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(54) **Fuel lance for a burner**

(57) The present invention relates to a lance (6) for the introduction of gaseous fuel into a burner (1), in particular premix burner, of a combustion chamber of a gas turbine plant, with a base (7) and a shaft (8) projecting from the latter. In a state in which the lance (6) is installed in the burner (1), the base (7) projects into the burner (1) perpendicularly to a main flow direction (10) prevailing in the burner (1), and the shaft (8) runs parallel to the main flow direction (10). The shaft (8) has at least one nozzle (12) for the introduction of gaseous fuel into the burner (1). The shaft (8) has an axial conical portion (11) tapering with an increasing distance from the base (7).

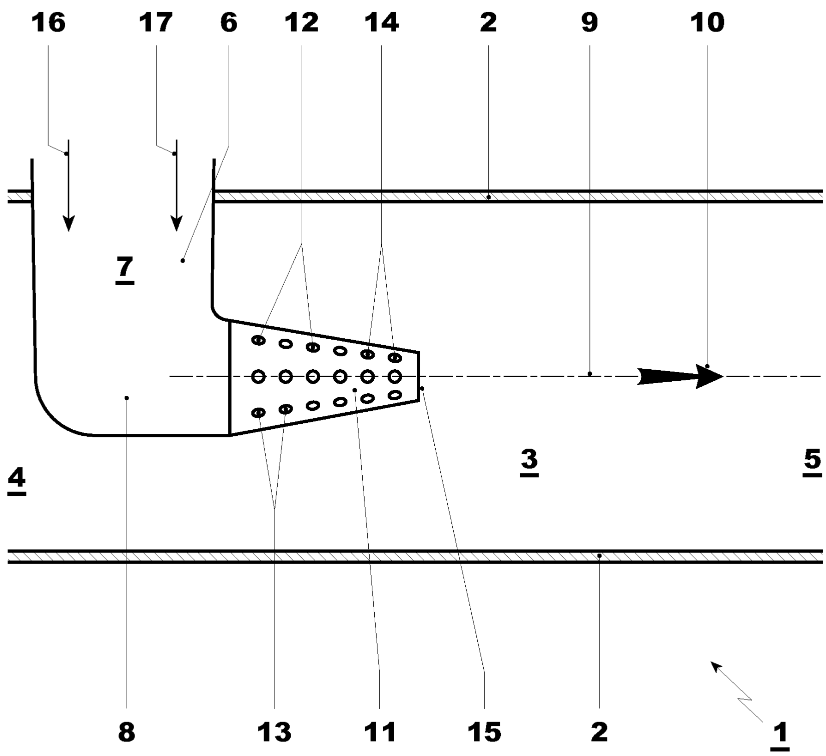

FIG. 1

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Description

Technical field

[0001] The present invention relates to a lance for the introduction of fuel into a burner, in particular into a premix burner, of a second combustion chamber of a gas turbine plant with sequential combustion having a first and a second combustion chamber. The invention relates, moreover, to a burner equipped with a lance of this type.

Prior art

[0002] In burners for combustion chambers of gas turbine plants, a lance may be provided for the introduction of gaseous and/or liquid fuel, for example for pilot operation or for stabilizing the combustion in a combustion space of the combustion chamber. A lance of this type as kwon for example from the DE4326802 may have a base and a shaft projecting perpendicularly from the latter. With the lance installed in the burner, the base extends perpendicularly with respect to a main flow direction prevailing in the burner, while the shaft runs parallel to this main flow direction. For introducing the fuel, the shaft is equipped with at least one nozzle. In this case, even a plurality of nozzles arranged in a row along the shaft in the circumferential direction may be provided, which are in each case configured such that they have for the fuel a main injection direction which is radial with respect to the main flow direction of the burner. The lance shaft usually has a cylindrical configuration.

