



(11)

EP 3 239 613 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.11.2017 Bulletin 2017/44

(51) Int Cl.:
F23R 3/14 (2006.01) **F23R 3/34 (2006.01)**
F23R 3/36 (2006.01) **F23D 11/38 (2006.01)**

(21) Application number: **16167741.4**

(22) Date of filing: **29.04.2016**

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

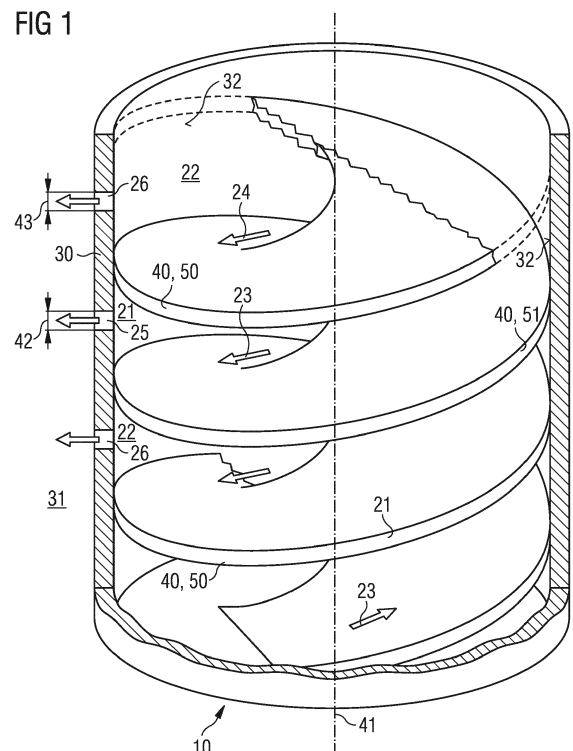
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(54) **BURNER COMPONENT, BURNER, AND METHODS OF MANUFACTURING OR OPERATING OF THESE FOR DUAL FUEL OPERATION**

(57) The invention is related to a burner, a burner component (10) and to methods of manufacturing and operation, in which the burner component (10), particularly a swirler vane or a fuel lance for a burner of a gas turbine engine, comprises a first fluid channel (21) to guide a first fluid (23), particularly a first fuel, during operation; a second fluid channel (22) to guide a second fluid (24), particularly a second fuel, during operation, the second fluid channel (22) being free of passages to the first fluid channel (21); at least one first hole (25) to provide a first passage from the first fluid channel (21) through a wall (30) of the burner component (10) for supplying the first fluid (23) into a burner space (31) during operation; at least one second hole (26) to provide a second passage from the second fluid channel (22) through the wall (30) of the burner component (10) for supplying the second fluid (24) into the burner space (31) during operation. The burner component (10) further comprises a helically shaped separating barrier (40) between the first fluid channel (21) and the second fluid channel (22).

FIG 1



Description

FIELD OF THE INVENTION

[0001] The present invention relates to a burner component and more particularly to a burner through which dual fluids are provided, particularly dual fuel, for combustion in a turbomachine, particularly a gas turbine engine.

BACKGROUND OF THE INVENTION

[0002] In a gas turbine engine typically ambient air may be compressed by a compressor section and provided to a combustor in which the substantially ambient air will be mixed fuel, the mixture being combusted in a combustion chamber of the combustor, to provide a driving force for a subsequent turbine section - an expansion turbine - in which a hot fluid from the combustor will drive rotor blades of the turbine to drive again one or several shafts. One of the shafts is typically connected to rotor blades of the expansion turbine - turbine rotor blades - and also to rotor blades of the compressor section - compressor rotor blades - so that fluidic forces generated by the combustor and acting upon the turbine rotor blades result directly in revolution of that shaft and the connected compressor rotor blades, which lead to - due to interaction with guide vanes of the compressor and due to reduced cross sectional area of the fluidic path in the compressor - to compression of the ambient air.

[0003] As explained, compressed ambient air and fuel is provided to the combustor. Typically the compressed air is swirled - via a swirler or a swirl generator - and fuel is injected into the swirled air to provide a well mixed fluid. This air/fuel mixture is ignited and burned in a combustion chamber of the combustor. In gas turbine engines a continuous combustion takes place in which constantly an air/fuel mixture is provided and burned such that a stable flame is formed in the combustion chamber.

[0004] Different types of fuels have different combustion properties. Modern combustors of stationary gas turbine engines are designed to operate with different types of fuel and in a broad range of working modes. Even though a combustor may be designed for a specific fuel type, for example natural gas from a specific source of delivery, it may be possible to operate the combustor with different fuels. Nevertheless the risk for instable combustion or flashbacks may increase.

[0005] During startup of the gas turbine engine, it is common to supply so called pilot fuel to guarantee a stable flame. The pilot fuel may be injected at a different position into the combustion space. The pilot fuel may possibly also be a different fuel type, e.g. liquid fuel, while a so called main fuel is natural gas. When the engine reaches full load operation pilot fuel may not be needed anymore and can be shut off or at least reduced.

[0006] When designing a burner dimensioning and positioning of fuel injection holes is widely performed in con-

sideration of operation on natural gas of a specific gas composition. When operating with different fuel with the same burner design, a stable combustion may require changes in some burner design properties, for example to have a larger effective area for gas injection in case of low calorific value gases, geometry modifications to adapt to physical properties - e.g. physical properties like gas density, diffusivity, reactivity, mixing time - of the different fuel types. In some incidents maybe also a richer air/fuel mixture will be configured, i.e. a higher percentage of fuel in the air/fuel mixture. The latter may be in conflict with an approach called Dry Low Emission (DLE), in which a lean combustion is performed to reduce emissions, like NOx. Additionally, a richer combustion may result in unwanted coking of surfaces. In other configuration, often the overall air/fuel mixture is the same as the compressor air flow and the gas fuel energy flow are unchanged even if using different gases.

[0007] Different gases as fuels usually have different physical properties from natural gas - e.g. propane has higher density, hydrogen has higher diffusivity and reactivity. Nevertheless good premixing is wanted for different gaseous or liquid fuels.

[0008] It may often be desirable - e.g. for reactive fuel like hydrogen - to reduce the mixing time or residence time (defined as time for the gas molecule to move from the injection point to the flame front). This results that there is less premixing and therefore locally there will be pockets with richer air/fuel mixtures and also leaner air/fuel mixtures.

[0009] Using a different type of fuel in a burner not designed for this type of fuel could lead to combustion instabilities, flashbacks, attachment of the flame on burner metal surfaces, combustion noise, or mechanical vibrations.

[0010] Thus, a safe approach to use a different type of fuel would be to replace the burner with an optimized burner design for the other type of fuel.

[0011] There is the goal to achieve fuel flexibility without replacing of burner components.

SUMMARY OF THE INVENTION

[0012] The present invention seeks to mitigate the mentioned drawbacks.

[0013] This objective is achieved by the independent claims. The dependent claims describe advantageous developments and modifications of the invention.

[0014] In accordance with the invention there is provided a burner component, particularly a swirler vane or a fuel lance for a burner of a gas turbine engine, comprising a first fluid channel to guide a first fluid, particularly a first fuel, during operation, and a second fluid channel to guide a second fluid, particularly a second fuel, during operation. The second fluid channel is free of passages to the first fluid channel. Thus both fluid channels are completely separate and independent from another. The burner component comprises at least one first hole to

provide a first passage from the first fluid channel through a wall of the burner component for supplying the first fluid into a burner space during operation and at least one second hole to provide a second passage from the second fluid channel through the wall of the burner component for supplying the second fluid into the burner space during operation. The burner component further comprises a helically shaped separating barrier between the first fluid channel and the second fluid channel.

[0015] With "burner space" not only the main combustion chamber is considered, but also a mixing chamber or swirler passages.

[0016] Thus, the first fluid channel and the second fluid channel are arranged in a twisted manner, so that fluid travelling through one of the channels follows a helical path through the burner component.

