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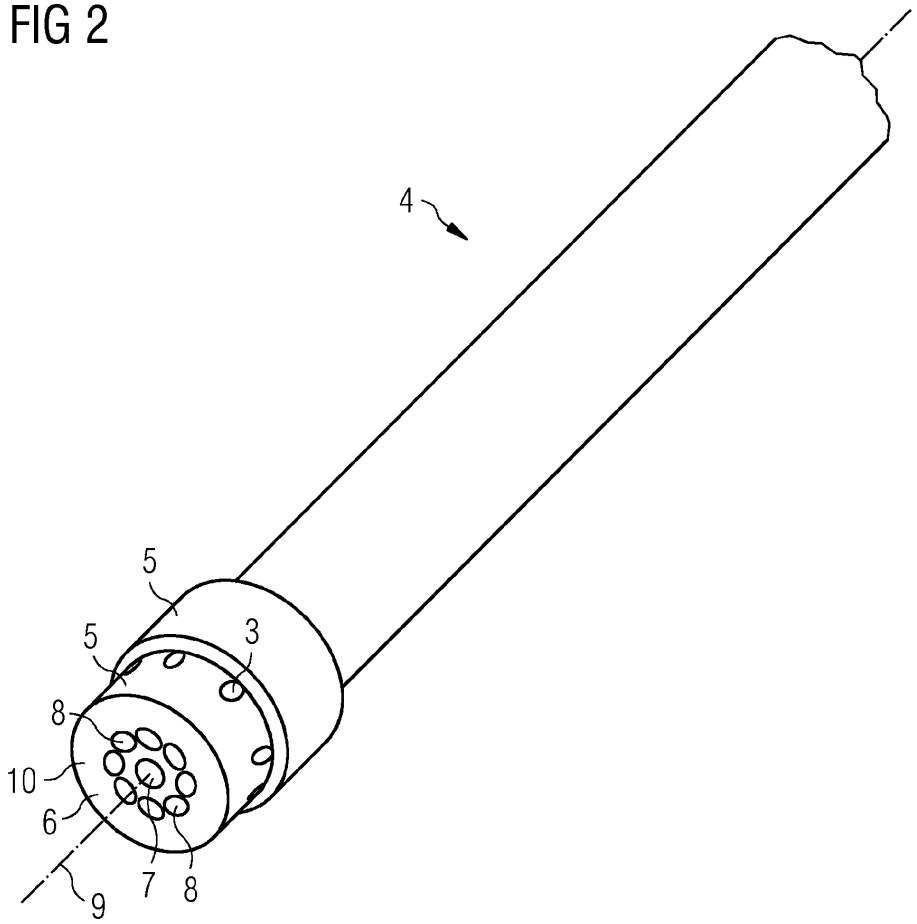
(54) **Pilot burner, burner, combustor and gas turbine engine**

(57) The present invention is related to a pilot burner (12) of a gas turbine engine, comprising a liquid pilot lance (4) with a pilot lance face (6), wherein the pilot burner (12) is made of a ferrous material, wherein a face (14) of the pilot burner (12) and/or the pilot lance face (6) comprise additionally a boron layer (10). The inventions further relates to a burner (1), a combustor and a gas turbine engine comprising at least one of such a pilot burner (12).

FIG 2



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Description

[0001] The present invention is related to a pilot burner of a gas turbine engine, comprising a liquid pilot lance with a pilot lance face, wherein the pilot burner is made of a ferrous material.. Further the invention is related to burner of a gas turbine engine, a combustor of a gas turbine engine and a gas turbine engine.

[0002] It is a problem of a pilot burner, in particular of a liquid pilot lance of a pilot burner that an extensive carbon build-up on the burner face and the pilot lance face takes place. Liquid fuel running can result in carbon build-up on the pilot lance face which can in particular lead to blockage of the air assist holes. Air assist holes and outlet orifice, respectively, are critical for atomisation and ignition of the liquid fuel and so blockages of the air outlet orifices can deteriorate the quality of the atomisation which can result in failed liquid fuel starts and inhibit liquid fuel operation.

