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(54) **FLEXURE SEAL FOR FUEL INJECTION NOZZLE**

FLEXURDICHTUNG FÜR KRAFTSTOFFEINSPRITZDÜSE

JOINT DE FLEXURE POUR LA BUSE D'INJECTION DE CARBURANT

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to injectors and nozzles for high temperature applications, and more particularly, to fuel injectors and nozzles for gas turbine engines.

2. Description of Related Art

[0002] A variety of devices and methods are known in the art for injecting fuel into gas turbine engines. Of such devices, many are directed to injecting fuel into combustors of gas turbine engines under high temperature conditions.

[0003] Fuel injectors are usually heat-shielded because of high operating temperatures arising from high temperature gas turbine compressor discharge air flowing around the housing stem and nozzle. The heat shielding prevents the fuel passing through the injector from breaking down into its constituent components (i.e., "coking"), which may occur when the wetted wall temperatures of a fuel passage exceed 400°F (204°C). The coke in the fuel passages of the fuel injector can build up to restrict fuel flow to the nozzle.

[0004] Heretofore, injectors have included annular stagnant air gaps as insulation between external walls, such as those in thermal contact with high temperature ambient conditions, and internal walls in thermal contact with the fuel. In order to accommodate differential expansion of the internal and external walls while minimizing thermally induced stresses, the walls heretofore have been anchored at one end and free at the other end for relative movement. If the downstream tip ends of the walls are left free for relative movement, even a close fitting sliding interface between the downstream tip ends can allow fuel to pass into the air gap formed between the walls. This can result in carbon being formed in the air gap, which carbon is not as good an insulator as air. In addition, the carbon may build up to a point where it blocks venting of the air gap to the stem, which can lead to an accumulation of fuel in the air gap. This can lead to diminished injector service life and may require frequent and costly cleaning of the fuel injector.

[0005] Such conventional methods and systems generally have been considered satisfactory for their intended purpose. However, there still remains a continued need in the art for a nozzle or fuel injector that allows for differential expansion while reducing or preventing fuel entry in the air gaps.

[0006] Document EP1811229 discloses a fuel injector for a gas turbine engine according to the preamble of claim 1.

[0007] The present invention provides a solution for these problems.

SUMMARY OF THE INVENTION

[0008] The purpose and advantages of the present invention will be set forth in and become apparent from the description that follows. Additional advantages of the invention will be realized and attained by the systems particularly pointed out in the written description and claims hereof, as well as from the appended drawings.

[0009] To achieve these and other advantages and in accordance with the purpose of the invention, as embodied herein, the invention provides a fuel injector according to claim 1. An inner air swirler may be disposed radially inward of a portion of the fuel swirler wall. An inner insulative gap may be defined between the fuel swirler and the inner air swirler, wherein the inner insulative gap may be in fluid communication with the main internal insulative gap. Flexible sealing means internal to the nozzle body may isolate the inner insulative gap from any ambient fluid entering into the main internal insulative gap therethrough and provide relative axial and radial movement between the fuel swirler wall and the inner air swirler.

[0010] The flexible sealing means may include an annular flexure beam disposed in a gap between the fuel swirler wall and the inner air swirler, wherein the annular flexure beam is joined at a first end to the fuel swirler wall and is joined at a second end to the inner air swirler. It is also contemplated that the flexible sealing means can include a c-seal, o-ring, d-ring, e-ring, or any other suitable type seal disposed between the fuel swirler wall and the inner air swirler. It is further contemplated that the flexible sealing means can include a bellows structure disposed across the main insulative gap. Such a bellows structure can be disposed between the fuel conduit and a portion of the exterior wall surrounding the fuel conduit. The inner air swirler can include an upstream portion and a downstream portion joined together, the downstream portion being joined to the fuel swirler wall, with an upstream seal section of the downstream portion of the inner air swirler forming an annular flexure beam disposed between the upstream portion of the inner air swirler and the fuel swirler wall.

[0011] Isolating means are provided internal to the injector body for sealing a portion of the main insulative gap from ambient fluids and providing relative movement between the interior and exterior walls of the injector body. The isolating means can include a generally sigmoid flexure seal disposed across a portion of the main insulative gap between the exterior wall and the prefilmer. It is contemplated that at least a portion of the main insulative gap can contain a noble gas, vacuum, or other suitable insulative material. It is also contemplated that the main insulative gap can include stagnant air that is vented by an opening located in a region where fuel can not enter. A portion of the main insulative gap within the feed arm can be vented to engine compressor discharge air.