[0017] The invention allows guiding of two different fluids in a very compact cross-section. Furthermore it allows to integrate fluid channels into a solid component so that no external pipes need to be attached to an exterior of a burner component.

[0018] The invention is particularly advantageous with the fluid channels have exit holes - the mentioned first and second holes - through which the delivered fluid can exit the burner component for being injected into a combustion space or into a passage through which air travels. By this compact fluid channel design the exit holes can be located very close to another which would not be possible if two standard pipes would be used. Furthermore, due to the helical design of two distinct fluid channels, the exit holes positions and exit holes sizes can be optimised for different fuel types, e.g. the first fluid channel and its exit holes are designed for supply natural gas of a specific type and the second fluid channel and its exit holes are designed for a different fuel, e.g. hydrogen, a different natural gas, liquid fuel of specific composition, diesel. In consequence, the same burner component can be used to operate the gas turbine engine with two different fuel types. No hardware adaptations are needed if the operation is switched from one fuel type to another.

[0019] This design can even be extended for three or fluid channels, which all are twisted to another. This would allow a wide range of operation in respect of fuel flexibility.

[0020] Preferably the burner component is a part of a combustor of a gas turbine engine, particularly a swirler vane or swirler wing which is also used to inject fuel into a to be swirled further fluid - e.g. compressed air - or a fuel lance for a burner to inject fuel into a burner space.

[0021] While the primary goal of a swirler may be to generate swirl on compressed air, a lot of times swirlers provide fuel injection holes to inject fuel into the to be swirled compressed air stream. A swirler comprises vanes or wings that have an exterior shape to guide or direct fluids between adjacent vanes or wings, and according to the invention the burner component may be such a swirler vane or wing or may be a part of such component.

[0022] A fuel lance may be of an elongated form, for example cylindrical, and allows egress of delivered fluids into a burner space or a passage into which the fuel lance extends. According to the invention the delivery of different fluids through the interior of the fuel lance is reduced in footprint. And again, exit holes dimensioning and positioning can be optimised of the given fluid type that will be passed through the respective fluid channel.

[0023] It may be advantageous that particularly DLE (dry low emission) burners can maintain its high capabilities on natural gas compositions but in parallel allows to expand its operation to other gas compositions without having the geometrical and structural limits imposed by the natural gas injection holes. A customer can easily switch between the fluids depending on the fluid that is operated. This feature therefore allows to expand the accepted fuel flexibility range, meaning for example a larger range of Wobbe index or a larger range of hydrogen concentration, which may be a limiting factor in prior art designs in which only one fuel line with specific exit holes are provided. In operation and in accordance with the invention, an operation with two different fuels will not negatively affect NOx emissions in either mode of operation, as the exit holes can be positioned and sized in a substantially optimal way.

[0024] In the following the inventive concept is discussed in more detail, including discussion of variations and specific embodiments.

[0025] According to an embodiment helically shaped separating barrier may be twisted around a centre line and further walls of the first fluid channel and of the second fluid channel follow together substantially a tubular shape. Particularly both channels may form substantially a circular overall cross section. The centre line may be straight line, e.g. for a cylindrical fuel lance, but alternatively the centre line may follow a more complex path.

[0026] One option would also be that the centre line is a circle, e.g. if the fluid channels are integrated in a cylindrical burner tip via which fuel is provided into a burner space. Available space in the cylindrical burner tip may be limited and the invention allows to integrate a fuel rail or fuel manifold - generally called "fuel channeled path" - for more than one fluid into the burner tip. The exit holes may be distributed along a circumference of the burner tip.

[0027] In this latter case of a distribution along a circular burner tip the helicoid structure preferably evolves horizontally instead of vertically, when the burner tip lies in a horizontal plane. The helicoidal separation wall between the two gas passages within the available fuel channeled path may allow the use of additive manufacturing also when developed horizontally. A confining wall for the thread may be preferably not cylindrical, instead the two threaded passages should have preferably a circular section area. Such a vertical helicoid could be useful when the fuel or gas holes for the two different fluids or fuels need to be placed along a vertical line.

[0028] As said, exit holes size and positioning can be

adapted to the specific fuel type which is anticipated to be provided during operation.

[0029] In an embodiment more than two holes of the at least one first hole of the first fluid channel may be arranged substantially on a straight line. Additionally or alternatively more than two holes of the at least one second hole of the second fluid channel may be arranged also on a straight line. The mentioned two straight lines may be optionally a common straight line. Note that deviations from a perfect straight line obviously are also possible.

[0030] The geometrical orientation of the at least one first hole and of the at least one second hole may be the same, i.e. the direction of the holes into the burner space is identical. This is particularly advantageous in case that the burner component is part of a swirler vane as the direction of injection into a passing by air flow may be from a preferred angle, for example an injection of fuel into a perpendicular air flow through a swirler passage between two swirler vanes.

[0031] Nevertheless there may be also examples to not align all holes on a line. For a cylindrical fuel lance it may be advantageous to have the at least one first hole and of the at least one second hole distributed around the circumference. So at least two of the at least one first hole may be arranged on a spiral manner.

[0032] In an embodiment the plurality of holes of the at least one first hole may define a first surface pattern of outlets on a surface of the burner component, and the plurality of holes of the at least one second hole may define a second surface pattern of outlets on a surface of the burner component. A first layout of the first surface pattern and a second layout of the second surface pattern may be different to another. "Layout" is understood as distribution of holes on a surface, a number of holes, and distances between adjacent holes. Possibly the first fuel may have advantageously a specific number of exit holes in a specific distance to another to allow optimal operation - i.e. low NOx emission, stable combustion without flashbacks, etc. - with the first fuel, whereas a different number of exit holes and/or different specific distances will be used for the second fluid channel for operation with a second fluid, so to guarantee also optimal operation for the second fluid.

[0033] If all of the at least one first hole have identical size this would mean that possibly different amount of fuel is ejected due to different local pressure of the first fluid within the first channel. To configure proper amount of ejected fuel considering a given pressure for the supply of the first fluid, several of the at least one first hole may have different first hole diameters. Additionally or alternatively also the passage cross section of the first channel can be reduced in size along a length of the first channel.

[0034] If the at least one first hole has a first hole diameter and the at least one second hole has a second hole diameter, the second hole diameter may be different to the first hole diameter, possibly optimised for the se-

lected first and second fluid. For example, considering the holes are arranged in an order in direction of a fluid flow through the respective fluid channels, an initial hole of the at least one first hole may have a different diameter than an initial hole of the at least one second hole, a consecutive hole of the at least one first hole may have a different diameter than a consecutive hole of the at least one second hole, and so forth.

[0035] Not yet mentioned, but the manufacturing of the burner component could be complex. Therefore it is proposed that the separating barrier may be integrally formed within the burner component and produced via additive manufacturing, sometimes called 3D printing. Preferably a powder based system may be considered, like selective laser melting (SLM) or selective laser sintering, wherein successive layers are selectively fused to build a body of the burner component. Particularly walls of the first fluid channel, wall of the second fluid channel, and the helically shaped separating barrier are physically fused together, while void spaces forming conduits for the first fluid channel, the second fluid channel, the at least one first hole, and the at least one second hole will only be filled temporarily with loose powder which will be removed again during the manufacturing process.

[0036] As already indicated, the invention is directed to at least two channels that are twisted about another. The channels may be arranged in form of a double helix. If a terminology is used that is common in the field of threads, e.g. for screws and bolts, this twisted design defines a double-start or a multiple-start thread. The "start" can be considered the inlets to the fluid channels at a supply end.

[0037] "Double-start" means that exactly two channels are part of the twisted design. In other words, two barriers are turned around a central line of symmetry and define the separating barrier. A "double-start thread" may also be called "double thread screw".

[0038] "Multiple-start" means that multiple channels are part of the twisted design. In consequence also multiple barriers are turned around a central line of symmetry and define the separating barrier.

