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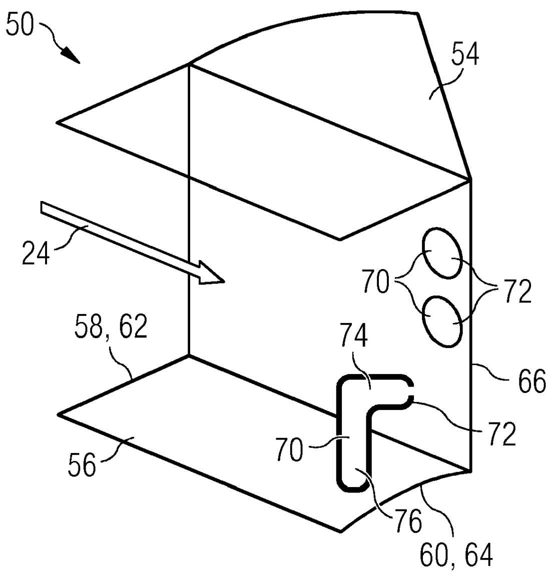
(54) **Swirler for a burner of a gas turbine engine, burner of a gas turbine engine and gas turbine engine**

(57) The present invention is related to a Swirler (50) for a burner (30) of a gas turbine engine (10), comprising a plurality of vanes (54) extending from an outer radius (64) of the swirler (50) to an inner radius (62) of the swirler (50) and a plurality of mixing channels (56) between the vanes (54) to channel air (24) from a radially outer end (58) of the mixing channel (56), located essentially at an outer radius (64) of the swirler (50), to a radially inner end (60) of the mixing channel (56), located essentially at an inner radius (62) of the swirler (50), at least one main injection means (52) for providing fuel for a main flame of the gas turbine engine (10), the main injection means (52) arranged at and/or in at least one of the mixing channels (56), and at least one pilot injection means (70) for providing fuel for a pilot flame of the gas turbine engine (10). Further, the invention is related to a burner (30) of a gas turbine engine (10) and to a gas turbine engine (10).

FIG 3



EP 2 942 563 A1

Description

[0001] The present invention is related to a swirler for a burner of a gas turbine engine, comprising a plurality of vanes extending from an outer radius of the swirler to an inner radius of the swirler and a plurality of mixing channels between the vanes to channel air from a radially outer end of the mixing channel, located essentially at an outer radius of the swirler, to a radially inner end of the mixing channel, located essentially at an inner radius of the swirler, at least one main injection means for providing fuel for a main flame of the gas turbine engine, the main injection means arranged at and/or in at least one of the mixing channels, and at least one pilot injection means for providing fuel for a pilot flame of the gas turbine engine. Further, the invention is related to a burner of a gas turbine engine, comprising a swirler and a combustion chamber and further to a gas turbine engine, comprising at least one burner.

[0002] Modern gas turbine engines are commonly used in industrial applications. To achieve the goal of an environmental-friendly operation of the gas turbine engine, the gas turbine engine is operated in a DLE-combustion mode (DLE: Dry Low Emission) producing low emissions, especially low NOx-emissions. A low flame temperature can be used to achieve this goal in combination with a lean mixture environment. To sustain this flame at or near the lean combustion limit, a pilot flame, fed by a pilot injection means, is used. Further, a good and uniform mixing of air and fuel in a burner of the gas turbine engine has to be achieved. In modern gas turbine engines swirlers are used for this task.

[0003] Fig. 1 shows a sectional view of an example of a gas turbine engine 10. The terms upstream and downstream refer to the flow direction of the air flow and/or working gas flow through the engine unless otherwise stated. The terms forward and reward refer to the general flow of gas through the engine. The term axial, radial and circumferential are made with reference to a rotational axis 20 of the gas turbine engine 10. The gas turbine engine 10 comprises, in flow series, an inlet 12, a compressor section 14, a combustor section 16 and a turbine section 18 which are generally arranged in flow series and generally in the direction of a longitudinal or rotational axis 20. The gas turbine engine 10 further comprises a shaft 22 which is rotatable about the rotational axis 20 and which extends longitudinally through the gas turbine engine 10. The shaft 22 drivingly connects the turbine section 18 to the compressor section 14.