[0003] Whereas, in a conventional burner, it is usually natural gas which is injected as gaseous fuel with the aid of the lance, in modern burners there is provision for using a fuel gas containing hydrogen gas. A fuel gas of this type may be produced, for example, from long-chain hydrocarbons by means of partial oxidation. This artificially produced fuel gas may therefore also be designated as synthesis gas or syngas. As a rule, such a fuel gas containing hydrogen gas also additionally contains carbon monoxide gas. Such a fuel gas is distinguished, as compared with conventional natural gas, by a significantly increased reactivity which leads to higher reaction temperatures, lower ignition temperatures and higher flame velocities.

[0004] Conventional burners or conventional lances are unsuitable for operation with such a highly reactive fuel gas. The early ignition of this fuel gas prevents the desired mixture formation and increases the risk of flashback. Moreover, if mixture formation is deficient, pollutant emissions rise.

Presentation of the invention

[0005] This is where the present invention comes in. The invention, as characterized in the claims, is concerned with the problem of specifying for a lance of the type initially mentioned or for a burner equipped with it an improved embodiment which is distinguished, in particular, in that it can be operated with a fuel gas containing hydrogen gas or syngas and at the same time has improved intermixing and increased operating reliability.

[0006] This problem is solved, according to the invention, by means of the subjects of the independent claims. Advantageous embodiments are the subject matter of the dependent claims.

[0007] The invention is based on the general idea of configuring an axial portion of the lance conically, specifically such that the shaft portion tapers with an increasing distance from the base. It has been shown that, with the aid of such a conical portion, the mixing behavior of fuel and oxidizer gas in the burner can be influenced positively. In particular, the fuel can be introduced in a directed manner axially, radially and in the circumferential direction in the region of the conical portion, this likewise being advantageous for intensive intermixing. An embodiment is particularly expedient, therefore, in which the at least one nozzle, in particular each nozzle, is arranged on the conical portion. By the respective nozzle being mounted on the conical portion, the respective nozzle, which typically is formed only by an outlet orifice, possesses a main injection direction which is no longer solely oriented radially, as in the case of a cylindrical shaft, but also has an axial direction component. Since the main injection direction is thus inclined toward the main flow direction of the burner, the risk of a contacting of the fuel gas with a burner wall can be reduced, which would lead to an enrichment of fuel gas in the region of the burner wall. Correspondingly, this measure leads to an improved intermixing of fuel gas and oxidizer gas.

[0008] In one embodiment the at least one nozzle has an annular orifice extending as a slit-shaped opening around the conical part of the shaft.

[0009] Basically, a plurality of nozzles may be arranged, distributed, on the conical portion. It is conceivable, for example, to have a row or a plurality of rows of nozzles or outlet orifices arranged next to one another in the circumferential direction. Additionally or alternatively, a plurality of nozzles may also be arranged, spaced apart from one another axially, on the conical portion. With nozzles or outlet orifices spaced apart from one another in the axial direction, the conicity of the conical portion brings about a variation in the distance between the respective outlet orifice and a longitudinal mid-axis of the shaft. If only because of this, an improved three-dimensional propagation of the fuel can be achieved within the burner.

[0010] According to an advantageous embodiment, the lance may be equipped with an introduction device, with the aid of which an inert protective gas can be introduced into the burner. Owing to the directed injection of a protective gas of this type, which, for example, may be nitrogen, early contacting between the fuel gas and oxidizer gas can be avoided, with the result that the ignition timepoint can be delayed. The propagation of the fuel over the entire throughflow cross section of the burner can thereby be assisted.

[0011] In case of dual fuel applications, i.e. burners which are capable of burning gaseous and liquid fuels, additional injection means for injection of the liquid fuel have to be provided. Typically these means are nozzles for the injection of liquid fuel, which are arranged in the lance and for example inject fuel in the main flow direction from the downstream end of the shaft, as known for example from the DE4326802.

[0012] Further important features and advantages may be gathered from the subclaims, from the drawings and from the accompanying figure description with reference to the drawings.

Brief description of the drawings

[0013] Preferred exemplary embodiments of the invention are illustrated in the drawings and are explained in more detail in the following description, the same reference symbols referring to identical or similar or functionally identical components.

[0014] In the drawings, in each case diagrammatically,

Fig. 1 shows a greatly simplified longitudinal section through a burner with a lance,

Figs. 2 to 5 show greatly simplified side views of the lance in different embodiments.