[0012] The flexible sealing means can be formed as a separate component.

[0013] These and other features of the systems and methods of the subject invention will become more readily apparent to those skilled in the art from the following detailed description of the preferred embodiments taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] So that those skilled in the art to which the subject invention appertains will readily understand how to make and use the devices and methods of the subject invention without undue experimentation, preferred embodiments thereof will be described in detail herein below with reference to certain figures, wherein:

Fig. 1 is a cross-sectional, side elevation view of a first representative embodiment of a nozzle portion of a fuel injector constructed in accordance with the present invention, showing an annular flexure beam between the fuel swirler and the inner air swirler; and

Fig. 2 is a cross-sectional side elevation view of a representative embodiment of a nozzle portion of a fuel injector constructed in accordance with the present invention, showing a two-part inner air swirler forming a flexure seal across the insulative gap between inner air swirler and the fuel swirler.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Reference will now be made to the drawings wherein like reference numerals identify similar structural features or aspects of the subject invention. For purposes of explanation and illustration, and not limitation, a partial view of an exemplary embodiment of an injector in accordance with the invention is shown in Fig. 1 and is designated generally by reference character 200. Another embodiment of the injector in accordance with the invention, or aspects thereof, are provided in Fig. 2, as will be described. The devices and methods of the invention can be used in gas turbine engines, or in any other suitable application, for enhanced injector performance.

[0016] As shown in Fig. 1, a fuel delivery passage 212 connects a fuel inlet of the injector with discharge outlet 204, allowing for a flow of fuel through the injector 200. An interior wall 208, including fuel conduit 213 within feed arm 218 and prefilmer 227 in nozzle body 220, bounds one side of fluid delivery passage 212. There is also an exterior wall 210, including the outer wall of feed arm 218 and outer air swirler 224, interposed between internal wall 208 and ambient conditions. An insulative gap 206 exists between walls 208, 210, portions of which are generally annular. This helps insulate interior fuel passage 212 from ambient conditions. Insulative gap 206 is important for reducing or preventing coking that can occur if the fuel reaches temperatures around 204.44°C (400°F). Coking inside the fuel passage could eventually choke the fuel flow if unchecked.

[0017] Relatively warm ambient compressor discharge gasses flowing around exterior wall 210 can cause thermal expansion, whereas the relatively cool fuel keeps interior wall 208 relatively cool, limiting thermal expansion. Additionally, walls 208, 210 need not have the same coefficient of thermal expansion. Thus in operating conditions there can be a significant difference in the thermal expansion of walls 208, 210. In order to reduce stress arising from the thermal gradients, walls 208 and 210 have downstream tip ends 214 that are moveable with respect to one another and form an interface that allows fluid to pass therebetween to gap 206.

[0018] Gap 206 continues from feed arm 218 through nozzle portion 220 of injector 200. Flexure seal 222 divides gap 206 into a downstream portion 206a and upstream portion 206b. Flexure seal 222 discourages ambient fluids including fuel from entering upstream gap 206b through the opening between wall tips 214. This keeps upstream gap 206b clear from fuel and thus prevents coking buildup therein. Flexure seal 222 is elongate and includes a portion generally sigmoid in shape, as shown in cross-section in Fig. 1. It can therefore flex to accommodate different amounts of thermal expansion between interior and exterior walls 208, 210. Those skilled in the art will readily appreciate that a variety of suitable shapes can be used in lieu of the sigmoid shape shown in Fig. 1 without departing from the spirit and scope of the invention. Flexure seal 222 forms a portion of outer wall 210, joining the outer air cap (which includes outer air swirler 224) and feed arm 218 portions of outer wall 210. Another end 222b is joined to interior wall 208, to further extend the generally sigmoid cross-sectional shape of flexure seal 222. Flexure seal 222 can be joined to injector 200 by brazing, welding, fastening, or any other suitable joining method. Flexure seal 222 accommodates radial thermal expansion differences about the centerline of nozzle body 220. Flexure seal 222 also accommodates thermal expansion differences in other directions, such as the direction along the centerline of feed arm 218, which can also be significant.

[0019] In further accordance with the invention, a fuel swirler wall 226 is located radially inward from prefilmer portion 227 of annular wall 208, with a fuel prefilming chamber defined therebetween. An inner air swirler 228 is disposed radially inward from fuel swirler wall 226 with an insulative gap 230 therebetween. In this manner, inner swirler 228 also acts as a heat shield insulating fuel in the prefilmer chamber from hot gases flowing through inner swirler 228.

