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(54) FUEL AIR MIXER ASSEMBLY FOR A GAS TURBINE ENGINE COMBUSTOR

(57) A combustor (56) for a gas turbine engine (20) includes a multiple of fuel air mixer assemblies (102) arranged around an engine central longitudinal axis (A), each of the fuel air mixer assemblies (102) including a non-round swirler (114, 116) which at least partially receives a nozzle (100) along the axis (F) of each of the respective fuel air mixer assemblies (102).

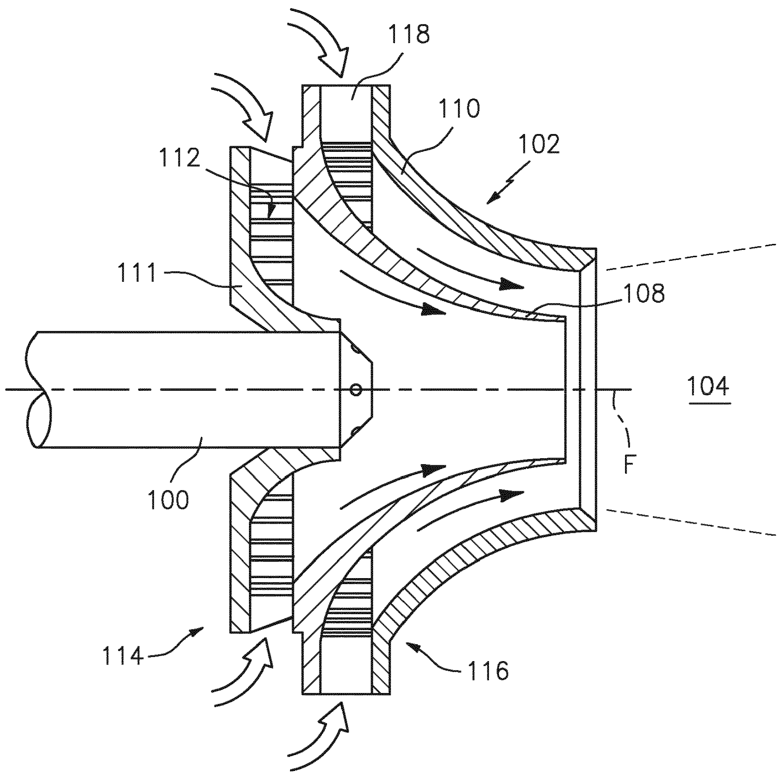

FIG. 4

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Description

BACKGROUND

[0001] The present disclosure relates to a gas turbine engine and, more particularly, to a fuel air mixer assembly for a combustor section therefor.

[0002] Gas turbine engines, such as those which power modern commercial and military aircraft, include a compressor for pressurizing a supply of air, a combustor for burning a hydrocarbon fuel in the presence of the pressurized air, and a turbine for extracting energy from the resultant combustion gases. The combustor generally includes radially spaced apart inner and outer wall assemblies that define an annular combustion chamber therebetween.

[0003] Gas turbine combustors typically utilize a fuel nozzle integrated with air introduction that effectively mixes the fuel spray with air to generate a fine spray for ignition and continuous combustion. The fuel air mixer assembly in most modern combustors includes a swirler where one or more air passages interact with one or more fuel passages from a fuel nozzle.

[0004] The fuel air mixer assembly includes slots or holes radially outboard of the fuel nozzle to interact as a system to provide an atomized fuel-air mixture that is conical in shape. These axisymmetric conical fuel air mixtures provide flame patterns which form uniform periodic horseshoe shaped impact, or "touchdown regions," on the combustor wall surfaces which may ultimately form hot spots that may result in premature failure.

SUMMARY

[0005] A fuel air mixer assembly according to one disclosed non-limiting embodiment of the present disclosure includes a non-round swirler arranged along a swirler axis; and a non-round fuel nozzle received at least partially within the non-round swirler.

[0006] An aspect of the present disclosure includes, wherein the non-round fuel nozzle includes a multiple of fuel jets, a first of the multiple of fuel jets of a size different than a second of the multiple of fuel jets.

[0007] A further aspect of the present disclosure includes, wherein the non-round fuel nozzle is arranged along the swirler axis.

[0008] A further aspect of the present disclosure includes, wherein the non-round fuel nozzle is elliptical in cross-section.

[0009] A further aspect of the present disclosure includes, wherein the non-round fuel nozzle is rectilinear in cross-section.

[0010] A combustor for a gas turbine engine according to one disclosed non-limiting embodiment of the present disclosure includes a multiple of fuel air mixer assemblies defined around an engine central longitudinal axis, each of the multiple of fuel air mixer assemblies including a non-round swirler which at least partially receives a fuel nozzle along a swirler axis of each of the respective multiple of mixer assemblies, each of the multiple of fuel air mixer assemblies operable to provide a non-round fuel air mixture spray pattern that at least partially overlaps an adjacent non-round fuel air mixture spray pattern.

[0011] An aspect of the present disclosure includes, wherein the non-round swirler of each of the respective multiple of fuel air mixer assemblies is elliptical.

[0012] A further aspect of the present disclosure includes, wherein the non-round swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked relative to the major axis of an adjacent one of the multiple of mixer assemblies.

[0013] A further aspect of the present disclosure includes, wherein the swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked to define a circular distribution around an engine central longitudinal axis.

[0014] A further aspect of the present disclosure includes, wherein the fuel-air mixture pattern from each of the respective multiple of fuel air mixer assemblies at least partially overlaps an adjacent one of the respective multiple of mixer assemblies.

[0015] A combustor for a gas turbine engine according to one disclosed non-limiting embodiment of the present disclosure includes a multiple of fuel air mixer assemblies defined around an engine central longitudinal axis, each of the multiple of fuel air mixer assemblies including a non-round swirler which at least partially receives a fuel nozzle along the axis of each of the respective multiple of fuel air mixer assemblies operable to provide a non-round fuel air mixture spray pattern, each of the multiple of fuel air mixer assemblies being clocked in relation to the circumferential position within the combustor.

