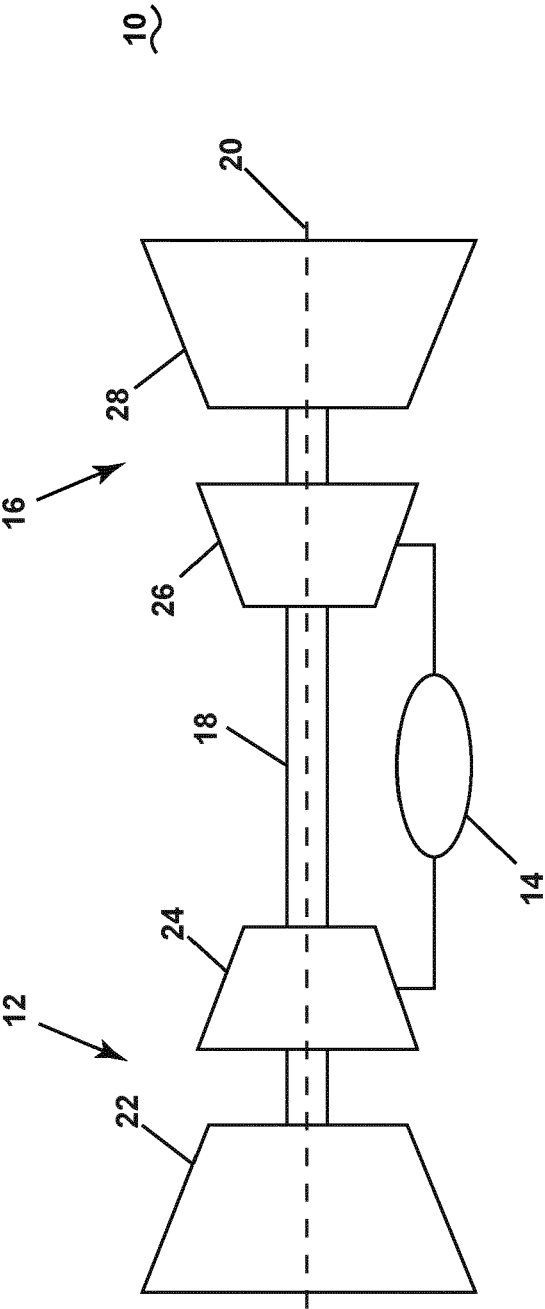


FIG. 1

