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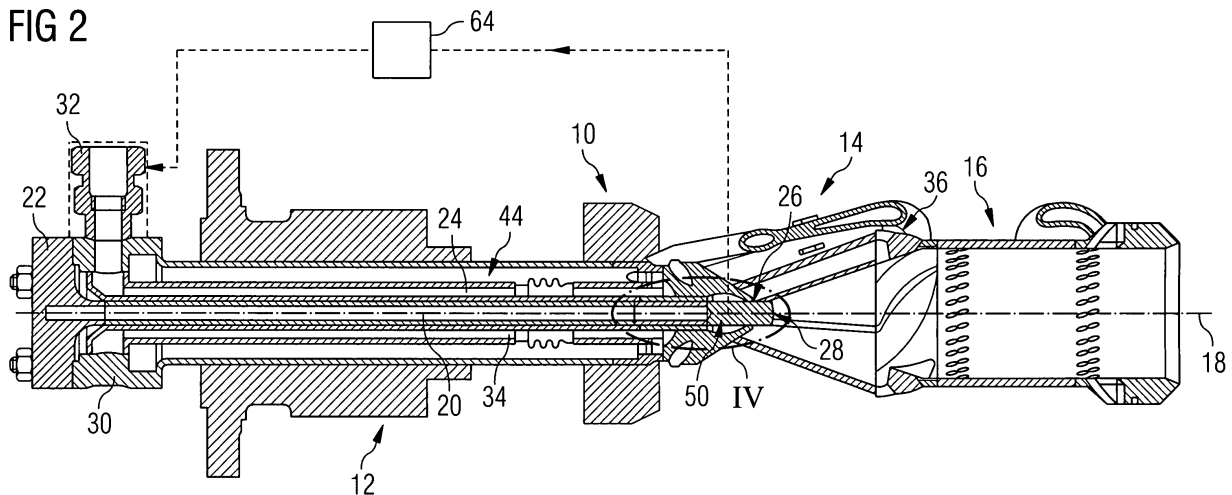
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61294 Finspong (SE)**(54) **Burner for a gas turbine and method for controlling fuel supply to a burner**

(57) The invention relates to a burner (10) for a gas turbine having a fuel supply device (20, 34, 44) for supplying fuel into the burner (10), which burner (10) is configured for mixing the fuel with an oxygen containing gas to generate a combustion medium to be supplied to a combustion chamber of the gas turbine. According to the invention said burner (10) is provided with a pressure measurement device (20) for pressure measurement in

the combustion medium and comprising a measuring point (28) defining the location of the pressure measurement, wherein the measuring point (28) is located inside the burner (10), and the burner (10) is provided with a control device (64) configured for controlling the fuel supply of the fuel supply device (20, 34, 44) based on the pressure measurement and/or configured for controlling the air supply to the burner (10) based on the pressure measurement.

FIG 2**EP 1 942 303 A1**

Description

Field of the invention

[0001] This invention relates to a burner for a gas turbine having a fuel supply device for supplying fuel into the burner, which burner is configured for mixing the fuel with an oxygen containing gas to generate a combustion medium to be supplied to a combustion chamber of the gas turbine. Further, the invention relates to a gas turbine comprising such a burner. In addition the invention relates to a method of controlling fuel supply to a burner of a gas turbine, in which burner the fuel is mixed with an oxygen containing gas to generate a combustion medium to be supplied to a combustion chamber of the gas turbine.

Background of the invention

[0002] A gas turbine in general comprises one or several burners of the above mentioned type typically leading into an annular combustion chamber. The burners are each supplied with fuel in liquid or gaseous form, which is mixed with an oxygen containing gas, like air, in a mixing section of the burner, resulting in a combustion medium. Subsequently, the combustion medium is supplied to the combustion chamber for combustion. In order to supervise the combustion process, at least three pressure-measurement devices in the form of pressure probes are placed inside the combustion chamber. The pressure probes are connected via a piping system to an outer wall of the typically annular combustion chamber. The measurement points of the pressure probes are typically placed asymmetrically along the circumference of the combustion chamber inside the chamber. The pressure probes have the function of measuring any pressure pulsations of the combustion medium contained inside the combustion chamber.

