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(54) **FUEL NOZZLE**

(57) A fuel nozzle (20) for a turbine engine, comprises: a flange (30) defining at least one flange passage (32,32'); a tip (50) spaced from the flange (30) , the tip (50) defining at least one tip passage (52,52'); a stem (40) having a first stem end (42a) fixedly joined to the flange (30) and a second stem end (42b) fixedly joined to the tip (50), the stem (30) having a peripheral wall extending lengthwise between the first stem end (42a) and the second stem end (42b) and peripherally around a stem chamber (44), the tip (50) sealing the stem chamber (44) at the second stem end (42b); and at least one fuel line (60,60') extending at least partially inside the stem chamber (44) and having a first line end (60a,60'a) fluidly connected to the at least one flange passage (32,32') and a second line end fluidly (60b,60'b) connected to the at least one tip passage (52,52').

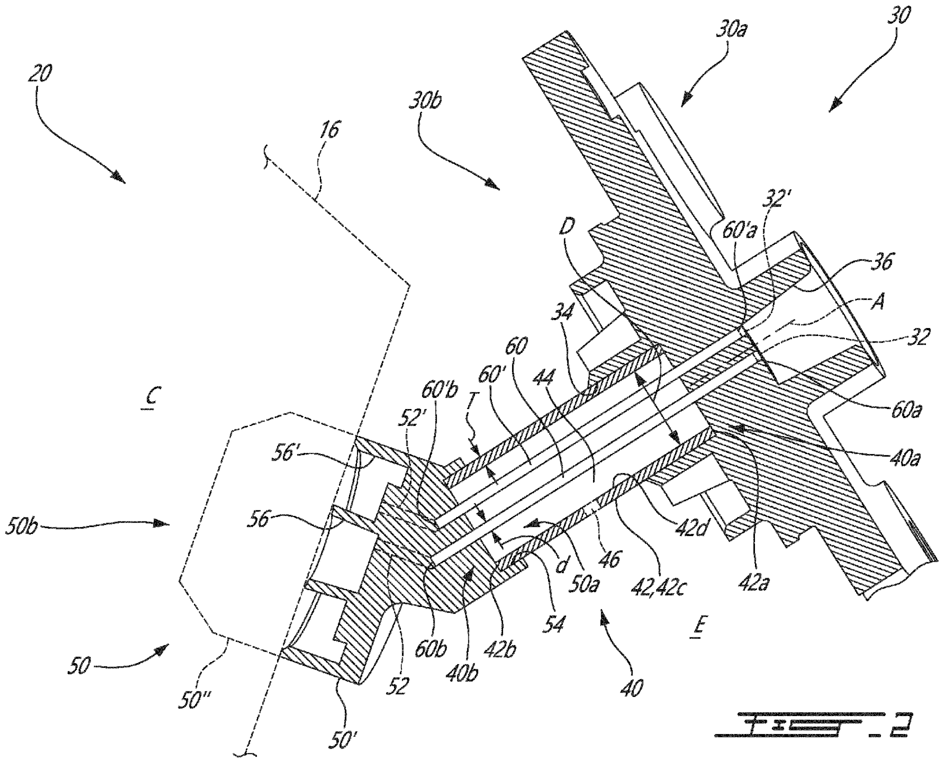

FIG. 2

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Description

TECHNICAL FIELD

[0001] The application relates generally to turbine engines and, more particularly, to fuel nozzles for turbine engines.

BACKGROUND OF THE ART

[0002] In a turbine engine, the areas surrounding the combustor have elevated temperatures because of the heat generated by the combustor as fuel is combusted therein. Transfer of such thermal energy may influence the function of components surrounding the combustor, such as fuel nozzles. For example, the structures defining passages via which fuel flows inside fuel nozzles may require particular thermal management consideration.

SUMMARY

[0003] According to an aspect of the present invention, there is provided a fuel nozzle for a turbine engine, comprising: a flange defining at least one flange passage; a tip spaced from the flange, the tip defining at least one tip passage; a stem having a first stem end fixedly joined to the flange and a second stem end fixedly joined to the tip, the stem having a peripheral wall extending lengthwise between the first stem end and the second stem end and peripherally around a stem chamber, the tip sealing the stem chamber at the second stem end; and at least one fuel line extending at least partially inside the stem chamber and having a first line end fluidly connected to the at least one flange passage and a second line end fluidly connected to the at least one tip passage.

[0004] Optionally, and in accordance with the above, the first stem end and the second stem end are respectively joined to the flange and to the tip by brazing, welding or soldering.