[0016] An aspect of the present disclosure includes, wherein the non-round swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked relative to the major axis of an adjacent one of the multiple of mixer assemblies.

[0017] A further aspect of the present disclosure includes, wherein the swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked to define a circular distribution around an engine central longitudinal axis.

[0018] A further aspect of the present disclosure includes, wherein the non-round fuel-air mixture pattern from each of the respective multiple of fuel air mixer assemblies at least partially overlaps an adjacent one of the respective multiple of mixer assemblies.

[0019] A further aspect of the present disclosure includes, wherein the swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is oriented to be generally parallel with respect to an inner and outer combustor liner assembly.

[0020] A further aspect of the present disclosure includes, wherein the swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked with respect to an inner and outer combustor liner assembly.

[0021] A further aspect of the present disclosure includes, wherein the swirler of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked to form a circular arrangement around an engine axis.

[0022] A further aspect of the present disclosure includes, wherein the fuel nozzle of each of the respective multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked around an engine axis.

[0023] A further aspect of the present disclosure includes, wherein the swirler of at least one of the multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked relative to at least one other of the multiple of mixer assemblies.

[0024] A further aspect of the present disclosure includes, wherein the fuel nozzle of at least one of the multiple of fuel air mixer assemblies is arranged such that a major axis thereof is clocked relative to at least one other of the multiple of mixer assemblies.

[0025] "Clocked" as defined herein refers to the rotational position of the non-round swirler around the swirler axis.

[0026] The foregoing features and elements may be combined in various combinations without exclusivity, unless expressly indicated otherwise. These features and elements as well as the operation thereof will become more apparent in light of the following description and the accompanying drawings. It should be appreciated, however, that the following description and drawings are intended to be exemplary in nature and non-limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Various features will become apparent to those skilled in the art from the following detailed description of the disclosed non-limiting embodiment. The drawings that accompany the detailed description can be briefly described as follows:

FIG. 1 is a schematic cross-section of an example of gas turbine engine architecture.

FIG. 2 is an expanded longitudinal schematic sectional view of a combustor section.

FIG. 3 is a perspective partial longitudinal sectional view of the combustor section.

FIG. 4 is a sectional view of a fuel air mixer assembly.

FIG. 5 is a face view of a bulkhead assembly with a multiple of fuel air mixer assemblies indicating a spray pattern orientation according to one disclosed non-limiting embodiment.

FIG. 6 is a schematic view of a fuel air mixer assembly according to another disclosed non-limiting embodiment.

FIG. 7 is a schematic view of a fuel air mixer assembly according to another disclosed non-limiting embodiment.

FIG. 8 is a schematic view of a fuel nozzle according to another disclosed non-limiting embodiment.

DETAILED DESCRIPTION

[0028] FIG. 1 schematically illustrates a gas turbine engine 20. The gas turbine engine 20 is disclosed herein as a two-spool turbofan that generally incorporates a fan section 22, a compressor section 24, a combustor section 26 and a turbine section 28. The fan section 22 drives air along a bypass flowpath while the compressor section 24 drives air along a core flowpath for compression and communication into the combustor section 26 then expansion through the turbine section 28. Although depicted as a turbofan in the disclosed non-limiting embodiment, it should be appreciated that the concepts described herein are not limited to use with turbofans as the teachings may be applied to other types of turbine engines such as a turbojets, turboshafts, and three-spool (plus fan) turbofans.

[0029] The engine 20 generally includes a low spool 30 and a high spool 32 mounted for rotation about an engine central longitudinal axis A relative to an engine static structure 36 via several bearing structures 38. The low spool 30 generally includes an inner shaft 40 that interconnects a fan 42, a low pressure compressor ("LPC") 44 and a low pressure turbine ("LPT") 46. The inner shaft 40 drives the fan 42 directly or through a geared architecture 48 to drive the fan 42 at a lower speed than the low spool 30. An exemplary reduction transmission is an epicyclic transmission, namely a planetary or star gear system.

[0030] The high spool 32 includes an outer shaft 50 that interconnects a high pressure compressor ("HPC") 52 and high pressure turbine ("HPT") 54. A combustor 56 is arranged between the high pressure compressor 52 and the high pressure turbine 54. The inner shaft 40 and the outer shaft 50 are concentric and rotate about the engine central longitudinal axis A which is collinear with their longitudinal axes.

[0031] Core airflow is compressed by the LPC 44, then the HPC 52, mixed with the fuel and burned in the combustor 56, then expanded over the HPT 54 and the LPT 46. The HPT 54 and LPT 46 rotationally drive the respective low spool 30 and high spool 32 in response to the expansion.

[0032] With reference to FIG. 2, the combustor section 26 generally includes a combustor 56 with an outer combustor wall assembly 60, an inner combustor wall assembly 62 and a diffuser case module 64. The outer combustor wall assembly 60 and the inner combustor wall assembly 62 are spaced apart such that a combustion chamber 66 is defined therebetween. The combustion chamber 66 is generally annular in shape.

[0033] The outer combustor wall assembly 60 is spaced radially inward from an outer diffuser case 64A of the diffuser case module 64 to define an outer annular plenum 76. The inner combustor wall assembly 62 is spaced radially outward from an inner diffuser case 64B of the diffuser case module 64 to define an inner annular plenum 78. It should be appreciated that although a particular combustor is illustrated, other combustor types with various combustor liner arrangements will also benefit herefrom. It should be further appreciated that the disclosed cooling flow paths are but an illustrated embodiment and should not be limited only thereto.

[0034] In this example, the combustor wall assemblies 60, 62 contain the combustion products for direction toward the turbine section 28. Each combustor wall assembly 60, 62 generally include a respective support shell 68, 70 which supports one or more liner panels 72, 74 mounted to a hot side of the respective support shell 68, 70. The combustor wall assemblies 60, 62 may also be referred to as combustor liner assemblies. Although a dual wall liner assembly is illustrated, a single-wall liner may also benefit herefrom.