[0003] In order to operate the gas turbine fuel efficiently, the fuel content in the combustion medium is reduced as much as possible. In this operating mode, also referred to as lean burn mode, the flames in the combustion chamber often operate close to instability, which always leads to the danger of rising pressure pulsations in the combustion chamber. If pressure pulsations are detected by the pressure probes in the combustion chamber a control equipment picks up the signal from the probes and affects the fuel/supply to the specific burner in a way, which counter balances the disturbing pressure pulsations.

[0004] However, the pressure pulsations arising in the combustion chamber of conventional gas turbines are not always contained sufficiently.

Summary of the invention

[0005] It is an object of the present invention to provide a gas turbine comprising a burner of the above mentioned type and a method of the above mentioned type, by

means of which pressure pulsations in the combustion chamber of the gas turbine can be contained more effectively.

[0006] The above object is solved according to the present invention by providing a burner of the above mentioned kind, which burner is provided with a pressure measurement device for pressure measurement in said combustion medium and which pressure measurement device comprises a measuring point defining the location of said pressure measurement, wherein the measuring point is located inside said burner, and the burner is further provided with a control device configured for controlling the fuel supply of the fuel supply device based on the pressure measurement and/or configured for controlling the air supply to the burner based the pressure measurement. The pressure measurement device is an additional element attributed to the burner. Further, the object is solved according to the invention by providing a gas turbine comprising such a burner. Additionally, the object is solved according to the invention by providing a method of the above mentioned type comprising the steps of: measuring the pressure, in particular measuring pressure pulsations, of the combustion medium inside the burner, and controlling the fuel supply based on the pressure measurement and/or controlling the fuel supply to the burner based on the pressure measurement.

[0007] By arranging the measuring point inside the burner of the gas turbine a more reliable detection of pulsations in the combustion medium contained in the combustion chamber can be obtained. The interior of the burner, in which the pressure measurement device according to the invention is arranged, has a different configuration as compared to the inside of the combustion chamber. Due to the reliable detection of arising pulsations in the combustion medium, the control device is able to modify the fuel supply accordingly and therewith contain pressure pulsations in the combustion chamber very effectively.

[0008] By arranging the measuring point inside the burner according to the invention the pressure measurement device can further be operated in a range of high sensitivity. This is as the flame of the combustion process is typically limited to the combustion chamber and the pressure pulsations reflecting into the burner are therefore reduced in scale as compared to the pressure pulsations inside the combustion chamber. Therefore, the pressure measurement device can be operated in a range of high sensitivity, which allows the pressure to be measured with a higher accuracy.

[0009] Further, the volume of the combustion medium contained inside the burner is typically smaller than the volume of the combustion medium contained inside the combustion chamber.

[0010] Therefore, possible pressure pulsations are not as strong inside the burner as they are inside the combustion chamber. Further, destructive influences of the pressure pulsations on the measurement system, possibly leading to a brake-down of the pressure measure-

ment system can essentially be avoided according to the inventive solution.

[0011] Further, as according to the invention the pressure can be measured inside each of the burners connected to the combustion chamber the influence of single burners on the pressure pulsations can easily be monitored. In case pressure pulsations in a certain burner have different characteristics as compared to the pressure pulsations in other burners, the operating conditions of the respective burner can be adjusted individually to eliminate differential pressure pulsation characteristics. Therefore, the pressure pulsations in the combustion chamber can be controlled in a very accurate manner.

[0012] Further, the pressure measurement device of the burner according to the invention can easily be changed or removed for functional testing by removing the pressure probe part or the whole burner from the gas turbine. This allows for very easy maintenance operations, as no work has to be done inside the combustion chamber for the above purposes. Further, no specific connections inside the combustion chamber are required for the pressure measurement device.

[0013] Additionally, upgrades of already installed gas turbines with the burner according to the invention can easily be conducted by merely adding the inventive pressure measurement device and the control device to each of the existing burners. Also existing burners could be exchanged with burners having the pressure measurement device and the control device according to the invention.

