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(54) **Pilot system for combustors**

(57) A secondary nozzle (100) for a combustor includes a feed nozzle having center channel (214) surrounded by a fuel channel (212) and a pilot channel. The secondary nozzle (100) also includes a housing (106) that surrounds at least a portion of the feed nozzle and

includes a fuel inlet channel (208) in a first plane and pilot inlet feed channel (202) in a second plane different than the first plane, the fuel inlet channel (208) and the pilot inlet feed channel (202) interconnected to one another within the housing (106).

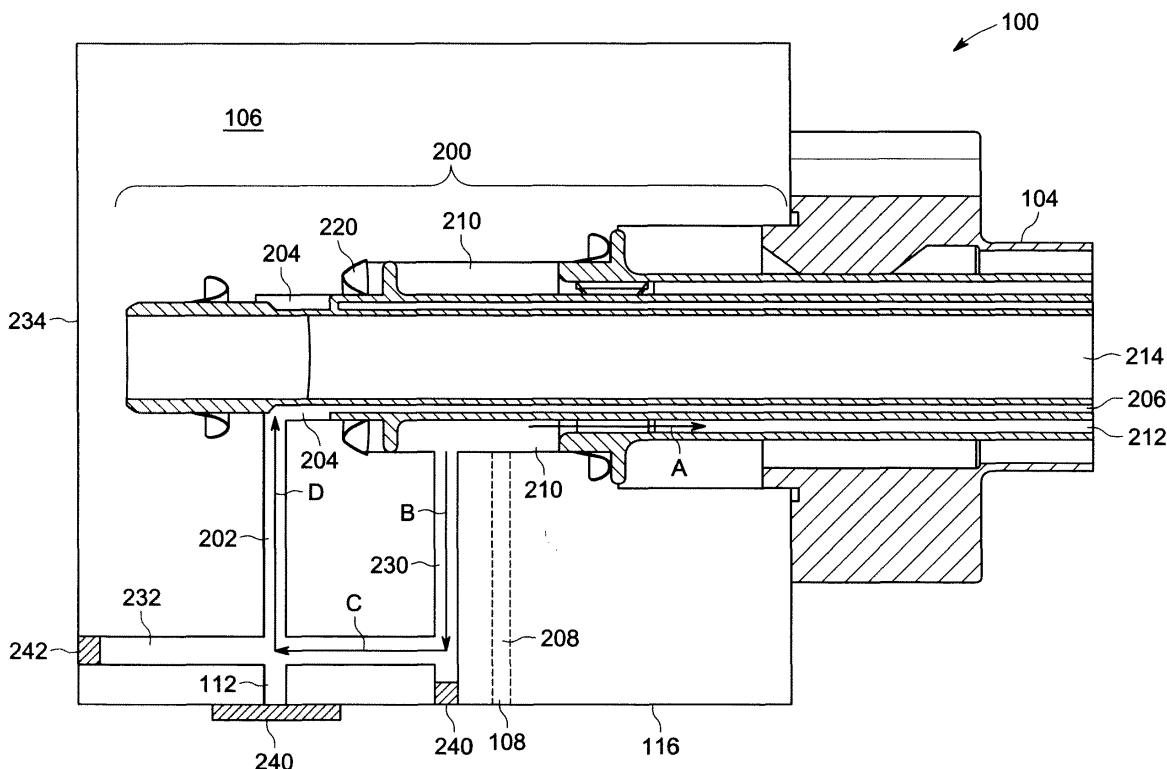


FIG. 2

Description

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to combustor and, in particular, to providing pilot fuel to a secondary fuel nozzle.

[0002] Gas turbine engines for generating electricity may include dual-stage dual-mode combustors. These combustors may include a first stage combustion chamber and a second stage combustion chamber interconnected by a throat region. Each chamber may include one or more fuel nozzles. Depending on the mode of operation, combustion may occur in the first stage combustion chamber, the second stage combustion chamber, or in both chambers. When combustion occurs in the second chamber, the fuel injected from nozzles disposed at or near the throat region mixes with air in the first chamber prior to ignition in second chamber. A fuel nozzle disposed in the region near the secondary combustion chamber shall be referred to herein as a "secondary fuel nozzle."

[0003] It has been discovered that provision of a pilot flame at a distal end of a secondary fuel nozzle may provide, advantages in combustor operation. The pilot flame is produced by a pilot system integrated with the secondary fuel nozzle. The pilot system usually receives fuel from the secondary fuel supply through a jumper conduit that is outside the combustion system. Such a connection causes additional pieces to be added to the system and, consequently, reduces durability while raising costs.