[0004] In operation of the gas turbine engine 10, air 24, which is taken in through the air inlet 12, is compressed by the compressor section 14 and delivered to the combustion or burner section 16. The burner section 16 comprises a burner plenum 26, one or more combustion chambers 28, defined by a double wall can 27 and at least one burner 30 fixed to each combustion chamber 28. The combustion chambers 28 and the burners 30 are located inside the burner plenum 26. The compressed air 24 passing through the compressor 14 and the diffuser 32 is discharged from the diffuser 32 into the burner plenum 26 from where a portion of the air enters the burner 30 and is mixed with a gaseous or liquid fuel. The air/fuel-mixture is then burned and the combustion gas 34 or working gas from the combustion is channelled via a transition duct 35 to the turbine section 18.

[0005] The turbine section 18 comprises a number of blade-carrying discs 36 attached to the shaft 22. In the present example, two discs 36 each carry an annular array of turbine blades 38. However, the number of blade-carrying discs 36 could be different, i.e. only one disc or more than two discs. In addition, guiding vanes 40 which are fixed to a stator 42 of the gas turbine engine 10 are disposed between the turbine blades 38. Between the exit of the combustion chamber 28 and the leading turbine blades 38 inlet guiding vanes 44 are provided.

[0006] The combustion gas 34 from the combustion chamber 28 enters the turbine section 18 and drives the turbine blades 38 which in turn rotate the shaft 22. The guiding vanes 40, 44 serve to optimize the angle of the combustion or working gas on the turbine blades 38. The compressor section 14 comprises an actual series of guide vane stages 46 and rotor blade stages 48.

[0007] As mentioned above, swirlers are used to provide an optimal air/fuel mixture, both for the main fuel and for the pilot fuel. This is essentially difficult for liquid fuel. For liquid pilot fuel often a single pilot injection means, mainly positioned at a face of the burner, is used. For swirler arrangements it is known, like in WO 2007/104599 A1 or GB 2 333 832, to alternatively or additionally use an (semi-)enclosed space near the face of the burner to inject pilot fuel and air into it to achieve a good mixing of pilot fuel and air. According to another solution, as disclosed in GB 2 444 737 A, fuel is injected on a surface and air flowing by is atomizing it into small droplets.

[0008] If especially a very dense spray of liquid fuel is used for the pilot fuel injection, the droplets of the fuel can hit each other and also walls of the swirler and/or the burner. Especially in the case of liquid fuel this can lead to the problems of poor atomization and carbon build up on surfaces of the burner. This can lead to a reduction in combustion control and to a locally very rich flame, burning poorly with high unburnt hydrocarbon and NOx emissions. Especially the carbon build up on surfaces can change fuel injection means by blocking injection holes both for the main and for the pilot injection.

[0009] It is an object of the present invention to solve the aforesaid problems and drawbacks at least partly. In particular, it is an object of the present invention to provide a swirler, a burner and a gas turbine engine, which allow an injection of especially liquid pilot fuel in an easy and cost efficient way with no or at least highly reduced carbon build up on surfaces of the swirler and/or the burner and/or the combustion can of the gas turbine engine.

[0010] The aforesaid problems are solved a swirler of a burner of a gas turbine engine according to independent claim 1, by a burner of a gas turbine engine according to claim 14 and a gas turbine engine according to claim 15. Further features and details of the present invention result from the subclaims, the description and the drawings. Features and details discussed with respect to the swirler can also be applied to the burner and the gas turbine engine and vice versa, if of technical sense.

[0011] According to a first aspect of the invention the aforesaid object is achieved by a swirler for a burner of a gas turbine engine, comprising a plurality of vanes extending from an outer radius of the swirler to an inner radius of the swirler and a plurality of mixing channels between the vanes to channel air from a radially outer end of the mixing channel, located essentially at an outer radius of the swirler, to a radially inner end of the mixing channel, located essentially at an inner radius of the swirler, at least one main injection means for providing fuel for a main flame of the gas turbine engine, the main injection means arranged at and/or in at least one of the mixing channels, and at least one pilot injection means for providing fuel for a pilot flame of the gas turbine engine. The swirler according to the invention is characterized in that the at least one pilot injection means is arranged at and/or in at least one of the mixing channels.

