US 20100192583A1

(19) United States
(12) Patent Application Publication
Cano Wolff et al.
(10) Pub. No.: US 2010/0192583 A1
(43) Pub. Date: Aug. 5, 2010

(54) **NON-ROTATIONAL STABILIZATION OF THE FLAME OF A PREMIXING BURNER**

(76) Inventors: **Mariano Cano Wolff**, Ratingen (DE); **Patrick Ronald Flohr**, Mülheim a.d. Ruhr (DE); **Matthias Hase**, Mülheim (DE); **Martin Lenze**, Essen (DE); **Jürgen Meisl**, Mülheim an der Ruhr (DE); **Paul Pixner**, Münster/ Westf (DE); **Uwe Remlinger**, Leverkusen (DE); **Kai-Uwe Schildmache**, Mülheim a.d. Ruhr (DE); **Thomas Alexis Schneider**, Mülheim a.d. Ruhr (DE); **Jaap van Kampen**, Roermond (NL)

Correspondence Address:
SIEMENS CORPORATION
INTELLECTUAL PROPERTY DEPARTMENT
170 WOOD AVENUE SOUTH
ISELIN, NJ 08830 (US)

(21) Appl. No.: **12/663,886**

(22) PCT Filed: **Jun. 19, 2008**

(86) PCT No.: **PCT/EP08/57757**

§ 371 (c)(1), (2), (4) Date: **Apr. 14, 2010**

(30) **Foreign Application Priority Data**

Jun. 21, 2007 (EP) 07012207.2

Publication Classification

(51) **Int. Cl.**
F23D 14/02 (2006.01)
F23R 3/18 (2006.01)
F23D 11/10 (2006.01)
F23R 3/28 (2006.01)

(52) **U.S. Cl.** **60/737**; 60/749; 60/806

(57) **ABSTRACT**

A method for stabilizing the flame of a premixing burner, comprising a reaction chamber containing a fluid is provided. The method includes injecting an air-fuel mixture into the reaction chamber at a speed that is different from that of the fluid present in the reaction chamber, adjusting the speed such that vortices form at the boundary between the air-fuel mixture and the surrounding fluid. A premixing burner including a reaction chamber and at least one premixing spray nozzle opening into the reaction chamber is also provided. The premixing burner injects an air-fuel mixture into the reaction chamber at a speed that is different from that of the surrounding fluid, the speed being adjusted such that vortices from at the boundary between the air-fuel mixture and the surrounding fluid.