Ways of implementing the invention

[0015] According to Fig. 1, a burner 1 comprises a burner wall 2 which laterally delimits a mixing space 3. On an inlet side 4 of the burner 1, an oxidizer gas flow, in particular an air flow, enters the burner 1 or the mixing space 3. On an outlet side 5, a gas flow leaves the burner 1 or the mixing space 3 and can enter a combustion space of a combustion chamber, not shown. In the mounted state, the burner 1 forms an integral part of said combustion chamber which itself forms an integral part of a gas turbine plant.

[0016] The burner 1 has a lance 6, with the aid of which a gaseous fuel can be introduced into the burner 1 or into the mixing space 3. The fuel gas is preferably a fuel gas containing a hydrogen gas.

[0017] The shaft 8 is positioned preferably centrally in the burner 1 or in the mixing space 3 with the aid of the base 7, specifically such that a longitudinal mid-axis 9 of the shaft 8 extends at least approximately parallel to a main flow direction 10 which, when the burner 1 is in operation, is established by virtue of the flow of oxidizer gas through it. The shaft 8 projects from the base 7 essentially at right angles. Correspondingly, in the installation state shown, the base 7 extends essentially perpendicularly with respect to the main flow direction 10. However, an inclined installation in the flow direction or opposite to the flow direction may also be envisaged. In the region of the base 7, the lance 6 is fastened to the burner wall 2.

[0018] The shaft 8 has a conical portion 11 which tapers with an increasing distance from the base 7. On the conical portion 11, the lance 6 or the shaft 8 has at least one nozzle 12, through which the gaseous fuel can be injected into the mixing space 3. In a simple type of construction, the respective nozzle is formed in each case by its outlet orifice 13 incorporated into the conical portion 11. Forming the respective nozzle 12 on the conical portion 11 necessarily results for the respective nozzle 12 in a main injection direction which has both a radial and an axial component. Normally, during injection, the respective nozzle 12 forms a conical spray jet, the longitudinal mid-axis of which defines the main injection direction. By the main injection directions being inclined, as compared with a purely radial orientation, the oxidizer gas flow, even at higher flow velocities, can give rise for the injected fuel to a sufficient deflection of the fuel flow toward the main flow direction 10. A concentration of fuel gas in the region of the burner wall 2 can thereby be avoided. The measures shown thus assist an intensive intermixing between the fuel gas and the oxidizer gas.

[0019] According to the exemplary embodiments shown here for the lance 6, the conical portion 11 may have a plurality of nozzles 12 or a plurality of outlet orifices 13 which are arranged, distributed, on the conical portion 11. For example, at least one row 14 on the conical portion 11 may be formed, which has a plurality of nozzles 12 or outlet orifices 13 arranged next to one another in the circumferential direction and which extends annularly and coaxially with respect to the longitudinal mid-axis 9 of the shaft 8. In particular, in this case, the plurality of such rows 14 spaced apart axially from one another may be formed on the conical portion 11. By virtue of these rows 14 arranged axially next to one another or one behind the other in the main flow direction 10, the fuel can be injected, staged, into the burner 1. In this case, the nozzles 12 or their outlet orifices 13 within the respective rows 14 are located on different radii or at different distances with respect to the longitudinal mid-axis 9. As a result, as uniform a distribution of the fuel as possible can be achieved within a throughflow cross section of the burner 1 or of the mixing space 3. For example, fuel which is injected via nozzles 12, the outlet orifices 13 of which are at a greater distance from the longitudinal mid-axis 9, reaches radially outer regions of the flow in the mixing space 3, while fuel gas which is injected via nozzles 12, the outlet orifices 13 of which are at shorter distances from the longitudinal mid-axis 9, remains in a radially inner core region of the flow in the mixing space 3. To that extent staged injection of the fuel assists homogeneous mixture formation.