[0014] Further, the pressure measurement device according to the invention can be used for learning on acoustic modes in a combustion chamber, which develop in the case, in which a large number of burners, for example thirty burners, are attached to a single combustion chamber. The signals measured at each of the pressure measurement devices of the associated burners can be used to understand high frequency modes developing in combustion chambers connected to such a large number of burners.

[0015] Advantageously, the control device is configured for controlling the rate and/or the pressure of the fuel supplied by the fuel supply device based on the pressure measurement. Therewith, the fuel content in the combustion medium can be modified, which causes a modification of the mode of combustion in the combustion chamber.

[0016] It is further preferable, if the pressure measurement device is configured to detect pressure pulsations in the combustion medium and the control device is configured to modify the fuel supply in response to the detected pressure pulsations. Preferably, the control device is configured to increase the rate of fuel supplied in response to the detection of pressure pulsations in the combustion medium. In particular, the rate of fuel supplied is increased, if the pressure pulsations exceed a given threshold. This measure is particularly useful if the combustion chamber is operated at lean burn condition. In

this case the flame is always on the edge of instability. If instability occurs pressure fluctuations in the longitudinal direction of the flame arise. The pressure measurement device in the associated burner detects the fluctuations and increases the rate of fuel supplied to the given burner. The resulting richer fuel content in the combustion medium prevents an escalation of the pressure pulsations and forces the flame back to a stable state. Advantageously, a return to lean burn will gradually be made by means of a programmed sequence by the control device.

[0017] Advantageously, the burner comprises a mixing section for generating the combustion medium by mixing the oxygen containing gas and fuel and the measuring point is arranged inside the mixing section of the burner. This way, the pressure inside the mixing section of the burner can be measured by the pressure measurement device. Pressure fluctuations in the combustion chamber typically cause predictable pressure variations in the mixing section of the burner. Therefore, measuring the pressure inside the mixing section allows for a very accurate and reliable control of pressure pulsations in the associated combustion chamber.

[0018] It is further preferable, if the pressure measurement device is arranged in the fuel supply device. The pressure measurement device and the fuel supply device can also be part of the same structure. Preferably, the pressure measurement device has the shape of a fuel injection center lance for injecting fuel into the burner. Such fuel injection lances are known in the state of the art and are particularly used for injecting liquid fuel into the mixing section of the burner. Also for burners, which do not have such a fuel injection lance, like burners using a gaseous fuel, the inclusion of such a pressure measurement device having the shape of a fuel injection lance fits well into the design of the overall burner and can be retrofitted easily in existing burner designs. Also, the design of such a fuel injection lance can be optimised with respect to the fluid dynamics inside the burner. In case of a burner already having a fuel injection lance, like burners using liquid fuel, only the existing fuel injection lance has to be replaced by a fuel injection lance including the pressure measurement function according to the invention.

[0019] It is further advantageous, if the pressure measurement device comprises a pressure sensor or a transducer for converting physical pressure into an information signal, like an electrical signal. The pressure sensor can be configured to use silicon, quartz, and/or dielectric thin films as sensor materials. The pressure sensor can also comprise an optical sensor.

[0020] It is particularly advantageous, if the pressure measurement device has an elongated shape. Preferably, the pressure measurement device is at least partially of cylindrical shape and/or is formed in the shape of a rod. Due to its elongated shape the pressure measurement device can easily be mounted to extend at least partially inside the burner with the measuring point reaching into the mixing section of the burner without disturbing

the given fluid dynamics inside the burner. Typically, the burner has a tube-like shape having a longitudinal axis. The pressure measurement device is preferably configured to be arranged with its elongated shape extending parallel to the longitudinal axis of the burner. Preferably, the pressure measurement device is arranged in the center of the tube-shaped burner. In this case, the fluid flow inside the burner, which has a preferred flow direction parallel to the longitudinal axis, is not affected by the presence of the pressure measurement device.

[0021] It is further preferable, if the pressure measurement device comprises an attachment element for attaching the pressure measurement device to the burner and an extension element having an elongated shape, wherein the measuring point is located at a distal end of the extension element with respect to the attachment element.