[0012] The swirler according to the invention can be used in a burner of a gas turbine engine to produce an air/fuel mixture. This air/fuel mixture is afterwards burned in a combustion chamber of the burner. The swirler comprises a plurality of vanes. The vanes, which are preferably circularly arranged around a centre of the swirler, extend from an outer radius of the swirler to an inner radius of the swirler, essentially defining a cylindrical shape of the swirler. Between the vanes, a plurality of mixing channels is formed. Each mixing channel provide an outer end and an inner end, wherein, caused by the shape of the vanes, the outer end is essentially located at the outer radius of the swirler and the inner end is essentially located at the inner radius of the swirler. For the production of the air/fuel mixture, air is channelled through these mixing channels and fuel, especially liquid fuel, is injected into the stream of air out of the main injection means. The main injection means can be located in each of the mixing channels or only in selected ones. The main injection means are arranged such that the air streaming through the swirler transports the atomized fuel into the region of the burner, which is designated for the main flame of the burner of the gas turbine engine. Additionally, the swirler comprises at least one pilot injection means for providing fuel for a pilot flame of the gas turbine engine. Due to the intended operation of the gas turbine engine in a DLE mode, the temperature of the main flame is kept at a low temperature. Therefore the flame can be unstable and likely to go out. The pilot flame fed by the fuel of the pilot injection means provides heat and ensures a continuous burning of the main flame.

[0013] According to the invention, the at least one pilot injection means is arranged at and/or in at least one of the mixing channels. The air channelled through the mixing channels can reach high velocities. This is due to the high pressure of the air and/or a possible reduction in flow cross-section in the swirler. By positioning the pilot injection means in one of the mixing channels, the fuel, especially liquid fuel, can be directly injected into the rapidly streaming air. An especially good atomization of the fuel into the air can therefore be achieved. At the mixing channels, especially at and near the inner end of the mixing channels, turbulences are additionally induced due to the join points of the air flows of the different mixing channels. These turbulences can be used to further enhance the atomization of the injected fuel. Further structures, like (semi-)confined spaces or surfaces, on which the fuel is deposited, can be avoided. Preferably the fuel is injected into the air such that the air transports the fuel into the intended region of a pilot flame of the burner of the gas turbine engine. A contact with any surface of the swirler and/or the burner can be avoided or at least significantly be reduced. Especially the danger of a carbon build up on surfaces in the swirler and/or the burner can therefore be reduced, if not completely avoided. An environmental friendly and fuel efficient operation of a gas turbine engine comprising a burner with a swirler according to the invention can therefore be achieved and secured.

[0014] Further, a swirler according to the invention can be characterized in that the at least one pilot injection means comprises two or more injection points. These injections points are distributed along the respective pilot injection means and may differ in size. By providing more than one injection point it is possible to achieve a more uniform distribution of the air/fuel mixture. It is further possible, to change the number of injection points used for the pilot fuel injection. Therefore it is possible to alter the amount of fuel used for the pilot flame according to the actual requirements. Therefore an especially well adjustable operation of a gas turbine engine comprising a burner with a swirler according to the invention is possible.

[0015] In a further advanced arrangement of a swirler according to the invention, the at least one pilot injection means comprises an angled tip. With this angled tip, an improved possibility to control the direction of the injected pilot fuel can be provided. According to the invention, angled describes the direction of the tip of the pilot injection means, in respect to the residual body of the injection means and/or in respect to the direction of the streaming air in the mixing channel. This angled tip according to the invention can be for instance an external bending of a head portion of the at least one pilot injection means, but also an internal angled tip, for instance comprising an angled conduct inside the tip of the at least one pilot injection means, is possible. During operation it should be avoided that the pilot fuel is injected into a region of the streaming air which flows afterwards into the region of the main flame. With an angled tip such a penetration of pilot fuel into the main flame can easily be prevented.

[0016] In addition, a swirler according to the invention can be characterized in that the at least one pilot injection means is arranged at a distance from a center of the swirler of 90% to 150%, preferably 100% to 120%, of the inner radius of the swirler at and/or in the at least one mixing channel. In an alternative embodiment of a swirler according to the invention, the at least one pilot injection means is arranged at a distance from a center of the swirler of 40% to 70%, preferably 50% to 60%, of the outer radius of the swirler at and/or in the at least one mixing channel. It is essential in both possible embodiments of a swirler according to the invention that the pilot injection means is positioned in a region of the swirler in which the air is channelled and flows afterwards into the pilot flame region. This is important due to the fact that the channelled air flows with increased velocity and a specific direction and the position of the injection and therefore the position of the pilot injection means inside the swirler takes advantage of this flow characteristic. This position can be near or at the outer end of the mixing channel, inside the mixing channel and/or near or at the inner end of the mixing channel. The actual position for an ideal placement of the pilot injection means highly depends on the design of the swirler, the burner and last but not least of the gas turbine engine as a whole. With a positioning of the pilot fuel injection means depending on the inner or outer radius of the swirler, a wide variation of burner designs can be provided with pilot injection means perfectly fitted to the needs of the specific burner. An especial large application spectrum of a swirler according to the invention is therefore possible.