[0035] Each of the liner panels 72, 74 may be generally rectilinear and manufactured of, for example, a nickel based super alloy, ceramic or other temperature resistant material and are arranged to form a liner array. The liner array includes a multiple of forward liner panels 72A, 72B and the multiple of aft liner panels 74A, 74B. The multiple of forward liner panels 72A, 72B and the multiple of aft liner panels 74A, 74B are arranged to line the hot side of the inner shell 70 (FIG. 3).

[0036] The combustor 56 further includes a forward assembly 80 immediately downstream of the compressor section 24 to receive compressed airflow therefrom. The forward assembly 80 generally includes an annular hood 82, a bulkhead assembly 84, a multiple of fuel injectors 86 and a multiple of swirlers 114, 116. The multiple of fuel injectors 86 and the multiple of swirlers 114, 116 define a multiple of fuel air mixer assemblies 102 (FIG. 4) for a Rich-Quench-Lean (RQL) combustor that directs the fuel-air mixture into the combustor chamber generally along an axis F, also referred to as a swirler axis F. It should be appreciated that although a RQL combustor is disclosed in the illustrated embodiment, other combustor technologies such as a Lean Premixed (LP) combustor will also benefit herefrom.

[0037] The bulkhead assembly 84 includes a bulkhead support shell 96 secured to the combustor wall assemblies 60, 62, and a multiple of circumferentially distributed bulkhead liner panels 98 secured to the bulkhead support shell 96 (FIG. 2). The annular hood 82 extends radially between, and is secured to, the forwardmost ends of the combustor wall assemblies 60, 62. The annular hood 82 includes a multiple of circumferentially distributed hood ports 94 that accommodate the respective fuel injectors 86 and direct air into the forward end of the combustion chamber 66 through the respective swirler 114, 116.

[0038] The forward assembly 80 introduces primary combustion air into the forward section of the combustion chamber 66 while the remainder enters the outer annular plenum 76 and the inner annular plenum 78. The multiple of fuel air mixer assemblies 102 and adjacent structure generate a blended fuel-air mixture that supports stable combustion in the combustion chamber 66.

[0039] Opposite the forward assembly 80, the outer and inner support shells 68, 70 are mounted to a first row of Nozzle Guide Vanes (NGVs) 54A in the HPT 54 to define a combustor exit. The NGVs 54A are static engine components which direct combustion gases onto a first turbine rotor in the turbine section 28 to facilitate the conversion of pressure energy into kinetic energy.

[0040] With reference to FIG. 4, each of the multiple of fuel air mixer assemblies 102 includes a fuel nozzle 100 of the fuel injector 86 that is at least partially received within the non-round swirler 114, 116 to generate a non axis-symmetric shaped fuel-air mixture spray pattern 104. The fuel nozzle 100 may be round or non-round. Each fuel nozzle 100 is located within the respective non-round swirler 114, 116 to mix the fuel into the pressurized air for distribution into the combustion chamber 66. As defined herein, a "swirler" may generate, for example, zero swirl, a counter-rotating swirl, a specific swirl which provides a resultant swirl or a residual net swirl which may be further directed at an angle. It should be appreciated that various combinations thereof may alternatively be utilized. The non-round swirler 114, 116 may be machined or cast from high temperature alloys, or may be grown by additive manufacturing due to the nature of the shape.

[0041] In one embodiment, the non-round swirler 114, 116 is elliptical, curve elliptical in cross section, or of other non-round shape to generate the non axis-symmetric (e.g., elliptical) fuel-air mixture pattern 104 (FIG. 5). Although various non axis-symmetric shapes may be provided, the adjective "elliptical" is used herein as an example swirler or swirler component having a major diameter extending in a radial direction greater than a minor diameter extending in a circumferential direction about the axis F.

[0042] The non-round swirler 114, 116 includes an inner shroud 108 positioned around the fuel nozzle 100 to form a fuel air exit 109 and an outer shroud 110 positioned radially outward from the inner shroud 108 to define an air exit 113 (FIG. 6). A fuel nozzle guide 111 may house the fuel nozzle 100 to form a rear housing in relation to the swirler body 114, 116 to retain the fuel nozzle 100 therein and to accommodate thermal excursions. A plurality of swirler vanes 112, 118 are positioned between the shrouds 108 and fuel nozzle guide 111 such that combustion air may enter into the combustion chamber through a plurality of air passages between the swirler vanes 112, 118. A first swirler 114 is positioned around the nozzle 100 as described above and a second swirler 116 is positioned radially outward from the first swirler 114. In such an arrangement, the inner shroud 108 and the outer shroud 110 of the second swirler 116 may be joined by a second plurality of vanes 118.

[0043] The elliptical fuel-air mixture pattern 104 and resultant elliptical flame pattern may be beneficial compared to a fully conical axis-symmetric spray in that the elliptical fuel-air mixture pattern 104 orientation can be tailored to the combustion chamber (FIG. 5). For annular combustors, the combustor wall assemblies 60, 62 are essentially concentric rings that capture the flame for direction to the HPT 54. The elliptical flame pattern of each fuel air mixer assembly 102 is appropriately clocked to minimize impact on the combustor wall assemblies 60, 62 (FIG. 6).

[0044] The volume of the combustor is related to combustion efficiency, emissions, and ultimately, the exit temperature profile. The combustor wall assemblies 60, 62 often create a boundary and recirculation zone critical to ignition and flame stabilization, however the combustor wall assemblies 60, 62 can be impacted by the flame pattern which result in local hot spots. The non-round swirler 114, 116 maintains the inner and outer recirculation zones to facilitate flame stabilization while limiting the flame impact upon the combustor wall assemblies 60, 62.