[0003] Previously the issue has been solved by either removing the liquid pilot lance and by manually cleaning the pilot lance face to remove the carbon build-up or by replacing the whole pilot burner or the liquid pilot lance of the burner with a new burner or with a new liquid pilot lance.

[0004] It is an object of the present invention to solve aforesaid problems of a pilot burner at least partly. In particular, it is an object of the present invention to provide a pilot burner of a gas turbine engine, a burner with a pilot burner, a combustor with a burner and a gas turbine engine, as well, which can be operated over a long time and which have an improved liquid fuel starting reliability.

[0005] Aforesaid objects are solved by a pilot burner of a gas turbine engine according to independent claim 1, a burner of a gas turbine engine according to independent claim 12, a combustor of a gas turbine engine according to independent claim 13 and a gas turbine engine according to independent claim 14. Further features and details of the present invention result from the sub claims, the description and the drawings. Features and details discussed with respect to the pilot burner can also be applied to the burner, the combustor and the gas turbine engine and vice versa.

[0006] According to a first aspect of the invention aforesaid objects are solved by a pilot burner of a gas turbine engine, comprising a liquid pilot lance with a pilot lance face, wherein the pilot burner is made of a ferrous material, characterized in that a face of the pilot burner and/or the pilot lance face comprise additionally a boron layer..

[0007] The pilot lance face of the liquid pilot lance is directed to the burning zone of a combustor of a gas turbine engine.

[0008] Such a pilot burner or such a liquid pilot lance of a pilot burner can be operated over a long time and has an improved liquid fuel starting reliability. The pilot burner face, the pilot lance face and therefore the liquid pilot lance have an improved and extended life cycle compared to the known pilot burner, pilot lances faces and liquid pilot lances, because of the boron layer at the pilot burner face and/or the pilot lance face.

[0009] The boron layer has been boronised to the pilot burner face and/or the pilot lance face in a thermo-chemical hardening process. That means a boron layer is in the sense of the invention a boronised layer at the pilot burner face and/or the pilot lance face of a liquid pilot lance of the pilot burner.

[0010] Boronising is a thermo-chemical surface hardening process in which boron atoms are diffused into the surface of a ferrous material to form complex borides with the base metal. That means, there is no mechanical interface between the complex borides and the substrate as boronising is a true diffusion process. The boron layer is hard and can comprise a slippery surface. The boron layer is capable of sustain use at high temperatures. In other words, such a pilot burner face and/or such a pilot lance face and therefore such a liquid pilot lance have a high stability at high temperatures. Advantageously the boron layer is resistant to temperatures till or over 600-650°C.

[0011] The ferrous material of the pilot burner can be for example carbon steel, low alloy steel, stainless steel, tool steel, etc.. The liquid pilot lance is metallic. Preferred the liquid pilot lance is made of IN625 with less than 5% Fe.

[0012] Advantageously the boron layer has a hardness of 1300-2500HV (HV = Vickers Hardness), in particular a hardness of 1800-2500HV. An advantage of such boron layer is that the boron layer has an improved adhesion compared to conventional hard material coatings. Another advantage of such boron coated pilot burner face and/or the pilot lance face is that the pilot burner face and/or the pilot lance face have a high resistance against adhesive and abrasive wear.

[0013] In particular such a pilot burner face and/or such a liquid pilot lance of a pilot burner can prevent that carbon build-up on the pilot lance face takes place. The pilot burner face and/or the pilot lance face have a reduced coefficient of friction.

[0014] The boron layer at the pilot burner face and/or the pilot lance face is a mechanically stable layer which reduces the rate and severity of carbon deposition thus minimising any carbon build-up on the pilot burner face and/or the pilot lance face. In particular the boron layer reduces the carbon build-up at the outlet orifice for the liquid fuel and at the at least one outlet orifice for the air at the pilot burner face and/or the pilot lance face.