[0005] Optionally, and in accordance with any of the above, the first line end and the second line end are respectively fixedly joined to the flange and to the tip by brazing, welding or soldering.

[0006] Optionally, and in accordance with any of the above, the first stem end and the second stem end are respectively matingly received by the flange and the tip such that the stem chamber extends from inside the flange to inside the tip.

[0007] Optionally, and in accordance with any of the above, the first stem end and the second stem end are cylindrical in shape.

[0008] Optionally, and in accordance with any of the above, the stem has a constant wall thickness throughout a length thereof.

[0009] Optionally, and in accordance with any of the above, the peripheral wall has a thickness of between 0.89 mm and 1.52 mm at a location spaced away from the flange and from the tip.

[0010] Optionally, and in accordance with any of the above, the at least one fuel line is cylindrical in shape.

[0011] Optionally, and in accordance with any of the above, an inner diameter of the peripheral wall is between 7 and 15 times an outer diameter of the at least one fuel line.

[0012] Optionally, and in accordance with any of the above, an or the inner diameter of the peripheral wall is between 10.2 mm and 15.2 mm.

[0013] Optionally, and in accordance with any of the above, the stem has an opening defined in the peripheral wall at an intermediate location between the tip and the flange, the opening in fluid communication between the stem chamber and outside the fuel nozzle.

[0014] Optionally, and in accordance with any of the above, the opening is located closer to the flange than to the tip.

[0015] Optionally, and in accordance with any of the above, the opening has a cross-sectional area that is less than 0.6 mm^2.

[0016] According to another aspect of the present invention, there is provided a turbine engine comprising: a case surrounding an air plenum; a combustor surrounded by the air plenum, the combustor defining a combustion chamber; and a fuel nozzle for injecting a fuel-air mixture into the combustion chamber, the fuel nozzle comprising: a flange attached to the case, the flange defining at least one flange passage; a tip projecting into the combustion chamber, the tip defining at least one tip passage; a hollow stem body structurally connecting the tip to the flange, the hollow stem body having a peripheral wall extending lengthwise from a first stem end to a second stem end, the peripheral wall having an inner surface circumscribing a stem chamber, the flange and the tip sealing the stem chamber respectively at the first stem end and at the second stem end; and at least one fuel line extending through the stem chamber and fluidly connecting the at least one flange passage to the at least one tip passage.

[0017] Optionally, and in accordance with any of the above, the hollow stem body has an opening defined in the peripheral wall in fluid communication between the stem chamber and the air plenum outside of the combustor.

[0018] Optionally, and in accordance with any of the above, the opening has a cross-sectional area of no greater than 0.6 mm^2.

[0019] Optionally, and in accordance with any of the above, the first stem end and the second stem end are respectively joined to the flange and to the tip by brazing, welding or soldering.

[0020] Optionally, and in accordance with any of the above, the at least one fuel line has a first line end and a second line end, and wherein the first line end and the second line end are respectively joined to the flange and to the tip by brazing, welding or soldering.

[0021] Optionally, and in accordance with any of the above, the second stem end and the second line end are parallel to one another.

[0022] Optionally, and in accordance with any of the above, the hollow stem body and the at least one fuel line are provided in the form of nested tubes.

DESCRIPTION OF THE DRAWINGS

[0023] Reference is now made to the accompanying figures in which:

Fig. 1 is a schematic cross sectional view of a turbine engine; and

Fig. 2 is a cross-sectional view of a fuel nozzle of the turbine engine of Fig. 1 taken along the line 2-2 of Fig. 1.

DETAILED DESCRIPTION

[0024] Fig. 1 illustrates a gas turbine engine 10 of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication a fan 12 through which ambient air is propelled, a compressor section 14 for pressurizing the air, a combustor 16 in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, and a turbine section 18 for extracting energy from the combustion gases.

[0025] Referring to Figs. 1 and 2, the gas turbine engine 10 has fuel nozzles 20 or injectors mounted between an annular case 11 of the gas turbine engine 10 and the combustor 16. The case 11 surrounds a cavity E forming an air plenum, hereinafter "engine cavity E", around the combustor 16. The combustor 16 defines a combustion chamber C circumscribed by radially inner and radially outer combustor liners of the combustor 16 inside the engine cavity E. Fig. 2 shows an embodiment of one of the fuel nozzles 20. The illustrated nozzle 20 generally comprises a number of external parts secured together, namely, a flange 30 which is securable to the case 11, a stem 40 adapted to be disposed inside the engine cavity E and extending from the flange 30, and a tip 50 inside the engine cavity E located at the end of the stem 40. The flange 30 is typically bolted to an exterior of the case 11. The stem 40 is configured to structurally support the tip 50 on the flange 30. A portion of the nozzle 20, which may include a portion of the flange 30 and/or a portion of the stem 40, extends from outside the case 11 to inside thereof via an opening defined in the case 11. The tip 50 of the nozzle 20 is positioned so as to extend through a corresponding opening defined in a dome wall portion of the combustor 16, and thus extends from outside the combustion chamber C to inside the combustion chamber C. The tip 50 may be monolithic or, as will be described further below, may comprise a plurality of components 50', 50" suitably assembled. In some embodiments, only one of such components 50', 50" extends through the opening of the combustor 16.