[0017] According to another preferred development of the invention a swirler can be characterized in that the at least one pilot injection means are constructed as a fuel injection lance, preferably as a removable fuel injection lance. Such a fuel injection lance can be positioned inside the mixing channel. The positioning of the fuel injection lance inside the mixing channel can be done at the radially outer end of the mixing channel, at the radially inner end of the mixing channel or in between. The height of the fuel injection lance can further easily be adapted to the needs of the specific swirler and/or burner of the gas turbine engine. Therefore it is possible, to choose the ideal position of the fuel injection lance inside the mixing channel to meet the demands of the gas turbine engine to be used in. A removable fuel injection lance can be preferably removed from outside the swirler assembly. An easy and time-saving replacement of the pilot injection means is therefore possible.

[0018] In a further improvement of a swirler according to the invention the fuel injection lance is adjustable in height. It is possible to use an electric motor or a hydraulic system to achieve the change of height of the fuel injection lance. During the changes of the operation of the gas turbine engine, for instance a load change, the flow of air through the mixing channels can be altered. By adjusting the height of the fuel injection lance this change of the flow of air can be compensated. A stable operation of the gas turbine engine, especially regarding the pilot flame, can therefore be achieved.

[0019] Alternatively, a swirler according to the invention can be characterized in that the at least one pilot injection means are arranged in a wall of one of the vanes, especially in a wall of one of the vanes facing into at least one of the mixing channels. The pilot fuel injection means is therefore constructed as part of the vanes. No further parts are necessary. Especially, elements extending into the mixing channel can be avoided. The accumulation of carbon build up can therefore further be reduced.

[0020] In a further improvement of a swirler according to the invention the at least one pilot injection means are arranged at a trailing edge of one of the vanes. The trailing edges of the vanes of the swirler are positioned at the inner end of the respective mixing channel. Therefore, the injection of the fuel into the channelled air is carried out at the inner end of the mixing channels and therefore in a region which is highly turbulent. A very good atomization of the pilot fuel into the air can therefore be achieved.

[0021] According to another preferred development of the invention a swirler can be characterized in that the at least one pilot injection means is arranged at and/or extends into the at least one mixing channel up to 30%, preferably 5% to 10%, of the height of the at least one mixing channel. The air streaming to the pilot flame region flows through the mixing channels at different heights depending on the position along a length of the respective mixing channel. Therefore the ideal height of the injection of pilot fuel into the channelled air depends on the position of the pilot injection means, especially regarding the distance to the centre of the swirler. The further away from the centre the pilot injection means are located, the higher should the pilot injection means extend into the mixing channel. By extending into the at least one mixing channel up to 30%, preferably 5% to 10%, of the height of the at least one mixing channel an ideal placement of the fuel injection means for every respective swirler arrangement can be achieved.

[0022] In addition, a swirler according to the invention can be characterized in that the swirler comprises at least two pilot injection means, the at least two pilot injection means arranged at or near different mixing channels of the swirler. The positioning in different mixing channels prevents carbon build up of fuel injected of one of the pilot injection means on another of the pilot injection means. Two or more pilot injection means positioned in and/or near different mixing channels further improve the evenness of pilot fuel injection and therefore of the pilot flame. In addition, not all of the installed pilot injection means have to operate at the same time. The amount of pilot fuel injected can therefore be adjusted by altering the number of pilot injection means used for the injection. A further improved operation of a gas turbine engine equipped with such a swirler according to the invention can therefore be achieved.

[0023] In a further advanced arrangement of a swirler according to the invention, the at least one pilot injection means and the at least one main injection means are arranged at and/or in different mixing channels of the swirler. The positioning of the at least one pilot injection means and the at least one main injection means in different mixing channels prevents carbon build up of fuel injected of one of the injection means on the other of the injection means. Further, an easier mechanical fit of these structures into a swirler according to the invention can be achieved.