[0020] According to Fig. 2, in a special embodiment, there may be provision for a multiplicity of nozzles 12 to be arranged, distributed over a large area, on the conical portion 11. The outlet orifices 13 of these nozzles 12 may in this case possess comparatively small cross sections. In particular, the lance 6 may be equipped here with micronozzles 12, in which the diameters of the outlet orifices 13 are in the order of a millimeters. Penetration into the oxidizer flow of the fuel jet from these small nozzles is limited. As a result the region of the burner into which fuel can be injected with these nozzles depends on the radius on the tapered section of the lance from which they inject fuel. By arranging the nozzles almost step less at different radii, the fuel distribution in the burner can be practically continuously adjusted as required. In all the embodiments, the nozzles 12 or their outlet orifices 13 are preferably dimensioned such that the fuel stream is reliably freed from the outer surface of the lance 6 and can be picked up by the oxidizer flow.

[0021] In the embodiment shown in Fig. 3, two rows of nozzles 12 or outlet orifices 13 are formed on the shaft 8 or on its conical portion 11. Whereas, in the downstream row 14, the individual nozzles 12 or outlet orifices 13 are arranged exactly in alignment in the circumferential direction, the upstream row 14 exhibits a circumferentially irregular arrangement of adjacent nozzles 12 or outlet orifices 13. Owing to this variable arrangement of the nozzles 12 or outlet orifices 13, in particular, individual adaption to varying flow ratios in the circumferential direction can be implemented within the burner 1. The burner 1 is per se expediently configured symmetrically, as a result of which as homogeneous a flow profile as possible is to be achieved within the mixing space 3. However, the base 7 of the lance 6 forms a significant flow obstacle, the wake of which impairs the symmetry within the flow profile. For example, the arrangement of the individual nozzles 12 or of the individual outlet orifices 13 may be coordinated with the wake such that a concentration of fuel in the wake subjected to a less pronounced throughflow is avoided.

[0022] According to Fig. 4, it is likewise possible to equip the conical portion 11 with nozzles 12 which differ from one another in terms of their outlet orifices 13. In the example, there can be seen an outlet orifice 13' which is arranged approximately centrally within the conical portion 11 and which obviously has a larger cross-sectional area than the other outlet orifices 13 of the other nozzles 12. By virtue of this measure, too, an individual adaptation of the fuel injection to the flow profile in the burner 1 can be implemented. The possibilities described, and other possibilities, for adapting the fuel injection to the flow profile of the burner 1 serve in each case the purpose of achieving within the mixing space 3, over the entire throughflow cross section of the burner 1, as uniform and as even a distribution of the fuel gas in the oxidizer gas as possible.

[0023] Fig. 5 shows a further embodiment in which at least one nozzle 12 with an annular outlet orifice 13 is arranged on the conical portion 11. In the example, two nozzles 12 of this type with annular outlet orifices 13 are arranged, spaced apart axially from one another, on the conical portion 11.

[0024] The embodiments shown here have in common the fact that the conical portion 11 in each case is truncated, with the truncated end called top 15, remote from the base 7, of the shaft 8. In this case, therefore, the conical portion 11 extends essentially completely from the base 7 as far as the top 15. In the examples shown, moreover, the conical portion 11 has a frustoconical configuration, so that, here, the top 15 lies in a plane which extends perpendicularly with respect to the longitudinal mid-axis 9. It is clear that here, too, other termination geometries may be envisaged. For example, the top 15 may have a convex configuration, particularly in the manner of a spherical segment. Pointed cones without truncation are also conceivable.

[0025] According to an advantageous embodiment, the top 15 of the shaft 8 is free of nozzles 12 for gaseous fuel and free of outlet orifices 13 gaseous fuel. This means that the overall injection of gaseous fuel takes place solely via the conical portion 11. Unless explicitly specified a nozzle incorporated into the conical portion has to be understood to be a nozzle in or on the conical surface of the conical and not as nozzle in or on the top of the conical portion.

[0026] In case of a dual fuel application the liquid fuel is typically injected from a nozzle arranged in the center of the top 15 of the conical portion 11, which forms the downstream end of the lance.