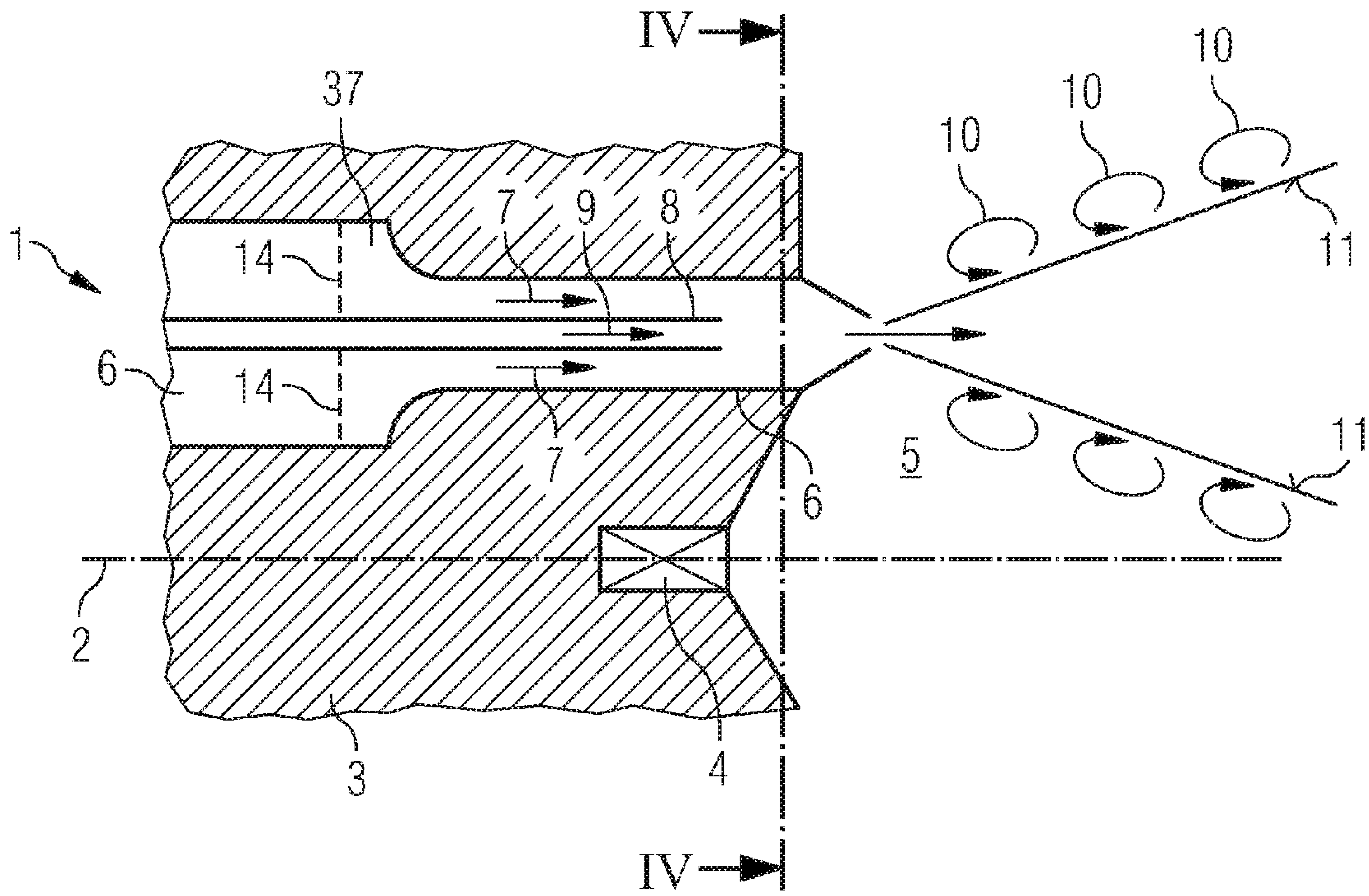


FIG 1

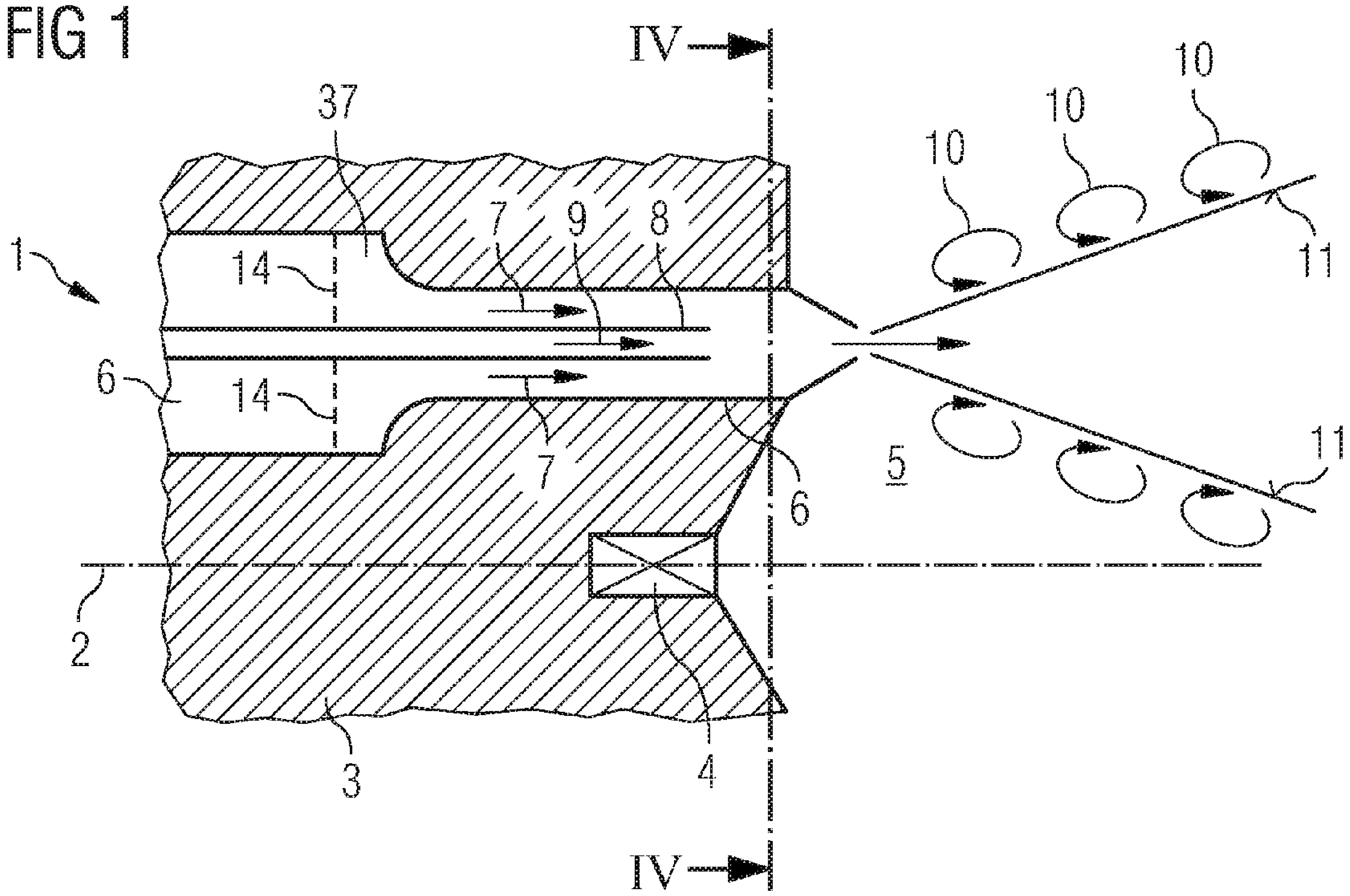


FIG 2

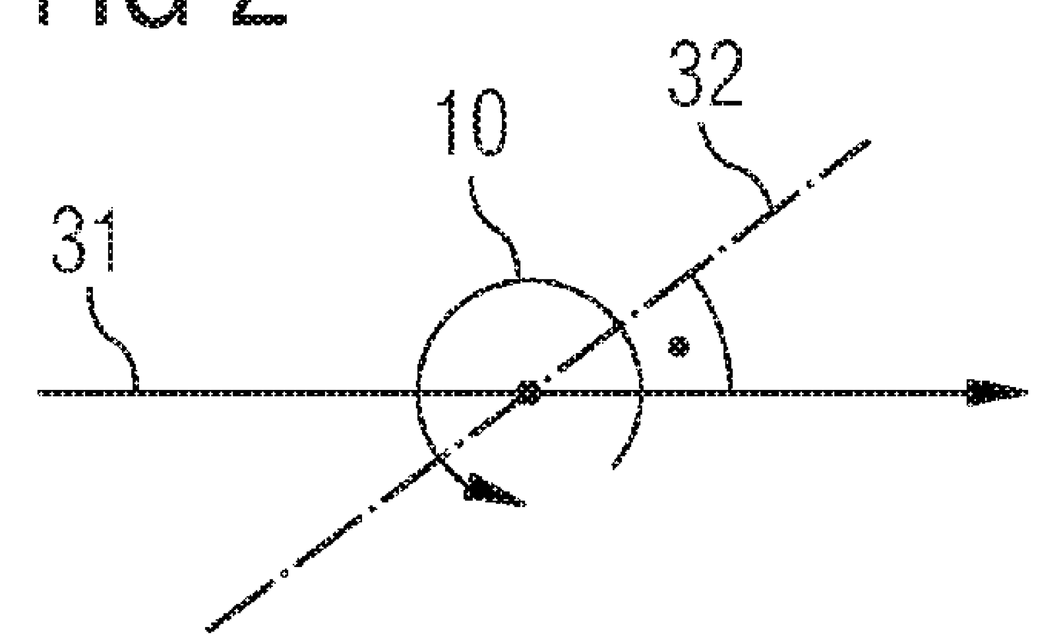


FIG 3

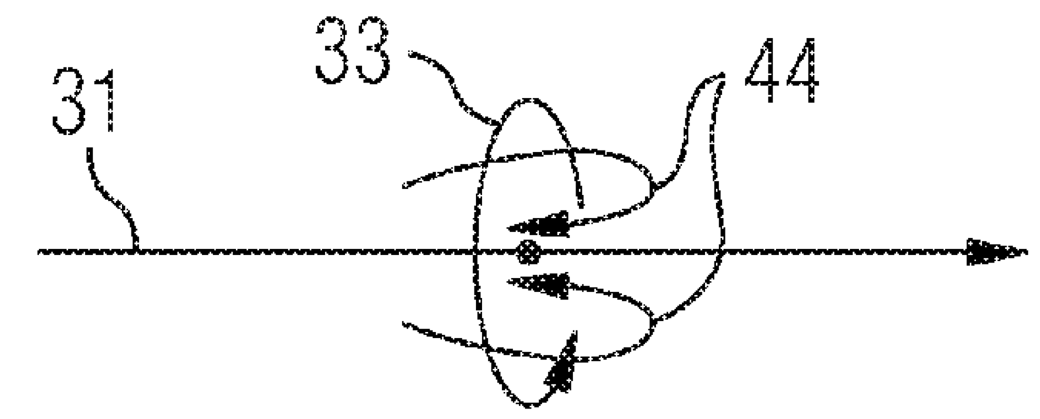