[0024] According to another preferred development of the invention a swirler can be characterized in that the at least one pilot injection means and the at least one main injection means are arranged at different heights and/or extend into different heights of the respective at least one mixing channel of the swirler and/or cause fuel to penetrate to different heights of the respective at least one mixing channel of the swirler, especially by regulation of an injection velocity. In the mixing channels, the air both for the pilot flame region and for the main flame region is channelled but at different heights. By constructing the swirler according to the invention such that the at least one pilot injection means and the at least one main injection means are arranged at different heights and/or extend into different heights of the respective at least one mixing channel and/or cause fuel to penetrate to different heights of the respective at least one mixing channel of the swirler, especially by regulation of an injection velocity, it can easily be ensured that the pilot fuel flows to the pilot flame region and the main fuel flows to the main flame region. No further guiding elements are necessary.

[0025] Further, according to a second aspect of the invention, the object is solved by a burner of a gas turbine engine, comprising a swirler and a combustion chamber. A burner according to the invention is characterized in that the swirler is constructed according to the first aspect of the invention. The use of such a swirler provides the same advantages which have been discussed in detail according to a swirler according to the first aspect of the invention.

[0026] In addition, according to a third aspect of the invention, the object is solved by a gas turbine engine, comprising at least one burner. A gas turbine engine according to the invention is characterized in that the burner is constructed according to the second aspect of the invention. The use of such a burner provides the same advantages, which have been discussed in detail according to a burner according to the second aspect of the invention.

[0027] The present invention is descripted with respect to the accompanied figures. The figures show schematically:

Fig. 1 a sectional view of a gas turbine according to prior art,

Fig. 2 a sectional view of a part of a first embodiment of a swirler according to the invention,

Fig. 3 a side view of a part of a second embodiment of a swirler according to the invention and

Fig. 4 a sectional view of a third embodiment of a swirler according to the invention.

[0028] Elements having the same functions and mode of action are provided in figs. 1 to 4 with the same reference signs.

[0029] In fig. 2 a sectional view of a first possible embodiment of a part of a swirler 50 according to the invention is shown. In this partial view, two vanes 54 and a mixing channel 56 in between are depicted. The mixing channel 56 extends from an outer end 58 to an inner end 60, wherein the outer end 58 is essentially located at an outer radius 62 of the swirler 50 and the inner end 60 is essentially located at an inner radius 64 of the swirler 50. Air 24 is channelled through the mixing channel 56 from the outer end 58 to the inner end 60, both for the main flame and the pilot flame of the burner 30 of the gas turbine engine 10 (not shown). In the mixing channel 56 a main injection means 52 is located to provide fuel for the main flame. It is positioned such that the air 24 flowing past the main injection means 52 is automatically atomizing the fuel and transporting the fuel as an air/fuel mixture into the main flame region. In addition a pilot injection means 70 is also positioned in the mixing channel 56. In this embodiment of a swirler 50 according to the invention, the pilot injection means 70 is positioned at a smaller radius in respect to the centre of the swirler 50 than the main injection means 52. The pilot injection means 70 is positioned such that the air 24 flowing past the pilot injection means 70 is automatically atomizing the fuel and transporting the fuel as an air/fuel mixture into the pilot flame region. No further elements are necessary for atomization and/or guiding the fuel/air mixture to the pilot flame region. The accumulation of carbon build up can therefore be prohibited in an especially easy way.

[0030] Fig. 3 shows a side view of a part of a second embodiment of a swirler 50 according to the invention. A single vane 54 and the adjacent mixing channel 56 are shown. An arrow symbolizes the air 24 channelled through the mixing channel 56 from its outer end 58 located essentially at the outer radius 62 of the swirler 50 to its inner end 60 located essentially at the inner radius 64 of the swirler 50. Several possible embodiments of a pilot injection means 70 are depicted. One of the pilot injection means 70 is constructed as a fuel injection lance 76. Such a fuel injection lance 76 can preferably be constructed as a removable fuel injection lance 76. A replacement of the pilot injection means 70 is in this case possible in a very easy manner, especially if the fuel injection lance 76 can be removed from outside of the assembly of the swirler 50. In addition, the fuel injection lance 76 can be adjustable in height. A very easy way to compensate for changes in the flow of the channelled air 24 can in this case be achieved. Further, the fuel injection lance 76 shown in this figure comprises an angled tip 74.