[0026] A first side 30a of the flange 30 generally faces away from the combustor 16, whereas a second side 30b of the flange 30 generally faces the stem 40 and the combustor 16. A first side 40a of the stem 40 generally faces the flange 30, whereas a second side 40b of the stem 40 generally faces the tip 50. A first side 50a of the tip 50 generally faces the stem 40, whereas a second side 50b of the tip 50 generally faces the combustor 16.

[0027] In operation, fuel is supplied to at least one fuel passage 32, 32' of the flange 30 (or flange passage 32, 32') of the illustrated nozzle 20, in this case from a manifold (not shown) of the engine 10 in fluid communication with a plurality of the fuel nozzles 20 of the engine 10. The at least one fuel passage 32, 32' is defined by the flange 30 so as to suitably condition the flow of fuel downstream of the manifold. The fuel exits the fuel nozzle 20 at the tip 50 via at least one fuel passage 52, 52' thereof (or tip passage 52, 52'), from which it is injected into the combustor 16 and ignited to generate heat. The at least one fuel passage 52, 52' is defined by the tip 50 as to suitably condition the flow of fuel as it flows therein and/or exits therefrom, for example to incorporate air with the fuel so as to generate a spray.

[0028] The fuel nozzle 20 is configured to provide suitable fluid connection(s) between the fuel passage(s) 32, 32' of the flange 30 and the fuel passage(s) 52, 52' of the tip 50. The fuel nozzle 20 comprises at least one fuel line 60, 60' extending lengthwise, at least partially, inside the stem 40. Each one of the at least one fuel line 60, 60' has two opposite ends, namely a first end 60a, 60'a in fluid communication with a corresponding one of the at least one fuel passages 32, 32' of the flange 30, and a second end 60b, 60'b in fluid communication with a corresponding one of the fuel passages 52, 52' of the tip 50. Depending on the embodiment, the first end(s) 60a, 60'a and/or the second end(s) 60b, 60'b may extend outside the stem 40. The fuel nozzle 20 may be referred to as a "simplex" nozzle if it includes a sole fuel line 60, or as a "duplex" nozzle if it includes a pair of fuel lines 60, 60'. Fuel nozzles 20 having more than two fuel lines, and a corresponding number of fuel passages 32, 52, are contemplated.

[0029] The flange 30 can define one or more flange cavities 34, 36, for example one such cavity 34 located on the second side 30b of the flange 30 for receiving the stem 40, and at least one other such cavity 36 located on the first side 30a of the flange 30 in fluid communication with the at least one fuel passage 32, 32'.

[0030] The tip 50 can define one or more tip cavities 54, 56, 56', for example one such cavity 54 located on the first side 50a of the tip 50 for receiving the stem 40, and at least one other such cavity 56, 56' located on the second side 50b of the tip 50 in fluid communication with the at least one fuel passage 52, 52'.

[0031] Still referring to Fig. 2, the stem 40 has a hollow stem body 42 (hereinafter "body") that in this case is monolithic, and extends peripherally so as to circumscribe a stem chamber 44 inside which the at least one fuel line 60, 60' extends, while providing structure to the stem 40.