[0020] With continuing reference to Fig. 1, nozzle 200 includes vents 244, which allow for air in gaps 206/230 to freely expand and contract with changes in temperature. Vents 244 are openings at diametrical clearances between components, such as interfaces between tip ends 214, but can also include bores passing through single components such as inner air swirler 228 and outer wall 210. When injector 200 is not in operation, fuel can

be drawn into vents 244 by capillary action, gravity, and/or suction caused by the contraction of cooling air in gaps 206/230, for example when the engine shuts down. Subsequently, if the fuel is heated upon operation of injector 200, coking can occur within gaps 206/230. However, flexure seal 222 has the advantage of discouraging fuel from passing through vents 244 into upstream portions of gap 206b.

[0021] In order to discourage ambient fluids including fuel entering gap 230, an annular flexure beam 232 separates gap 230 into upstream and downstream portions 230a and 230b, respectively. Flexure beam 232 is joined at one end to fuel swirler wall 226, and at its other end to inner air swirler 228. This configuration allows for relative thermal expansion differentials between walls 226, 228 while preventing coking in upstream gap 230a, which is contiguous with gap 206. Thus flexure beam 232 and flexure seal 222 working in conjunction can seal gaps 206/230 from fuel while still allowing for relative thermal expansion differences in the various parts of injector 200.

[0022] It is possible for gap 206 to be airtight. Gap 206 can contain a vacuum, which provides significant insulation between walls 208 and 210. It is also possible to fill gap 206 with air, which can also provide suitable insulation. Noble gasses, such as Argon, can also be used as an insulation gas in gap 206, with the advantage of superior heat shielding compared to air. Noble gasses also reduce oxidation of stainless steel, nickel, and other alloys commonly used in nozzle construction. A further advantage of using noble gasses is inflammability. Other insulating materials can also be used, such as fiber insulation, insulating powders, and insulative slurries. Those skilled in the art will readily appreciate that any suitable insulation material can be used in gap 206 without departing from the scope of the invention.

[0023] While gap 206 can be airtight, as discussed above, it is not necessary for gap 206 to be airtight. It is also contemplated that the main insulative gap can include stagnant air that is vented by an opening located in a region where fuel can not enter. For example, a vent into gap 206 can be included so as to allow venting of gap 206 with compressor discharge air such that fuel cannot enter gap 206.

[0024] While flexure seal 222 has been shown as an individual component joined to other nozzle components, it is also possible for a flexure seal to be formed integrally with at least one other nozzle component. For example the flexure seal can be formed integrally with an outer air swirler, e.g. swirler 224. Those skilled in the art will readily appreciate how to form flexure seals integrally with one or more other nozzle parts without departing from the scope of the invention.

[0025] An additional advantage of using a sealed insulating cavity in accordance with the invention is that the pressure gradient across the sealed cavity and the exterior of the inlet fitting of the injector can be reduced when compared to a vented air cavity. The pressure inside the sealed cavity will be determined by the pressure of the gas during welding and the temperature of the gas during operation. Therefore, stress on the inlet fitting can be reduced by matching the desired operating pressure with the pressure of the gas at the time of manufacture. Ideally, the combustor pressure would be accounted for across two areas, the nozzle tip and the inlet, with each accounting for half of the total combustor pressure. In this manner, the full combustor pressure will not act on the inlet fitting.

[0026] With reference now to Fig. 2 injector 900 includes inner wall 908, exterior wall 910, with gap 906 therebetween, sigmoid seal 922, air cap 924, prefilmer 927, and fuel swirler 926 much as described above. Gap 930 between fuel swirler 926 and the inner air swirler is sealed by a two-part inner air swirler wall with upstream section 933 joined to downstream section 928, which is in turn joined to fuel swirler 926. A seal portion 932 of downstream section 928 is located between upstream section 933 and fuel swirler 926. This two-part inner air swirler construction allows seal portion 932 of downstream section 928 of the inner air swirler to function much as flexure beams 232/632 described above. This allows the inner air swirler and upstream portion of the heat shield to be formed as one integral piece, thereby reducing the number of components and joints. Thus, while exemplary nozzles have been described above in conjunction with sigmoid flexure seals, flexure beams, c-seals, o-rings, etc., and bellows, those skilled in the art will readily appreciate that any combination of suitable seals can be used without departing from the scope of the invention.