At the end of the angled tip 74 an injection point 72 of this pilot injection means 70 is positioned. By choosing the angle of the angled tip 74, either in respect to the residual body of the pilot injection means 70 or in respect to the channelled air 24 or in respect to both, an especially effective injection of pilot fuel into the channelled air 24 can be achieved. This angled tip 74 can be for instance as depicted an external bending of a head portion of the at least one pilot injection means 70, but also an internal angled tip 74, for instance comprising an angled conduct inside the tip of the at least one pilot injection means 74, is possible. Especially a penetration of pilot fuel into the main flame can easily be prevented. The other embodiment of the pilot injection means 70 comprises two injection points 72. These injection points are positioned in the vane 54, in particular at the trailing edge 66 of the vane 54. Due to the positioning in the vane 54, no further elements are necessary to construct the pilot injection means 70. Therefore this embodiment is an especial easy way to construct a pilot injection means 70. At the trailing edge 66 of the vane 54, the air 24 from different mixing channels 56 are joining by what turbulences can occur. These turbulences support the atomizing of the fuel provided by the pilot injection means 70. An even better fuel/air mixture can therefore be achieved.

[0031] In fig. 4 a sectional view of a third embodiment of a swirler 50 according to the invention is depicted. The swirler 50 comprises a plurality of vanes 54 extending from an outer radius 64 to an inner radius 62, only two of them marked with reference signs for lucidity. Between the vanes 54 a plurality of mixing channels 56 is located, of which only one is marked with a reference sign for lucidity. The mixing channels extend from an outer end 58 to an inner end 60. In this embodiment of a swirler 50 according to the invention, in each of the mixing channels 56 a main injection means 52 is positioned, each at a slightly different radial position. This contains the advantage that for different operation modes of the gas turbine engine 10 (not shown), for instance different load levels, a special set of main injection means 52, adjusted for instance in total number and/or pattern, can be used. Further, at the inner end 60 of each of the mixing channels 56 and near a trailing edge 66 of the vanes 54, several pilot injection means 70 are located. At the inner end 60 of the mixing channels 56, especially due to the joining of the air flow of the different mixing channels 56 at the trailing edges 66 of the vanes 54, turbulences are additionally induced. These turbulences further enhance the atomization of the injected fuel out of the pilot injection means 70. Similar to the main injection means 52, the number and/or pattern of the pilot injection means 70 used for actual pilot fuel injection can be chosen according to the needs of the actual operation mode of the gas turbine engine 10. The pilot fuel is injected into the air such that the air transports the fuel into the intended region of a pilot flame of the burner 30 of the gas turbine engine 10 (not shown). A contact with any surface of the swirler 50 and/or the burner 30 can be avoided or at least significantly be reduced. Especially the danger of a carbon build up on surfaces in the swirler 50 and/or the burner 30 can therefore be reduced, if not completely avoided. An environmental friendly and fuel efficient operation of a gas turbine engine 10 comprising a burner 30 with a swirler 10 according to the invention can therefore be achieved.

Claims

1. Swirler (50) for a burner (30) of a gas turbine engine (10), comprising a plurality of vanes (54) extending from an outer radius (64) of the swirler (50) to an inner radius (62) of the swirler (50) and a plurality of mixing channels (56) between the vanes (54) to channel air (24) from a radially outer end (58) of the mixing channel (56), located essentially at an outer radius (64) of the swirler (50), to a radially inner end (60) of the mixing channel (56), located essentially at an inner radius (62) of the swirler (50), at least one main injection means (52) for providing fuel for a main flame of the gas turbine engine (10), the main injection means (52) arranged at and/or in at least one of the mixing channels (56), and at least one pilot injection means (70) for providing fuel for a pilot flame of the gas turbine engine (10),
   characterized in that
   the at least one pilot injection means (70) is arranged at and/or in at least one of the mixing channels (56).

2. Swirler (50) according claim 1,
   characterized in that
   the at least one pilot injection means (70) comprises two or more injection points (72).

3. Swirler (50) according one of the preceding claims,
   characterized in that
   the at least one pilot injection means (70) comprises an angled tip (74).

4. Swirler (50) according one of the preceding claims,
   characterized in that
   the at least one pilot injection means (70) is arranged at a distance from a center of the swirler (50) of 90% to 150%, preferably 100% to 120%, of the inner radius (62) of the swirler (50) at and/or in the at least one mixing channel (56).

5. Swirler (50) according one of the preceding claims 1 to 3, **characterized in that**
   the at least one pilot injection means (70) is arranged at a distance from a center of the swirler (50) of 40% to 70%, preferably 50% to 60%, of the outer radius (64) of the swirler (50) at and/or in the at least one mixing channel (56).