[0022] In a further preferred embodiment, the pressure measurement device contains a fluid conductive probing channel, which connects the measuring point to a pressure sensor. Therefore, the pressure sensor can be arranged in the pressure measurement device at a location different from the measuring point. In particular, the pressure sensor can be arranged outside of the burner. The pressure sensor is preferably arranged at a distal end portion of the burner with respect to the combustion chamber. In this case the pressure sensor is mounted at a secure location with respect to possible destructive influences of the pressure variations emanating from the combustion chamber. By arranging the pressure sensor far away from the measuring point, the pressure sensor can be located at a considerable distance from the heat source in the combustion chamber. Therefore, the pressure sensor can be kept at a reasonably low operating temperature. Preferably, the pressure sensor is located far enough away from the combustion chamber to keep its operating temperature below 500 °C.

[0023] It is further preferable, if the pressure sensor comprises an optical pressure sensor. In particular, this optical pressure sensor can be a fiber-optic pressure sensor, which advantageously contains a fiber-optic bragg grating attached to a flexible membrane as a pressure detection device. Such an optical pressure sensor allows for a very accurate pressure measurement. An optical pressure sensor can be operated at a high ambient temperature, e.g. at an ambient temperature of more than 500°C. It can therefore be located at the measuring point close to the combustion chamber, which leads to a very accurate pressure measurement. It is further advantageous, if the burner has a tube-like shape having a longitudinal axis and the pressure measurement device is arranged with its elongated shape extending parallel to the longitudinal axis, in particular being centered inside the burner. Therefore, the pressure measurement device basically extends along the longitudinal axis, that means is centred inside a tube-shape burner with respect to its radial extension.

[0024] In an advantageous embodiment of the gas tur-

bine according to the invention, the gas turbine comprises several inventive burners and the control device is configured for controlling the fuel supply to each of the burners separately based on the respective pressure measurements in the single burners. By regulating the burners individually, corrective action against local pressure imbalances can be taken by specific burners most suited for correcting the given pressure imbalance.

[0025] The features specified above with respect to the inventive burner can be transferred correspondingly to the inventive method. Advantageous embodiments of the inventive method resulting therefrom shall be covered by the disclosure of this invention.

Brief description of the drawings

[0026] A detailed description of the present invention is provided herein below with reference to the following diagrammatic drawings, in which:

Figure 1 is a front view of an embodiment of a burner of a gas turbine being provided with a first embodiment of a pressure measurement device according to the invention,

Figure 2 is a sectional view along II-II according to Figure 1,

Figure 3 is a sectional view along III-III according to Figure 1,

Figure 4 is a sectional view of a tip portion of a second embodiment of a pressure measurement device according to the invention arrangeable in the area designated by IV of the burner shown in Figure 2, and

Figure 5 is a detailed sectional view of a third embodiment of a pressure measurement device according to the invention.

Description of the preferred embodiments

[0027] Figures 1 and 2 depict an embodiment of a burner 10 for a gas turbine. Typically, several burners 10 of this type are connected to an annular combustion chamber of the gas turbine for supplying a combustion medium in the form of a fuel/air mixture required for operating the combustion process in a combustion chamber of the gas turbine. Therefore, these burners are typically arranged around the combustion chamber.

[0028] As shown in Figure 2, the burner 10 extends along a longitudinal axis 18 and comprises a fuel supply section 12, a mixing section 14 and a stabilising section 16. In the fuel supply section 12, fuel in liquid or gaseous form is supplied to the mixing section 14 by means of a fuel supply device 44 explained later in more detail. In the mixing section 14 air is introduced from the outside through air holes 36 and mixed with the fuel for forming

the combustion medium in form of a fuel/air mixture. The mixing section 14 has the shape of a cone expanding in the flow direction of the supplied fuel, i.e. from left to right according Fig. 2. The mixing section 14 leads into the stabilising section 16 which is of cylindrical shape and is designed to stabilise the flow of the combustion fuel. The stabilising section 16 connects into the combustion chamber, which follows at the right side end of the stabilising section 14 according to Fig. 2, but is not shown in the Figure. In the combustion chamber the combustion fuel is combusted for powering the gas turbine.