[0015] The boron layer at the pilot burner face and/or the pilot lance face can extend the life of the pilot burner face and/or the pilot lance face and thus the life of the liquid pilot lance of the pilot burner and the life of the pilot burner. Another advantage is the benefit with respect to the service of the pilot burner and/or the liquid pilot lance of the pilot burner. The boron layer at the pilot burner face and/or the pilot lance face enables an improved atomisation of liquid fuel resulting in an improved ignition of the liquid pilot lance.

[0016] According to a preferred development of the invention an advantageous liquid pilot lance is characterised in that the outlet orifice for the liquid fuel is arranged coaxial to a longitudinal axis of the liquid pilot lance and two or more outlet orifices for the air are surrounding the outlet orifice for the liquid fuel. The outlet orifice for the liquid fuel can be arranges offset to the outlet orifices for the air. Advantageously the outlet orifice for the liquid fuel and the outlet orifices for the air are arranged next to each other in a plane. Such a liquid pilot lance enables a good mixture of the liquid fuel and the air.

[0017] Further, a liquid pilot lance is preferred, which is characterized in that the two or more outlet orifices for the air are arranged at a circular path with the outlet orifice for the liquid fuel in the centre of the circular path. Such a liquid pilot lance guarantees a good mixing of liquid fuel and air. Because of the boronised layer at the pilot lance face the deposition of carbon can be reduced at the pilot lance face.

[0018] In particular it is of advantage, if the outlet orifice for the liquid fuel and/or the at least one outlet orifice for the air of a liquid pilot lance comprise/comprises a boron layer. In other words, a liquid pilot lance is preferred which is characterised in that the fuel outlet and/or the air outlets comprise a boronised layer. Such a liquid pilot lance minimises any carbon build-up on the air assist holes. As a result, the atomisation of liquid fuel can be improved. Because of the improved atomisation of liquid fuel the ignition of the liquid pilot lance can be improved, as well. The boron layer prevents carbon building at the outlet orifices. Thus a good and steady exhaust of liquid fuel and air can be reached.

[0019] A further preferred liquid pilot lance is characterized in that the liquid fuel duct and/or the at least one air duct comprise/comprises a boron layer. This reduces the carbon build-up at the end of the liquid fuel duct and/or at the at least one air duct. Such a liquid pilot lance reduces the possibility of a blockage at the end of the liquid fuel duct and the end of the at least one air duct because of the minimised carbon building at these areas.

[0020] The boron layer at the pilot burner face and/or the pilot lance face of the liquid pilot lance provides good resistance against abrasive and adhesive wear, high temperatures, corrosion and carbon build-up. The boron layer increases the lifetime of the pilot burner face and/or the liquid pilot lance and thus of a pilot burner and a combustor comprising such a pilot burner and/or such a liquid pilot lance. All kind of steel can be processed, but alloy elements reduce adhesion. Therefore, a liquid pilot lance is preferred, wherein the pilot lance face comprises a Nickel-Titanium-alloy or a Nickel-Titanium-based-alloy, in particular IN625.

[0021] To build the boron layer at the pilot burner face and/or the pilot lance face the boronising process can be carried out with powders or pastes. The boron layer thickness can be between 50-350 μm, in particular between 250-350 μm for abrasive resistance.

[0022] The pilot burner face and/or the pilot lance face can be uneven. In particular the liquid lance face can be shaped wavelike. But preferred is pilot burner with a pilot burner face and/or a pilot lance face which are planar. A planar pilot burner face and/or a planar pilot lance face with a boron layer minimise the deposition of carbon at the pilot lance face.

[0023] Advantageously the pilot lance face and the pilot lance body of a liquid pilot lance are formed in one piece, in particular monolithic. Alternative to that a liquid pilot lance is preferred which is characterized in that the pilot lance face is an extra plate which is fixed at the front of the pilot lance body. Such a pilot lance face is replaceable. In case of an extensive carbon build-up at the pilot lance face, only the pilot lance face has to be removed and not the pilot lance body, as well.