FIG 4

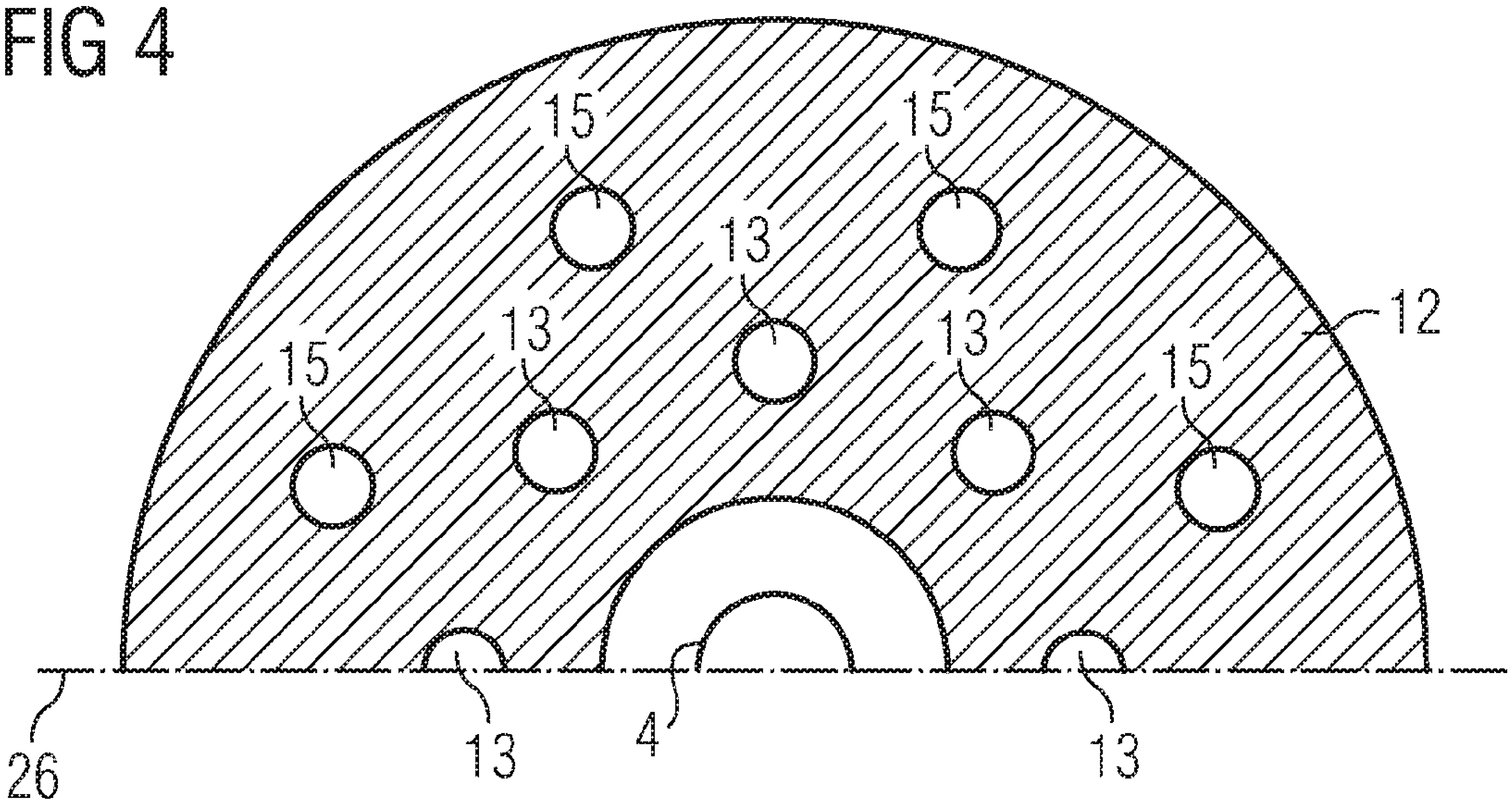

15
15
13
12
15
13
13
15
13
4
13
26

FIG 5

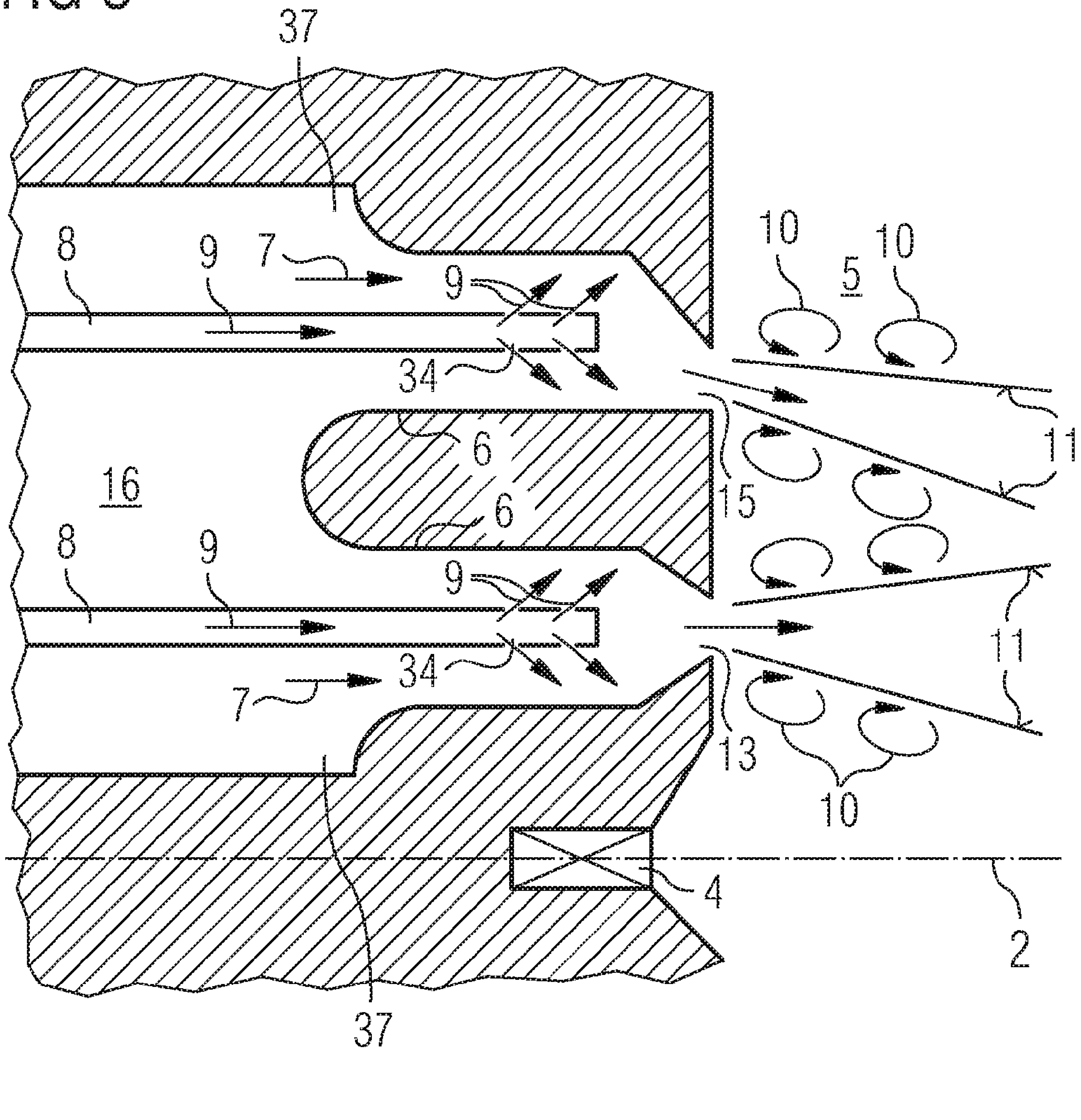
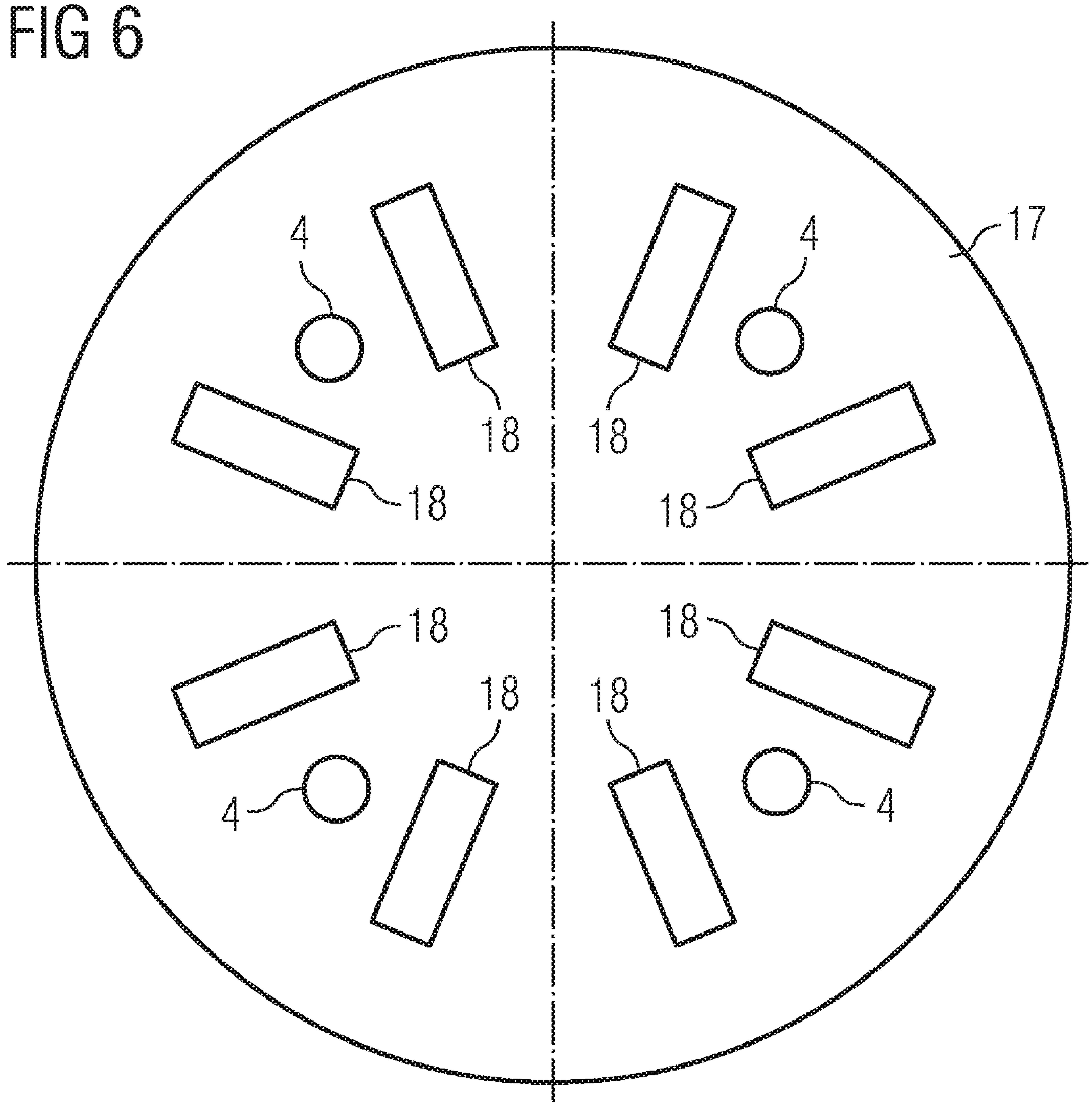