[0027] The methods and systems of the present invention, as described above and shown in the drawings, provide for a nozzle with superior properties including discouraging or sealing fuel from entering insulation gaps. While the apparatus and methods of the subject invention have been shown and described with reference to preferred embodiments, those skilled in the art will readily appreciate that changes and/or modifications may be made thereto without departing from the scope of the subject invention as defined by the claims.

Claims

1. A fuel injector (200, 900) for a gas turbine engine, the injector comprising a feed arm (218), a nozzle (220), and:

   a) an inlet at an upstream end of the nozzle;
   b) a discharge outlet at a downstream end of the nozzle;
   c) a fuel delivery passage (212) extending between the inlet and the discharge outlet;
   d) an interior wall (208, 908) comprising a fuel conduit (213) within the feed arm (218) and an interior annular wall (227) within the nozzle, the interior wall (208, 908) bounding one side of the

fuel delivery passage along a length thereof, wherein the interior wall (208, 908) is in heat transfer relation with fluid passing through the fuel delivery passage;
e) an exterior wall (210, 910) comprising an outer wall of the feed arm (218) and an exterior annular wall (224, 924) of the nozzle, the exterior wall being interposed between the interior wall and ambient conditions, wherein the exterior and interior walls have downstream tip ends (214) that are adapted for relative longitudinal movement at an interface;
f) an internal insulating gap (206, 906) interposed between the interior and exterior walls to insulate the internal wall from ambient temperature conditions exterior to the nozzle; and
g) a generally sigmoid shaped flexure seal (222, 922) for isolating a portion of the insulating gap (206b) from ambient fluid entering into the portion of the gap through the interface and for allowing axial and radial movement between the interior and exterior annular walls,

characterised in that the flexure seal forms a portion of the exterior wall (210, 910) joining the exterior annular wall of the nozzle and the outer wall of the feed arm, and the flexure seal is joined to the interior wall.

2. A fuel injector as recited in claim 1, wherein the flexure seal is formed as a separate component.

3. A fuel injector as recited in claim 1 or 2, wherein at least a portion of the insulating gap contains a noble gas.

4. A fuel injector as recited in claim 1, 2 or 3, further comprising a fuel swirler wall (226, 926) disposed radially inward of a prefilmer portion (227, 927) of the interior annular wall, with a prefilmer chamber defined therebetween, an inner air swirler (228, 928) disposed radially inward of a portion of the fuel swirler wall, and an annular flexure beam (232) disposed in a gap (230) between the fuel swirler wall and the inner air swirler, the annular flexure beam being joined at a first end to the fuel swirler wall and being joined at a second end to the inner air swirler.

5. A fuel injector as recited in claim 1, 2 or 3, further comprising a fuel swirler wall (226, 926) disposed radially inward of a prefilmer portion (227, 927) of the interior annular wall, with a prefilmer chamber defined therebetween, an inner air swirler (228, 928) disposed radially inward of a portion of the fuel swirler wall, and a c-seal disposed between the fuel swirler wall and the inner air swirler.

6. A fuel injector as recited in claim 1, 2 or 3, further comprising a fuel swirler wall (226, 926) disposed radially inward of a prefilmer portion (227, 927) of the interior annular wall, with a prefilmer chamber defined therebetween, an inner air swirler (228, 928) disposed radially inward of a portion of the fuel swirler wall, and a bellows structure disposed across the internal insulating gap.

7. A fuel injector as recited in claim 1, 2 or 3, further comprising an inner air swirler including an upstream portion (933) and a downstream portion (928) joined together, the downstream portion being joined to a fuel swirler wall (926).

8. A fuel injector as recited in claim 7, wherein an upstream seal section (932) of the downstream portion (928) of the inner air swirler forms an annular flexure beam disposed between the upstream portion of the inner air swirler and the fuel swirler wall.