6. Swirler (50) according one of the preceding claims,

characterized in that
the at least one pilot injection means (70) are constructed as a fuel injection lance (74), preferably as a removable fuel injection lance (74).

7. Swirler (50) according claim 6,
characterized in that
the fuel injection lance (74) is adjustable in height.

8. Swirler (50) according one of the preceding claims 1 to 5,
characterized in that
the at least one pilot injection means (70) are arranged in a wall of one of the vanes (54), especially in a wall of one of the vanes (54) facing into at least one of the mixing channels (56).

9. Swirler (50) according claim 8,
characterized in that
the at least one pilot injection means (52) are arranged at a trailing edge (66) of one of the vanes (54).

10. Swirler (50) according one of the preceding claims,
characterized in that
the at least one pilot injection means (70) is arranged at and/or extends into the at least one mixing channel (56) up to 30%, preferably 5% to 10%, of the height of the at least one mixing channel (56).

11. Swirler (50) according one of the preceding claims,
characterized in that
the swirler comprises at least two pilot injection means (70), the at least two pilot injection means (70) arranged at or near different mixing channels (56) of the swirler (50).

12. Swirler (50) according one of the preceding claims,
characterized in that
the at least one pilot injection means (70) and the at least one main injection means (52) are arranged at and/or in different mixing channels (56) of the swirler (50).

13. Swirler (50) according one of the preceding claims,
characterized in that
the at least one pilot injection means (70) and the at least one main injection means (52) are arranged at different heights and/or extend into different heights of the respective at least one mixing channel (56) of the swirler (50) and/or cause fuel to penetrate to different heights of the respective at least one mixing channel (56) of the swirler (50), especially by regulation of an injection velocity.

14. Burner (30) of a gas turbine engine (10), comprising a swirler (50) and a combustion chamber (28),
characterized in that
the swirler (50) is constructed according one of the preceding claims.

15. Gas turbine engine (10), comprising at least one burner (30),
characterized in that
the burner (30) is constructed according claim 14.