37
10
10
5
7
9
8
9
34
6
11
16
6
15
8
9
9
11
34
7
13
10
4
2
37

FIG 6



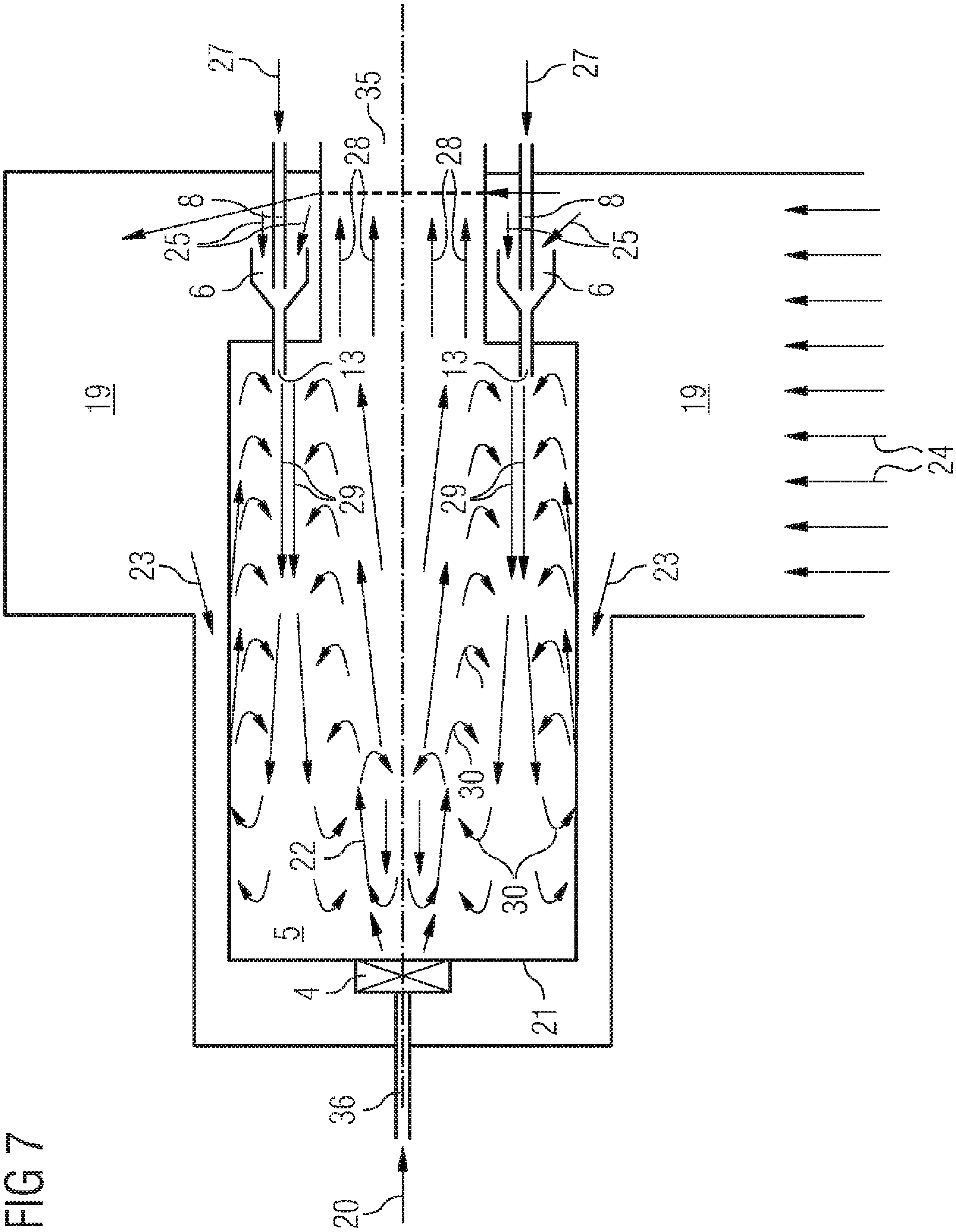


FIG 7

FIG 8

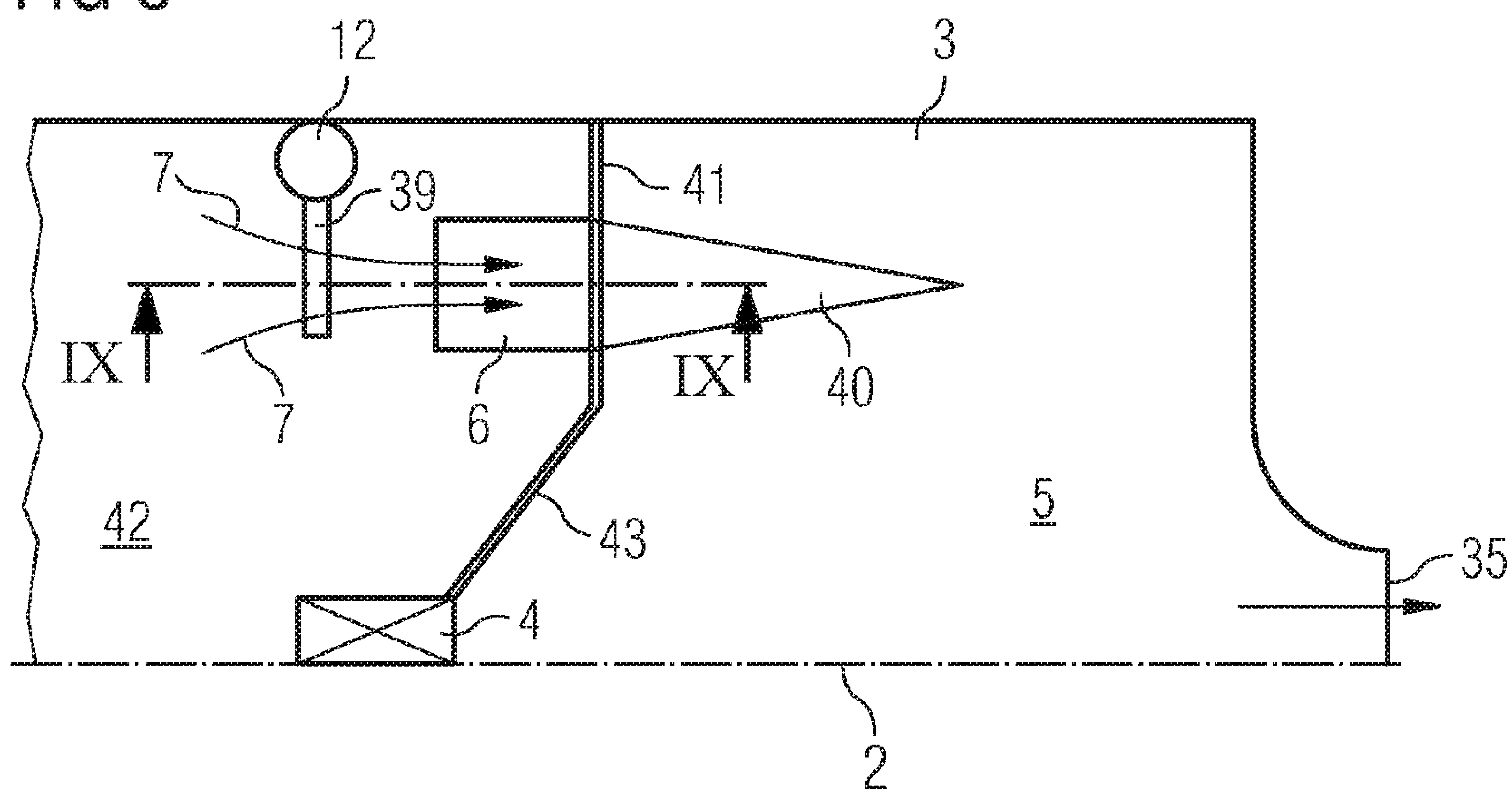
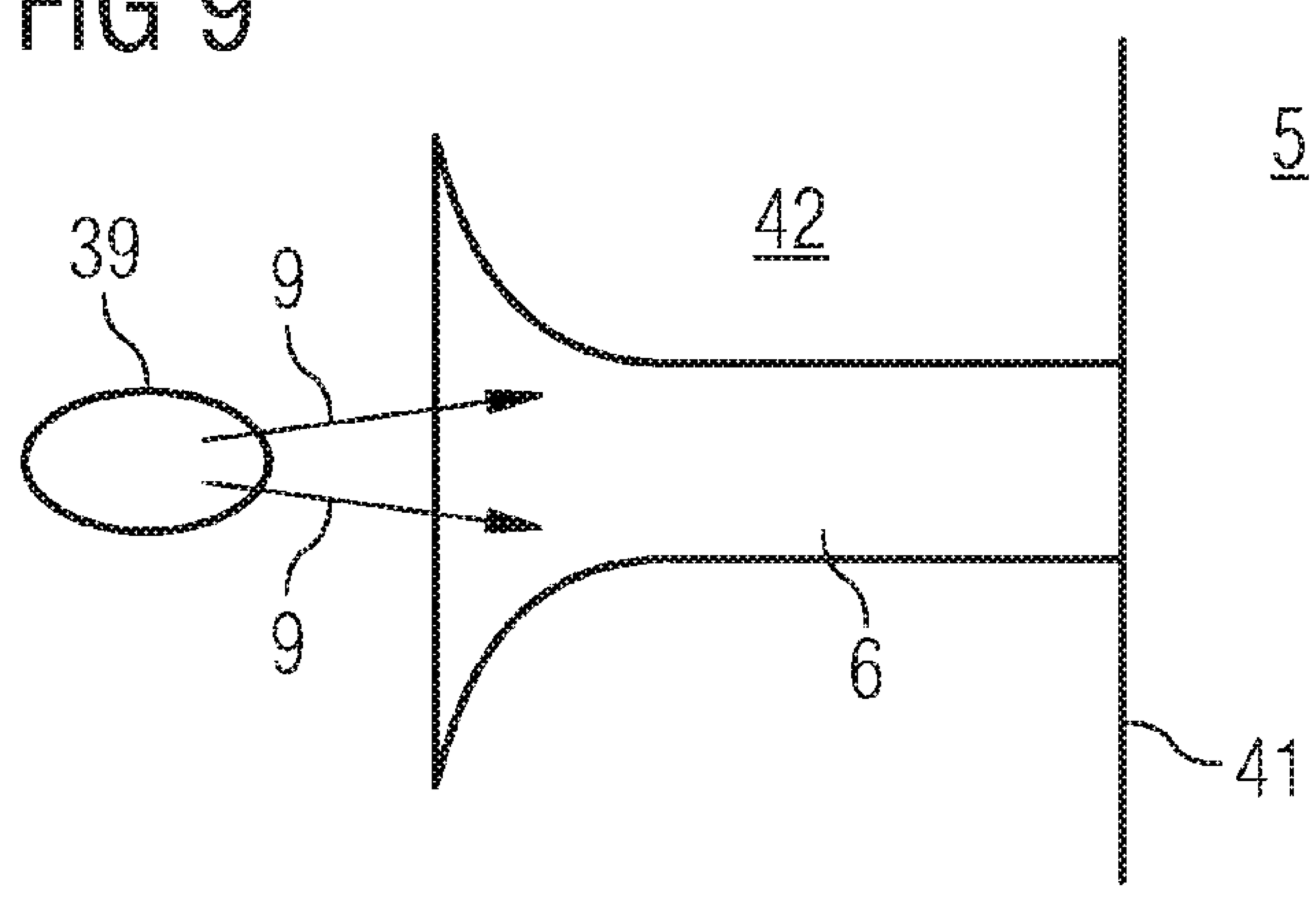