Patentansprüche

1. Kraftstoffeinspritzvorrichtung (200, 900) für ein Gasturbinentriebwerk, wobei die Einspritzvorrichtung einen Zuführungsarm (218), eine Düse (220) und Folgendes umfasst:

a) einen Einlass an einem stromaufwärtigen Ende der Düse;
b) eine Auslassöffnung an einem stromabwärtigen Ende der Düse;
c) einen Kraftstoffzufuhrkanal (212), der sich zwischen dem Einlass und der Auslassöffnung erstreckt;
d) eine Innenwand (208, 908), umfassend eine Kraftstoffleitung (213) in dem Zuführungsarm (218) und eine ringförmige Innenwand (227) in der Düse, wobei die Innenwand (208, 908) eine Seite des Kraftstoffzufuhrkanals entlang einer diesbezüglichen Länge begrenzt, wobei die Innenwand (208, 908) mit Fluid, das durch den Kraftstoffzufuhrkanal hindurchgeht, in einer Wärmeübertragungsbeziehung steht;
e) eine Außenwand (210, 910), umfassend eine äußere Wand des Zuführungsarms (218) und eine ringförmige Außenwand (224, 924) der Düse, wobei die Außenwand zwischen der Innenwand und Umgebungsbedingungen eingefügt ist, wobei die Außen- und Innenwand stromabwärtige Spitzenenden (214) aufweisen, die für eine relative Längsbewegung an einer Schnittstelle angepasst sind;
f) einen inneren Isolierspalt (206, 906), der zwischen der Innen- und Außenwand eingefügt ist, um die innere Wand in Bezug auf Umgebungstemperaturbedingungen außerhalb der Düse zu isolieren; und

g) eine im Allgemeinen sigmoidförmige Biegedichtung (222, 922) zum Isolieren eines Teils des Isolierspalts (206b) in Bezug auf Umgebungsfluid, das in den Teil des Spalts durch die Schnittstelle eintritt und um eine axiale und radiale Bewegung zwischen der ringförmigen Innen- und Außenwand zu ermöglichen, **dadurch gekennzeichnet, dass** die Biegedichtung einen Teil der Außenwand (210, 910) formt, der die ringförmige Außenwand der Düse und die äußere Wand des Zuführungsarms verbindet, und die Biegedichtung mit der Innenwand verbunden ist.

2. Kraftstoffeinspritzvorrichtung nach Anspruch 1, wobei die Biegedichtung als eine getrennte Komponente geformt ist.

3. Kraftstoffeinspritzvorrichtung nach Anspruch 1 oder 2, wobei mindestens ein Teil des Isolierspalts ein Edelgas enthält.

4. Kraftstoffeinspritzvorrichtung nach Anspruch 1, 2 oder 3, ferner umfassend eine Kraftstoffverwirblerwand (226, 926), die von einem Prefilmer-Teil (227, 927) der ringförmigen Innenwand radial nach innen angeordnet ist, wobei eine Prefilmer-Kammer dazwischen definiert ist, einen inneren Luftverwirbler (228, 928), der von einem Teil der Kraftstoffverwirblerwand radial nach innen angeordnet ist, und ein ringförmiges Biegeelement (232), das in einem Spalt (230) zwischen der Kraftstoffverwirblerwand und dem inneren Luftverwirbler angeordnet ist, wobei das ringförmige Biegeelement an einem ersten Ende mit der Kraftstoffverwirblerwand verbunden ist und an einem zweiten Ende mit dem inneren Luftverwirbler verbunden ist.

5. Kraftstoffeinspritzvorrichtung nach Anspruch 1, 2 oder 3, ferner umfassend eine Kraftstoffverwirblerwand (226, 926), die von einem Prefilmer-Teil (227, 927) der ringförmigen Innenwand radial nach innen angeordnet ist, wobei eine Prefilmer-Kammer dazwischen definiert ist, einen inneren Luftverwirbler (228, 928), der von einem Teil der Kraftstoffverwirblerwand radial nach innen angeordnet ist, und eine C-Dichtung, die zwischen der Kraftstoffverwirblerwand und dem inneren Luftverwirbler angeordnet ist.

6. Kraftstoffeinspritzvorrichtung nach Anspruch 1, 2 oder 3, ferner umfassend eine Kraftstoffverwirblerwand (226, 926), die von einem Prefilmer-Teil (227, 927) der ringförmigen Innenwand radial nach innen angeordnet ist, wobei eine Prefilmer-Kammer dazwischen definiert ist, einen inneren Luftverwirbler (228, 928), der von einem Teil der Kraftstoffverwirblerwand radial nach innen angeordnet ist, und eine Balgstruktur, die durch den inneren Isolierspalt angeordnet ist.

7. Kraftstoffeinspritzvorrichtung nach Anspruch 1, 2 oder 3, ferner umfassend einen inneren Luftverwirbler, einschließend einen stromaufwärtigen Teil (933) und einen stromabwärtigen Teil (928), die miteinander verbunden sind, wobei der stromabwärtige Teil mit einer Kraftstoffverwirblerwand (926) verbunden ist.