[0039] Other terminology from the field of threads to define this design are "lead" and "pitch". "Lead" defines the distance taken in direction of the central line until when a specific fluid has performed one complete 360° rotation about the central line. "Pitch" defines substantially the distance taken in direction of the central line between the two barriers. "Pitch" is the distance from a crest of one thread of the separating barrier to the next crest.

[0040] So far it has been mentioned that the separating barrier is twisted about a central line. In this case the shape is quite equal to a helicoid as defined in Geometry as mathematical science.

[0041] Thus the separating barrier may comprise at least two helicoid walls twisted around a common centre line, the two helicoid walls being displaced to another along the common centre line. This may also be called

"closed right ruled generalized helicoid".

[0042] It may also be that the separating barrier is wrapped around a central cylinder. In this case the shape is similar to a cylinder with an external thread applied on its lateral surface.

[0043] The invention is not only directed to a burner component, but also to a burner as such, particularly a burner of a gas turbine engine. Such a burner may have multiple swirler vanes which are arranged according to the previously explained design. The swirler vanes may be arranged about a burner axis and define swirler passages for air into which the first fluid is provided via the first fluid channel and a second fluid is provided via the second fluid channel, both fluids being injected into the swirler passages during operation.

[0044] The swirler vanes may be arranged about a burner axis. The swirler may be an axial or a radial swirler. Alternatively the swirlers may be angled such that to the burner axis.

[0045] Additionally or alternatively to these swirler vanes, such a burner may have a fuel lance that is equipped with the inventive fluid channel design.

[0046] Furthermore the inventive features can also be used in a fuel rail embedded in a body of the burner.

[0047] The invention is also directed to a method of manufacturing. As previously mentioned, the helically shaped separating barrier may be additively manufactured. Particularly it will be generated as helicoid about a centre line. The helicoid shape is especially suitable for additive manufacturing because it develops upward in a way that there is always a lower layer of material available to add the new layer. Typically undercuts can be problematic for powder based additive manufacturing, but as for the helicoid adds each new layer has an underneath layer and is only slightly overhanging the underneath layer, the helicoids can be produced with additive manufacturing, particularly if the expanse of the helicoids is oriented vertically to a base plate upon which the burner component is generated.

[0048] Several swirlers and/or a fuel lance may be generated on one common additive manufacturing generation process. If the swirlers are angled in respect of a burner axis - and the burner axis being a vertical to the base plate - the helicoids may not be generated vertically to the base plate but with a slight angle. A 25° deviation from the vertical may be possible so that the gentle overhung structures can be generated, as each layer of the layer by layer generation shows only a slight overhang.

[0049] The invention is also directed to a method of operation of a burner. In that method the first fluid channel and the second fluid channel can be individually controlled. The method comprises the steps of: supplying a first fluid, particularly a first fuel or purging air, to the first fluid channel; supplying a second fluid, particularly a second fuel or purging air, to the second fluid channel; exhausting the first fluid from the first fluid channel via the at least one first hole into the burner space; and exhausting the second fluid from the second fluid channel via the at least

one second hole into the burner space.

[0050] Fuel can be provided only via a single one of the fluid channels at a given time, the other channel being purged with air or non-reactive fluid.

5 **[0051]** In another mode operation both fluid channels may be used to supply a main fuel via the first fluid channel and a pilot fuel via the second fluid channel.

[0052] In another mode operation both fluid channels may be used to supply a gaseous fuel - e.g. natural gas - via the first fluid channel and a another type of fuel - e.g. liquid fuel - via the second fluid channel.

10 **[0053]** In another mode operation both fluid channels may be used to supply the same type of fuel via both fluid channels, but the amount of supply being separately controllable.

15 **[0054]** Furthermore, one of the fluid channels can also be used to inject water into a burner space.

[0055] Particularly for most of the mentioned modes of operation, the method of operation may comprise the further steps of: throttling or increasing supply of the first fluid to the first fluid channel; and/or switching over the first fluid between the first fuel and the purging air; and/or throttling or increasing supply of the second fluid to the second fluid channel; and/or switching over the second fluid between the second fuel and the purging air.

20 **[0056]** The term "purging air" is used to indicate that the respective channel shall be evacuated from a previously used fuel and that no fluid enters the respective channel via its exit holes in an opposite direction. Nevertheless the fluid channels can be used to specifically to inject air into the burner space to modify the swirl in the burner or to change intentionally a local fuel concentration in the burner space.

25 **[0057]** It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this application.

30 **[0058]** The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

35 **[0059]** Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, of which:

- FIG. 1: shows schematically a burner component according to the invention;
 FIG. 2: shows sectional view of an exemplary burner incorporating the invention;
 FIG. 3: shows a detailed sectional view of a section of the burner shown in FIG. 2;
 FIG. 4: shows a more detailed sectional view of a section of the burner shown in FIG. 2;
 FIG. 5: shows a three dimensional view of the burner shown in FIG. 2 with the inventive fuel supply at three different locations at the burner.

[0060] The illustration in the drawing is schematical. It is noted that for similar or identical elements in different figures, the same reference signs will be used.

[0061] Some of the features and especially the advantages will be explained for an assembled and operating combustor or an assembled and operating gas turbine engine, but obviously the features can be applied also to the single components of the gas turbine but may show the advantages only once assembled and during operation. But when explained by means of a gas turbine during operation none of the details should be limited to a gas turbine while in operation.

DETAILED DESCRIPTION OF THE INVENTION

[0062] Referring now to FIG. 1, a burner component 10 is depicted in a simplified embodiment in a magnified drawing. The further figures then show more realistic embodiments. Particularly an exterior shape of the burner component 10 is shown in FIG. 1 merely as a cylinder. This may be true for some real life embodiments, e.g. if the burner component 10 is a fuel lance, but in other embodiments the exterior shape may be more complex, e.g. when the burner component 10 is a swirler vane of a passage through a burner body.

[0063] The burner component 10 shows a helically shaped separating barrier 40 which separates two fluid channels that are twisted around each other along a centre line 41, which could be considered to be a central axis.

[0064] The two fluid channels are the first fluid channel 21 and the second fluid channel 22. Each of these channels define a corkscrew-like channels to guide fluids, likes gases, liquids, or mixtures of both. The first fluid channel 21 is arranged to guide a first fluid 23 - indicated by an arrow. The first fluid 23 is particularly a first fuel, e.g. a gaseous fuel with a specific Wobbe Index and/or further parameters. The first fluid 23 could also be air, water, or a liquid fuel. The first fluid 23 could be specific kind of natural gas. The second fluid channel 22 is arranged to guide a second fluid 24 - indicated again by an arrow. The second fluid 24 is particularly a second fuel, e.g. a gaseous fuel with a different specific Wobbe Index and/or different further parameters. The second fluid 24 could also be air, water, or a liquid fuel. The second fluid 24 could be specific kind of natural gas.

[0065] The first fluid 23 and the second fluid 24 are

particularly different to another.

[0066] That means that the properties of the first fluid 23 and the second fluid 24 are different at a specific point in time.

5 **[0067]** The second fluid channel 22 is free of passages to the first fluid channel 21. Thus, the channels are distinct or separate to another. No mixing of the fuels occurs within the mentioned channels. This allows providing different types of fluids and/or different amount of fluids through the channels.

10 **[0068]** The footprint of the channels, as they are arranged helically, is small so that these channels can be incorporated in small components.

15 **[0069]** The first fluid channel 21 and the second fluid channel 22 are provided to deliver a fluid to specific locations at a combustor surface so that the delivered fluids can be ejected into a combustion chamber or any other location - e.g. a passage, like a swirler passage - within the combustor. To allow ejecting fluids, the burner component 10 comprises at least one first hole 25 - in FIG. 1 only one hole 25 is depicted but more could be present - to provide a first passage from the first fluid channel 21 through a wall 30 of the burner component 10 for supplying the first fluid 23 into a burner space 31 during operation. Furthermore, the burner component 10 comprises at least one second hole 26 - in FIG. 1 two holes 26 are depicted but a different number could be present - to provide a second passage from the second fluid channel 22 through the wall 30 of the burner component 10 for supplying the second fluid 24 into the burner space 31 during operation.