FIG 9



NON-ROTATIONAL STABILIZATION OF THE FLAME OF A PREMIXING BURNER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is the US National Stage of International Application No. PCT/EP2008/057757, filed Jun. 19, 2008 and claims the benefit thereof. The International Application claims the benefits of European Patent Office application No. 07012207.2 EP filed Jun. 21, 2007, both of the applications are incorporated by reference herein in their entirety.

FIELD OF INVENTION

[0002] The present invention relates to a method for stabilizing the flame of a premixing burner.

BACKGROUND OF INVENTION

[0003] Combustion oscillations can occur during the combustion of fuel or an air/fuel mixture in combustion chambers of gas turbines. Such oscillations are characterized by greatly increased pressure amplitudes at different frequencies. Combustion oscillations can occur in the combustion chamber itself as well as in the adjacent components of the gas turbine and can be measured there. Combustion oscillations are generally undesirable, as they have a negative effect on combustion and can damage the entire combustion system. Combustion oscillations primarily occur in premixing combustion systems, in other words in systems in which the fuel is mixed with air prior to ignition. They preferably occur when the flame is restricted to a relatively small location, in other words the reaction density is very high. So-called dead times are associated with such a compact flame with little local extension. If the dead times are within a specific narrow range, interactions can occur with the acoustics of the combustion chamber. This can cause combustion oscillations.

[0004] No system or method, with which combustion oscillations are completely avoided, is known to date. However there are a plurality of premixing combustion systems in which an air/fuel mixture is swirled and the flame is stabilized by recirculation zones. With such systems fuel is injected into an air flow and both are swirled, for example with the aid of so-called swirl blades. Once this mixture has covered a certain distance, it combusts downstream of the burner in a flame front, which is stabilized spatially by the flow field. However all these systems are characterized in that they produce a clearly defined and spatially limited flame. Therefore combustion oscillations or flame instabilities also inevitably occur here at certain operating points. These can cause extreme mechanical loading of the combustion chamber structure and should therefore be avoided or at least reduced.

[0005] An additional, widely used option for stabilizing the flame is the use of pilot flames. This is particularly significant during partial load operation of a gas turbine.

SUMMARY OF INVENTION

[0006] The object of the present invention is to provide an advantageous method for stabilizing the flame of a premixing burner. A further object of the invention is to provide an advantageous premixing burner.

[0007] These objects are achieved by a method for stabilizing the flame of a premixing burner as claimed in the claims and a premixing burner as claimed in the claims. The dependent claims contain further advantageous embodiments of the invention.

[0008] The inventive method for stabilizing the flame of a premixing burner, which comprises a reaction chamber containing a fluid, such as the combustion gases, is characterized in that an air/fuel mixture is injected into the reaction chamber at a speed that is different from that of the fluid present in the reaction chamber. The speed is set such that vortices form at the interface forming between the fuel or the air/fuel mixture and the fluid surrounding it.

[0009] The vortices forming in this process can be characterized in particular in that the axes of the vortices are perpendicular to the propagation direction of the air/fuel mixture. This differentiates them from the vortices which occur in the above-mentioned premixing combustion systems, in which an air/fuel mixture is swirled. The axes of the vortices which result primarily from the swirling of the air/fuel mixture are parallel to the propagation direction of the air/fuel mixture. Recirculation vortices also form as a result of the swirling, their axes being perpendicular to the propagation direction of the air/fuel mixture. However in contrast to the vortices resulting during swirling, the vortices resulting in association with the present invention are characterized in that no vortices occur with axes parallel to the propagation direction of the air/fuel mixture.

[0010] One advantage of the present invention is that complex swirling of the air/fuel mixture is not necessary, the air and fuel being thoroughly mixed by vorticity. Recirculation also causes the air/fuel mixture to be mixed with the hot combustion gas resulting during combustion. This stabilizes the burner as continuous ignition is thus achieved.

[0011] Fuel or an air/fuel mixture can be injected into the reaction chamber as pilot fuel for flame stabilization purposes. In this process the pilot fuel can be injected into the reaction chamber with a parallel or anti-parallel offset in respect of the air/fuel mixture. If the pilot fuel is injected into the reaction chamber with an anti-parallel offset in respect of the air/fuel mixture, the hot gases of the pilot flame are available to the premixing sprays for the hot gas intake. This reliably stabilizes the combustion reaction of the sprays. Since the hot gases also exit from the combustion chamber counter to the premixing spray direction, practically all the hot gas is available to ignite and stabilize the premixing sprays.

[0012] The air/fuel mixture can preferably be formed by injecting the fuel into an oxidation means in a premixing spray nozzle at a speed that is higher than that of the oxidation means. In particular the fuel can be injected into the oxidation means parallel to the flow direction of said oxidation means. Air, i.e. the oxygen in the air, can in particular serve as the oxidation means.

[0013] The side of the reaction chamber on which the pilot burner is located can also be cooled using an oxidation means, which is then fed to the pilot fuel during injection into the reaction chamber. The oxidation means can be air for example.

[0014] The major pressure loss in the premixing spray nozzles means that a large pressure difference is available for such cooling of the points that are subject to significant heat loading on the side of the combustion chamber where the pilot burner is located. This allows the application of different cooling technologies, such as impact spray cooling, impact spray cooling with surface enlargement or fin cooling. Dimple, longitudinal and transverse fins can be used for example for impact spray cooling with surface enlargement. Open combustion chamber cooling is then not required.

[0015] The inventive method, in particular the principle of anti-parallel injection of pilot fuel and air/fuel mixture described above, can be used both for tubular combustion chamber systems and annular combustion chamber systems. The pilot burner used here can be a rotationally stabilized burner or a spray burner.

[0016] Anti-parallel injection is particularly advantageous when spray burners disposed in an annular manner are used as the main burners. Stabilization of a number of spray flames disposed in an annular manner by a centrally disposed pilot flame with a flow direction parallel to the spray flames causes the main flow direction of the pilot flame to be counter to a recirculation flow around the spray flames, which can be problematic for ignition. This is because not all the pilot flame is available to ignite and stabilize the spray flames. The greater the recirculation, the less the pilot flame is able to ignite and stabilize. However significant recirculation of the hot combustion gases is essential for stable operation of the spray flames, in order to allow a hot gas intake into the sprays. The hot gas intake into the sprays ignites the spray flames and ensures continuous combustion.

[0017] The exit speed of the air/fuel mixture from the premixing spray nozzle into the reaction chamber or combustion chamber is preferably greater than the flame speed. The laminar flame speed is the speed at which the fresh gas flows to the flame front under laminar flow conditions during flame reactions. When the burner flames are laminar the flame front is fixed; when they are turbulent, as is the case in most technical combustion processes, the flame front fluctuates about a central position. The flame speed of the turbulent flame is a multiple of the speed of the laminar flame.

[0018] The inventive premixing burner additionally comprises a reaction chamber and at least one premixing spray nozzle opening into the reaction chamber. It is characterized in that the premixing spray nozzle is embodied such that an air/fuel mixture can be injected into the reaction chamber at a speed that is different from that of the surrounding fluid. The speed here is set so that vortices form at the interface forming between the air/fuel mixture and the fluid surrounding it. The inventive premixing burner essentially offers the advantages described above in relation to the inventive method.