BRIEF DESCRIPTION OF THE INVENTION

[0004] According to one aspect of the invention, a secondary nozzle for a combustor is provided. The secondary nozzle of this aspect includes a feed nozzle having center channel surrounded by a fuel channel and a pilot channel. The secondary nozzle of this aspect also includes a housing that surrounds at least a portion of the feed nozzle and includes a fuel inlet channel in a first plane and pilot inlet feed channel in a second plane different than the first plane. In this aspect, the fuel inlet channel and the pilot inlet feed channel are interconnected to one another within the housing.

[0005] According to another aspect of the invention, a method of providing fuel to a pilot location of a nozzle that includes a housing having a fuel inlet coupled and a feed nozzle partially surrounded by the housing and having a fuel channel coupled to the fuel inlet and a pilot channel separate from the fuel channel is provided. The method of this embodiment includes providing fuel to the fuel inlet and diverting, through the housing, a portion of the fuel from the fuel inlet to the pilot channel.

[0006] According to yet another aspect of the invention, combustor that includes a combustion chamber and a secondary nozzle coupled to and at least partially within the combustion chamber is provided. In this aspect, the

secondary nozzle includes a feed nozzle having center channel surrounded by a fuel channel and a pilot channel and a housing that surrounds at least a portion of the feed nozzle and includes a fuel inlet channel in a first plane and pilot inlet feed channel in a second plane different than the first plane. The fuel inlet channel and the pilot inlet feed channel are interconnected to one another within the housing.

[0007] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWING

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 shows an example of secondary nozzle according to one embodiment of the present invention;

FIG. 2 shows a cut-away side-view of the secondary nozzle shown in FIG. 1; and

FIG. 3 shows another cut-away side-view of the secondary nozzle of FIG. 1;

[0009] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0010] FIG. 1 shows an example of secondary nozzle 100 according to one embodiment of the present invention. The secondary nozzle 100 may be inserted into a combustion chamber such that the distal end 102 of the feed nozzle 104 is at or near a throat region of a dual stage combustion chamber. It shall be understood that while the description herein applies generally to a secondary nozzle, they may be applied to any combustor nozzle. Accordingly, hereinafter the term nozzle shall be used and includes either a primary or secondary nozzle.

[0011] The secondary nozzle 100 includes a housing 106. When the secondary nozzle 100 is coupled to a combustor, the housing may be external to the combustor. In one embodiment, the housing 106 includes a fuel inlet 108. Fuel received at the fuel inlet 108 is delivered through internal connections in the feed nozzle 104 to fuel pegs 110. Of course, some embodiments may not include fuel pegs 110. In such an embodiment, the fuel may be delivered to the distal end 102 via the feed nozzle 104.

[0012] It has been discovered that, during operation,

it may be beneficial to provide a pilot flame at the distal end 102 of the feed nozzle 104. To that end, prior art secondary nozzles may have included a pilot feed hole 112. The present invention may also include such a feed hole but, in one embodiment, the pilot feed hole is omitted or plugged. In the prior art, the pilot feed hole 112 was coupled to the secondary fuel supply and metered as required. As discussed above, such coupling was external to the housing and added additional expense and complexity.

[0013] According to one embodiment of the present invention, pilot fuel is provided to a pilot channel (not shown) within the feed nozzle 104 by a connection between the fuel inlet 108 and the pilot fuel transmission channel that is within the housing 106. The teachings herein may be applied, in one embodiment, to a housing of the prior art or may, in one embodiment, be created as an initial work piece.

[0014] In FIG. 1, the fuel inlet 108 is on a first face 114 of the housing 106 and the pilot feed hole 112 is on a second face 116 of the housing 106. Both holes travel toward the center of the housing 106 and provide fuel to portions of the feed nozzle 104 for delivery to downstream portions thereof. It shall be understood that, in one embodiment, the pilot feed hole 112 and the fuel inlet 108 are in different planes.

[0015] FIG. 2 shows a cut-away side-view of the secondary nozzle 100 of FIG. 1 taken in a plane perpendicular to the second face 116. The nozzle 100 includes a housing 106 and a feed nozzle 104. In one embodiment, the housing 106 surrounds a portion of the feed nozzle 104. In FIG. 2, an example of a surrounded portion is shown by reference numeral 200.