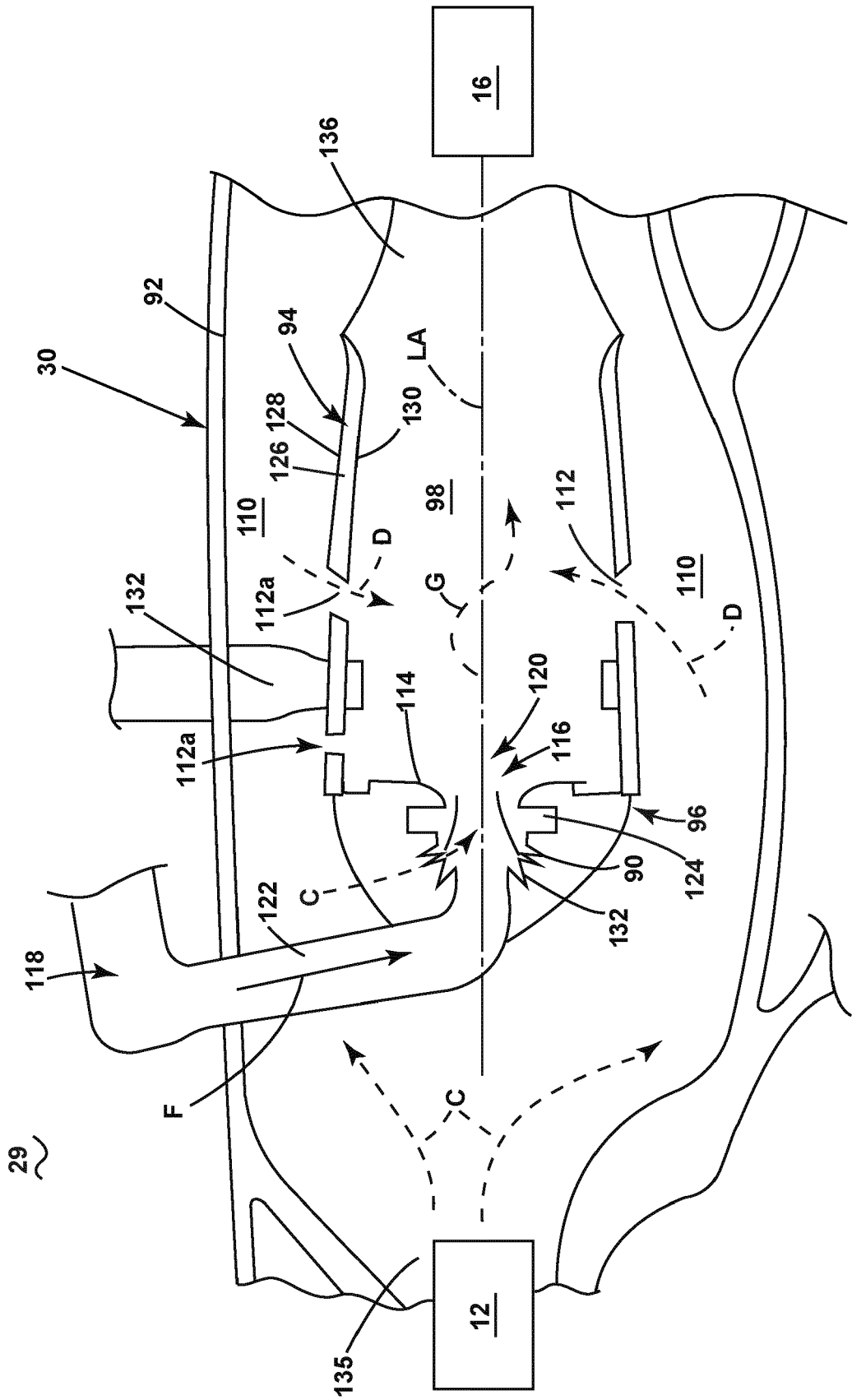
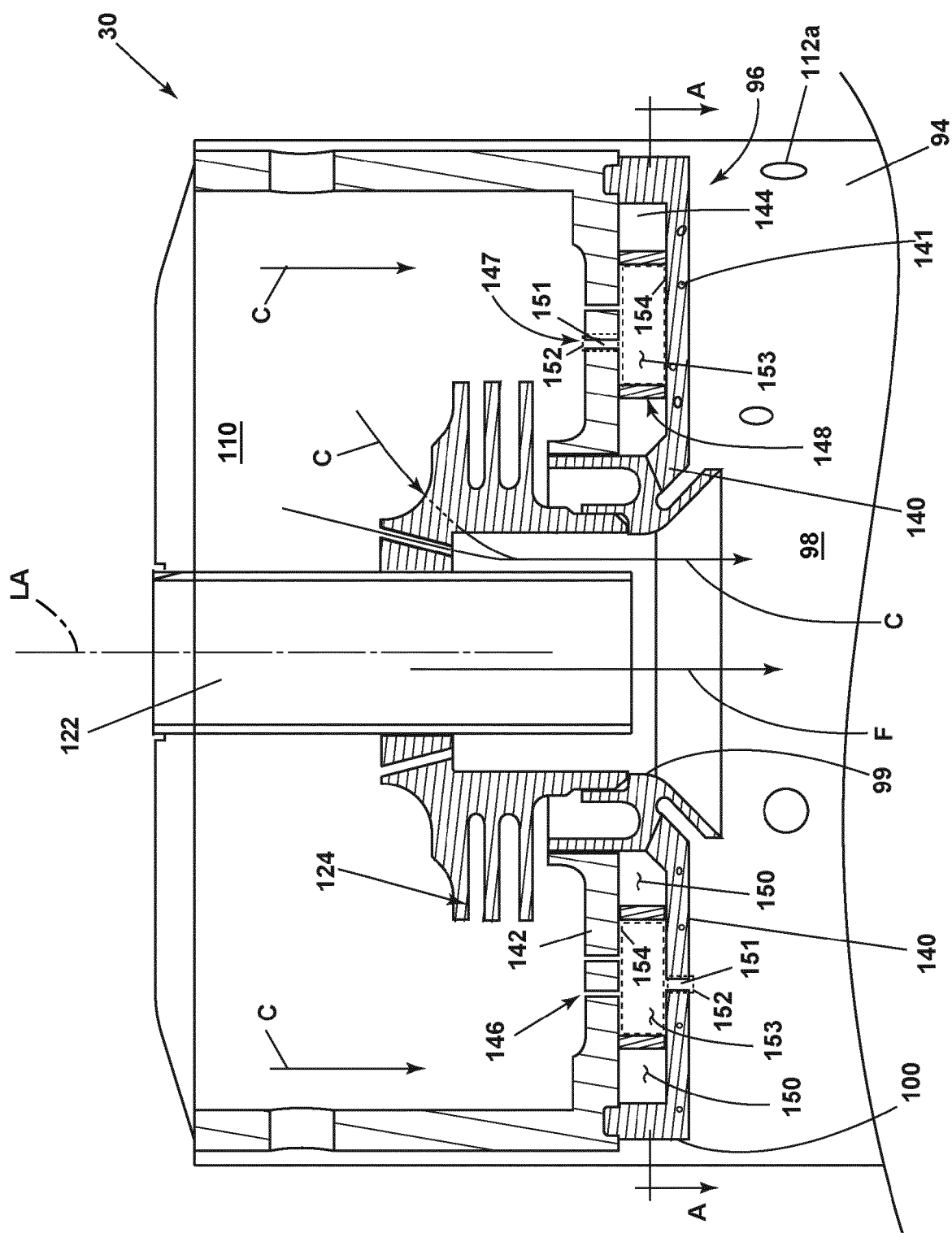