8. Kraftstoffeinspritzvorrichtung nach Anspruch 7, wobei ein stromaufwärtiger Dichtungsabschnitt (932) des stromabwärtigen Teils (928) des inneren Luftverwirblers ein ringförmiges Biegeelement formt, das zwischen dem stromaufwärtigen Teil des inneren Luftverwirblers und der Kraftstoffverwirblerwand angeordnet ist.

Revendications

1. Injecteur de carburant (200, 900) pour un moteur à turbine à gaz, l'injecteur comprenant un bras d'alimentation (218), une buse (220) et :

a) une entrée au niveau d'une extrémité amont de la buse ;
b) une sortie d'évacuation au niveau d'une extrémité aval de la buse ;
c) un passage de distribution de carburant (212) s'étendant entre l'entrée et la sortie d'évacuation ;
d) une paroi intérieure (208, 908) comprenant un conduit
de carburant (213) à l'intérieur du bras d'alimentation (218) et une paroi annulaire intérieure (227) à l'intérieur de la buse, la paroi intérieure (208, 908) délimitant un côté du passage de distribution de carburant sur la longueur de celui-ci, dans lequel la paroi intérieure (208, 908) est dans une relation de transfert de chaleur avec le fluide traversant le passage de distribution de carburant ;
e) une paroi extérieure (210, 910) comprenant une paroi externe du bras d'alimentation (218) et une paroi annulaire extérieure (224, 924) de la buse, la paroi extérieure étant interposée entre la paroi intérieure et les conditions ambiantes, dans lequel les parois intérieure et extérieure ont des extrémités de pointe aval (214) qui sont conçues pour un mouvement longitudinal relatif au niveau d'une interface ;
f) un espace d'isolation interne (206, 906) interposé entre les parois intérieure et extérieure pour isoler la paroi interne des conditions de température ambiantes à l'extérieur de la buse ; et
g) un joint de flexure de forme généralement sig-

moïde (222, 922) pour isoler une partie de l'espace d'isolation (206b) du fluide ambiant entrant dans la partie de l'espace à travers l'interface et pour permettre un mouvement axial et radial entre les parois annulaires intérieure et extérieure, **caractérisé en ce que** le joint de flexure forme une partie de la paroi extérieure (210, 910) reliant la paroi annulaire extérieure de la buse et la paroi externe du bras d'alimentation et le joint de flexure est relié à la paroi intérieure.

2. Injecteur de carburant selon la revendication 1, dans lequel le joint de flexure est formé en tant que composant séparé.

3. Injecteur de carburant selon la revendication 1 ou 2, dans
lequel au moins une partie de l'espace d'isolation contient un gaz noble.

4. Injecteur de carburant selon la revendication 1, 2 ou 3, comprenant en outre une paroi de tourbillonneur de carburant (226, 926) disposée radialement vers l'intérieur d'une partie de préfilmeur (227, 927) de la paroi annulaire intérieure, avec une chambre de préfilmeur définie entre elles, un tourbillonneur d'air interne (228, 928) disposé radialement vers l'intérieur d'une partie de la paroi de tourbillonneur de carburant et une poutre de flexure annulaire (232) disposée dans un espace (230) entre la paroi de tourbillonneur de carburant et le tourbillonneur d'air interne, la poutre de flexure annulaire étant reliée au niveau d'une extrémité à la paroi de tourbillonneur de carburant et étant reliée au niveau d'une seconde extrémité au tourbillonneur d'air interne.

5. Injecteur de carburant selon la revendication 1, 2 ou 3, comprenant en outre une paroi de tourbillonneur de carburant (226, 926) disposée radialement vers l'intérieur d'une partie de préfilmeur (227, 927) de la paroi annulaire intérieure, avec une chambre de préfilmeur définie entre elles, un tourbillonneur d'air interne (228, 928) disposé radialement vers l'intérieur d'une partie de la paroi de tourbillonneur de carburant et un joint en c disposé entre la paroi de tourbillonneur de carburant et le tourbillonneur d'air interne.

6. Injecteur de carburant selon la revendication 1, 2 ou 3, comprenant en outre une paroi de tourbillonneur de carburant (226, 926) disposée radialement vers l'intérieur d'une partie de préfilmeur (227, 927) de la paroi annulaire intérieure, avec une chambre de préfilmeur définie entre elles, un tourbillonneur d'air interne (228, 928) disposé radialement vers l'intérieur d'une partie de la paroi de tourbillonneur de carburant et une structure inférieure disposée à travers l'espace d'isolation interne.