[0024] According to another development of the invention a liquid pilot lance is preferred which is characterized in that the boron layer(s) is/are polished. A polished boron layer reduces the carbon build-up once again. A polished boron layer increases the atomisation of liquid fuel resulting in an improved ignition. A liquid pilot lance with a polished boron layer at the pilot lance face improves the liquid fuel starting reliability and extends the lifetime of the liquid pilot lance.

[0025] According to a second aspect of the invention the object is solved by a burner of a gas turbine engine comprising at least a pilot burner according to the first aspect of the invention, in particular according to one of the claims 1 to 11. The pilot burner comprises air ducts with merge into the air ducts of the liquid pilot lance. The burner provides the same advantages, which have been discussed in detail as to the pilot burner according to the first aspect of the invention.

[0026] According to a third aspect of the invention the object is solved by a combustor of a gas turbine engine comprising a burner according to the second aspect of the invention. The combustor can have two or more burner. Thereby, the combustor provides the same advantages, which have been discussed in detail as to the pilot burner according to the first aspect of the invention.

[0027] According to a last aspect of the invention the object is solved by gas turbine engine comprising at least one pilot burner according to the first aspect of the invention, in particular according to one of the claims 1 to 11. The gas turbine engine can comprise one or more burner and one or more combustors with one or more pilot burner each burner and combustor, respectively. Thereby, the gas turbine engine provides the same advantages, which have been discussed in detail as to the pilot burner according to the first aspect of the invention.

[0028] The present invention is further described with respect to the accompanying figures. The figures show schematically:

Figure 1 a burner with a pilot burner comprising a liquid pilot lance with carbon deposit at the pilot lance face,

Figure 2 a liquid pilot lance with a pilot lance face comprising a boron layer.

[0029] In fig. 1 a burner 1 with a pilot burner 12 comprising a liquid pilot lance 4 with carbon deposit 11 at the pilot lance face 6 is disclosed. Such carbon build-up 11 occurs at pilot lance faces 6, if liquid fuel is running out of the liquid fuel outlet orifice 7, shown in Fig. 2. The carbon build-up 11 on the pilot lance face 6 can lead to blockage of the air orifice outlets 8, see Fig. 2. The air outlet orifices 8 are essential for the atomisation and ignition of the liquid fuel and so blockages of the air outlet orifices 8 can deteriorate the quality of the atomisation which can result in failed liquid fuel starts and inhibit liquid fuel operation. Such a carbon build-up 11 can occur at the face 14 of the pilot burner 12, as well, with the same disadvantages like at the pilot lance faces 6.

[0030] The burner 1 comprises a pilot burner 12 with one or more air ducts. Further, the burner 1 comprises a liquid pilot lance 4 with a liquid fuel duct 2 and two or more air ducts 3. The liquid pilot lance 4 comprises a pilot lance body 5 and a pilot lance face 6. The ducts 2, 3 lead to the pilot lance face 6. The pilot lance face 6 comprises a liquid fuel outlet orifice 7 and air outlet orifices 8. The pilot lance body 5 and the pilot lance face 6 are made of ferrous material.

[0031] Fig. 2 shows schematically a liquid pilot lance 4 with a pilot lance face 6 comprising a boron layer 10 at the pilot lance face 6. That means, in a thermo-chemical surface treatment of boronising of the pilot lance face 6 a mechanically stable boron 10 layer has been deposited at the pilot lance face 6. The boron layer 10 reduces the rate and severity of carbon deposition thus minimising any carbon build-up 11 on the air outlet orifices 8 and the liquid fuel outlet orifice 7, extending the life of the liquid pilot lance 4.

[0032] Such a burner 1 and such a liquid pilot lance 4, respectively, can be operated over a long time and has an improved liquid fuel starting reliability. The liquid pilot lance 4 and therefore the burner 1 have an improved and extended life cycle compared to a liquid pilot lance 4 and a burner 1 without a boron layer 10.