[0016] The housing 106 may include the pilot feed hole 112. The pilot feed hole 112, as implemented in the prior art, allowed pilot fuel to be introduced to the pilot inlet feed channel 202. Fuel introduced to the pilot inlet feed channel 202 is received in a pilot receiving ring 204. Fuel introduced to the pilot receiving ring 204 travels down a pilot channel 206 portion of the feed nozzle 104 to a pilot location (not shown).

[0017] The housing 106 may also include the fuel inlet 108 that, via fuel inlet channel 208, provides fuel to the fuel ring 210. The fuel inlet channel 208 is shown in dotted lines indicating that it is in different plane than the pilot inlet feed channel 202 (as well as other housing-based channels shown in FIG. 2). Fuel introduced to the fuel ring 204 travels down a fuel channel 212 portion of the feed nozzle 104 to a fuel introduction location (not shown) where it is introduced to a combustion chamber when in operation.

[0018] The fuel channel 212 and the pilot channel 206 are, in one embodiment, concentric and both surround a center channel 214. The ordering and location of the fuel channel 212 and the pilot channel 206 is variable and not constrained to those shown in FIG. 2. As shown in FIG. 2, the fuel channel 212 and the pilot channel 206 may be separated from one another by a lip seal 220.

[0019] According to one embodiment, the pilot inlet feed channel 202 may be coupled within the housing 106 to the fuel ring 210. In this manner, fuel introduced to the fuel ring 210 may be used to supply the pilot channel 206. This internal coupling may allow for external conduit for supplying the pilot inlet feed channel 202 to be omitted. To this end, the housing 106 may include internal passages that connect the fuel ring 210 to the pilot inlet feed channel 202.

[0020] The internal passages that connect the fuel ring 210 to the pilot inlet feed channel 202 in FIG. 2 are shown as first passage 230 and second passage 232. The first passage 230 travels from the second face 116 to the fuel ring 210. In one embodiment, the first passage 230 is in a different plane than the fuel channel 212. In one embodiment, the first passage 230 may be formed by drilling into the second face 216 until the fuel ring 210 is reached. The second passage 232 travels from the proximal end 234 of the housing 106, through the pilot inlet feed channel 202, to the first passage 230. In one embodiment, the second passage 232 is in the same plane and the first passage 230. In one embodiment, the first passage 230 is plugged with a first plug 240 and the second passage 232 is plugged with a second plug. The plugs may be threaded plugs in one embodiment. Of course, other means of plugging the first passage 230 and the second passage 232 may be utilized within the scope of the present invention.

[0021] In operation, fuel is provided through the fuel inlet channel 208 to the fuel ring 210. From the fuel ring 210 at least a portion of the fuel travels, as indicated by arrow A, along fuel channel 212. Another portion of the fuel travels along the path shown by arrows B, C, and D, from the fuel ring 210, through the first passage 230, the second passage 232 and the pilot inlet feed channel 202 to the pilot receiving ring 204. From the pilot receiving ring 204 the fuel travels down the pilot channel 206. In one embodiment, the pilot inlet feed channel 202 may be plugged at one end. In one embodiment, the pilot inlet feed channel 202 is plugged with a blank flange 240.

[0022] FIG. 3 shows a cut-away side-view of the secondary nozzle 100 of FIG. 1 taken in a plane perpendicular to the second face 116. In this view, the pilot inlet feed channel 202 includes a flow control device 302 disposed therein. The flow control device 302 may be a pre-orifice with a c-seal. Such a pre-orifice may be used to reduce flow variation and may include a hat screen to protect the pilot receiving ring 204 from debris. In operation, the flow control device 302 may be removed and replaced with a pre-orifice having a smaller or larger internal passageway in order to vary the flow split between the main fuel inlet channel 212 and the pilot channel 206.

[0023] It shall be understood that the nozzle 100 disclosed herein may be utilized in a combustor. Accordingly, one embodiment of the present invention includes a combustor combined that includes a nozzle 100 as disclosed herein. In one embodiment, the feed nozzle 104 may have a

portion that extends into the combustor while in operation.

[0024] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

[0025] For completeness, various aspects of the invention are now set out in the following numbered clauses:

1. A secondary nozzle for a combustor comprising:

a feed nozzle having center channel surrounded by a fuel channel and a pilot channel;

a housing that surrounds at least a portion of the feed nozzle and includes a fuel inlet channel in a first plane and pilot inlet feed channel in a second plane different than the first plane, the fuel inlet channel and the pilot inlet feed channel interconnected to one another within the housing.