[0027] According to Fig. 1, a fuel feed 16, which is indicated here by an arrow, is provided for the introduction of fuel via the lance 6. This fuel feed 16 guides the gaseous fuel to the lance 6 and, within the lance 6, to the outlet orifices 13 of the individual nozzles 12. Furthermore, in a particularly advantageous embodiment, a protective gas feed 17, likewise indicated by an arrow, may be provided. This feeds to the burner 1 or the lance 6 an inert protective gas which leads within the lance 6 to at least one outlet orifice of a nozzle. For example, in the embodiment shown in Fig. 1, it is conceivable to assign the first row 14 upstream with respect to the main flow direction 10 or a plurality of upstream rows 14 to the protective gas feed 17, while the other, downstream rows 14 are assigned to the fuel gas feed 16. The nozzles assigned to the protective gas feed 17 are expediently arranged and/or configured such that the protective gas delays the intermixing of the fuel gas with oxidizer gas and therefore the spontaneous ignition of the mixture. For this purpose, the protective gas is introduced by the nozzles into the burner 1 expediently such that the oxidizer gas flowing in the burner 1 first impinges onto the inert protective gas before it impinges onto the fuel gas. This can for example realized by a concentric arrangement of nozzles, where the fuel gas is injected in the center nozzle and inert gas is injected by an annular nozzle, which surrounds the fuel nozzle. In another embodiment this is realized by injecting protective gas through a nozzle upstream of the fuel injection nozzle. In particular the direct contact between oxidizer gas and fuel in the stagnation region on the upstream side of the fuel jets can be avoided for example by well directed inert protective gas injected directly into this region. By the intermixing of fuel gas and oxidizer gas thus being delayed, uniform distribution within the flow cross section can be improved. Further, the momentum of the inert gas can be used to increase the fuel penetration into the oxidizer gas flow. A suitable inert protective gas is, for example, nitrogen gas (N_2). The burner 1 proposed here and the lance 6 proposed here are especially suitable for use with a fuel gas containing hydrogen gas, since they allow for the particular features of this highly reactive fuel gas, such as, for example, a higher reaction temperature, lower spontaneous ignition temperature and higher flame velocity.

List of reference symbols

[0028]

1	Burner
2	Burner wall
3	Mixing space
4	Inlet side
5	Outlet side
6	Lance
7	Base
8	Shaft
9	Longitudinal mid-axis
10	Main flow direction
11	Conical portion
12	Nozzle
13	Outlet orifice
14	Row
15	Top
16	Fuel gas feed
17	Protective gas feed

Claims

1. A fuel lance (6) for the introduction of a gaseous fuel into a burner (1) of a second combustion chamber of a gas turbine plant with sequential combustion having a first and a second combustion chamber, which fuel lance comprises a base (7) and a shaft (8) projecting from the base, when mounted in the burner, the base (7) projecting into the burner (1) perpendicularly or at an inclination to a main flow direction (10) of an oxidizer flow prevailing in the burner (1), and the shaft (8) running parallel to the longitudinal direction of the burner, the shaft (8) having at least one nozzle (12) for the introduction of the gaseous fuel into the burner (1), **characterized in that** the shaft (8) has a conical portion (11) tapering with an increasing distance from the base (7).

2. The lance as claimed in claim 1, **characterized in that** at least two nozzles (12) are arranged on the conical portion (11).

3. The lance as claimed in claim 1 or 2, **characterized in that** a plurality of nozzles (12) are arranged in at least two annular rows (14) spaced apart from one another on the conical portion (11).

4. The lance as claimed in one of claims 1 to 3, **characterized in that** the at least one nozzle (12) has an annular outlet orifice (13) and is arranged coaxially to the shaft (8) on the conical portion (11) of the shaft (8).

5. The lance as claimed in one of claims 1 to 4, **characterized in that** a plurality of nozzles (12), which differ from one another in terms of the geometric form of their outlet orifices (13) or in terms of the cross-sectional area of their outlet orifices (13), are arranged on the conical portion (11).

6. The lance as claimed in one of claims 1 to 5, **characterized in that** the conical portion (11) comprises a top (15), remote from the base (7), of the shaft (8).

7. The lance as claimed in claim 6, **characterized in that** the top (15) of the conical portion (11) is free of nozzles (12) and/or outlet orifices (13) for gaseous fuel.