[0029] The fuel supply section 12 is provided with a first embodiment of a pressure measurement device 20 in the shape of a center fuel lance. The pressure measurement device 20 is arranged in the center of the fuel supply section 12 with respect to its extension radial to the longitudinal axis 18. Further a first fuel inlet 32 for supplying fuel in form of gas into the burner 10 is shown in Fig. 2. The fuel enters the burner 10 through the fuel inlet 32 and is subsequently guided into an inner gas tube 34 surrounding the pressure measurement device 20. The inner gas tube 34 acts as a fuel supply device for the first fuel inlet 32. Figure 3 shows a second fluid inlet 42 for fuel in the form of gas, which is connected to an outer gas tube 44 surrounding the inner gas tube 34.

[0030] The outer gas tube 44 therefore acts as a fuel supply device for fuel entering through the second fuel inlet 42. Figure 3 also shows a third fuel inlet 38, which is designed for the supply of fuel in liquid or gaseous form. The fuel inlet 38 is connected to a channel 40 for ducting fuel inside the pressure measurement device 20, which acts in the embodiment shown in Fig. 2 and 3 also as a fuel supply device in form of a center fuel lance for supplying the liquid fuel into the mixing section 14.

[0031] The pressure measurement device 20 comprises an attachment element 22 for attaching the pressure measurement device 20 to a housing 30 of the fuel supply section 12. The attachment element 22 is followed by an extension element 24 of elongate shape extending along the longitudinal axis 18 of the burner 10. The extension element 24 extends through the fuel supply section 12 and into the mixing section 14. The tip portion or distal end 26 of the extension element 24 with respect to the attachment element 22 is positioned inside the mixing section 14.

[0032] At the distal end 26 of the extension element 24, a measuring point 28 is located, at which the pressure of the combustion medium inside the mixing section 14 can be measured. This is done using a pressure sensor 50, which either can be located at the measuring point 28 or can be connected with the measuring point 28 via a fluid conductive probing channel. In this case, the pressure sensor 50, which is not shown in detail in Figure 2 can also be located outside of the pressure measurement device.

[0033] The pressure value obtained by the pressure measurement sensor 50 is read out by a control device 64, shown schematically in Fig. 2. The control device 64

can certainly be arranged inside the burner 10 or at any other location of the gas turbine. The control device 64 generates a control signal from the pressure reading for controlling the fuel supply through the inlets 32, 38 and/or 42. For this purpose the inlets 32, 38 and/or 42 are equipped with a respective valve which is controlled by the control device 64 in order to regulate the rate and/or the pressure of the fuel supplied through the gas tubes 34 and 44 and/or the pressure measurement device 20.

[0034] Figure 4 shows a schematic view of an end portion of an extension element 24 of a second embodiment of a pressure measurement device 20. This end portion of the extension element 24 corresponds to the portion of the pressure measurement device 20 contained in the area IV of Figure 2. The end portion contains a pressure sensor 50 in the form of a transducer, which is exposed to the combustion medium via a small bore 48 in the distal end 26 of the device 20.

[0035] Figure 5 shows a third embodiment of the pressure measurement device 20 according to the invention. The device 20 contains an attachment element 22 including attachment bores 60 for attaching the device 20 to a housing 30 of the burner 10. Corresponding to the device 20 according to Fig. 2 the attachment element 22 is followed by an extension element 24 having a distal end 26 or a tip portion. Near the distal end 26, a pressure sensor 50 is contained in the extension element 24. The pressure sensor 50 in the embodiment according to Fig. 5 is configured as an optical sensor, which contains an optical fibre 52, an optical lens 54 and a bragg-grating 56.

[0036] In a further embodiment of the pressure measurement device 20, not shown in the drawings, the pressure sensor 50 can also be arranged on a feed side 62 of the device 20. In this case, a fluid conductive probing channel extends inside the extension element 24 starting from the measuring point 28 at the distal end 26 of the extension element 24. With this probing channel the pressure variations at the measuring point 28 are guided to the pressure sensor arranged outside of the device 20.