2. The secondary nozzle of clause 1, further comprising:

a flow control device disposed within the pilot inlet feed channel.

3. The secondary nozzle of clause 2, wherein the flow control device is a pre-orifice.

4. The secondary nozzle of clause 1, further comprising:

a flange plugging a pilot feed hole of the pilot inlet feed channel.

5. The secondary nozzle of clause 1, wherein the housing includes at least a first face and a second face, the first face including a fuel inlet coupled to the fuel inlet channel and the second face including a pilot feed hole coupled to the pilot inlet feed channel.

6. The secondary nozzle of clause 5, further comprising:

a flange plugging the pilot feed hole of the inlet

feed channel.

7. The secondary nozzle of clause 1, wherein the fuel inlet channel terminates at a fuel ring surrounding at least a portion of the nozzle.

8. The secondary nozzle of clause 7, wherein the housing includes a first passage passing from an external wall of the housing to the fuel ring and a second passage passing from a different external wall of the housing through the pilot inlet feed channel to the first passage.

9. The secondary nozzle of clause 8, further comprising:

a first plug that seals the first passage at the external wall; and

a second plug that seals the second passage at the different external wall.

10. A method of providing fuel to a pilot location of a nozzle that includes a housing having a fuel inlet coupled and a feed nozzle partially surrounded by the housing and having a fuel channel coupled to the fuel inlet and a pilot channel separate from the fuel channel, the method comprising:

providing fuel to the fuel inlet; and

diverting, through the housing, a portion of the fuel from the fuel inlet to the pilot channel.

11. The method of clause 10, further comprising:

delivering the fuel from the fuel inlet to a fuel ring;

wherein diverting includes:

diverting the portion of the fuel from the fuel ring to a pilot inlet feed channel within the housing and coupled to the pilot channel.

12. A combustor comprising:

a combustion chamber;

a secondary nozzle coupled to and at least partially within the combustion chamber, the secondary nozzle including:

a feed nozzle having center channel surrounded by a fuel channel and a pilot channel;

a housing that surrounds at least a portion of the feed nozzle and includes a fuel inlet channel in a first plane and pilot inlet feed channel in a sec-

ond plane different than the first plane, the fuel inlet channel and the pilot inlet feed channel interconnected to one another within the housing.

13. The combustor of clause 12, wherein the secondary nozzle further includes:

a flow control device disposed within the pilot inlet feed channel.

14. The combustor of clause 12, wherein the secondary nozzle further includes:

a flange plugging a pilot feed hole of the pilot inlet feed channel.

15. The combustor of clause 12, wherein the fuel inlet channel terminates at a fuel ring surrounding at least a portion of the nozzle.

16. The combustor of clause 15, wherein the housing includes a first passage passing from an external wall of the housing to the fuel ring and a second passage passing from a different external wall of the housing through the pilot inlet feed channel to the first passage.

17. The combustor of clause 16, further comprising:

a first plug that seals the first passage at the external wall; and
a second plug that seals the second passage at the different external wall.

Claims

1. A secondary nozzle (100) for a combustor comprising:

a feed nozzle having center channel (214) surrounded by a fuel channel (212) and a pilot channel (206);
a housing (106) that surrounds at least a portion of the feed nozzle (104) and includes a fuel inlet channel (208) in a first plane and pilot inlet feed channel (202) in a second plane different than the first plane, the fuel inlet channel (208) and the pilot inlet feed channel (202) interconnected to one another within the housing (106).

2. The secondary nozzle (100) of claim 1, further comprising:

a flow control device (302) disposed within the pilot inlet feed channel (202).

3. The secondary nozzle (100) of claim 2, wherein the

flow control device (302) is a pre-orifice.

4. The secondary nozzle (100) of any of the preceding claims, further comprising:

a flange plugging a pilot feed hole (112) of the pilot inlet feed channel (202).

5. The secondary nozzle (100) of any of the preceding claims, wherein the housing (106) includes at least a first face (114) and a second face (116), the first face (114) including a fuel inlet (108) coupled to the fuel inlet channel (208) and the second face (116) including a pilot feed hole (112) coupled to the pilot inlet feed channel (202).

6. The secondary nozzle (100) of claim 5, further comprising:

a flange plugging the pilot feed hole (112) of the inlet feed channel (202).