[0045] With reference to FIG. 5, the non-round swirlers 114, 116 are arranged such that each of the elliptical spray patterns 104 are generally oriented such that a major axis 103 thereof is clocked around the engine axis A. Each of the elliptical spray patterns 104 is clocked to define a circular distribution in which the Z-axis thereof is collinear with the engine central longitudinal axis A in an X-Y-Z coordinate system. In other words, the engine central longitudinal axis A represents the Z-axis in the X-Y-Z coordinate system of the non-round swirler 114, 116 with respect to the arrangement of the elliptical spray pattern 104. In this distribution, each of the adjacent elliptical spray patterns 104 provides an overlap area 105 which facilitates a contiguous annular flame pattern while limiting the flame spread in the radial minor axis 107 direction to minimize a "touchdown region" on the surfaces of the inner and outer combustor wall assemblies 60, 62.

[0046] The spray pattern of the fuel air mixture exiting the swirlers 114, 116 and thus the resulting flame is an elliptical, or curved elliptical shape that minimizes the impact against the inner and outer combustor wall assemblies 60, 62. The spreading of the fuel spray and flame radially around the annulus between the combustor wall assemblies 60, 62 provides a more uniform hot gas mixture as opposed to local conical hot spots with cooler areas therebetween, yet minimizes impact on the combustor wall assemblies 60, 62.

[0047] The shape of the fuel spray and resulting flame can be tailored in shape by the swirler shape and/or air passages thereof as well as the fuel nozzle spray pattern. That is, the major axis 103 of the non-round swirler 114, 116 coincides with a major axis of the non-round fuel nozzle 100. Furthermore, the non-round fuel nozzle 100 can also be tailored or clocked with respect to the shape of the non-round swirler 114, 116 to further enhance circumferential mixing while minimizing flame touchdown size and shape. This may further minimize global cooling air usage as well as locally resulting in a far more durable system as well as enhanced combustion characteristics such as stability and exit temperature uniformity.

[0048] With reference to FIG. 6, in another embodiment, the non-round fuel nozzle 100A is of an elliptical shape to correspond with the generally non-round swirler 114, 116 for further control of the spray pattern.

[0049] With reference to FIG. 7, in another embodiment, the non-round fuel nozzle 100B is of a rectilinear or flat shape that is oriented with the generally non-round swirler 114, 116 for further control of the spray pattern.

[0050] With reference to FIG. 8, in another embodiment, the non-round fuel nozzle 100C may alternatively include a multiple of fuel jets 200 that include fuel jets 200A, 200B that are of differing sizes to effect the non-round spray pattern. That is, the distribution of fuel jet sizes provides non axis-symmetric fuel spray pattern even though the fuel nozzle body 202 is round. That is, the fuel nozzle body 202 may be round or non-round but the fuel jets 200 are tailored in size to provide various fuel spray patterns to interact with the non-round swirler 114, 116 to optimize flame exit temperature uniformity.

[0051] The non-round swirler 114, 116 orients the elliptical spray pattern 104 such that the flame has minimal impact on the combustor wall assemblies 60, 62. This can reduce the requirements for cooling air to maintain metal temperatures below the material melting point. Furthermore, reduced cooling air usage facilitates more efficient downstream tailoring of the exit temperature quality of the combustor to enhance overall engine efficiency and specific fuel consumption. As the non-round swirler 114, 116 is non axis-symmetric, the circumferential distance between the swirlers 114, 116 (FIG. 5) can also be optimized to improve exit temperature quality, which results in a hot gas profile that exits the combustor 66 in a more uniform manner. This, for example, translates to improved turbine vane and airfoil durability that may be a significant driver for engine maintenance costs.

[0052] The use of the terms "a" and "an" and "the" and similar references in the context of description (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or specifically contradicted by context. The modifier "about" used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context (e.g., it includes the degree of error associated with measurement of the particular quantity). All ranges disclosed herein are inclusive of the endpoints, and the endpoints are independently combinable with each other. It should be appreciated that relative positional terms such as "forward," "aft," "upper," "lower," "above," "below," and the like are with reference to the normal operational attitude of the vehicle and should not be considered otherwise limiting.

[0053] Although the different non-limiting embodiments have specific illustrated components, the embodiments of this invention are not limited to those particular combinations. It is possible to use some of the components or features from any of the non-limiting embodiments in combination with features or components from any of the other non-limiting embodiments.

[0054] It should be appreciated that like reference numerals identify corresponding or similar elements throughout the several drawings. It should also be appreciated that although a particular component arrangement is disclosed in the illustrated embodiment, other arrangements will benefit herefrom.

[0055] Although particular step sequences are shown, described, and claimed, it should be appreciated that steps may be performed in any order, separated or combined unless otherwise indicated and will still benefit from the present disclosure.

[0056] The foregoing description is exemplary rather than defined by the limitations within. Various non-limiting embodiments are disclosed herein, however, one of ordinary skill in the art would recognize that various modifications and variations in light of the above teachings will fall within the scope of the appended claims. It is therefore to be appreciated that within the scope of the appended claims, the disclosure may be practiced other than as specifically described. For that reason, the appended claims should be studied to determine true scope and content.

Claims

1. A fuel air mixer assembly (102), comprising:

a non-round swirler (114, 116) arranged along a swirler axis (F); and
a fuel nozzle (100) received at least partially within the non-round swirler (114, 116).

2. The assembly as recited in claim 1, wherein the fuel nozzle (100) is non-round.

3. The assembly as recited in claim 1 or 2, wherein the fuel nozzle (100) includes a multiple of fuel jets (200A, 200B), and a first of the fuel jets (200A, 200B) is of a different size to a second of the fuel jets (200A, 200B).

4. The assembly as recited in claim 1, 2 or 3, wherein the fuel nozzle (100) is arranged along the swirler axis (F).

5. The assembly as recited in any preceding claim, wherein the fuel nozzle (100) is elliptical (100A) or rectilinear (100B) in cross-section.

6. A combustor (56) for a gas turbine engine (20), comprising:
a multiple of fuel air mixer assemblies (102) as recited in any preceding claim defined around an engine central longitudinal axis (A), wherein each of the fuel air mixer assemblies (102) is operable to provide a non-round fuel air mixture spray pattern.

7. The combustor as recited in claim 6, wherein each non-round fuel air mixture spray pattern at least partially overlaps an adjacent non-round fuel air mixture spray pattern.