The at least one fuel line 60, 60' is spaced from the inner wall of the hollow stem body 42 by an annular insulating gap. Hence, in addition to supporting the tip 50, the stem 40 provides thermal insulation to the at least one fuel line 60, 60'. Stated otherwise, the stem 40 serves a dual function as it is both a support for the tip 50 and a heat shield for the at least one fuel line 60, 60'. As such, surrounding the stem 40 with a dedicated heat shield is not necessary in most embodiments. The body 42 is elongated, and extends lengthwise from a first end 42a of the stem 40, also referred to as a proximal end 42a (i.e., the end that is the closest to the flange 30) to a second end 42b (i.e., the end that is the furthest from the flange 30), also referred to as a distal end 42b. The stem body 42 extends proximate to the flange 30 along a first stem axis, such that it is matingly connected to the flange 30 along the first stem axis. In this case, the first stem end 42a is matingly received by the flange cavity 34 defined on the second side 30b of the flange 30. The flange 30 may be said to seal the stem chamber 44 from the engine cavity E. The stem body 42 extends proximate to the tip 50 along a second stem axis, such that it is matingly connected to the tip 50 along the second stem axis. In this case, the second stem end 42b is matingly received by the tip cavity 54 defined on the first side 50a of the tip 50. The tip 50 may be said to seal the stem chamber 44 from the combustion chamber C and from the engine cavity E. Depending on the embodiment, the stem body 42 may be said to follow a certain path as it extends lengthwise. In the present embodiment, the first stem axis and the second stem axis are collinear, and thus correspond to a same axis A. Also, in this embodiment, the stem body 42 fully extends along the axis A, and thus follows a linear path. In other embodiments, at least a portion of the stem body 42 may follow a non linear path. In some such embodiments, the first stem axis and the second stem axis may be at an angle relative to one another.

[0032] As mentioned hereinabove, the stem body 42 is hollow, and may thus be said to include a peripheral wall having an outer surface 42c (i.e., a surface exposed at least in part to the engine cavity E) and an inner surface 42d (i.e., a surface circumscribing the stem chamber 44). The stem body 42 may be cylindrical in shape, and thus may extend axially and circumferentially relative to the axis A, with the outer surface 42c and the inner surface 42d being spaced by a thickness T relative to the axis A, i.e., in this case a radial thickness, that is the same at the first stem end 42a, at the second stem end 42b, and at either axial position therebetween. Stated otherwise, the stem body 42 may have an outer diameter and an inner diameter (shown at D) that are constant throughout its length. Other configurations are contemplated for the peripheral wall.

[0033] The stem 40 and the at least one fuel line 60, 60' are sized and arranged relative to one another so as to provide suitable insulation to the at least one fuel line 60, 60' from the high temperatures in effect in the vicinity of the fuel nozzle 20 as the engine 10 operates. For instance, the temperature inside the engine cavity E around the combustor can attain 1000 F, or approximately 537.8 C, whereas it may be desirable to maintain the stem chamber 44 at a temperature of about 600 F, or approximately 315.5 C, to minimize adverse heating of the fuel as it flows inside the at least one fuel line 60, 60'. For example, in order to provide a suitable air gap around the at least one fuel line 60, 60', the inner diameter D of the of the peripheral wall of the stem body 42 may be of between 7 and 15 times an outer diameter d of the at least one fuel line 60, 60'. In some embodiments, the inner diameter D may be of between about 0.4 inch and 0.6 inch, for example 0.5 inch, i.e., between about 10.2 mm and 15.2 mm, for example 12.7 mm. In some such embodiments, the outer diameter d may be of between about 0.030 inch and 0.090 inch, for example 0.060 inch, i.e., between about 0.76 mm and 2.30 mm, for example 1.52 mm.

[0034] Still referring to Fig. 2, in order to hinder the transfer of heat toward the fuel flowing inside the at least one fuel line 60, 60', a portion of the volume circumscribed by the outer surface 42c of the stem body 42 that is occupied by air (i.e., unoccupied by either of the stem body 42 nor the at least one fuel line 60, 60') may be maximised while maintaining the requisite structural integrity of the stem 40 as it holds the tip 50 relative to the flange 30. To this end, the thickness T of the peripheral wall of the stem body 42 may be much smaller than the inner diameter D. For example, the thickness T may be of between about 0.035 inch and 0.060 inch, for example 0.050 inch, i.e., between about 0.89 mm and about 1.52 mm, for example 1.27 mm. In embodiments, the thickness T is at least at a location that is spaced away from the flange 30 and from the tip 50. The peripheral wall may have multiple thicknesses at respective lengthwise locations. A thickness of the at least one fuel line 60, 60' may be of between about 0.010 inch and 0.025 inch, for example 0.015 inch, i.e., between about 0.254 mm and 0.635 mm, for example 0.381 mm. An inner diameter of the at least one fuel line 60, 60' may be of between about 0.10 inch and 0.25 inch, i.e., between about 2.5 mm and 6.4 mm.