FIG. 2



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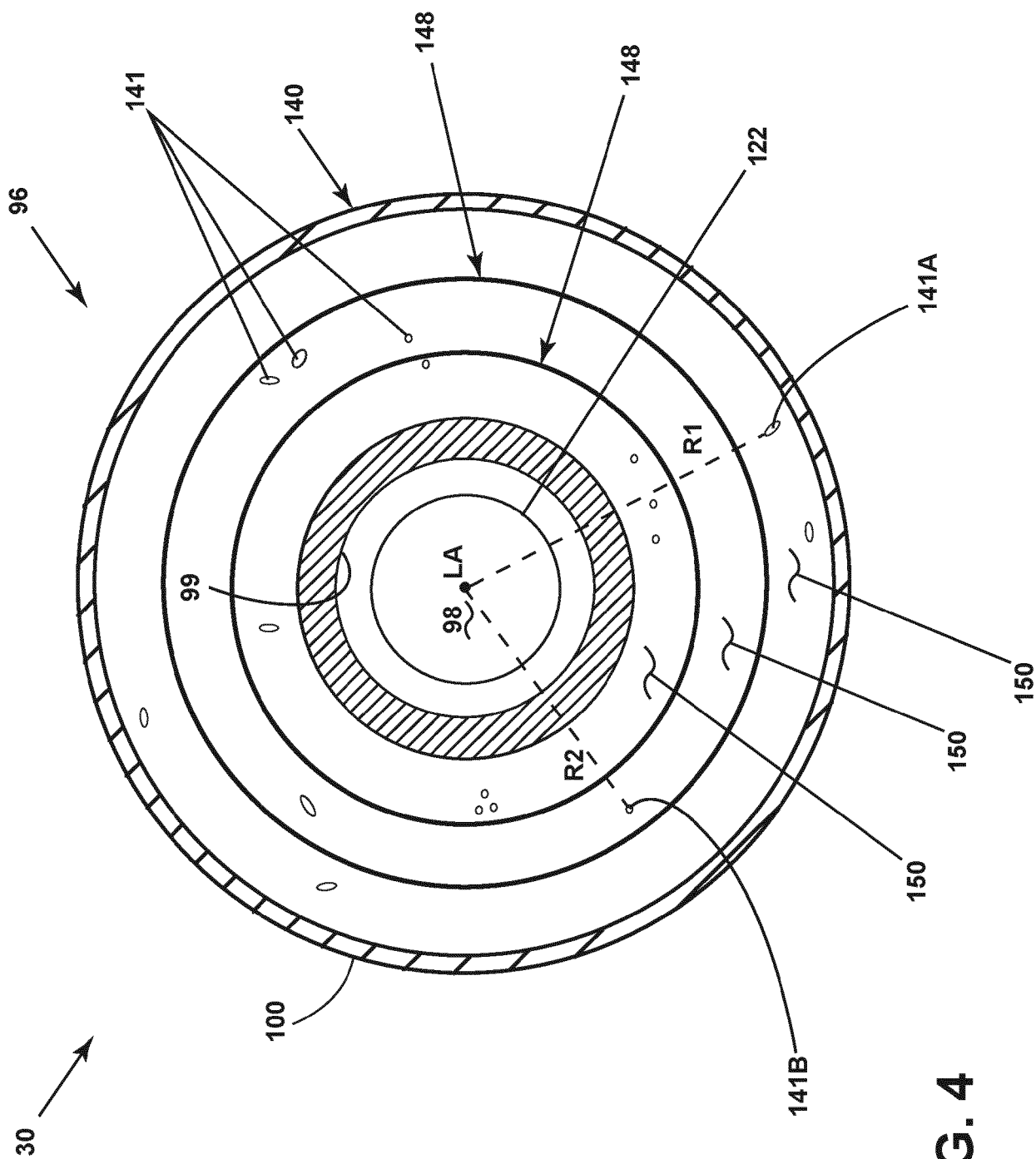
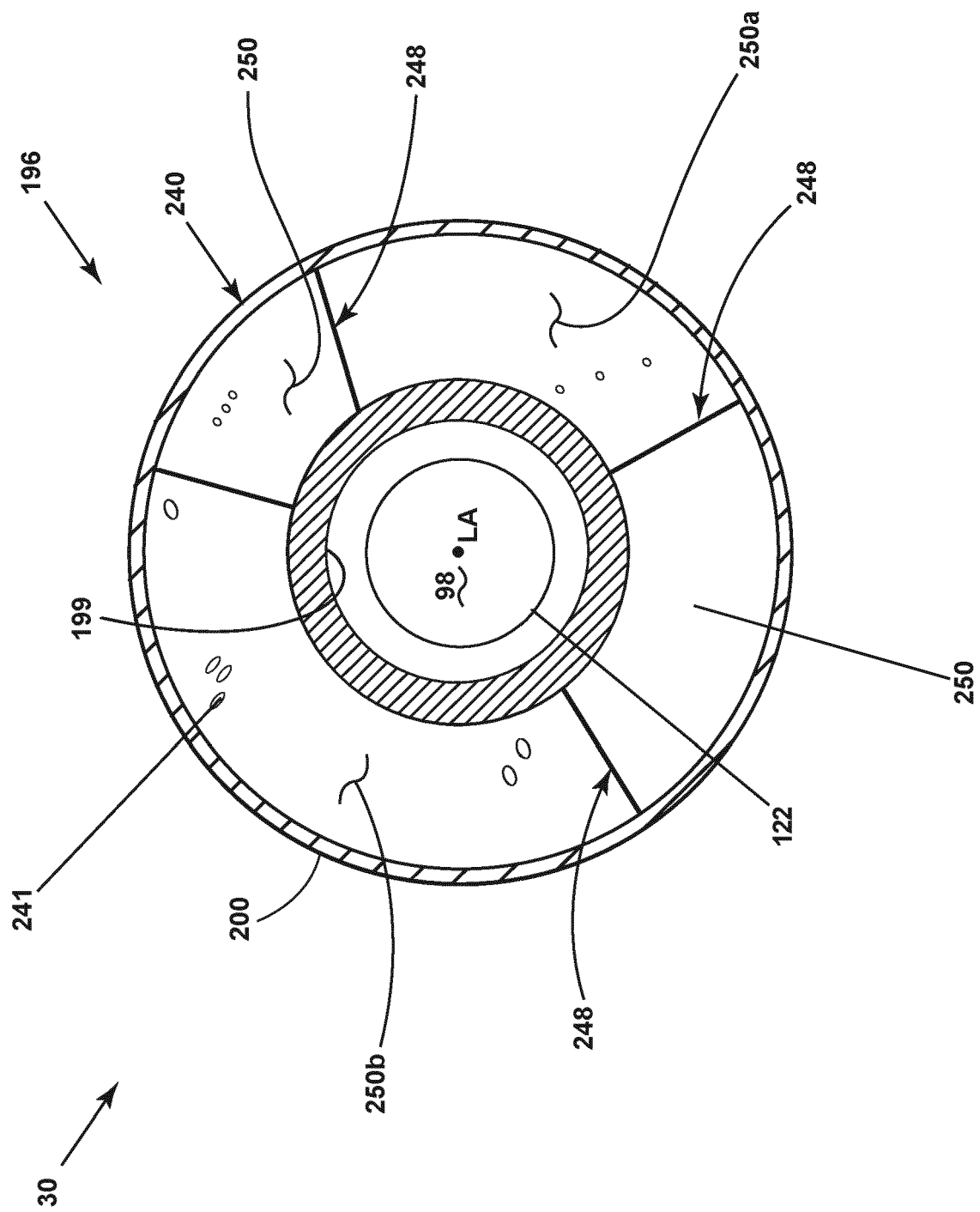