[0033] The boron layer 10 is very hard. The boron layer 10 is capable of sustain use at high temperatures. The pilot lance face 6 with such a boron layer 10 and thus a liquid pilot lance 4 with such a pilot lance face 6 have a high stability at high temperatures. Advantageously the boron layer is resistant to temperatures over 550-650°C or more.

[0034] The boron layer 10 at the pilot lance face 6 is a mechanically stable layer which reduces the rate and severity of carbon deposition thus minimising any carbon build-up on pilot lance face 6. Further, the boron layer 10 reduces the carbon build-up at the liquid fuel outlet orifice 7 and at the air outlet orifices 8 at the pilot lance face 6.

[0035] Advantageously, the boron layer 10 is polished. Such a polished boron layer 10 reduces the carbon build-up 11 once more. The polished boron layer 10 increases the atomisation of liquid fuel resulting in an improved ignition of the liquid pilot lance 4. Such a liquid pilot lance 4 improves the liquid fuel starting reliability and extends the lifetime of the liquid pilot lance 4.

Claims

1. Pilot burner (12) of a gas turbine engine, comprising a liquid pilot lance (4) with a pilot lance face (6), wherein the pilot burner (12) is made of a ferrous material, **characterized in that** a face (14) of the pilot burner (12) and/or the pilot lance face (6) comprise additionally a boron layer (10).

2. Pilot burner (12) according to claim 1, **characterized in that** the liquid pilot lance (4) comprises a liquid fuel duct (2) and at least one air duct (3), a pilot lance body (5) and a pilot lance face (6), the pilot lance face (6) comprising an outlet orifice (7) for the liquid fuel guided through the liquid fuel duct (2) and at least one outlet orifice (8) for the air guided through the at least one air duct (3).

3. Pilot burner (12) according to claim 1 or 2, **characterized in that** the outlet orifice (7) for the liquid fuel is arranged coaxial to a longitudinal axis (9) of the liquid pilot lance (4) and two or more outlet orifices (8) for the air are surrounding the outlet orifice (7) for the liquid fuel.

4. Pilot burner (12) according claim 3, **characterized in that** the two or more outlet orifices (8) for the air are arranged at a circular path with the outlet orifice (7) for the liquid fuel in the centre of the circular path.

5. Pilot burner (12) according to any of the preceding claims, **characterized in that** the outlet orifice (7) for the liquid fuel and/or the at least one outlet orifice (8) for the air comprise/comprises the boron layer (10).

6. Pilot burner (12) according to any of the preceding claims, **characterized in that** the liquid fuel duct (2) and/or the at least one air duct (3) comprise/comprises the boron layer (10).

7. Pilot burner (12) according to any of the preceding claims, **characterized in that** the pilot lance face (6) comprises a Nickel-Titanium-alloy or a Nickel-Titanium-based-alloy.

8. Pilot burner (12) according to any of the preceding claims, **characterized in that** the pilot burner face and/or the pilot lance face (6) is planar.

9. Pilot burner (12) according to any of the preceding claims, **characterized in that** the pilot lance face (6)

and the pilot lance body (5) are formed in one piece, in particular monolithic.

10. Pilot burner (12) according to any of the preceding claims, **characterized in that** the pilot lance face (6) is an extra plate which is fixed at the front of the pilot lance body (5).

11. Pilot burner (12) according to any of the preceding claims, **characterized in that** the boron layer(s) (10) is/are polished.