8. The combustor as recited in claim 6 or 7, wherein each of the fuel air mixer assemblies (102) is clocked in relation to the circumferential position within the combustor (56).

9. The combustor as recited in claim 6, 7 or 8, wherein the non-round swirler (114, 116) of each of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is:

clocked relative to the major axis (103) of an adjacent one of the fuel air mixer assemblies (102); and/or
clocked to define a circular distribution around an engine axis.

10. The combustor as recited in any of claims 6 to 9, wherein the fuel-air mixture pattern from each of the fuel air mixer assemblies (102) at least partially overlaps an adjacent one of the fuel air mixer assemblies (102).

11. The combustor as recited in any of claims 6 to 10, wherein the non-round swirler (114, 116) of each of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is oriented to be generally parallel with respect to an inner and outer combustor wall assembly (60, 62).

12. The combustor as recited in any of claims 6 to 10, wherein the non-round swirler (114, 116) of each of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is clocked with respect to an inner and outer combustor wall assembly (60, 62).

13. The combustor as recited in claims 6 to 12, wherein the fuel nozzle (100) of each of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is clocked around an engine axis.

14. The combustor as recited in any of claims 6 to 13, wherein the non-round swirler (114, 116) of at least one of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is clocked relative to at least one other of the fuel air mixer assemblies (102).

15. The combustor as recited in any of claims 6 to 14, wherein the fuel nozzle (100) of at least one of the fuel air mixer assemblies (102) is arranged such that a major axis (103) thereof is clocked relative to at least one other of the fuel air mixer assemblies (102).