7. Injecteur de carburant selon la revendication 1, 2 ou 3, comprenant en outre un tourbillonneur d'air interne contenant une partie amont (933) et une partie aval (928) reliées entre elles, la partie aval étant reliée à une paroi de tourbillonneur de carburant (926).

8. Injecteur de carburant selon la revendication 7, dans lequel une section de joint amont (932) de la partie aval (928) du tourbillonneur d'air interne forme une poutre de flexure annulaire disposée entre la partie amont du tourbillonneur d'air interne et la paroi de tourbillonneur de carburant.

FIG. 1

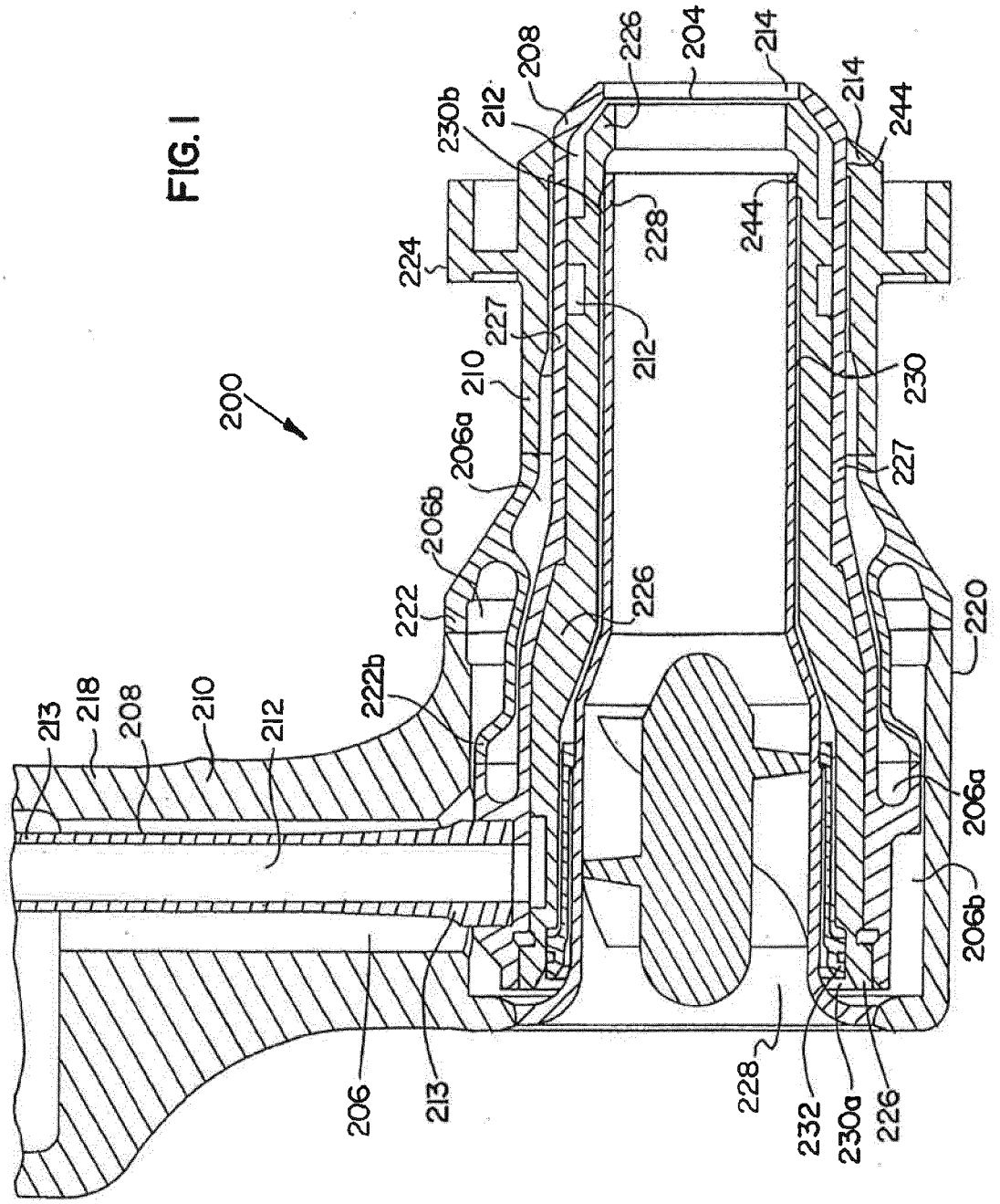
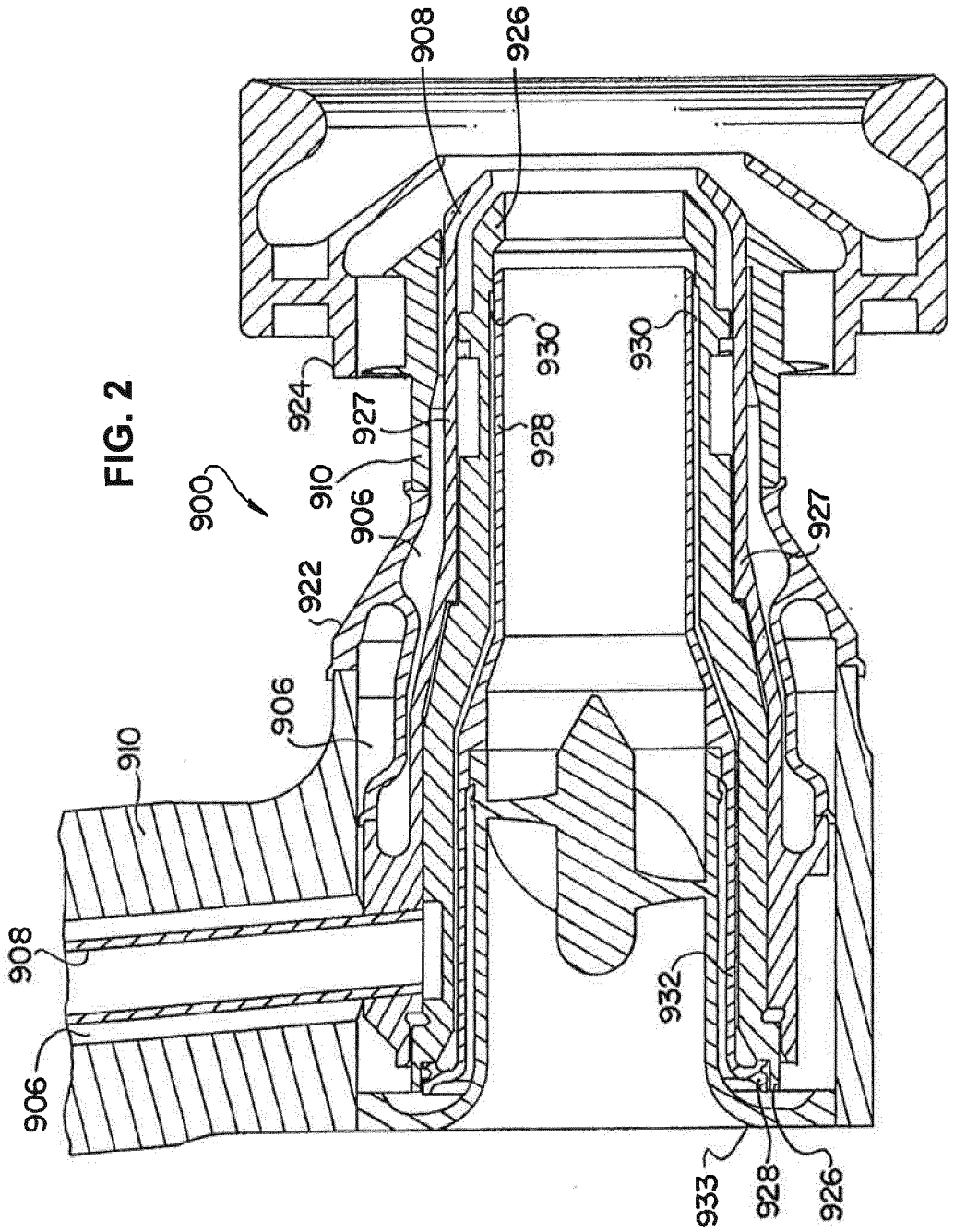

200
213
218
208
210
212
222b
222
206b
206a
210
227
212
208
226
204
214
230b
212
214
244
224
228
244
212
230
227
226
220
206a
206b
206
213
228
232
230a
226

FIG. 2


908
926
930
930
924
927
928
910
900
906
927
922
906
910
908
906
932
933
928
926

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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