25 **[0070]** The first fluid channel 21 and the second fluid channel 22 are delimited in the shown example by the wall 30 that follows substantially a tubular shape in which the helically shaped separating barrier 40 is located. The wall 30 may also have a different form.

30 **[0071]** The distribution of the at least one first hole 25 and the at least one second hole 26 may be such that the injection of the guided fluids happens at different locations into the burner space 31. The locations of these holes may be predefined such that the burner can adapt to different types of fuels, assuming that a stable combustion is preferred. Also the size of these holes can be predefined such that the burner is adapted to different types of fuels. For example a low calorific fuel as a first type of fluid may be supplied via the first fluid channel 21 while the second fluid channel 22 is only purged by air. If switchover to a high calorific fuel as a second type of fluid is wanted, then the first fluid channel 21 may be purged with air and the second fluid channel 22 can deliver this high calorific fuel. As the locations and size of the holes are different for both channels, the combustion can be optimised for both types of fuels.

35 **[0072]** This is particularly advantageous for dry low emission (DLE) burners in which a variation between differently supplied fuels allows stable combustion for the different fuels, as the hole positions and/or dimensions are optimised in order to avoid combustion noise or flash-

back problems. The same burner can be used, but the different fluid channels will be supplied with different fluids.

[0073] Without the invention, modification of the main gas holes which are optimised in positioning and/or dimensioning for natural gas. These holes are not optimal for different fuels. The problem with fixed holes for different fuels is that the gas fuel flexibility of the burner is limited by the existing main gas holes positioning and/or dimensions.

[0074] According to FIG. 1 the at least one first hole 25 has a first hole diameter 42 and the at least one second hole 26 has a second hole diameter 43 different to the first hole diameter 42. Particularly the holes sizes (42 versus 43) may be different by 5% to 40%. The appropriate size may be calculated or determined by experiments.

[0075] According to FIG. 1 the two helically formed fluid channels (21 and 22) extend along the centre line 41. The distribution of a plurality of the first holes 25 and a plurality of the second holes 26 is different to another. A first one of the second holes 26 may be in between two consecutive ones of the first holes 25, as shown in FIG. 1.

[0076] The orientation of the holes according to FIG. 1 is in the same direction. That means that all holes are arranged on a straight line. It may be advantageous though if the holes may be injecting the fluids into the burner space 31 in a different angle. In that case at a plurality of the first holes 25 are arranged on a first line, while the plurality of the second holes 26 are arranged on a second line, wherein these two lines are not identical.

[0077] According to FIG. 1 the separating barrier 40 comprises at least two helicoid walls 50 and 51 that are twisted around the common centre line 41. The two helicoid walls 50, 51 are displaced to another along the common centre line 41. If this structure is compared to the technology of threads this configuration would be called a double-start thread. Possibly - but not shown - more than two fluid channels can be twisted about the centre line 41. This configuration would be called a multiple-start thread.

[0078] It may be advantageous if the separating barrier 40 is integrally formed within the burner component 10, particularly produced via additive manufacturing. One advantageous technique is called selective laser melting (SLM). The helicoids shape would be especially suitable for additive manufacturing because it develops upward in a way that there is always a lower layer of material available to add the new layer during manufacturing.

[0079] A powder based additive manufacturing process may be performed such that the wall 30 and the helically shaped separating barrier 40 are generated layer by layer such that powder is distributed and a laser fuses a layer of powder with an underlying solidified structure. This will be performed repetitively layer by layer. For the helically shaped separating barrier 40 the laser for fusing of a layer of powder is slightly repositioned after every

layer so that layer by layer a helicoids structure is generated. The helically shaped separating barrier 40 will be formed as one solid component together with the wall 30. Further parts of the burner component 10 may also be generated by additive manufacturing in the same manufacturing process. For example a complete swirler wing may be generated as one single component. Possibly even the complete swirler comprised of several swirler wings could be generated in an additive manufacturing process. Finally, even a complete burner including one or several of these inventive structures can be generated in an additive manufacturing process so that the complete burner is one single solid component.

[0080] In reference to FIG. 1 previously the basic concept was explained. The following figures now show how this solution can be incorporated in different burner designs.

[0081] In FIG. 2 a burner is shown in a sectional view which is attached to a combustion chamber 309. FIG. 5 shows the same burner in a three dimensional view. The burner comprises a fuel lance 304 and a swirler with swirler wings 303. Via the fuel lance 304 a central gaseous fuel may be provided via holes 301 located at the fuel lance 304. The swirler wings 303 - also called as swirler vanes - define passages for air between the swirler wings 303. So called main gaseous fuel may be provided via holes 300 on the swirler wings 303. Both, the fuel lance 304 and the swirler wings 303, or each element individually, can be equipped with a helicoid fuel supply as explained in accordance with FIG. 1.

[0082] The exemplary burner of FIG.2 and FIG. 5 shows further downstream a mixer 305 in which the air and fuel can continue to mix. Holes 306 for air may be located at a surrounding wall of the mixer 305. These holes 306 allow to generate a film cooling effect, as expressed by arrows for film cooling air 307. A burner tip 308 follows the mixer 305. A wall of the burner tip 308 may optionally also be equipped with a helicoid fuel supply for pilot fuel as explained in accordance with FIG. 1. Therefore pilot fuel could be guided via inner channels or inner manifolds embedded in a body of the burner tip 308. Pilot fuel injectors 302, provided with fuel via the embedded helicoids fuel supply (which is not shown in FIG.2 but later indicated in FIG. 5) are also indicated in FIG. 2.

[0083] In operation a main flame 310 and pilot flames 311 will be established within the combustion chamber 309.

[0084] FIG. 3 shows an enlarged cross section of the swirler. In FIG. 3 the swirler wings are referenced by numeral 100. Each swirler wing 100 is burner component 10, as previously introduced. One swirler wing 100 at the top of the figure shows a cross section of the two twisted fluid channels 21 and 22, as introduced in accordance with FIG. 1. A second cross section is shown for a further swirler wing 100 which is position at a downward position in FIG. 3. The latter swirler wing 100 also shows several first holes 25 and several second holes 26. In the exam-

ple, and depicted from left to right, two holes 25 follow another, and afterwards the holes 25 and 26 are arranged alternately. This is just an example how the holes could be positioned differently to another.

[0085] A third swirler wing 100 is shown substantially in the middle of the FIG.3. For that swirler wing 100, which is not shown in a sectional view as its position is behind the drawing plane, only the holes 25 and 26 are shown on a surface of the swirler wing 100. In the example all holes are arranged on a common line on the surface of the swirler wing 100. To better understand the orientation of the different swirler wings 100, FIG. 5 should be consulted.

[0086] As seen in FIG. 3 the two fluid channels 21 and 22 have different cooling holes positions. The distance between each of the first holes 25 may be the same for all first holes 25. Alternatively the distance between each of the first holes 25 may change along a length of the first fluid channel 21. Hole sizes of all the first holes 25 could possibly be identical, but in a preferred way the hole sizes may be differing along the length of the first fluid channel 21. The hole sizes may be optimized according to the flow in the burner space 31 and also to the wanted local pressure in the fluid channels 21 and 22. Just as a pure example, a first one of a set of first holes 25 may have a diameter of 1.4 mm, a second one of 1.5 mm and a third one of 1.6 mm. Other values may be appropriate.

[0087] All these just mentioned options - equidistant distances or differing distances of the holes, as well as hole size options - are also valid for the second holes 26.

[0088] Hole sizes of the first holes 25 and the second holes 26 may be different to another. For example, the most upstream first hole 25 may have a different diameter than the most upstream second hole 26, the consecutive next first hole 25 may have a different diameter than the consecutive next second hole 26, etc.