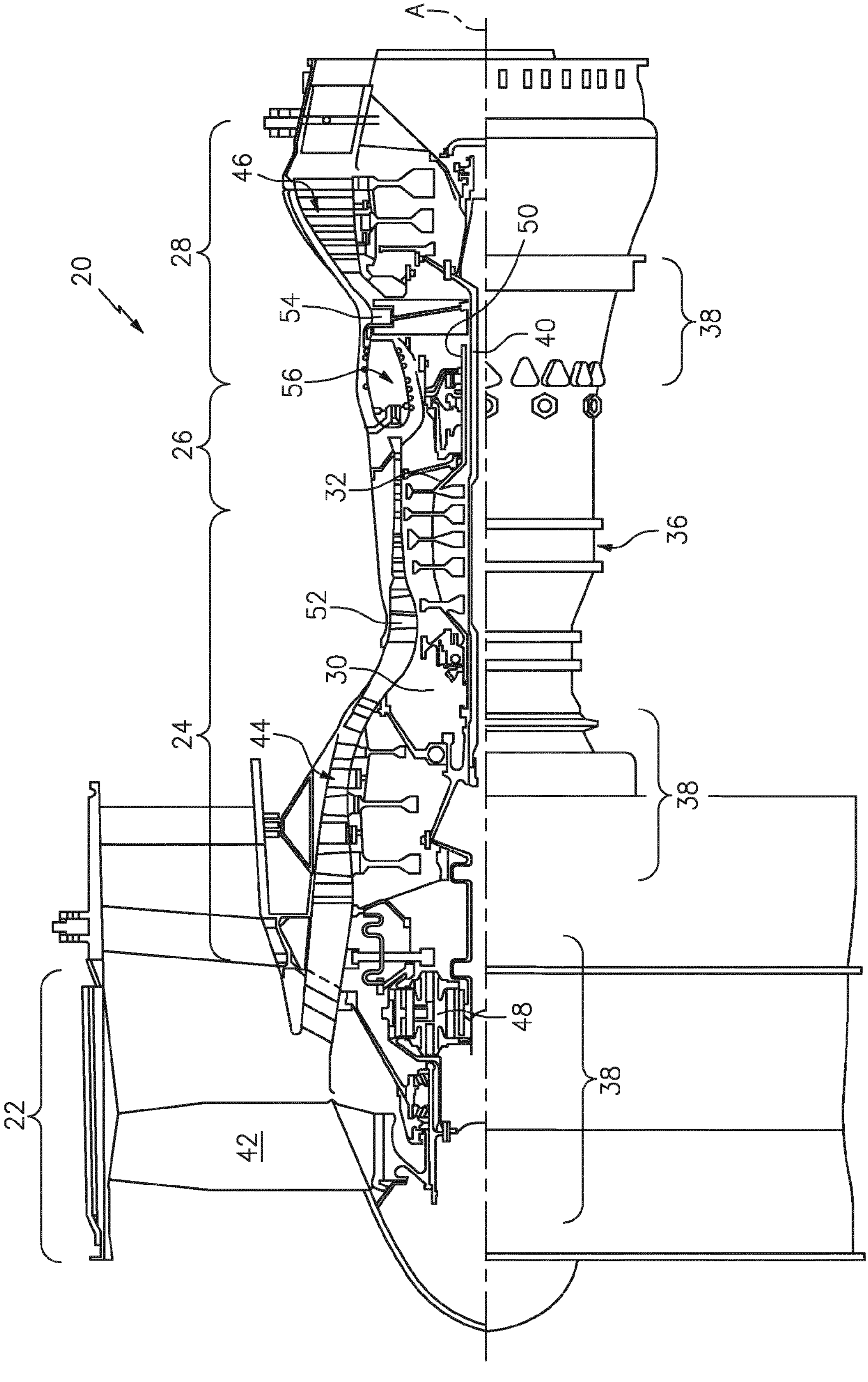

FIG. 1

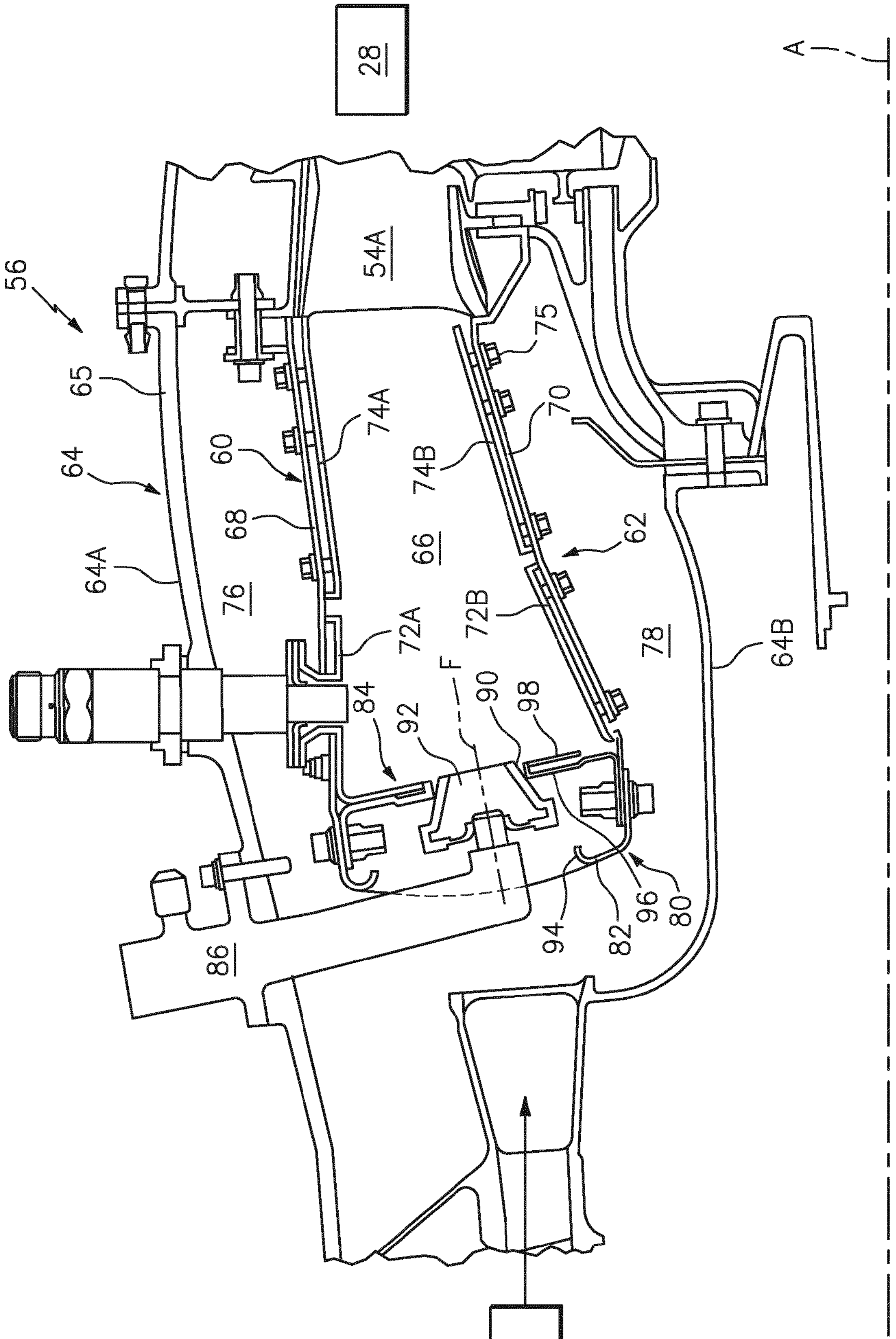
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FIG. 2