7. The secondary nozzle (100) of any of the preceding claims, wherein the fuel inlet channel (208) terminates at a fuel ring (210) surrounding at least a portion of the nozzle.

8. The secondary nozzle of clause 7, wherein the housing includes a first passage passing from an external wall of the housing to the fuel ring and a second passage passing from a different external wall of the housing through the pilot inlet feed channel to the first passage.

9. The secondary nozzle of clause 8, further comprising:

a first plug that seals the first passage at the external wall; and
a second plug that seals the second passage at the different external wall.

10. A method of providing fuel to a pilot location of a nozzle that includes a housing (106) having a fuel inlet (108) coupled and a feed nozzle (104) partially surrounded by the housing (106) and having a fuel channel (212) coupled to the fuel inlet (108) and a pilot channel (206) separate from the fuel channel (212), the method comprising:

providing fuel to the fuel inlet (108); and
diverting, through the housing (106), a portion of the fuel from the fuel inlet (108) to the pilot channel (206).

11. The method of claim 10, further comprising:

delivering the fuel from the fuel inlet (108) to a

fuel ring (210);

wherein diverting includes:

diverting the portion of the fuel from the fuel ring (210) to a pilot inlet feed channel (202) within the housing (106) and coupled to the pilot channel (206).

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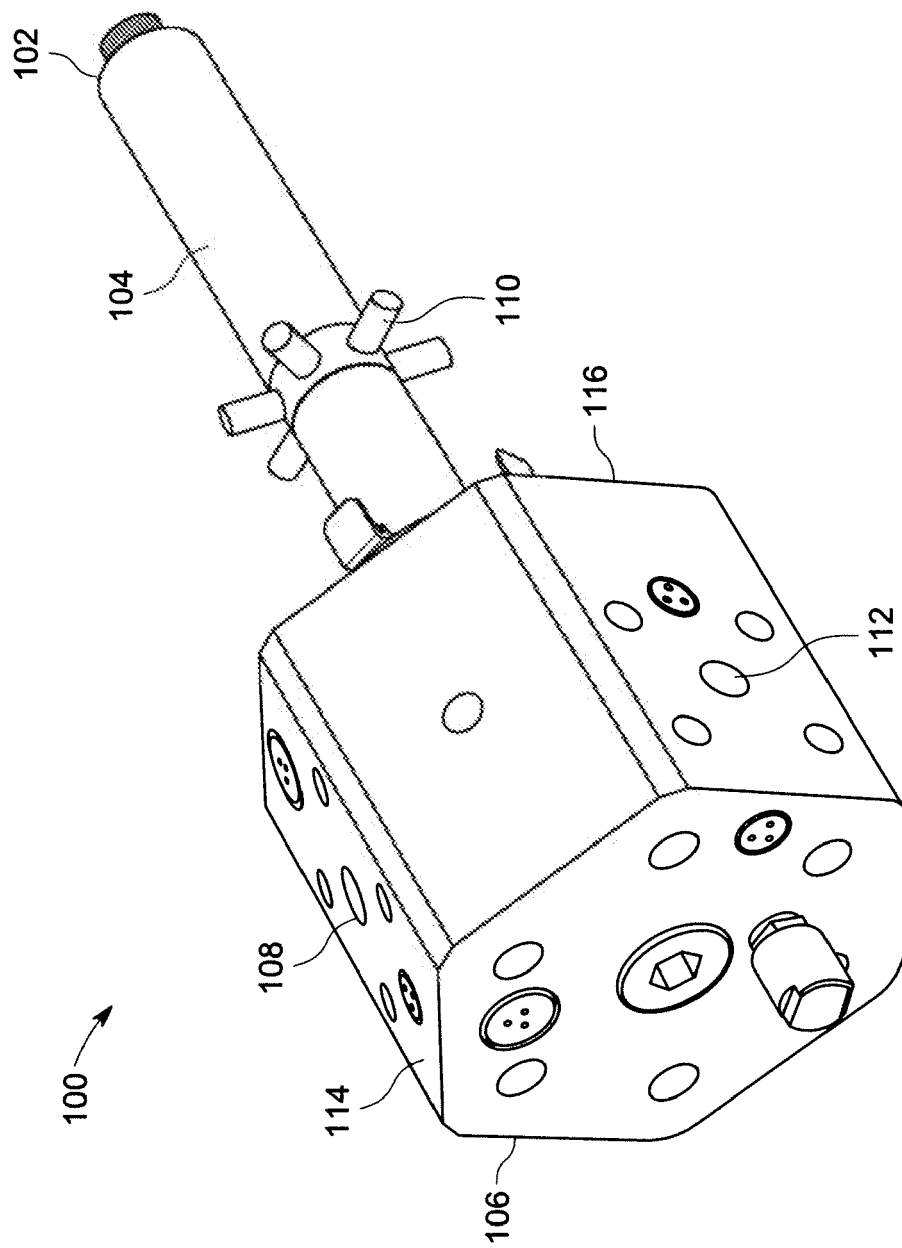