8. The lance as claimed in one of claims 1 to 7, **characterized in that** a multiplicity of nozzles (12) are arranged, distributed over a large area, on the conical portion (11) injecting the fuel from different radii of the conical portion (11) and thereby distributing the fuel to different regions of the burner.

9. The lance as claimed in one of claims 1 to 8, **characterized in that** the lance (6) has at least one nozzle (12) with a center orifice (13) for introducing gaseous fuel and a concentrically arranged larger orifice (13) for introducing an inert protective gas into the burner (1).

10. The lance as claimed in one of claims 1 to 8, **char-**

acterized in that the shaft (8) has at least one nozzle for introducing only protective gas.

11. The lance as claimed in claim 10, **characterized in that** at least one nozzle for introducing protective gas is arranged on the shaft (8) upstream of at least one fuel injection nozzle.

12. The lance as claimed in claim 10 or 11 **characterized in that** at least one nozzle for introduction of protective gas arranged on the shaft (8) is directed into a stagnation zone of a fuel jet, which is injected by a fuel injection nozzle (12).

13. The lance as claimed in one of claims 9 to 12 **characterized in that** at least one nozzle for introduction of protective gas arranged on the shaft (8) is directed parallel to or is combined with the fuel injection nozzle (12) thus increasing the fuel penetration into the oxidizer gas flow.

14. The lance as claimed in one of claims 1 to 13 **characterized in that** at least one nozzle for introduction of liquid fuel is arranged at the downstream end of the shaft (8).