[0019] The burner is an unswirled premixing burner. The air/fuel mixture is injected into a reaction chamber in the form of an unswirled spray. The spray entry speed here can preferably be above the flame speed. The spray entry speed can also preferably be higher than the speed of the fluid surrounding the spray. The free spray of each nozzle penetrates into the reaction chamber and in doing so absorbs surrounding fluid, predominantly already combusted air/fuel mixture, by carrying it along with it (so-called entrainment). This backflow stabilizes the flame. The speed and extension of the free spray determine the flame length, it being ensured that all the fuel combusts within the reaction chamber.

[0020] The premixing spray nozzle of the inventive premixing burner can preferably comprise a fuel nozzle. The premixing spray nozzle here can be embodied such that the fuel is injected through the fuel nozzle parallel to the flow direction of an oxidation means present in the premixing spray nozzle, for example compressor air, into said oxidation means. Alternatively the premixing spray nozzle can be embodied such that the fuel nozzle has at least one injection opening, which allows injection of the fuel at an angle between 0° and 90° to the flow direction of an oxidation means present in the premixing spray nozzle.

[0021] In principle the inlet opening of the premixing spray nozzle opening into the reaction chamber and/or the opening of the fuel nozzle opening into the premixing spray nozzle can have a round, oval, rectangular or square form or can be embodied as a slot.

[0022] The premixing spray nozzle can also have an element which allows the setting of the oxidation means entry speed. This element for setting the oxidation means entry speed can be a valve or a perforated sheet for example.

[0023] The inventive premixing burner can comprise at least one pilot burner. The pilot burner can be a rotationally stabilized burner or a spray burner. A number of premixing spray nozzles can also be disposed to faun a ring or a number of concentric rings respectively around a pilot burner. Where a number of premixing spray nozzles are disposed to form a number of concentric rings around a pilot burner, it is advantageous if the premixing spray nozzles of the various rings are disposed with an offset from one another. The pilot burner here can in particular also be disposed such that the flow direction of the pilot flame runs anti-parallel to the spray direction of the spray flames.

[0024] As an alternative to an annular arrangement, a number of premixing spray nozzles can also be disposed in one or more rows. It is also advantageous here if the premixing spray nozzles of the various rows are disposed with an offset from one another. In any case it is also possible for the incident spray directions of the premixing spray nozzles to be at an angle between 0° and 90° to one another.

[0025] It has generally proven advantageous for a pilot burner to be disposed respectively between two premixing spray nozzles. The premixing spray nozzles or the premixing spray nozzle can preferably be disposed opposite the pilot burner and with an offset from it.

[0026] For the purposes of cooling, in particular for cooling the rear wall of the reaction chamber on the pilot burner side, the premixing burner can be surrounded by a fluid channel, which is connected to a cooling fluid inlet. The cooling fluid inlet can in particular be an air inlet.

[0027] The advantage of the present invention is the unswirled injection of an air/fuel mixture into the reaction chamber by way of nozzles, with optimum distribution of the heat release in the reaction chamber as a whole being achieved by specific configuration of the air inlets and gas mixing within the mixing channels. The improved distribution of the heat release hereby achieved allows greater combustion stability than conventional systems due to individual penetration depths. Combustion oscillations are thus avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] Further features, characteristics and advantages of the present invention are described below based on exemplary embodiments with reference to the accompanying figures, in which:

[0029] FIG. **1** shows a schematic diagram of the cross-section through a part of the rear wall of an inventive premixing burner as a first exemplary embodiment.

[0030] FIG. **2** shows a schematic diagram of the propagation direction of the air/fuel mixture and a resulting vortex.

[0031] FIG. **3** shows a schematic diagram of a vortex produced by swirling.

[0032] FIG. **4** shows a schematic diagram of the arrangement of the inlet openings around the pilot burner on the rear wall of an inventive premixing burner.

[0033] FIG. **5** shows a schematic diagram of the cross-section through a part of the rear wall of an inventive premixing burner as a second exemplary embodiment.

[0034] FIG. **6** shows a schematic diagram of the arrangement of inlet openings and pilot burners on the rear wall of an inventive premixing burner as a third exemplary embodiment.

[0035] FIG. **7** shows a schematic diagram of the cross-section through an inventive premixing burner in a longitudinal direction as a fourth exemplary embodiment.

[0036] FIG. **8** shows a schematic diagram of the cross-section through an inventive premixing burner in a longitudinal direction as a fifth exemplary embodiment.

[0037] FIG. **9** shows a schematic diagram of a section through an inventive premixing burner along the sectional plane IX-IX shown in FIG. **8**.

DETAILED DESCRIPTION OF INVENTION

[0038] The first exemplary embodiment of the present invention is described below with reference to FIGS. **1** to **4**.

[0039] FIG. **1** shows a schematic diagram of the cross-section through a part of the rear wall of a largely rotationally symmetrical premixing burner **1**. The center line **2** shows the axis of symmetry of the premixing burner **1**. The premixing burner **1** comprises a housing **3**, a pilot burner **4**, a reaction chamber **5** and a premixing spray nozzle **6**. The premixing spray nozzle **6** has an inlet opening **13**, which opens into the reaction chamber **5**. The pilot burner **4**, which in the present exemplary embodiment is a rotationally stabilized burner, is located in the center of the rear wall of the premixing burner **1**. It is concentrically surrounded by a number of premixing spray nozzles **6**, which are likewise located on the rear wall of the premixing burner **1**.

[0040] The premixing spray nozzle **6** contains a fuel nozzle **8**, which is surrounded by an air inlet channel **37**. The air inlet channel **37** and the pilot burner **4** open into the reaction chamber **5**. A perforated sheet **14** is present in the interior of the air inlet channel **37**. The perforated sheet **14** serves to regulate the speed of the inflowing oxidation means, which in the present exemplary embodiment is compressor air. The flow direction of the air flowing through the air inlet channel **37** is shown by arrows **7**.

[0041] Fuel is directed through the fuel nozzle **8** into the front part, i.e. the part facing the reaction chamber **5**, of the premixing spray nozzle **6**. The flow direction of the fuel is shown by an arrow **9**.

[0042] In the front part of the premixing spray nozzle **6** the inflowing air mixes with the fuel flowing in through the fuel nozzle **8**. This mixture is injected into the reaction chamber **5** through the inlet opening **13**. Injecting this mixture at high speed into the reaction chamber **5** causes an interface **11** to form between the gas present in the reaction chamber **5**, in the present exemplary embodiment already at least partially combusted air/fuel mixture, and the injected air/fuel mixture. Vortices **10** are produced at this interface **11** due to the speed difference between the mixture present in the reaction chamber **5** and the injected air/fuel mixture. These vortices **10** cause the injected air/fuel mixture to mix with the gas mixture present in the reaction chamber, said gas mixture containing in particular hot combustion gases, which help to stabilize the flame.

[0043] The air is preferably injected through the air inlet channel **37** into the front part of the premixing spray nozzle **6** at a lower speed than the speed of the fuel injected through the fuel nozzle **8** into the front part of the premixing spray nozzle **6**. This causes the air to be carried along by the fuel, encouraging the mixing of air and fuel due to so-called entrainment. To this end the air can be injected into the reaction chamber **5** in particular parallel to the fuel.

[0044] FIG. **2** shows a schematic outline of a vortex **10** resulting from the inventive method. FIG. **2** shows the propagation direction **31**, which is the same as the main flow direction, of the air/fuel mixture in the reaction chamber **5** and a resulting vortex **10** by way of example. The axis **32** of the vortex **10** is also outlined. The vortex axis **32** of the resulting vortex **10** here runs perpendicular to the propagation direction **31** of the air/fuel mixture. This differentiates the vortices resulting in the context of the present invention from the vortices which are primarily caused by swirling.

[0045] By way of a comparison FIG. **3** shows vortices **33** and **44**, which were caused by swirling. The axis of the vortex **33** primarily produced by swirling is characterized in that it is largely parallel to the propagation direction **31** of the swirled air/fuel mixture also outlined in FIG. **3**. Swirling also causes the formation of recirculation vortices **44**, the axes of which are perpendicular to the propagation direction **31** of the air/fuel mixture, as shown schematically in FIG. **3**.

[0046] The arrangement of the inlet openings **13** around the pilot burner **4** is outlined in FIG. **4**. FIG. **4** shows a schematic diagram of the upper half-plane of a section along the IV-IV sectional plane through the rear wall of the premixing burner **1** shown in FIG. **1**. The center line shown with the reference character **26** in FIG. **4** is perpendicular to the axis of symmetry shown with reference character **2** in FIG. **1**. FIG. **4** shows the pilot burner **4** and numerous first inlet openings and second inlet openings of premixing spray nozzles, said inlet openings being shown with the reference characters **13** and **15**.