FIG. 1

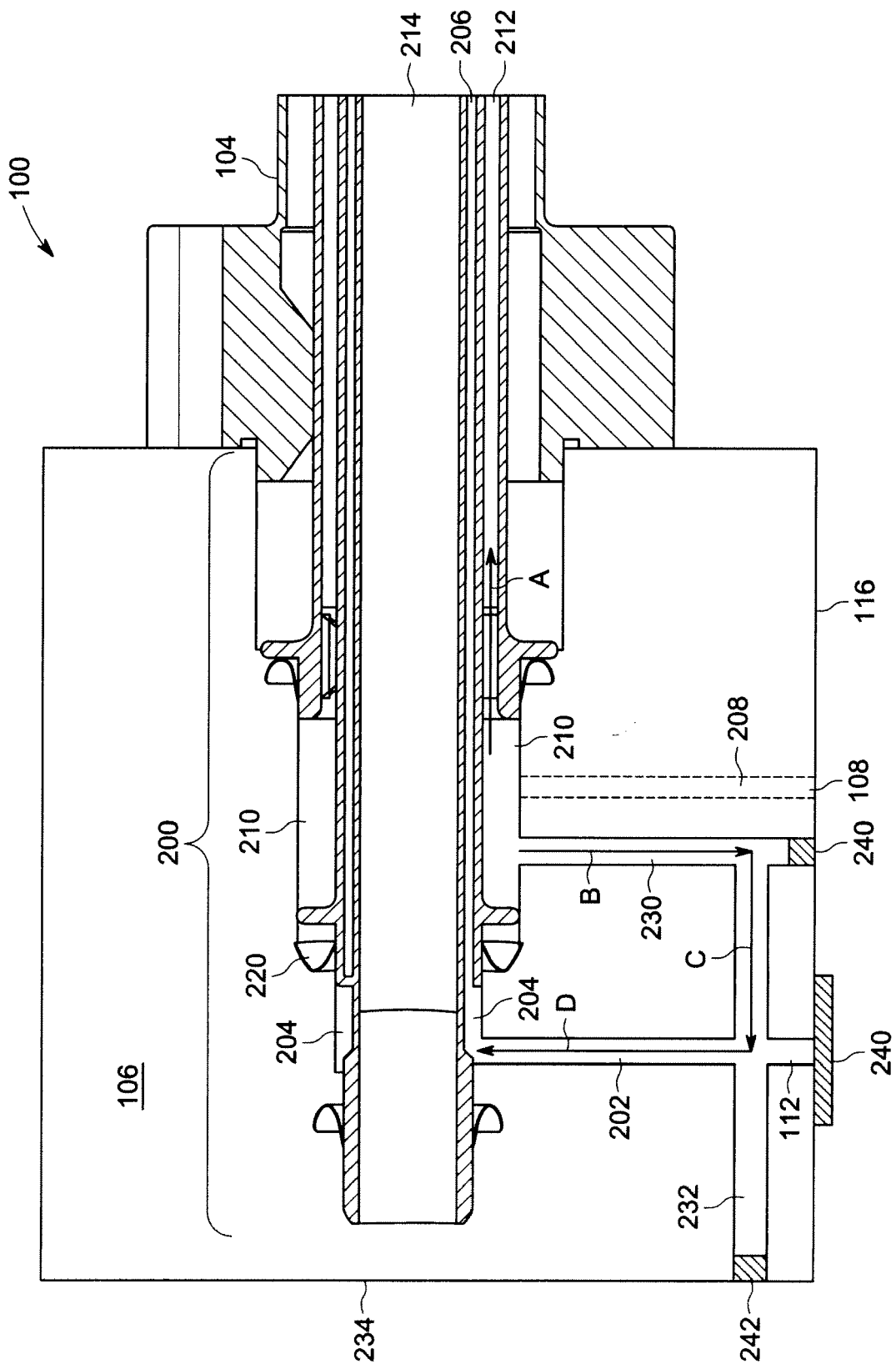


FIG. 2

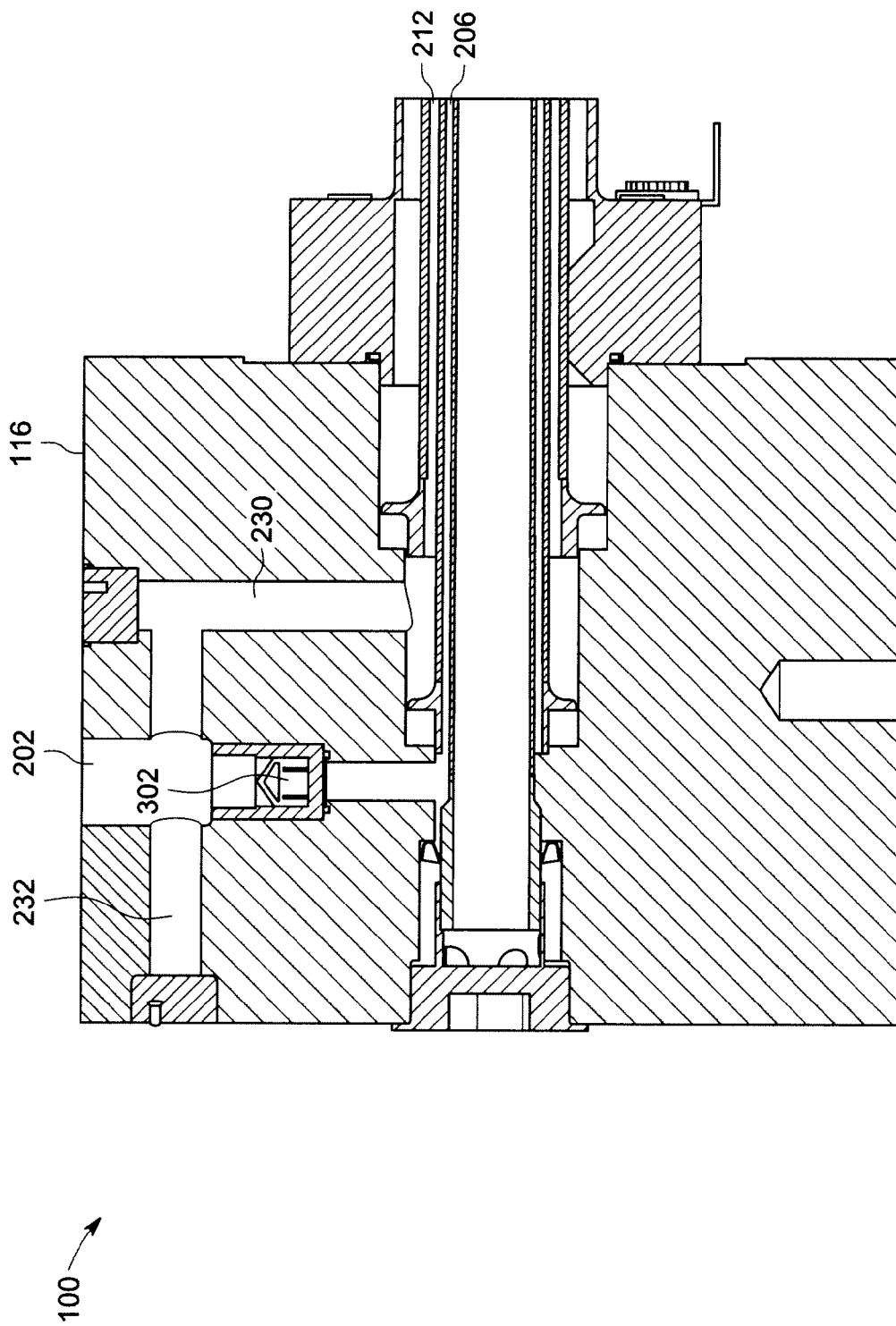


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 11 15 9915

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 2009/199561 A1 (HESSLER WILLIAM KIRK [US]) 13 August 2009 (2009-08-13) * page 2, paragraph 18 - page 4, paragraph 32 * * figure 2 *	1-11	INV. F23R3/34
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 July 2011	Examiner Gavriliu, Costin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 11 15 9915

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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