15. A burner having a lance (6) as claimed in one of claims 1 to 14.

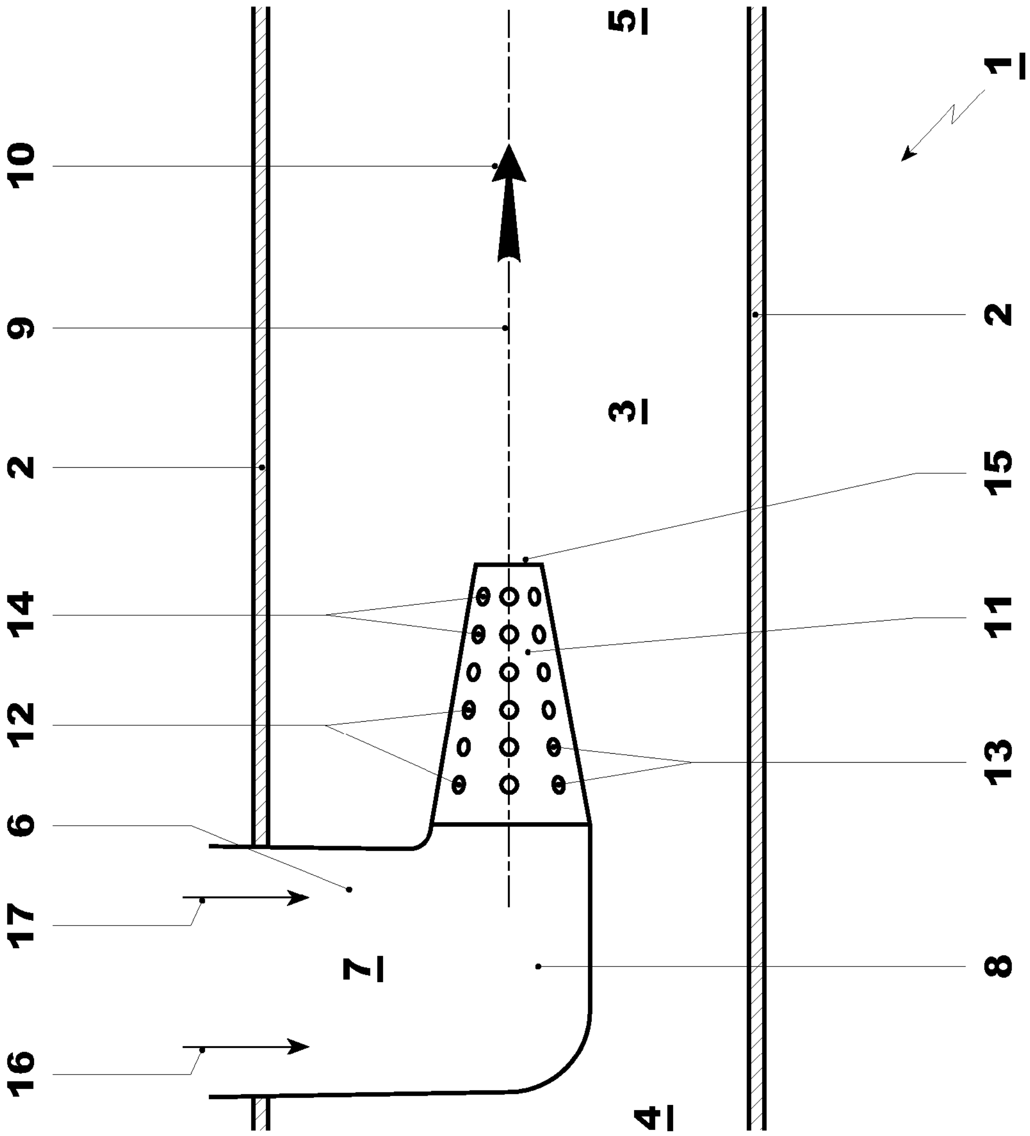


FIG. 1

FIG. 2

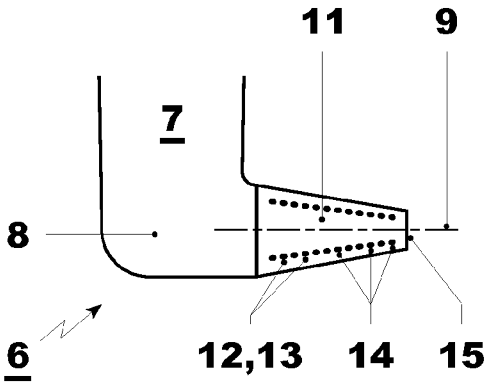


FIG. 3

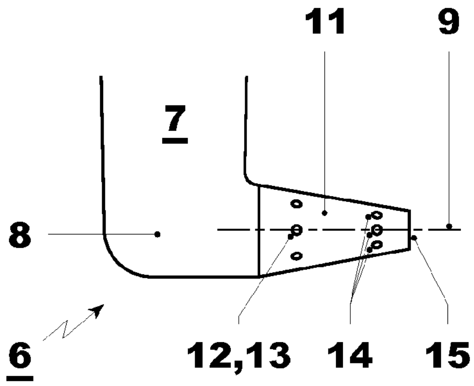


FIG. 4

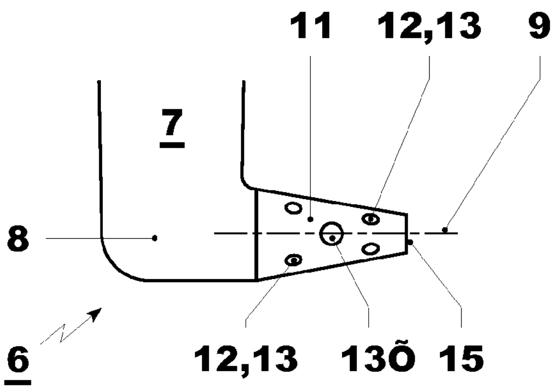
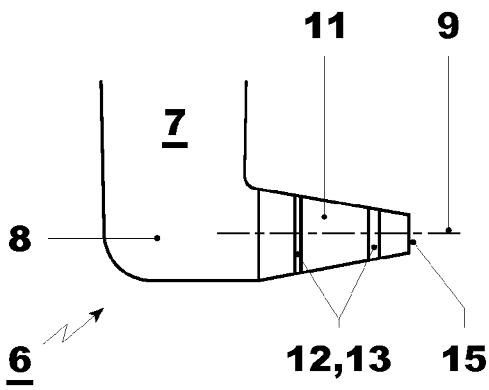


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 08 15 5968

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 February 2009	Gavriliu, Costin

CATEGORY OF CITED DOCUMENTS

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