[0047] The first inlet openings **13** are disposed on a concentric circle around the pilot burner **4**. The second inlet openings **15** are likewise disposed on a circle positioned concentrically around the pilot burner **4**, the second inlet openings **15** being at a greater distance from the pilot burner **4** than the first inlet openings **13**. The second inlet openings **15** are also disposed with an offset from the first inlet openings **13**. Alternatively any number of inlet openings can also be disposed on just one circle around the pilot burner **4**. Additionally or alternatively pilot burners can be disposed on a circle, the radius of which is different from the radius of the circles on which the first and second inlet openings **13** and **15** are disposed. The first inlet openings **13**, the second inlet openings **15** and/or the pilot burners can likewise be disposed with an axial offset from one another. A second exemplary embodiment of the present invention is described in more detail below with reference to FIG. **5**. Elements corresponding to elements described in the first exemplary embodiment are given the same reference characters and are not described again.

[0048] The particular features of the second exemplary embodiment for the premixing burner are shown in FIG. **5**. FIG. **5** shows a schematic diagram of the cross-section through a part of the rear wall of a largely rotationally symmetrical premixing burner. FIG. **5** shows the axis of symmetry **2** running through the center of the premixing burner. In the center of the rear wall is a pilot burner **4**, which, as in the first exemplary embodiment, is embodied as a rotationally stabilized premixing burner and is surrounded concentrically by premixing spray nozzles **6**. Fuel nozzles **8** are present in the premixing spray nozzles **6**. The fuel nozzles **8** are surrounded by air inlet channels **37**. Fuel and air **16** are injected into the reaction chamber **5** with the aid of the inlet openings **13** and **15**. To this end fuel is first injected through the fuel nozzle **8** into the front part of the premixing spray nozzles **6**, where it is mixed with air **16** from the air inlet channels **37**, and then directed on or injected into the reaction chamber **5**.

[0049] In the present exemplary embodiment the fuel nozzles **8** are characterized in that they have openings **34** on their sides facing the reaction chamber **5**, to allow the fuel to exit at an angle to the flow direction of the air flowing in through the air inlet channels **37**. The flow direction of the fuel is shown by arrows **9** in FIG. **5**, the flow direction of the air flowing through the air inlet channels **37** being shown by arrows **7**. FIG. **5** shows that the flow direction of the fuel **9** when exiting through the openings **34** is at an angle to the flow direction of the air **7** flowing through the air inlet channels **37**. This angle can be set as desired by corresponding configuration of the openings **34**. An angle between 0° and 45° between the flow direction of the exiting fuel **9** and the flow direction of the inflowing air **9** is particularly expedient here. The fuel is preferably injected into the air inlet channels **37** at a higher speed than the air. This favors penetration of the fuel into the air flow and thus the mixing of fuel and air.

[0050] In the present exemplary embodiment the air/fuel mixture is injected into the reaction chamber **5** through first inlet openings **13** parallel to the center line **2**. In contrast the air/fuel mixture is injected into the reaction chamber **5** through second inlet openings **15** at an angle to the center line **2**. Vortices **10** again form at the interfaces **11** between the injected air/fuel mixture and the air present in the reaction chamber **5**. These vortices **10** have the characteristics described in the previous exemplary embodiment.

[0051] A third exemplary embodiment of the present invention is described below with reference to FIG. **6**. Elements which correspond to the elements described in the first two exemplary embodiments are given the same reference characters and are not described again.

[0052] The premixing burner of the third exemplary embodiment is characterized by a different arrangement of inlet openings and pilot burners compared with the first two exemplary embodiments. FIG. **6** shows a schematic diagram of an alternative arrangement of inlet openings and pilot burners to the one in FIG. **4**. FIG. **6** shows a top view **17** of the rear side of the reaction chamber **5** viewed from the reaction chamber. Both the pilot burners **4** and the inlet openings **18** are disposed concentrically around the center point of the rear wall of the reaction chamber **5**. The pilot burners **4** and the inlet openings **18** here are at the same distance from the center point. The four pilot burners shown and the eight inlet openings **18** shown in FIG. **6** are disposed such that the inlet openings **18** respectively are adjacent to a pilot burner **4**. The inlet openings **18** are also characterized in that in contrast to the previously described exemplary embodiments they are not round but are embodied as rectangular slots with rounded corners. Any number of pilot burners and inlet openings can of course be used instead of four pilot burners **4** and eight inlet openings **18**.

[0053] The described arrangement has the advantage that the arrangement of a number of pilot burners means that the ignition paths are shorter than in the previously described exemplary embodiments with a central pilot burner. A further advantage is that the plurality of pilot burners allows flexible control of the burning off of the air/fuel mixture. Also the individual flames can be stabilized specifically with the aid of the various pilot burners.

[0054] A fourth exemplary embodiment of the present invention is described in more detail below with reference to FIG. **7**. Elements which correspond to the elements described in the first three exemplary embodiments are given the same reference characters and are not described again.

[0055] FIG. **7** shows a schematic diagram of the cross-section through a premixing burner in a longitudinal direction. The premixing burner shown in FIG. **7** contains in its interior a reaction chamber **5**, which has an outlet **35** for the combustion gases facing the turbine. The reaction chamber **5** is surrounded by a peripheral channel **19**. At the end of the reaction chamber **5** away from the outlet **35** is a pilot burner **4**. The outlet **35** of the reaction chamber **5** is surrounded in an annular manner by inlet openings **13** of premixing spray nozzles **6**. The inlet openings **13** are disposed opposite the pilot burner **4** and with a radial offset from it.

[0056] The pilot burner **4**, which in the present exemplary embodiment is embodied as a rotationally stabilized burner, is supplied with pilot fuel through a pilot fuel inlet **36**. The flow direction of the pilot fuel is shown by an arrow **20**. The pilot fuel is injected into the reaction chamber **5** by way of the pilot burner **4** and combusted there. Air is also supplied to the pilot burner from the peripheral channel **19**. To this end air from a compressor passes into the peripheral channel **19**. One portion of this air is directed out from there to the pilot burner **4** with another portion passing by way of the peripheral channel **19** to the inlet openings **13**. The flow direction of the air coming from the compressor is shown by the arrows **24**. The air flowing on to the pilot burner **4** is shown by the arrows **23**. The air reaching the premixing spray nozzles **6** is shown by the arrows **25**.

[0057] At the same time the rear side **21** of the reaction chamber **5** is cooled by the air flowing to the pilot burner **4**. The rear side **21** is exposed to greater thermal loads than conventional burners due to the inlet openings **13** opposite it, through which an air/fuel mixture is injected at high speed into the reaction chamber **5**. Corresponding cooling is therefore advantageous.

[0058] Each premixing spray nozzle **6** in FIG. **7** comprises a fuel nozzle **8**. The fuel nozzle **8** opens into the front part of the premixing spray nozzle **6**, which in turn opens into the reaction chamber **5** by way of an inlet opening **13**. Fuel is directed into the fuel nozzle **8**. The flow direction of the fuel is shown by arrows **27**. The fuel is injected by way of the fuel nozzles **8** into the front part of the premixing spray nozzle **6**. Air is mixed with the fuel there. The flow direction of the air is shown by arrows **25**. The air used passes from the compressor by way of the peripheral channel **19** into the premixing spray nozzle **6**.

[0059] The flow direction of the air/fuel mixture injected into the reaction chamber **5** by way of the inlet opening **13** is shown with arrows **29**. The high speed of the injected air/fuel mixture causes vortices to form at the interface between the injected air/fuel mixture and the gas surrounding it. The flow direction of the vortices is shown by arrows **30**. The vortices cause the injected air/fuel mixture to be mixed with the gas present in the reaction chamber **5**. This gas is air and hot gas resulting from the combustion of the pilot flame. The hot gas flowing from the pilot burner toward the turbine assists with the formation of such vortices here. At the same time the entire pilot flame present in the reaction chamber **5** is available to ignite and stabilize the spray flames. This is achieved in that the pilot burner **4** and the inlet openings **13** are disposed anti-parallel to one another and with a radial offset.

[0060] The main flow direction of the fuel and hot gas of the pilot flame is shown by arrows **22**. This main flow direction **22** of the hot gas of the pilot flame assists recirculation around the premixing sprays. The high degree of mixing thus achieved in the reaction chamber **5** promotes stable combustion in the reaction chamber, thereby preventing undesirable combustion oscillations.

[0061] Further possible variants of the present invention are described below as a fifth exemplary embodiment with reference to FIGS. **8** and **9**. Elements which correspond to the elements described in the first four exemplary embodiments are given the same reference characters and are not described again.

[0062] FIG. **8** shows a schematic diagram of the cross-section through an inventive premixing burner in a longitudinal direction as a fifth exemplary embodiment. FIG. **8** also shows the axis of symmetry **2**, the housing **3** of the premixing burner, a premixing spray nozzle **6** and a centrally disposed pilot burner **4**, which is intended to ensure ignition of the air/fuel mixture. The pilot burner **4** is set back axially by way of a cone **43**. A number of premixing spray nozzles **6** are disposed with rotational symmetry around the axis of symmetry **2**, in other words also around the pilot burner **4**.