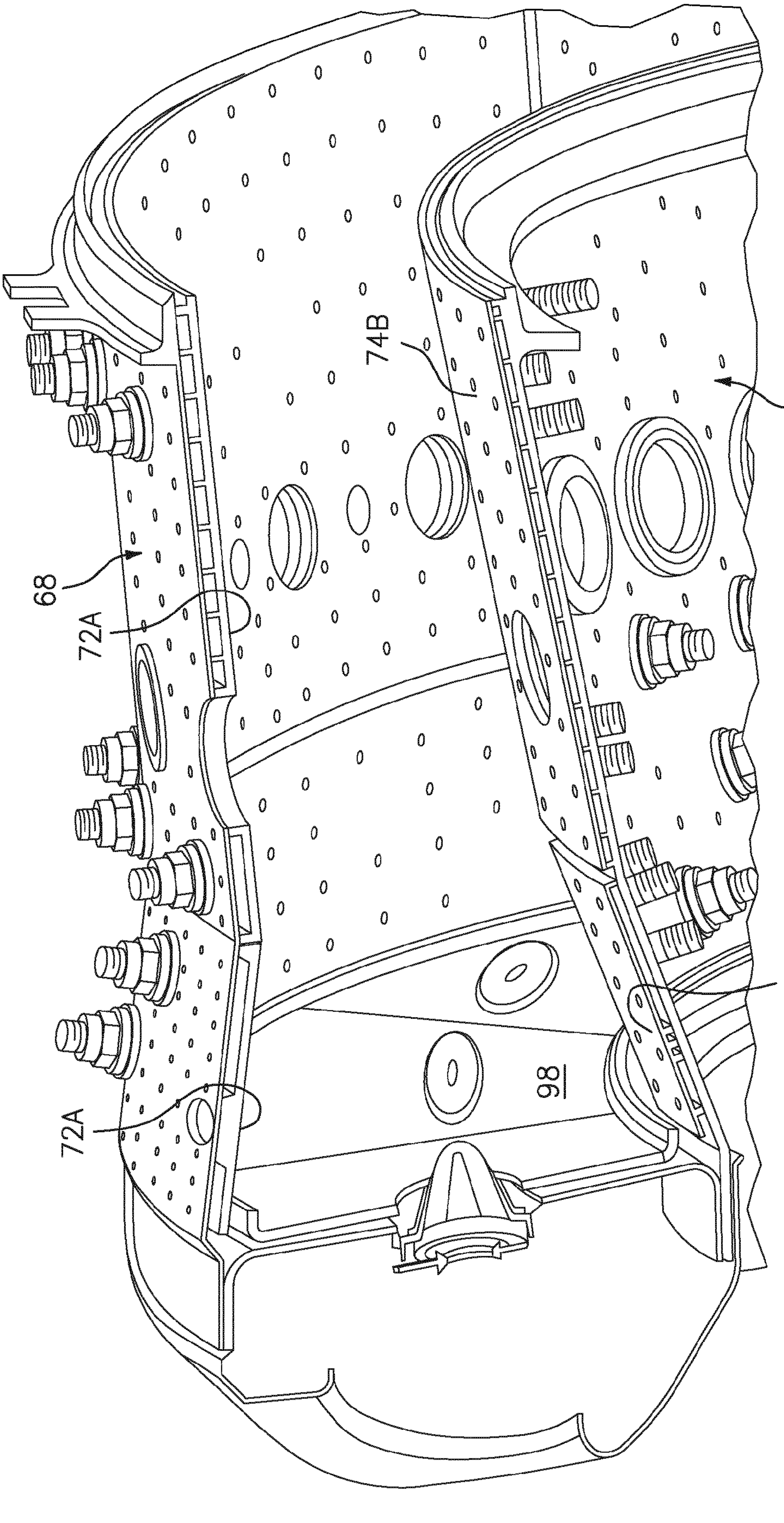

FIG. 3

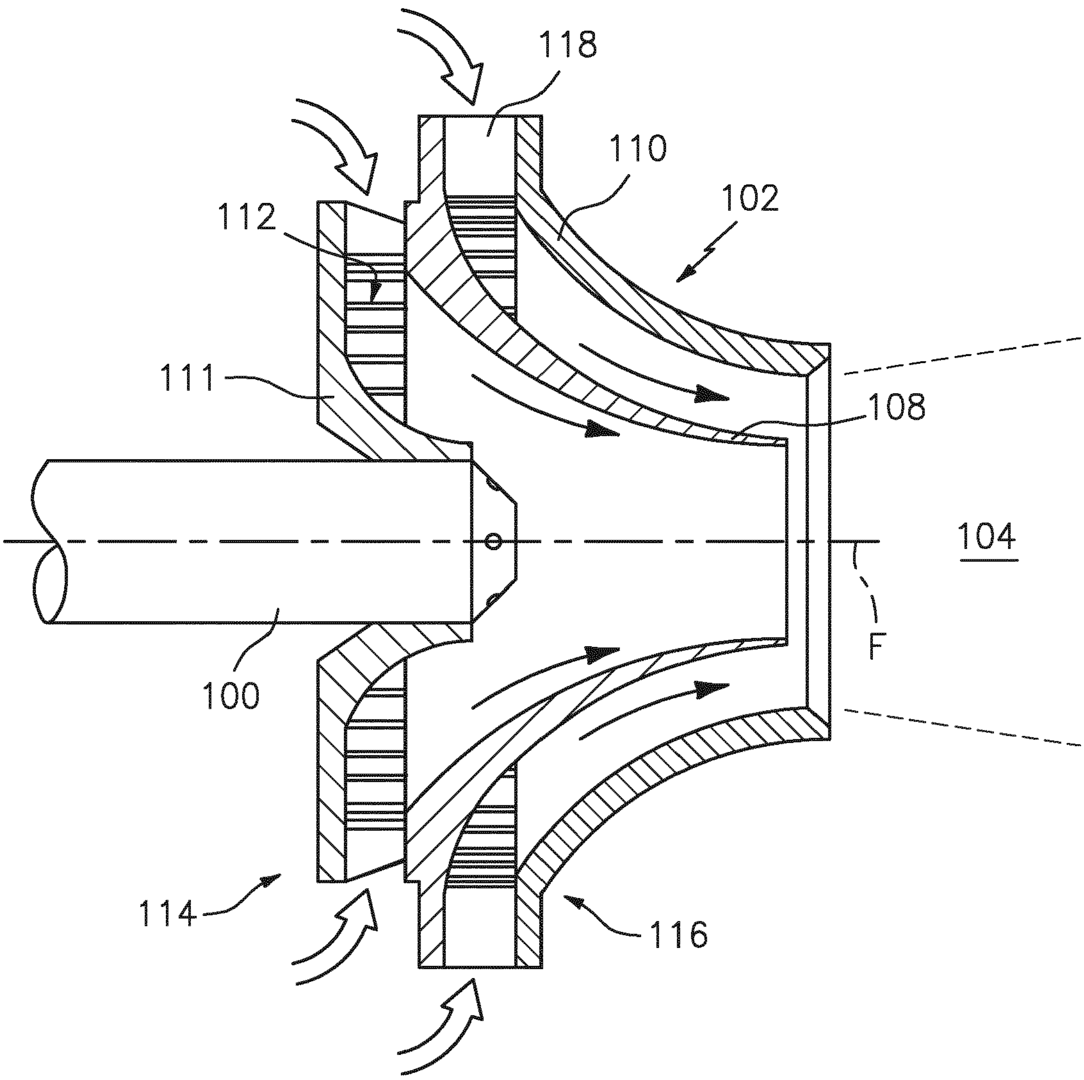

FIG. 4

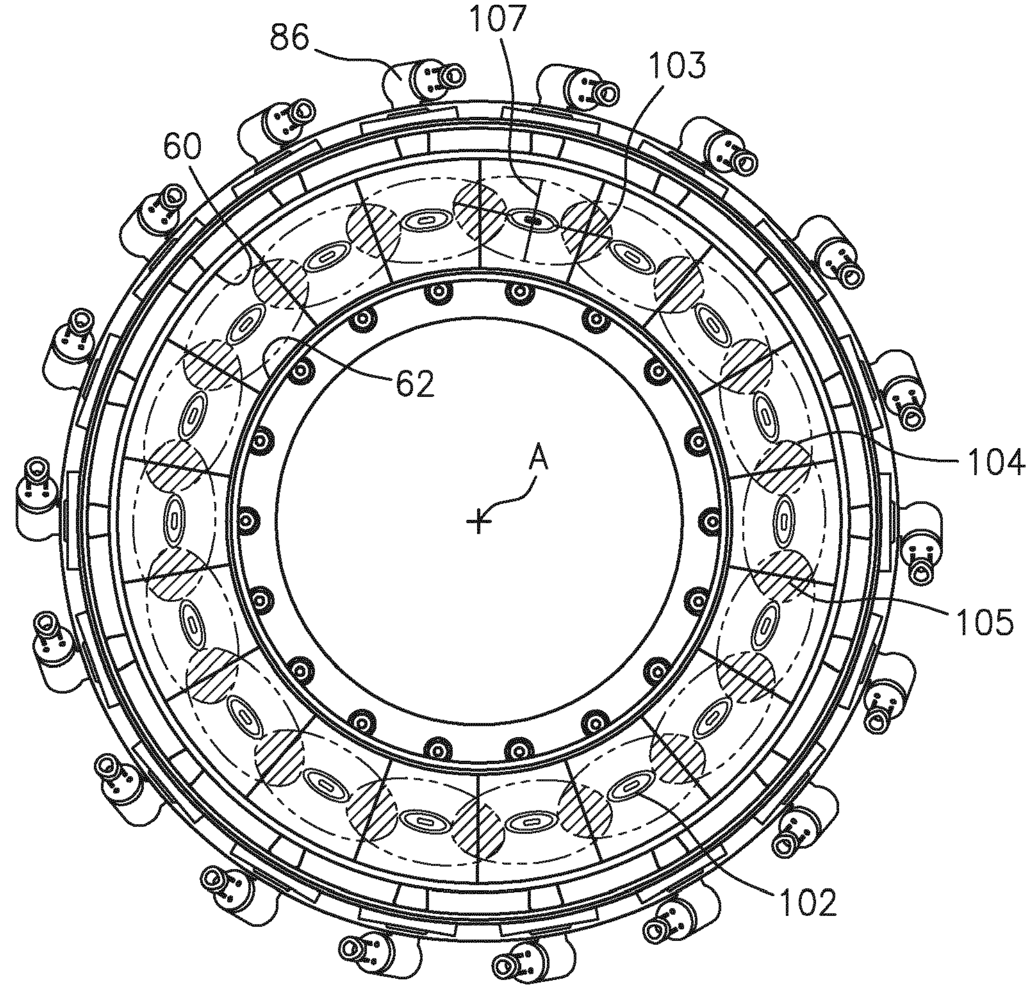

FIG. 5

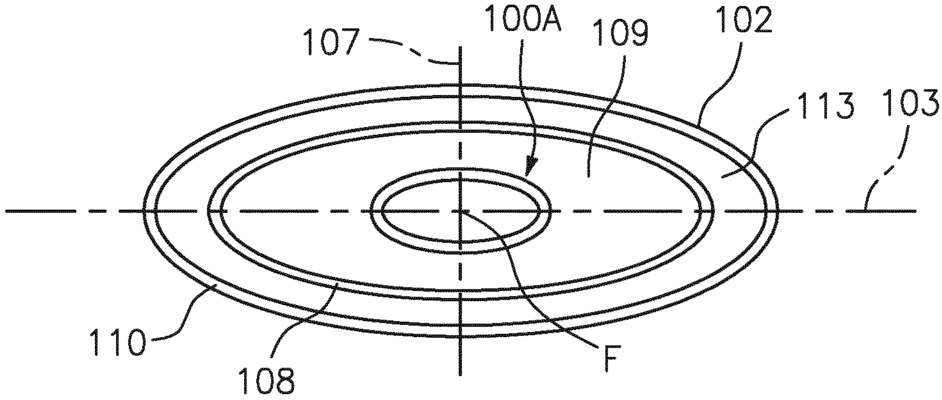

FIG. 6

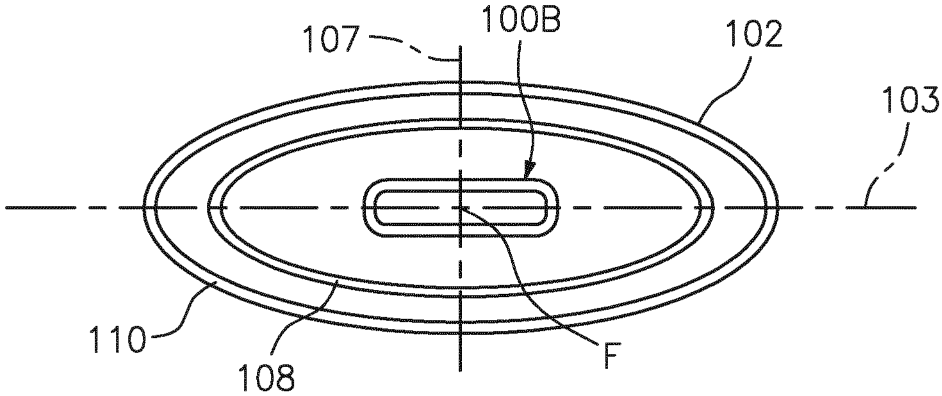

FIG. 7

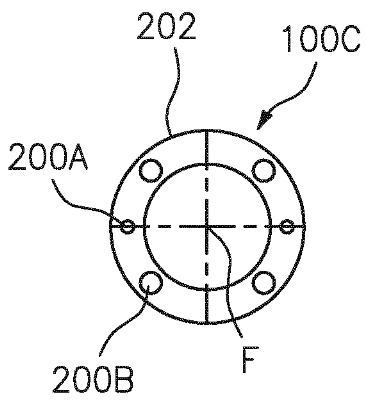

FIG. 8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 17 3047

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2014/165578 A1 (BURD STEVEN W [US]) 19 June 2014 (2014-06-19) * paragraphs [0022] - [0024], [0040], [0041], [0046], [0049], [0051], [0053]; figures 1,4,9 *	1,3-7,10	INV. F23R3/14 F23R3/28
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A	US 3 763 650 A (HUSSEY C ET AL) 9 October 1973 (1973-10-09) * column 6, line 550 - column 7, line 30; figures 4-6 *	1,3	

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	2 October 2018	Mougey, Maurice

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 3047

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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