[0089] According to FIG. 4 a further magnified view of two swirler wings 100 are shown, including the supply of fuel. Two different fuel supplies are indicated by arrows, leading into the first fluid channel 21 and the second fluid channel 22. The helicoids structure inside the swirler wing 100 is indicated in a cross sectional view for one of the swirler wings 100. For a second swirler wing 100, the helicoid internal structure for the first fluid channel 21 and the second fluid channel 22 is only indicated by dashed lines. On that swirler wing 100 the plurality of holes 25 and 26 are indicated.

[0090] Not explicitly shown, the hole sizes of several holes 25 may be different to another, to guarantee the proper pressure of the first fluid 23 through the holes 25. The hole sizes of several holes 26 may also be different to another, again to guarantee the proper pressure of the second fluid 24 through the holes 26.

[0091] FIG. 5 now shows such a burner 105 in a three dimensional view. In a swirler section 101 swirler wings 100 are shown. A burner space 31 may be represented by passages between the swirler wings 100 and/or by a

central void between the swirler wings 100. The swirler wings 100 again define the burner component 10. Outlet holes 25 and 26 are indicated in one of the swirler wings 100. The internal helicoid first and second fluid channels (21 and 22) are indicated by dashed lines.

[0092] The mixer 305 including its holes 306 is located in a mixing section 102, followed by a burner tip section 103.

[0093] In the burner tip section 103, several holes are present that again could be provided with fluids via helicoid passages.

[0094] A inwardly facing surface of the burner tip section 103 may be equipped with first holes 25' and second holes 26'. A wall of the burner tip section 103, in which these holes are located, defined a burner component 10' as defined in accordance with FIG. 1. For example different types of pilot fuel may be provided via the holes 25' and 26'. Alternatively air may be injected via these holes to enhance the turbulence. As a further option, water or another fluid may be injected via the holes 25' and 26'. This configuration allows injection of a specific fluid via the holes 25' while another fluid may be injected via holes 26'. An internal helicoid structure is indicated by a first fluid channel 21' and a second fluid channel 21' via dashed lines.

[0095] Very similar to the previous paragraph, a front face of the burner tip section 103 may also be equipped with first holes 25" and second holes 26". A wall of the burner tip section 103, in which these holes are located, defined a burner component 10" as defined in accordance with FIG. 1. For example different types of pilot fuel may be provided via the holes 25" and 26". As a further option, water or another fluid may be injected via the holes 25" and 26". This configuration allows injection of a specific fluid via the holes 25" while another fluid may be injected via holes 26". An internal helicoid structure is indicated by a first fluid channel 21" and a second fluid channel 21" via dashed lines.

[0096] Thus, in FIG.3 three different locations are shown in which the inventive helicoids structure could be incorporated.

[0097] FIG. 6 shows a different type of burner 105. A swirler vane 100' may be present, which incorporates a burner component 10, that defines two internal fluid passages as defined in accordance with FIG. 1. The helicoids fluid channels are indicated by a fuel supply line with reference numerals 21 and 22 identifying the first fluid channel 21 and the second fluid channel 22.

[0098] The inventive helicoid multi fuel supply can be used for different kinds of burner designs. As the geometrical expanse of that helicoids structure is small, it can be included in all kinds of burner components, like fuel lances, fuel rails, swirler vanes, different body party of a burner.

[0099] The invention is advantageous as at least two different fluids can be provided to a burner space. For example the invention can use a main gas channel and an additional main gas channel, the latter to provide the

possibility to add extra injection holes on the burner wings and therefore adapt the hole positioning and/or dimensioning to the needs of the transported additional gas. Fuels with slightly different compositions can be guided through the two distinct channels. The invention is particularly advantageous if two fuels are supplied with very different properties, like natural gas provided via the first fluid channel and a highly reactive fuel like hydrogen via the second fluid channel.

[0100] The holes for injecting fuel into a burner space can be positioned in a way that a design optimised for natural gas can be left unchanged because the other fuel is supplied via the other fluid channel. A control software can switch between main fuel feeding depending on the fuel that needs to be burnt. If one fluid channel is inactive, it may be purged with air. Purging with air may be performed that no combustion fluids can enter - by a reverse flow - a channel that is substantially inactive.

[0101] The additive manufacturing allows new opportunities in the possible shapes to be used for the main gas channels and this invention take advantage of this. The current space allowed for the main gas channel is therefore divided between the first fluid and the second fluid without interfering with the injection holes diameter and/or positioning by using a helicoidally shaped wall between the first and second fluid channel. The helicoids shape is especially suitable for additive manufacturing because it develops upward in a way that there is always a lower layer of material available to add the new layer. The division of two main gas channels by the use of a helicoid allows to maintain untouched the predesigned natural gas injection holes while adding extra possible locations for having further injection holes for a second fluid.

[0102] Advanced DLE burners will maintain higher capabilities on natural gas compositions but at the same time operation can be expanded to other gas compositions without having limits imposed by the natural gas injection holes. During operation fuel supply can easily be switched between a first and a second fuel depending on the fuel that is to be used. The presented features allow expanding an designed fuel flexibility range, i.e. a larger range of Wobbe index or a larger range of hydrogen concentration, that would otherwise (if only one single channel is provided in a burner with only one set of injection holes) be limited by having only one set of fuel injection holes. A combustor can meet continuously very low NOx emission even when operating on different fuels, for which different fuel injection holes positions and/or dimensions are needed.

[0103] To recapture, the two fluid channels with different fluid injection holes can be used for several modes of operation:

- Running a machine on a specific type of fuel but be flexible if a different type of fuel is provided to the burner (in a switchover during operation or after a restart).

- Both channels can be used during operation, but the fuel supply is controlled based on the load of the engine. In this situation possibly also the same fuel type is used but one has the function of a main fuel and one of a pilot fuel, both separately controllable.
- One fluid channel can be used to supply natural gas, one fluid channel is optimised to supply diesel or another type of fuel, for example hydrogen.
- One fluid channel can be used to supply low Wobbe index fuels, one fluid channel is optimised for high Wobbe index fuels.
- The second channel can be initially inactive and be activated, particularly if a low Wobbe index fuel is supplied via the first channel, during operation once a specific pressure level in the first channel has been reached.
- One channel can be designed to explicitly guide air to allow air cooling or fuel/air mixing at locations that were not easily accessible without the invention.
- Optimised combustion in respect of flashbacks and combustion noise particularly due to defined fuel velocity and to defined heat load of the fuel as a result of specific hole diameter for the different fluid channels.
- The hole pattern and the hole diameters can be adapted to different physical behaviours of different fuels.

Claims

1. Burner component (10), particularly a swirler vane (100) or a fuel lance (304) for a burner of a gas turbine engine, comprising

- a first fluid channel (21) to guide a first fluid (23), particularly a first fuel, during operation;
- a second fluid channel (22) to guide a second fluid (24), particularly a second fuel, during operation, the second fluid channel (22) being free of passages to the first fluid channel (21);
- at least one first hole (25) to provide a first passage from the first fluid channel (21) through a wall (30) of the burner component (10) for supplying the first fluid (23) into a burner space (31) during operation;
- at least one second hole (26) to provide a second passage from the second fluid channel (22) through the wall (30) of the burner component (10) for supplying the second fluid (24) into the burner space (31) during operation;

characterised in that

the burner component (10) further comprises a helically shaped separating barrier (40) between the first fluid channel (21) and the second fluid channel (22).