[0063] The premixing burner comprises a reaction chamber **5** with an outlet **35** leading to the turbine and a plenum **42**, which is opposite the outlet **35** and is separated spatially from the reaction chamber by a top plate **41**. The plenum **42** contains compressor air, which is injected into the reaction chamber **5** by the premixing spray nozzles **6**. The flow direction of the air is shown by arrows **7**.

[0064] A fuel distributor **12** is also disposed in the plenum **42**, being connected to a spur line **39**. In FIG. **8** the fuel distributor **12** is disposed at a greater radius from the axis of symmetry **2** than the spur line **39**. Of course the spur line **39** can also be disposed at a greater radius than the fuel distributor **12**. The spur line **39** is used to inject fuel into the premixing spray nozzle **6**. The fuel mixed with the compressor air is injected into the reaction chamber **5** by way of the premixing spray nozzle **6** and combusted there. The free spray of the resulting flame is shown with the reference character **40**.

[0065] FIG. **9** shows a schematic diagram of a section through the premixing burner shown in FIG. **8** along the sectional plane IX-IX indicated there. FIG. **9** again shows the reaction chamber **5**, which is separated from the plenum **42** by the top plate **41**. Incorporated in the top plate **41** is a premixing spray nozzle **6**, by way of which an air/fuel mixture is injected into the reaction chamber **5**. In the plenum **42** is a spur line **39**, which can be used to inject fuel into the premixing spray nozzle **6**. The flow direction of the fuel is shown by arrows **9**.

[0066] The reaction chamber **5** of the fifth exemplary embodiment essentially consists of a cylinder, to one side of which air and fuel are supplied by way of the top plate **41**. In addition to the fuel distributor **12** flow channels can also be positioned in the plenum **42**, allowing the air and fuel flow to be guided and aligned. Also a number of pilot burners can be present instead of just one pilot burner. One or a number of pilot flames should guarantee the burning off or ignition of the mixture here. It is also possible to combust the fuel just by way of the pilot burner(s) **4** at low fire powers.

[0067] The air/fuel mixture can enter the reaction chamber **5** by way of radial slots, as described in conjunction with FIG. **6**. Flow channels are positioned on the slots, which are used to direct the flow and in which fuel and air are mixed. Various arrangements of the premixing spray nozzles **6** and pilot burners **4** in the top plate **41** are possible here.

[0068] In a first variant the premixing spray nozzles **6** can be positioned around a centrally located pilot burner **4** as described in conjunction with FIG. **4**. They only extend over part of the annular surface in a radial direction and fount two groups, which are offset peripherally and radially. The pilot burner **4** can be set back axially by way of a cone **43** as in FIG. **8**. However a flush structure can also be realized. Both the inner and outer rings of premixing spray nozzles **6** have their own fuel inlet, so that the fuel can be staggered.

[0069] As a second variant the premixing spray nozzles **6** can be positioned in just one ring around a central pilot burner **4**, as shown in FIG. **8**. This variant is structurally simpler than the first variant.

[0070] A third variant has three (alternatively four or any other number greater than one) pilot burners **4** and six (alternatively eight or any other number greater than one) premixing spray nozzles **6**. The premixing spray nozzles **6** and the pilot burners **4** are positioned on the same circumference, as described in conjunction with FIG. **6**. The region of the burner in proximity to the axis is unaffected in this variant and can therefore serve to recirculate or feed back already reacted gas. Fuel injection in principle takes place in a similar manner to the variants mentioned above. The fuel supply can be staggered using two fuel distributors, respectively supplying every second inlet opening.

[0071] The proposed arrangements allow fuel to be injected into the air using simple structural methods. This is advantageous compared with variants in which a large number of circular premixing spray nozzles **6** are used. The first variant has the advantage that the two rows of premixing spray nozzles **6** allow the air flow and fuel quantities to be coordinated. It is also simple to stagger or displace the fuel quantity axially, so that the radial fuel distribution can be manipulated if required. The third variant has the advantage that the arrangement of three (or four or any other number greater than one) pilot burners **4** means that the ignition paths are shorter than with the first two variants with a central burner.

[0072] To summarize, in the context of the present invention the reaction is distributed spatially by appropriate flow guidance. It is thus possible largely to avoid combustion-induced instabilities. The air/fuel mixture is injected into the reaction chamber at high speed. The resulting high level of turbulence and significant flow shearing prevents oxidation of the mixture by way of a flame. The reaction or oxidation is thus distributed over the reaction chamber. Nitrogen oxide production is thus minimal due to extensive premixing.

1.-23. (canceled)

24. A method for stabilizing the flame of a premixing burner including a reaction chamber containing a fluid, comprising:

injecting an air/fuel mixture into the reaction chamber at a first speed that is different from a second speed of the fluid present in the reaction chamber wherein the air/fuel mixture injected into the reaction chamber is in a form of an unswirled spray;

setting the first speed such that a plurality of vortices form at an interface forming between the air/fuel mixture and the fluid surrounding the air/fuel mixture, the plurality of vortices faun due to a set speed difference between a mixture present in the reaction chamber and the air/fuel mixture; and

injecting a fuel or the air/fuel mixture into the reaction chamber as a pilot fuel using a pilot burner, the pilot fuel is injected into the reaction chamber with a parallel or an anti-parallel offset from the air/fuel mixture.

25. The method as claimed in claim **24**, wherein a plurality of axes of the plurality of forming vortices are perpendicular to a propagation direction of the air/fuel mixture.

26. The method as claimed in claim **24**, wherein the air/fuel mixture is formed by injecting the fuel into an oxidation means in a premixing spray nozzle at a third speed that is higher than a fourth speed of the oxidation means.

27. The method as claimed in claim **26**, wherein the fuel is injected into the oxidation means parallel to a flow direction of the oxidation means.

28. The method as claimed in claim **24**, wherein a side of the reaction chamber where the pilot burner is located is cooled using the oxidation means which is then fed to the pilot fuel during injection into the reaction chamber.

29. The method as claimed in claim **26**, wherein the oxidation means is air.

30. A premixing burner, comprising:

a reaction chamber;

a premixing spray nozzle opening into the reaction chamber; and

a pilot burner,

wherein an air/fuel mixture may be injected into the reaction chamber at a first speed that is different from a second speed of a fluid surrounding the air/fuel mixture,

wherein the first speed is set such that a plurality of vortices form at an interface forming between the air/fuel mixture and the fluid,

wherein the plurality of vortices form due to a set speed difference between a mixture present in the reaction chamber and the injected air/fuel mixture, and

wherein the pilot burner injects a fuel or the air-fuel mixture into the reaction chamber with a parallel or an anti-parallel offset from the air/fuel mixture.

31. The premixing burner as claimed in claim **30**, wherein the premixing spray nozzle includes a fuel nozzle.

32. The premixing burner as claimed in claim **31**, wherein the premixing spray nozzle injects the fuel into an oxidation means through the fuel nozzle parallel to a flow direction of the oxidation means located in the premixing spray nozzle.

33. The premixing burner as claimed in claim **31**, wherein the fuel nozzle includes a first inlet opening, which allows injection of the fuel at a first angle between 0° and 90° to the flow direction of the oxidation means located in the premixing spray nozzle.

34. The premixing burner as claimed in claim **30**, wherein a second inlet opening of the premixing spray nozzle opening into the reaction chamber is round, oval, rectangular, or square or is embodied as a slot, and/or an opening of the fuel nozzle opening into the premixing spray nozzle is round, oval, rectangular or square or is embodied as a slot.

35. The premixing burner as claimed in claim **30**, wherein the premixing spray nozzle includes an element for setting an entry speed of the oxidation means.

36. The premixing burner as claimed in claim **35**, wherein the element is a valve or a perforated sheet.

37. The premixing burner as claimed in claim **30**, wherein the pilot burner is a rotationally stabilized burner or a spray burner.

38. The premixing burner as claimed in claim **37**, wherein a plurality of premixing spray nozzles are disposed to form a ring or a plurality of concentric rings around the pilot burner.

39. The premixing burner as claimed in claim **38**,

wherein the plurality of premixing spray nozzles are disposed to form a plurality of concentric rings around the pilot burner, and

wherein the plurality of premixing spray nozzles of the various rings are disposed with an offset from one another.

40. The premixing burner as claimed in claim **30**, wherein the plurality of premixing spray nozzles are disposed in a row.

41. The premixing burner as claimed in claim **30**, wherein the incident spray directions of the plurality of premixing spray nozzles are at a second angle between 0° and 90° to one another in the reaction chamber.

42. The premixing burner as claimed in claim **30**, wherein a pilot burner is disposed between two premixing spray nozzles.

43. The premixing burner as claimed in claim **30**,

wherein the premixing spray nozzle is disposed opposite the pilot burner, and

wherein the premixing spray nozzle includes a radial offset from the pilot burner.

44. The premixing burner as claimed in claim **30**, wherein the premixing burner is surrounded by a fluid channel, the fluid channel is connected to a cooling fluid inlet.

45. The premixing burner as claimed in claim **44**, wherein the cooling fluid inlet is an air inlet.

* * * * *