[0035] In some embodiments, the stem 40 may have an opening 46 defined in the peripheral wall at a location where the outer surface 42c is exposed to the engine cavity E, with the opening 46 extending through the peripheral wall from the inner surface 42d to the outer surface 42c. The opening 46 is thus in fluid communication between the stem chamber 44 and the engine cavity E, and more specifically a portion of the engine cavity E that is outside the combustor 16. By way of the opening 46, the pressure inside the stem chamber 44 may tend to equilibrate with that of the engine cavity E. The opening 46 is sized so as to be small relative to the stem chamber 44 so as to prevent ingress of hot air into the stem chamber 44. For example, the opening 46 may have a cross-sectional area that is of less than about 0.15 % of an area of the outer surface 42c that is exposed to the engine cavity E. In embodiments, the opening 46 has a cross-sectional area that is no greater than about 0.0009 square inches, i.e., no greater than about 0.6 mm^2. In embodiments, the opening 46 is cylindrical in shape. In some such embodiments, the opening 46 may have a diameter of between about 0.015 inch and 0.025 inch, i.e., between about 0.38 mm and 0.63 mm. Also, the opening 46 may be located closer to the flange 30 than to the tip 50, such that it is spaced away from the heat source (i.e., the combustor 16) and thus less susceptible to let heat enter the stem chamber 44. In embodiments, the opening 46 is a sole opening defined in the peripheral wall. In embodiments, more than one opening 46 is provided in the peripheral wall.

[0036] Components of the fuel nozzle 20 interfacing one another may be fixedly joined, i.e., permanently joined or in a manner not intended to be disjoined, by various suitable means. For example, the first stem end 42a and the second stem end 42b may be respectively fixedly joined to the flange 30 and to the tip 50 by brazing, welding or soldering. Likewise, the first line end(s) 60a, 60'a and the second line end(s) 60b, 60'b may be respectively fixedly joined to the flange 30 and to the tip 50 by brazing, welding or soldering. Advantageously, the fuel nozzle 20 may be arranged such that brazing can be used to fixedly join multiple components of the fuel nozzle 20 in one heating operation or, stated otherwise, so that multiple joints of the fuel nozzle 20 may be brazed at once. It should be noted that the opening 46 may serve as a vent during a heat treatment cycle, for example a brazing cycle, so that pressures inside and outside the stem chamber 44 may equilibrate, and/or for gasses generated or used during the heat treatment cycle to evacuate from the stem chamber 44. Fitment of any two components of the fuel nozzle 20 may refer to the secure, yet non permanent assembly of such two components, in some cases with a brazing media (e.g., paste, powder, or preform material) disposed at the interface therebetween. For example, the first stem end 42a may be fitted to a complementary shape of the flange 30, for example the flange cavity 34, whereas the first line end(s) 60a, 60'a may be fitted to complementary shape(s) of the flange 30, for example distal portion(s) of the fuel passages 32, 32'. The second stem end 42b may be fitted to a complementary shape of the tip 50, for example the tip cavity 54, whereas the second line end(s) 60b, 60'b may be fitted to complementary shape(s) of the tip 50, for example proximal portion(s) of the fuel passages 52, 52'. In the depicted embodiment, the outer surface 42c of the stem body 42 interfaces a radially inner surface of the flange 30 at the first stem end 42a, and interfaces a radially inner surface of the tip 50 at the second stem end 42b. As such, the first and second stem ends 42a, 42b are respectively recessed in, or matingly received by, the flange 30 and the tip 50, such that end portions of the stem chamber 44 may be said to be located inside the flange 30 and inside the tip 50. Stated otherwise, the stem chamber 44 may extend from inside the flange 30 to inside the tip 50 In other embodiments, the inner surface 42d of the stem body 42 may interface a radially outer surface of the flange 30 and/or a radially outer surface of the tip 50. The fuel nozzle 20 may be arranged so as to facilitate the simultaneous fitment of the stem 40 and of the at least one fuel line 60, 60' to the flange 30 and/or to the tip 50. For example, upon the flange 30 being fitted onto the stem 40 and onto the at least one fuel line 60, 60', the first stem end 42a and the first line end(s) 60a, 60'a may extend parallel to one another, and/or the second stem end 42b and the second line end(s) 60b, 60'b may extend parallel to one another. Upon the tip 50 being fitted onto the stem 40 and onto the at least one fuel line 60, 60', the second stem end 42b and the second line end(s) 60b, 60'b may extend parallel to one another, and/or the first stem end 42a and the first line end(s) 60a, 60'a may extend parallel to one another. The at least one fuel line 60, 60' may be cylindrical in shape. In some such embodiments, the stem 40 and the at least one fuel line 60, 60' are all cylindrical in shape, and extend parallel to one another upon the nozzle 20 being assembled.