2. Burner component (10) according to claim 1,
characterised in that
the helically shaped separating barrier (40) is twisted
around a centre line (41) and
inner surfaces (32) of the wall (30) of the first fluid
channel (21) and of the second fluid channel (22)
follow together substantially a tubular shape. 5
3. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
more than two holes of the at least one first hole (25)
are arranged on a straight line; and/or
more than two holes of the at least one second hole
(26) are arranged on a straight line; and/or
more than two holes of the at least one first hole (25)
and of the at least one second hole (26) are arranged
on a common straight line. 10 15
4. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the plurality of holes of the at least one first hole (25)
define a first surface pattern of outlets on a surface
of the burner component (10), and
the plurality of holes of the at least one second hole
(26) define a second surface pattern of outlets on a
surface of the burner component (10), and
a first layout of the first surface pattern and a second
layout of the second surface pattern are different to
another. 20 25 30
5. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the at least one first hole (25) has a first hole diameter
(42) and the at least one second hole (26) has a
second hole diameter (43) different to the first hole
diameter (42). 35 40
6. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the separating barrier (40) is integrally formed within
the burner component (10) and produced via additive
manufacturing. 45
7. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the first fluid channel (21), the second fluid channel
(22), and the separating barrier (40) define a multi-
ple-start thread, particularly a double-start thread. 50
8. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the separating barrier (40) comprises at least two
helicoid walls (50, 51) twisted around a common cen-
tre line (41), the two helicoid walls (50, 51) being
displaced to another along the common centre line
(41). 55
9. Burner component (10) according to one of the pre-
ceding claims,
characterised in that
the first fluid channel (21) and the second fluid chan-
nel (22) are arranged in form of a double helix.
10. Burner (105) for a gas turbine engine,
characterised in that
the burner comprises a plurality of burner compo-
nents (10) defined according to one of the claims 1
to 9, each shaped as swirler vanes (100),
the swirler vanes (100) arranged about a burner axis
and define passages for air into which a first fluid
(23) provided via the first fluid channel (21) and a
second fluid (24) provided via the second fluid chan-
nel (22) are injected during operation.
11. Method of manufacturing of a burner component (10)
as defined in one of the claims 1 to 9,
comprising the steps of:

additively manufacturing the burner component
(10) layer by layer such that the helically shaped
separating barrier (40) is generated as helicoid
about the centre line (41).
12. Method of manufacturing according to claim 11,
characterised in that
an orientation of the centre line (41) is in a direction
with a maximum of 25° deviation from the vertical.
13. Method of operation of a burner (105), the burner
(105) comprising a burner component (10) as de-
fined according to one of the claims 1 to 9,
the method comprising the steps of:

- supplying a first fluid (23), particularly a first
fuel, to the first fluid channel (21);
- supplying a second fluid (24), particularly a sec-
ond fuel or purging air, to the second fluid chan-
nel (22);
- exhausting the first fluid (23) from the first fluid
channel (21) via the at least one first hole (25)
into the burner space (31);
- exhausting the second fluid (24) from the sec-
ond fluid channel (22) via the at least one second
hole (26) into the burner space (31).
14. Method of operation according to claim 13,
the method comprising the further steps of:

- throttling or increasing supply of the first fluid
(23) to the first fluid channel (21); and/or

- switching over the first fluid (23) between the first fuel and the purging air; and/or
- throttling or increasing supply of the second fluid (24) to the second fluid channel (22); and/or
- switching over the second fluid (24) between the second fuel and the purging air.