12. Burner (1) of a gas turbine engine comprising at least a pilot burner (12) according to one of the claims 1 to 11.

13. Combustor of a gas turbine engine comprising a burner (1) according to claim 12.

14. Gas turbine engine (200) comprising at least one pilot burner (12) according to one of the claims 1 to 11.

15. Gas turbine engine (200) comprising at least one burner (1) according to claim 12.

FIG 1

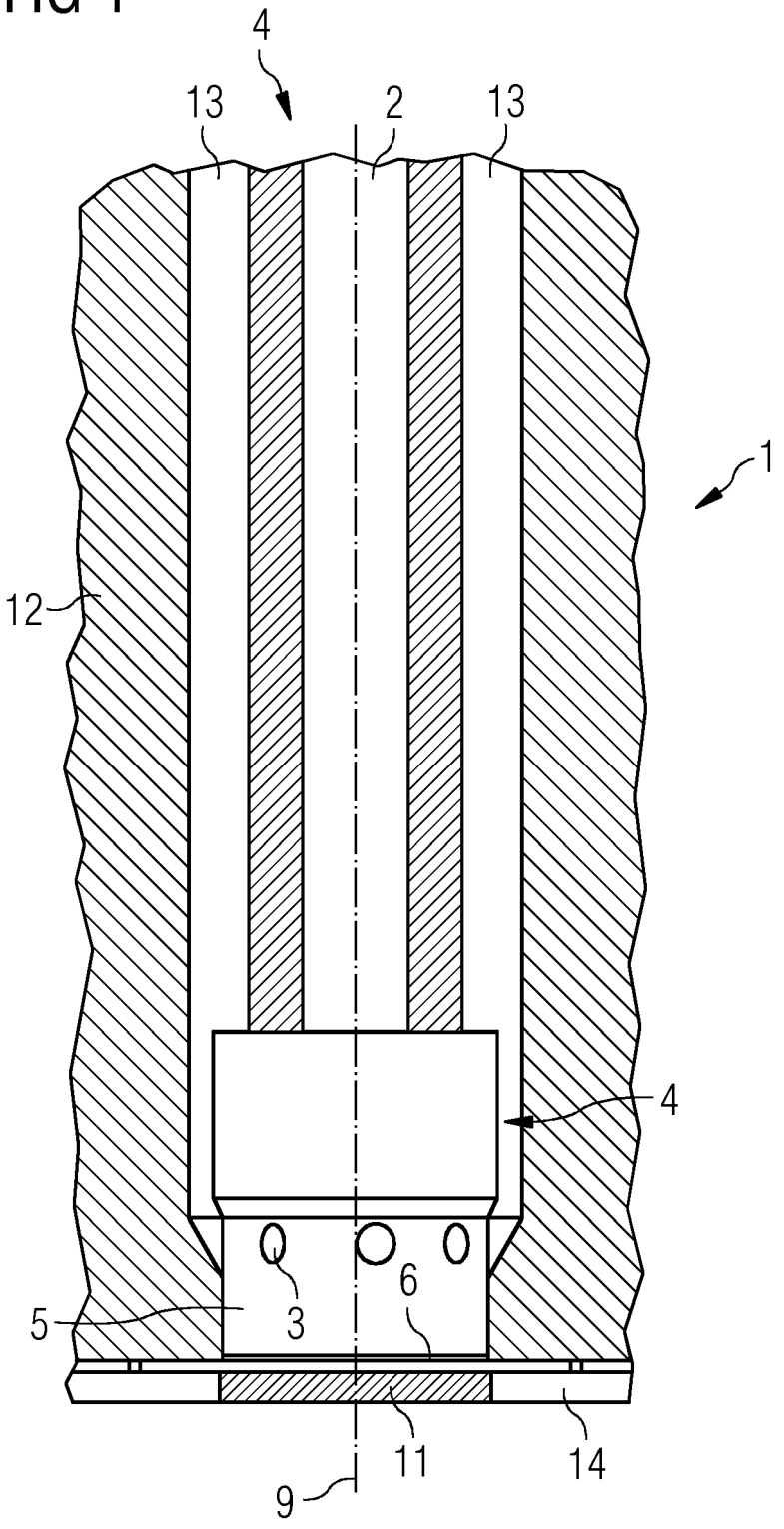