Claims

1. Burner (10) for a gas turbine having a fuel supply device (20, 34, 44) for supplying fuel into said burner (10), which burner (10) is configured for mixing said fuel with an oxygen containing gas to generate a combustion medium to be supplied to a combustion chamber of said gas turbine,
characterized in that said burner (10) is provided with a pressure measurement device (20) for pressure measurement in said combustion medium and comprising a measuring point (28) defining the location of said pressure measurement, wherein said measuring point (28) is located inside said burner (10), and said burner (10) is further provided with a control device (64) configured for controlling the fuel supply of said fuel supply device (20, 34, 44) based

on said pressure measurement and/or configured for controlling the air supply to said burner (10) based on said pressure measurement.

2. Burner according to claim 1,
characterized in that said control device (64) is configured for controlling the rate and/or the pressure of said fuel supplied by said fuel supply device (20, 34, 44) based on said pressure measurement. 5
3. Burner according to claim 1 or 2,
characterized in that said pressure measurement device (20) is configured to detect pressure pulsations in said combustion medium and said control device (64) is configured to modify said fuel supply in response to said detected pressure pulsations. 10
4. Burner according to claim 3,
characterized in that said control device (64) is configured to increase the rate of fuel supplied in response to said detection of pressure pulsations in said combustion medium. 15
5. Burner according to any one of the preceding claims,
characterized in that said pressure measurement device (20) is arranged in said fuel supply device (20). 20
6. Burner according to any one of the preceding claims,
characterized in that said pressure measurement device (20) has the shape of a fuel injection center lance for injecting fuel into said burner (10). 25
7. Gas turbine comprising a burner (10) according to any one of the preceding claims. 30
8. Gas turbine according to claim 7,
characterized in that said gas turbine comprises several of said burners (10) and said control device (64) is configured for controlling the fuel supply to each burner (10) separately based on the respective pressure measurements in the single burners (10). 35
9. Method for controlling fuel supply to a burner (10) of a gas turbine, in which burner (10) said fuel is mixed with an oxygen containing gas to generate a combustion medium to be supplied to a combustion chamber of said gas turbine,
characterized by the steps of: 40
 - measuring the pressure of said combustion medium inside said burner (10), and
 - controlling said fuel supply and/or the air supply to said burner (10) based on said pressure measurement. 45
10. Method according to claim 9,
characterized in that the rate and/or the pressure 50

of said fuel supplied to said burner is controlled based on said pressure measurement.

11. Method according to claim 9 or 10,
characterized in that in case pressure pulsations in the combustion medium are detected by said pressure measurement said fuel supply is modified, in particular the rate of said fuel supplied is increased. 55