FIG. 4



GE

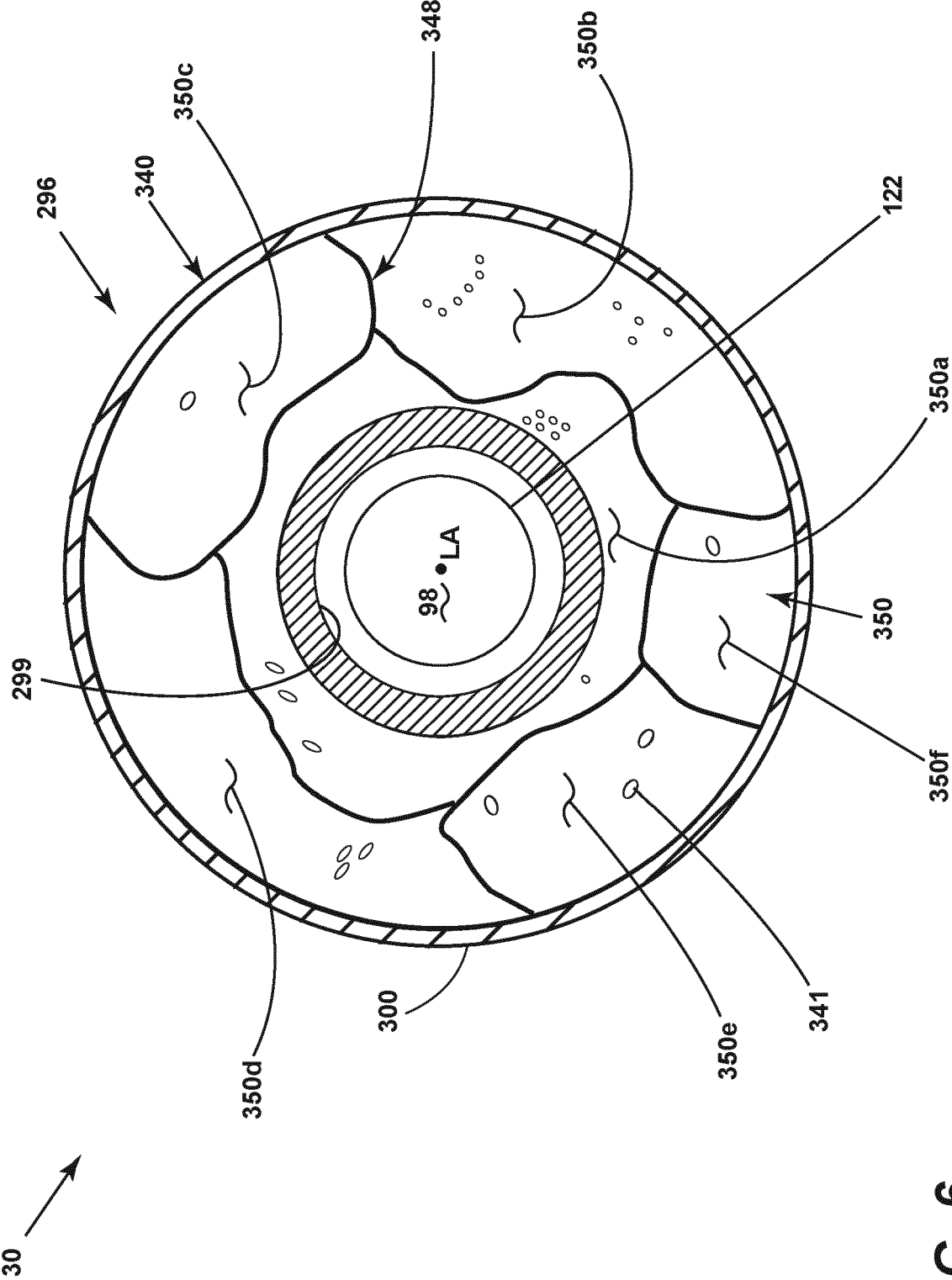


FIG. 6



EUROPEAN SEARCH REPORT

Application Number

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EPO FORM 1503 03:82 (P04C01)

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Place of search The Hague		Date of completion of the search 2 September 2022	Examiner Mootz, Frank
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