[0037] The flange 30, the stem 40, the tip 50 and/or the at least one fuel line 60, 60' are constructed of material(s) that are suitable for the joining means employed to assemble the nozzle 20. For example, in the case of brazing, such material(s) are metallic materials having a melting temperature that is higher than that of the brazing media. In some embodiments, the material(s) have a melting temperature that is of at least 2,200 F (1,206 C). The material(s) of which the stem 40 and/or the at least one fuel line 60, 60' may have particularly desirable properties in accordance with the dual function of the stem 40, for example high rigidity and low thermal conductivity.

[0038] At least in some embodiments, the stem 40 and/or the at least one fuel line 60, 60' are obtained from standardized structures requiring minimal machining steps before being assembled so as to form the nozzle 20. For instance, the stem 40 and/or the at least one fuel line 60, 60' can be made of tubing, in some cases having nominal dimensions that are readily available off-the-shelf. In some embodiments, a sole machining step to which the stem 40 and/or the at least one fuel line 60, 60' is/are submitted is lengthwise cutting. According to one aspect, the stem body 42 can be provided in the form of an outer tube and the at least one fuel line 60, 60' can be provided in the form of internal tube(s) inside the outer tube, thereby forming a nested tube arrangement.

[0039] The embodiments described in this document provide non-limiting examples of possible implementations of the present technology. Upon review of the present disclosure, a person of ordinary skill in the art will recognize that changes may be made to the embodiments described herein without departing from the scope of the present technology. Yet further modifications could be implemented by a person of ordinary skill in the art in view of the present disclosure, which modifications would be within the scope of the present technology.

Claims

1. A fuel nozzle (20) for a turbine engine (10), comprising:

   a flange (30) defining at least one flange passage (32,32');
   a tip (50) spaced from the flange (30) , the tip (50) defining at least one tip passage (52, 52');
   a stem (40) provided in the form of a straight tube having a first stem end (42a) fixedly joined to the flange (30) and a second stem end (42b) fixedly joined to the tip (50), the stem (30) having a peripheral wall extending lengthwise along a linear path between the first stem end (42a) and the second stem end (42b) and peripherally around a stem chamber (44), the first stem end (42a) and the second stem end (42b) being coaxial, the second stem end (42b) received into a cavity (54) defined in the tip (50), the tip (50) sealing the stem chamber (44) at the second stem end (42b); and
   at least one fuel line (60,60') extending at least partially inside the stem chamber (44) and having a first line end (60a,60'a) fluidly connected to the at least one flange passage (32,32') and a second line end (60b,60'b) fluidly connected to the at least one tip passage (52,52').

2. The fuel nozzle (20) of claim 1, wherein the first stem end (42a) and the second stem end (42b) are respectively joined to the flange (30) and to the tip (50) by brazing, welding or soldering.

3. The fuel nozzle of claim 1 or 2, wherein the first line end (60a,60'a) and the second line end (60b,60'b) are respectively fixedly joined to the flange (30) and to the tip (50) by brazing, welding or soldering.

4. The fuel nozzle (20) of any of the preceding claims, wherein the first stem end (42a) and the second stem end (42b) are respectively matingly received by the flange (30) and the tip (50) such that the stem chamber (44) extends from inside the flange (30) to inside the tip (50).

5. The fuel nozzle (20) of any of the preceding claims, wherein the first stem end (42a) and the second stem end (42b) are cylindrical in shape.

6. The fuel nozzle (20) of any of the preceding claims, wherein the stem (40) has a constant wall thickness throughout a length thereof.

7. The fuel nozzle (20) of any of the preceding claims, wherein the peripheral wall has a thickness of between 0.89 mm and 1.52 mm at a location spaced away from the flange (30) and from the tip (50).

8. The fuel nozzle (20) of any of the preceding claims, wherein the at least one fuel line (60,60') is cylindrical in shape.

9. The fuel nozzle (20) of claim 8, wherein an inner diameter (D) of the peripheral wall is between 7 and 15 times an outer diameter (d) of the at least one fuel line (60,60').

10. The fuel nozzle (20) of claim 8 or 9, wherein an or the inner diameter (D) of the peripheral wall is between 10.2 mm and 15.2 mm.

11. The fuel nozzle (20) of any of the preceding claims, wherein the stem has an opening (46) defined in the peripheral wall at an intermediate location between the tip (50) and the flange (30), the opening (46) in fluid communication between the stem chamber (44) and outside the fuel nozzle (20).

12. The fuel nozzle (20) of claim 11, wherein the opening (46) is located closer to the flange (30) than to the tip (50).