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FIG 1

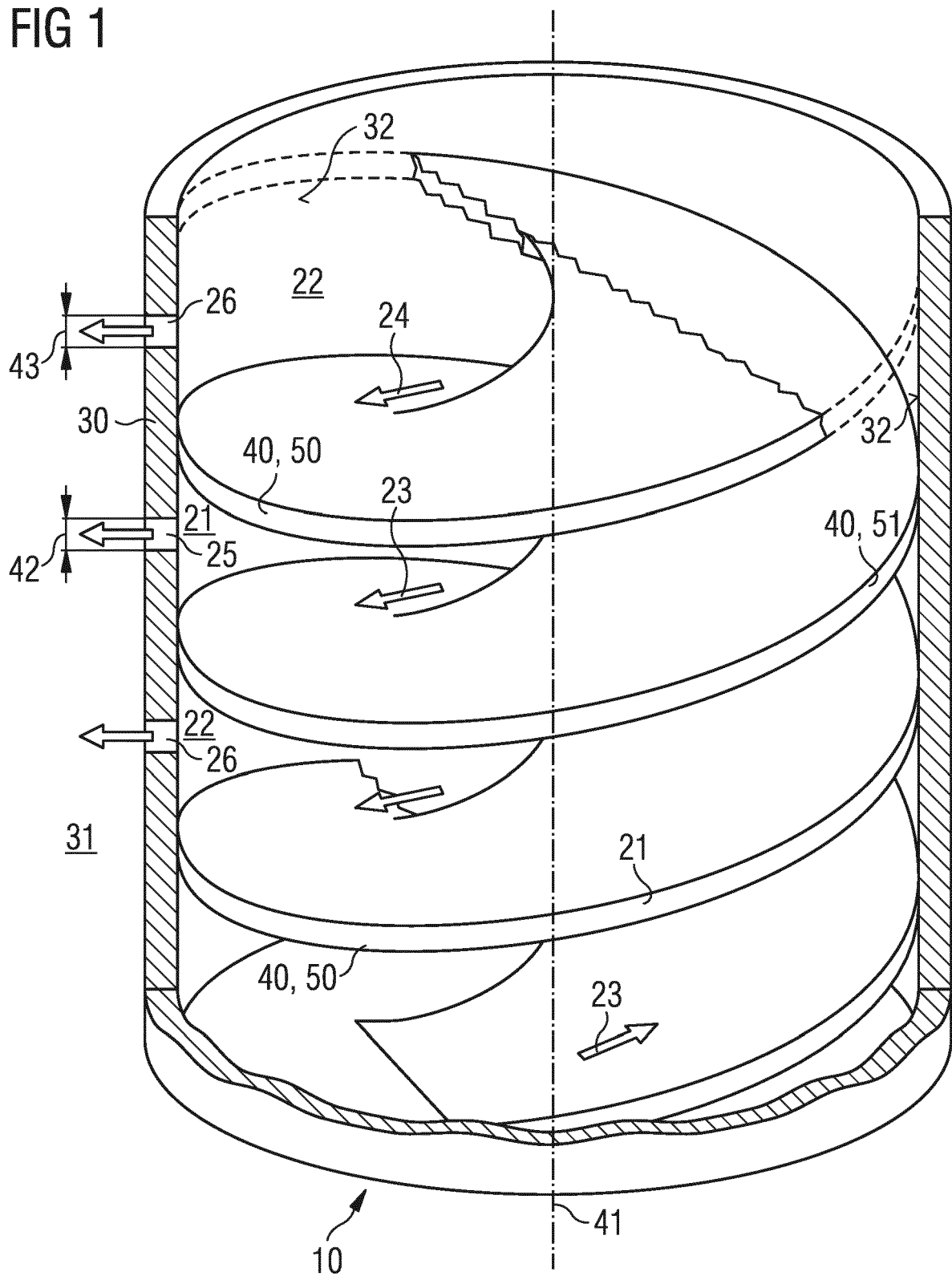


FIG 2

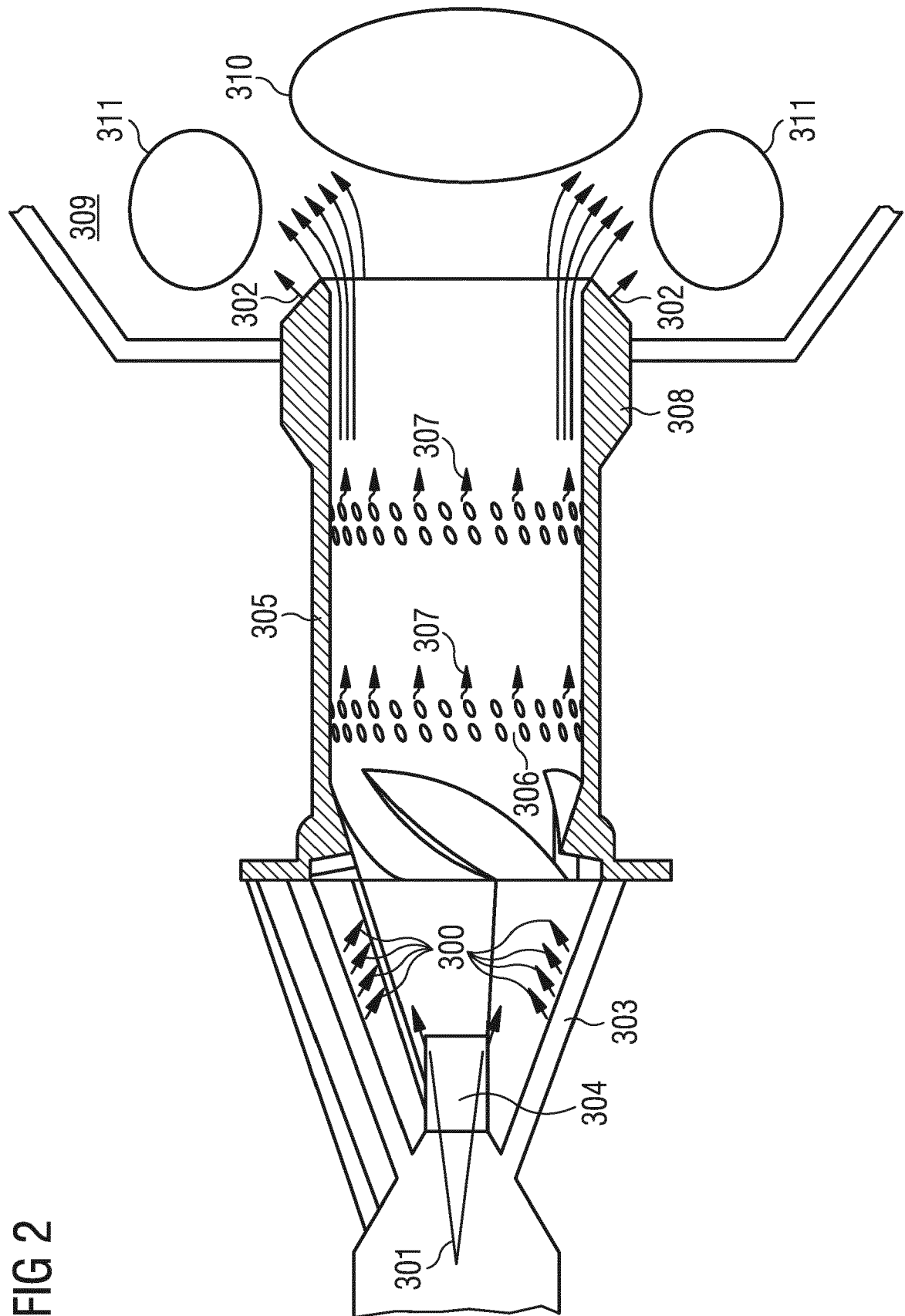


FIG 3

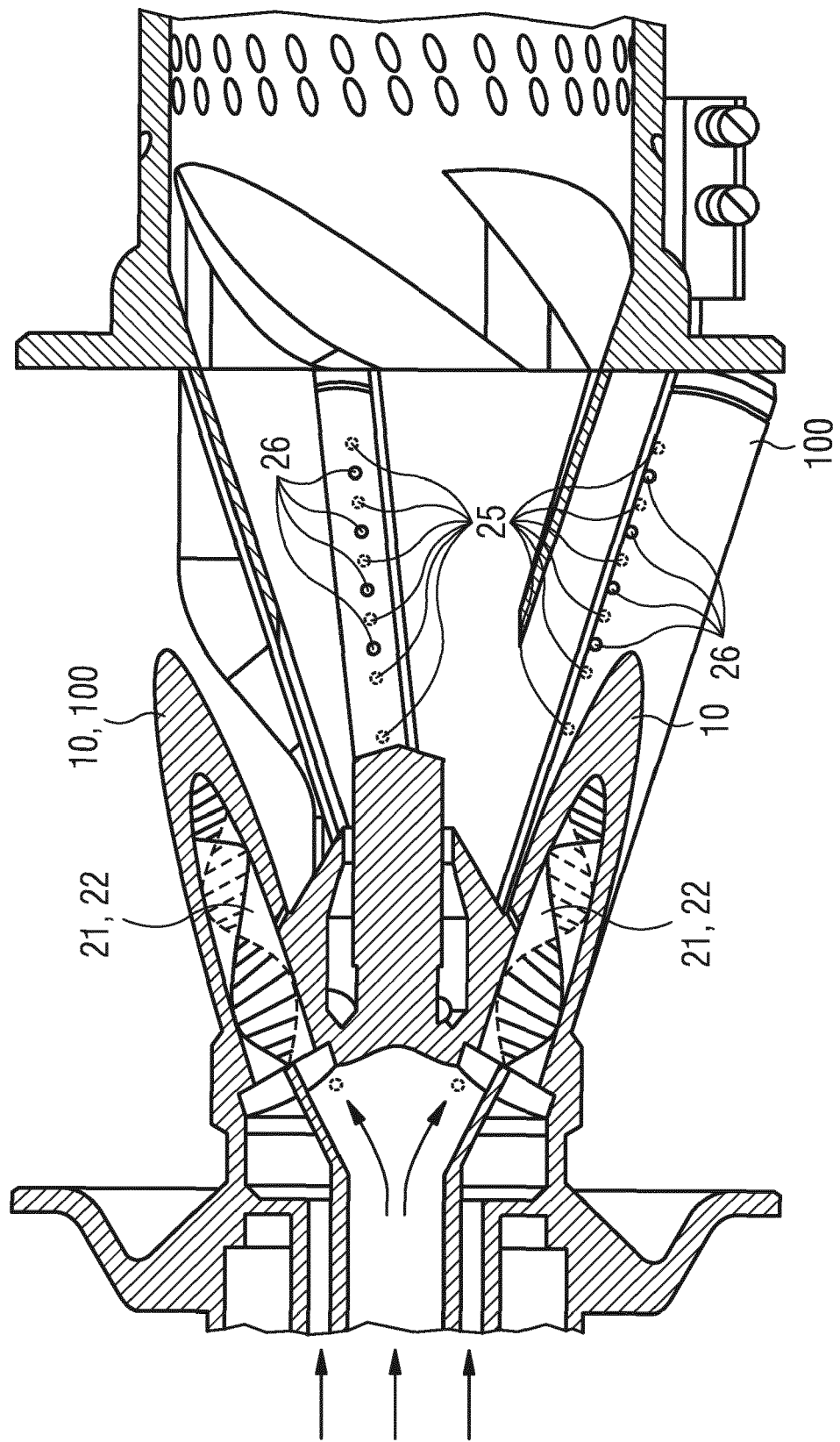


FIG 4

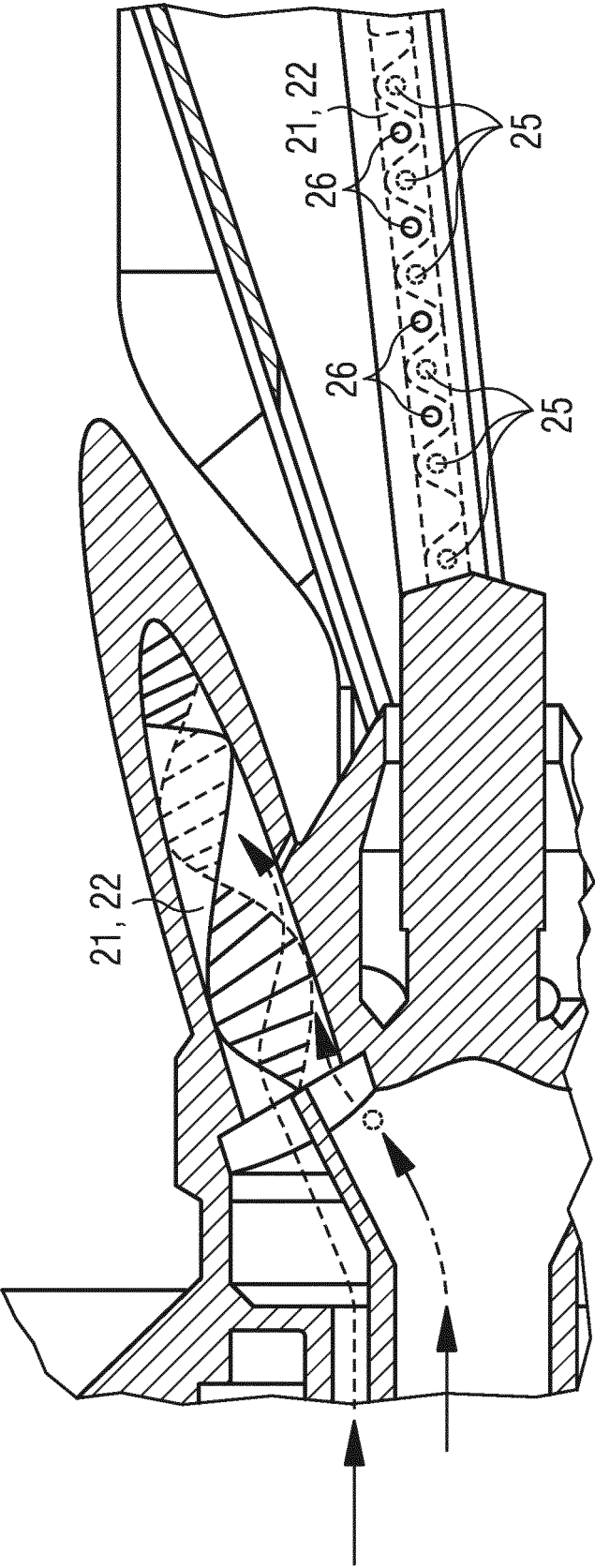


FIG 5

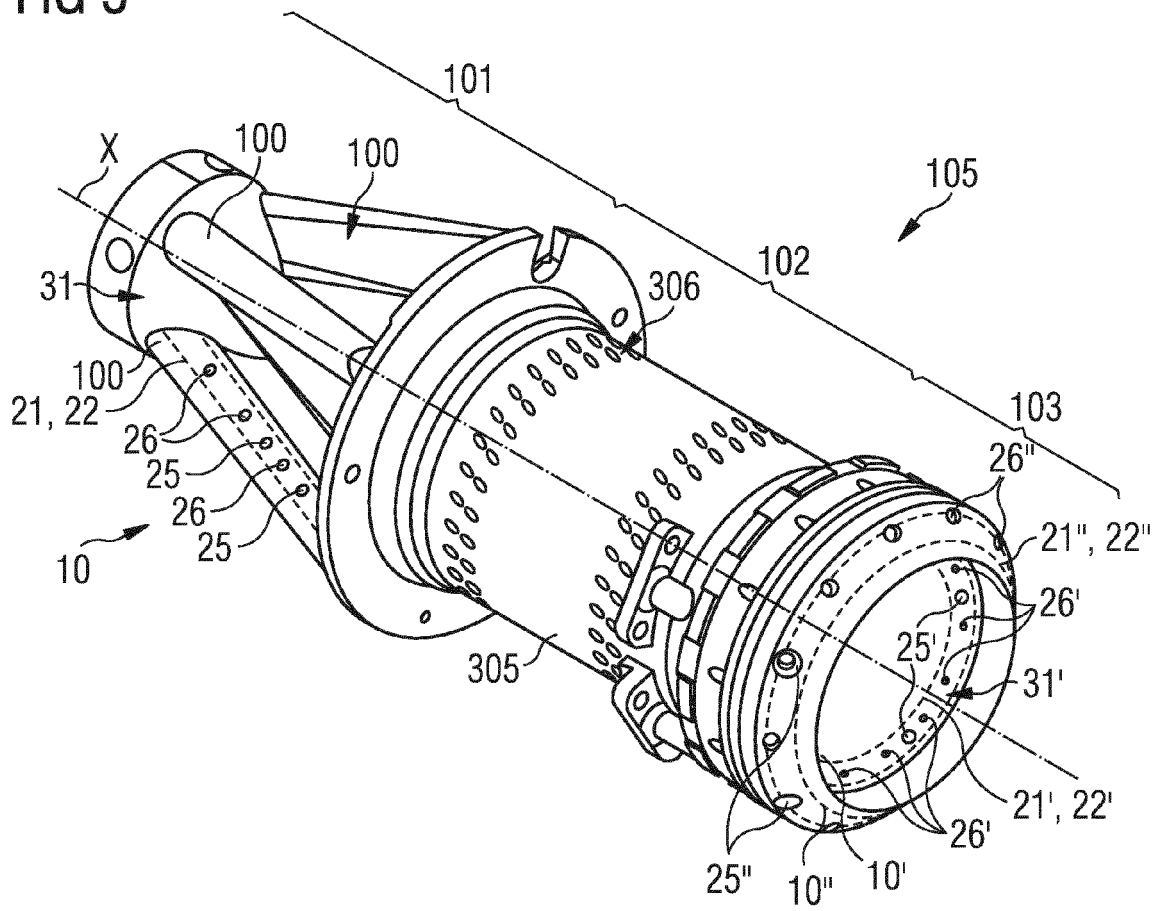
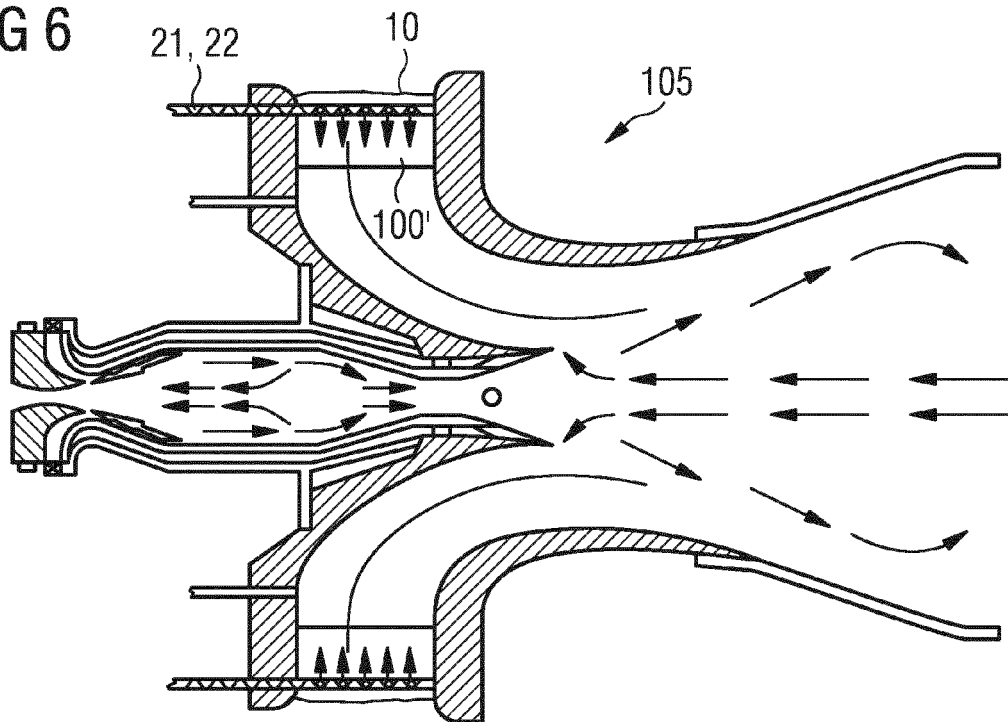


FIG 6





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Application Number
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Place of search The Hague		Date of completion of the search 31 October 2016	Examiner Harder, Sebastian
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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