FIG 1

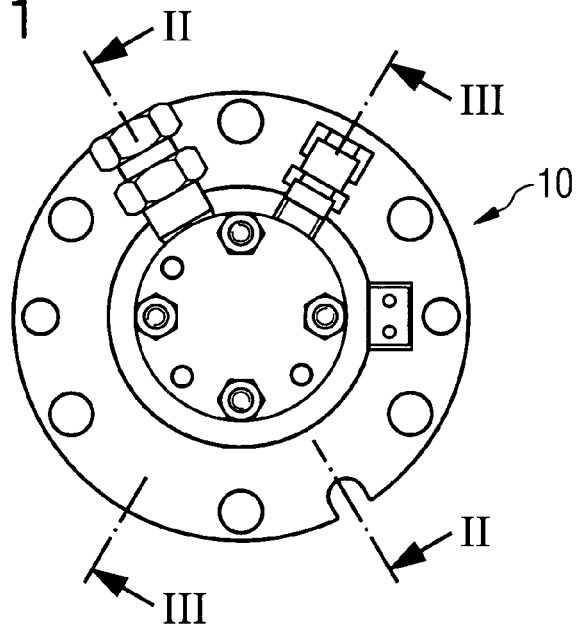


FIG 3

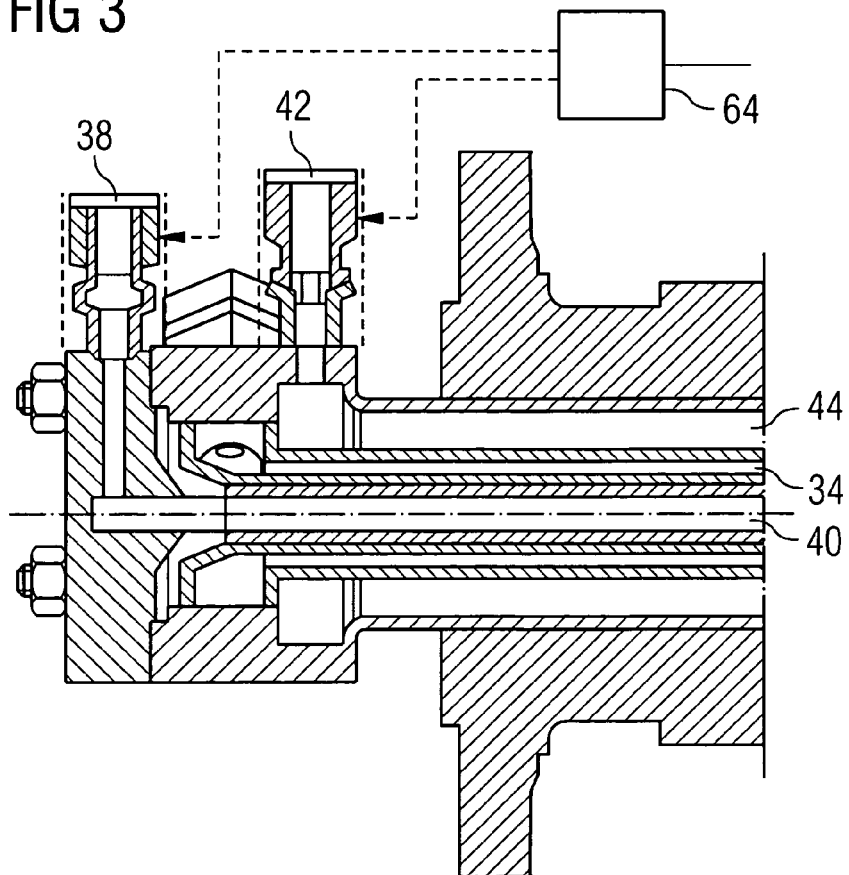


FIG 2

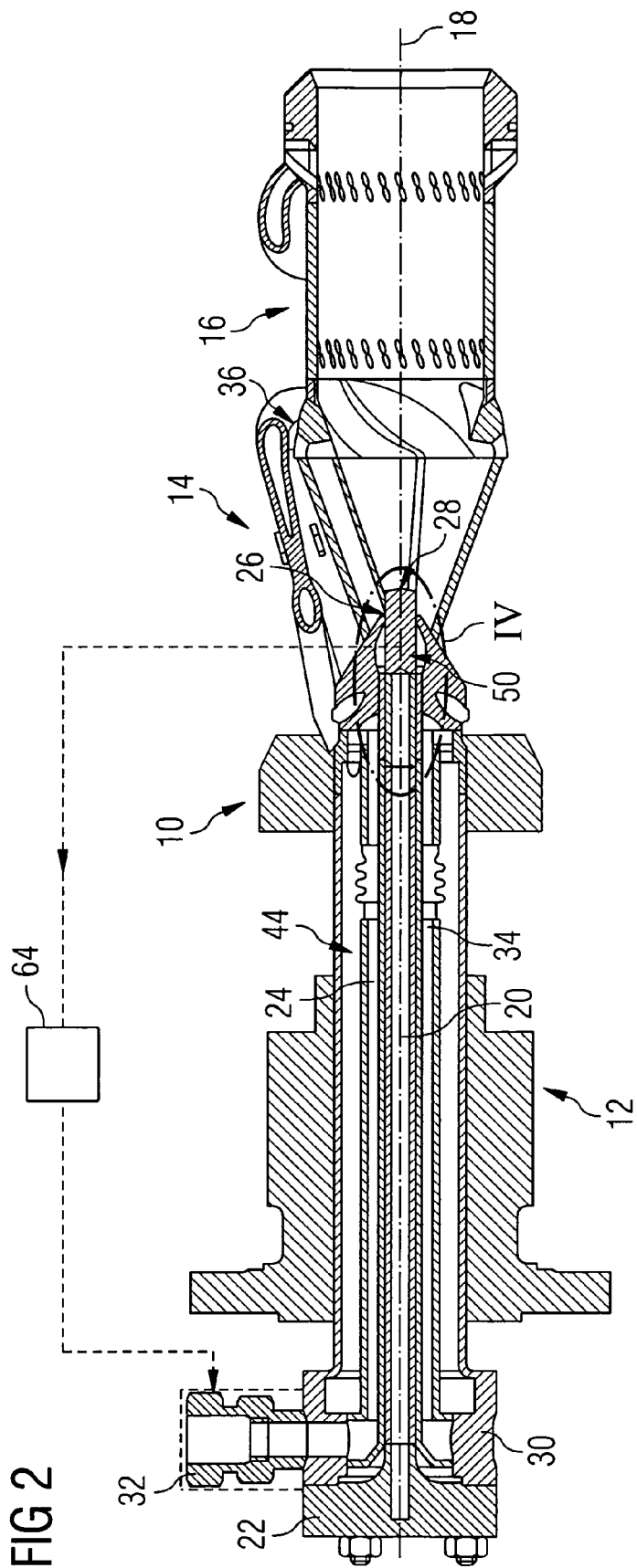


FIG 4

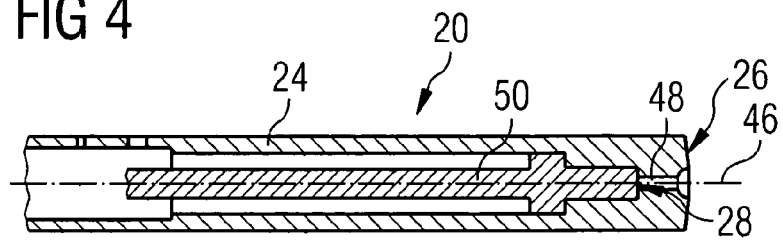
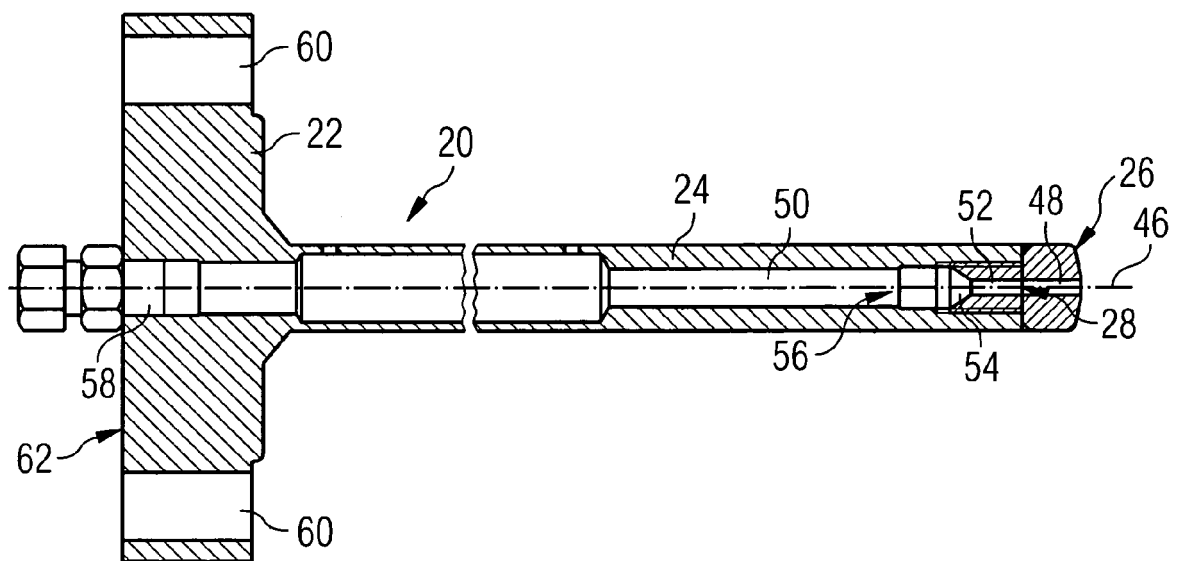


FIG 5





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 00 0036

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 07 00 0036

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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