13. The fuel nozzle (20) of claim 11 or 12, wherein the opening (46) has a cross-sectional area that is less than 0.6 mm^2.

14. A turbine engine (10) comprising:

    a case (11) surrounding an air plenum (E);
    a combustor (16) surrounded by the air plenum (E), the combustor (16) defining a combustion chamber (C); and
    a fuel nozzle (20) according to any of the preceding claims, the fuel nozzle (20) operable for injecting a fuel-air mixture into the combustion chamber (C).

15. The turbine engine (10) of claim 14, wherein the stem (40) and the at least one fuel line (60,60') are provided in the form of nested tubes.

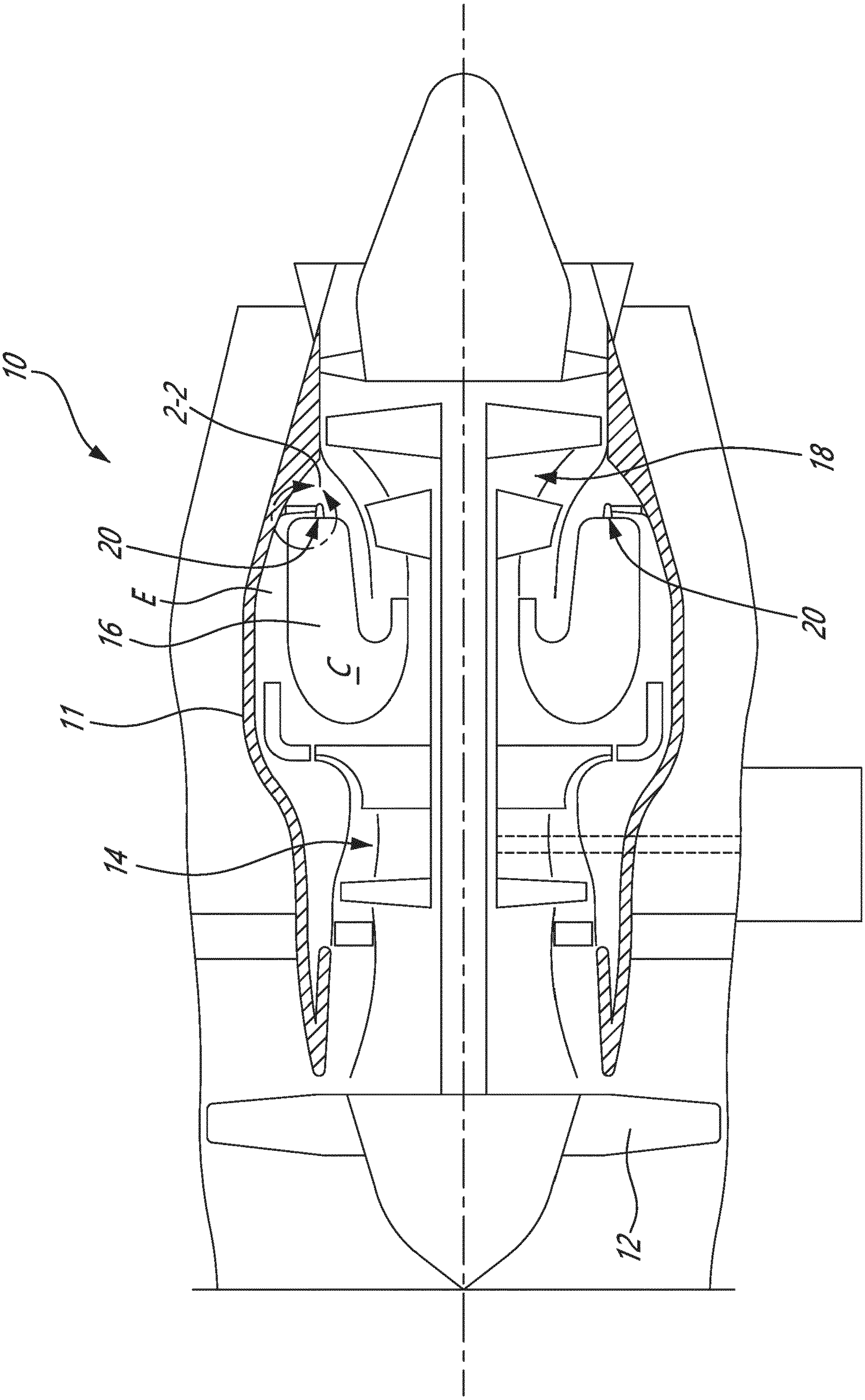
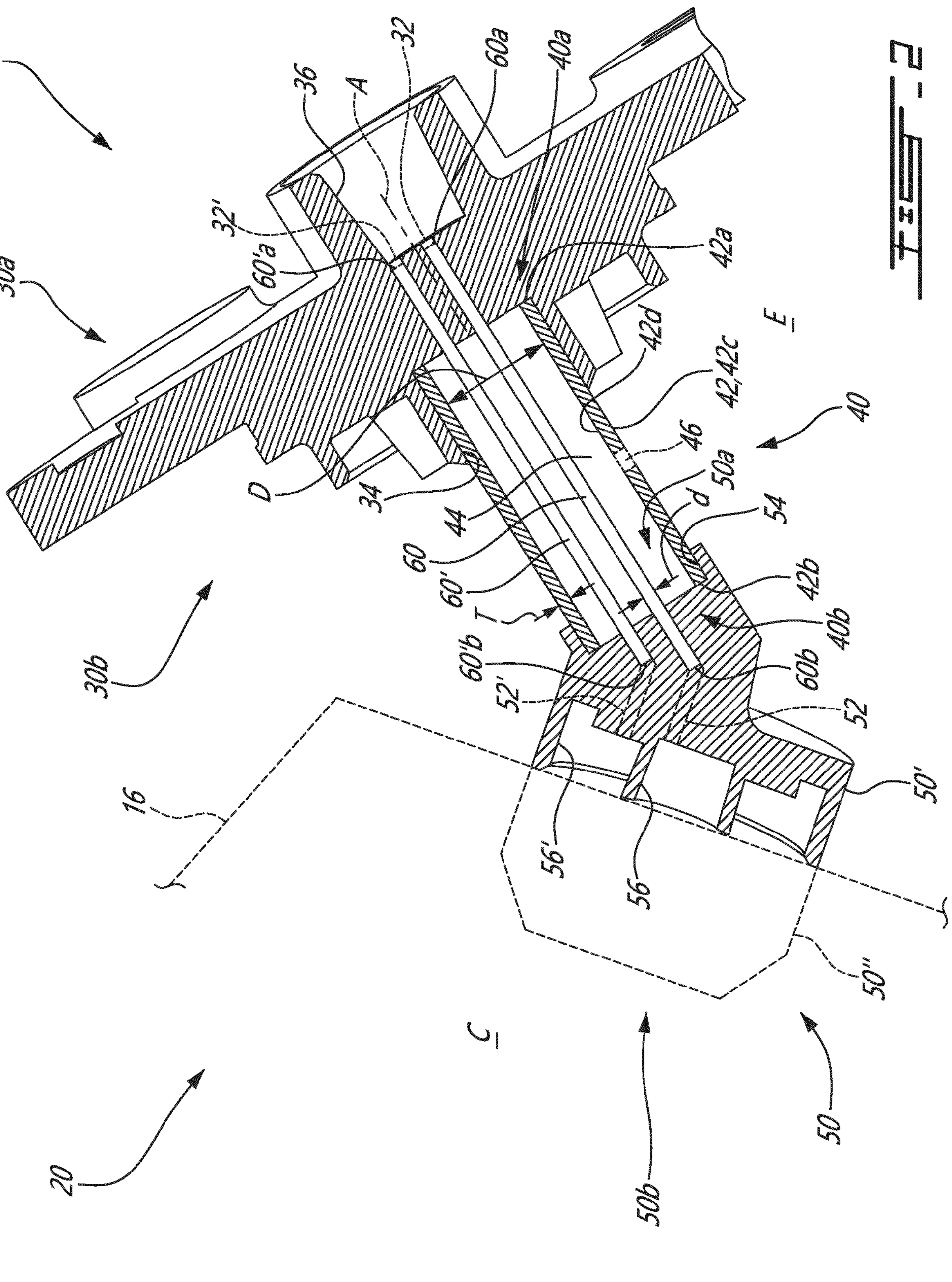


Fig-1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30a
30b
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A
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16
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50
20
C
E

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 7278

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 6 076 356 A (PELLETIER ROBERT R [US]) 20 June 2000 (2000-06-20) * column 7, line 27 - column 8, line 56; figures 5,6 *	1-6,8, 11,14,15	INV. F23R3/28
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A	US 2021/310413 A1 (NAKAMURA ORIO [JP]) 7 October 2021 (2021-10-07) * paragraph [0045] - paragraph [0048]; figures 2-4 *	1-15	

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	19 January 2024	Mootz, Frank

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