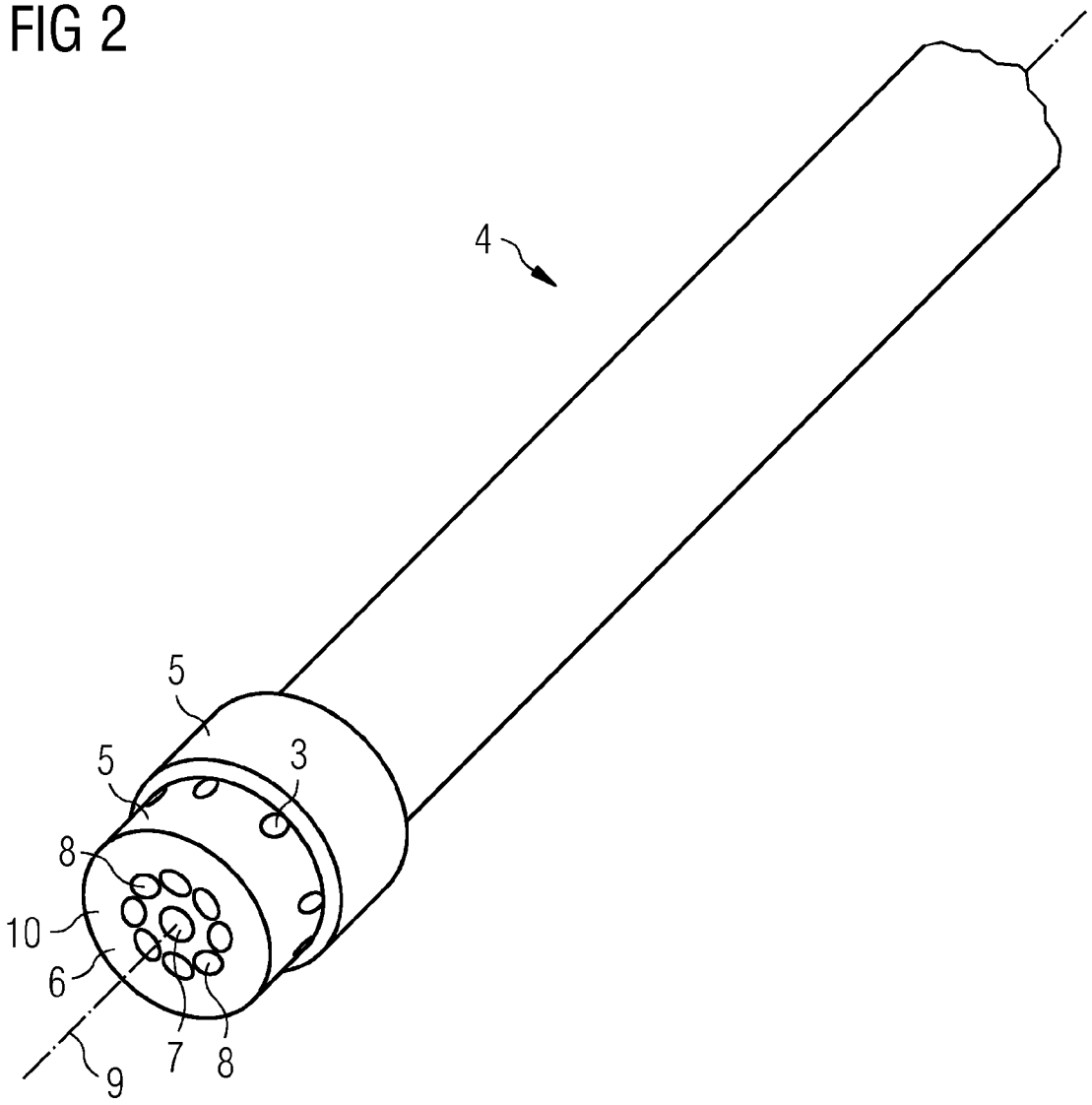


FIG 2



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EUROPEAN SEARCH REPORT

Application Number
EP 12 17 9053

DOCUMENTS CONSIDERED TO BE RELEVANT

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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
The Hague	4 December 2012	Harder, Sebastian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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