FIG 1 PRIOR ART

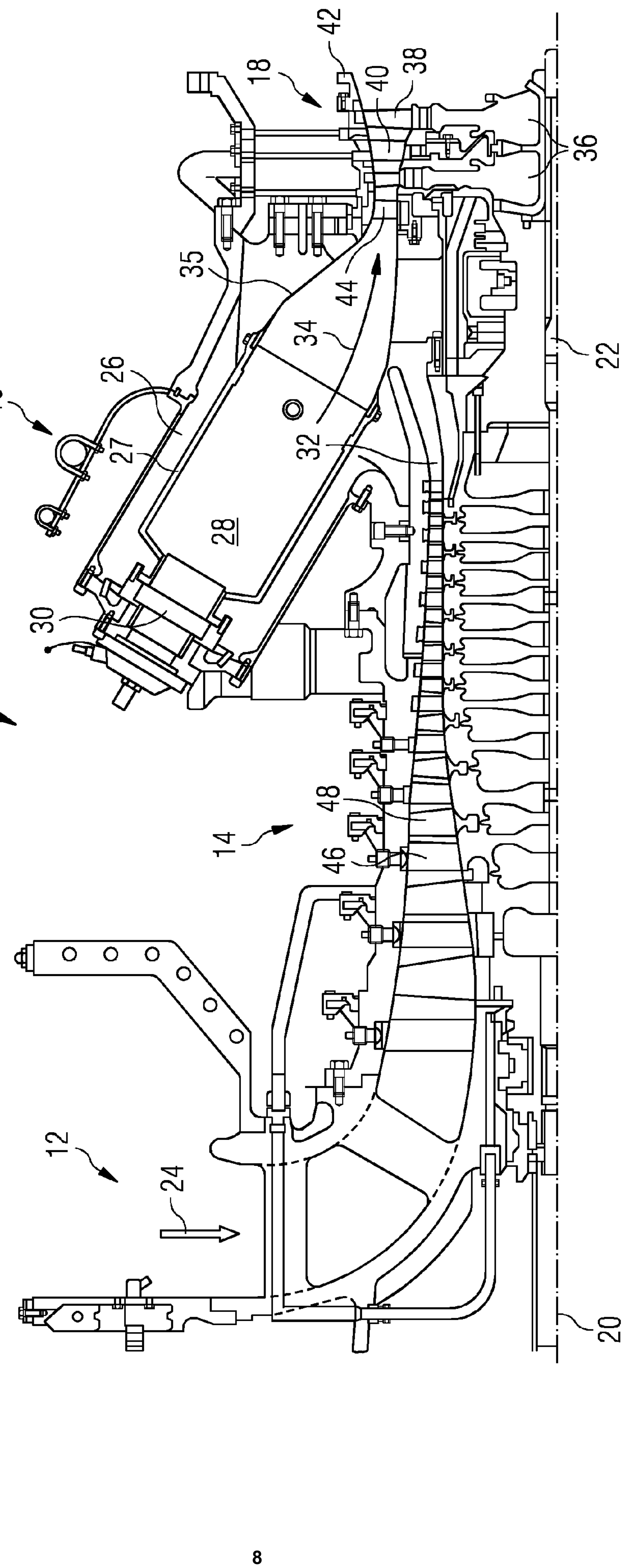


FIG 2

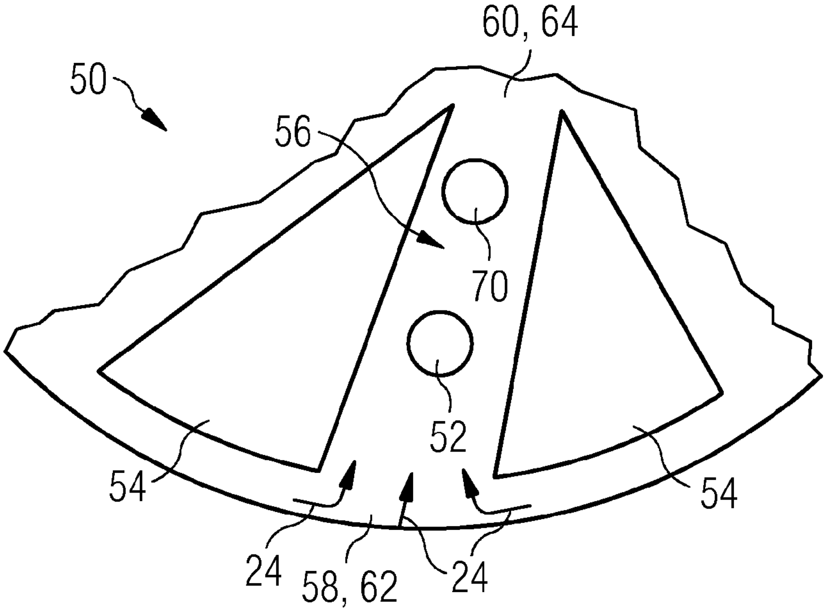

60, 64
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FIG 3

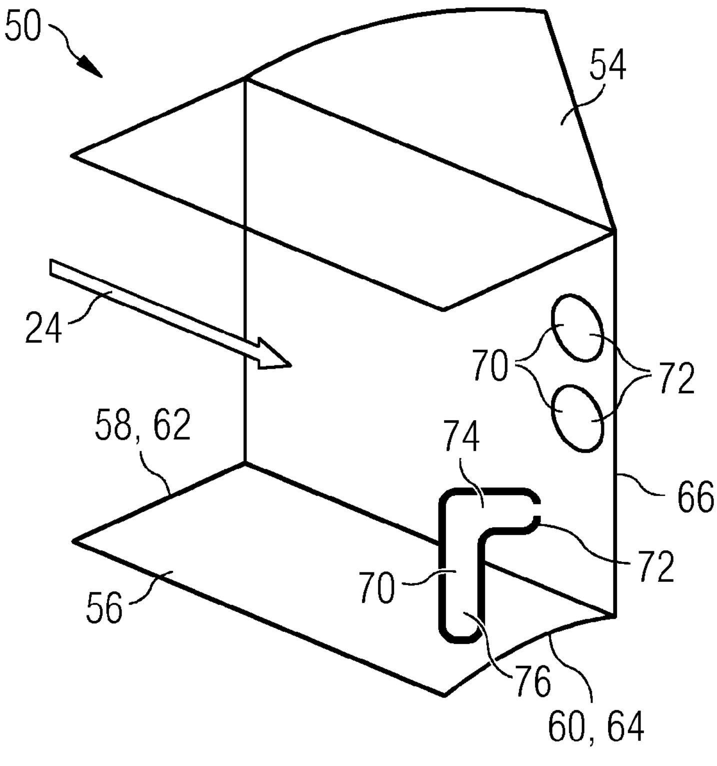
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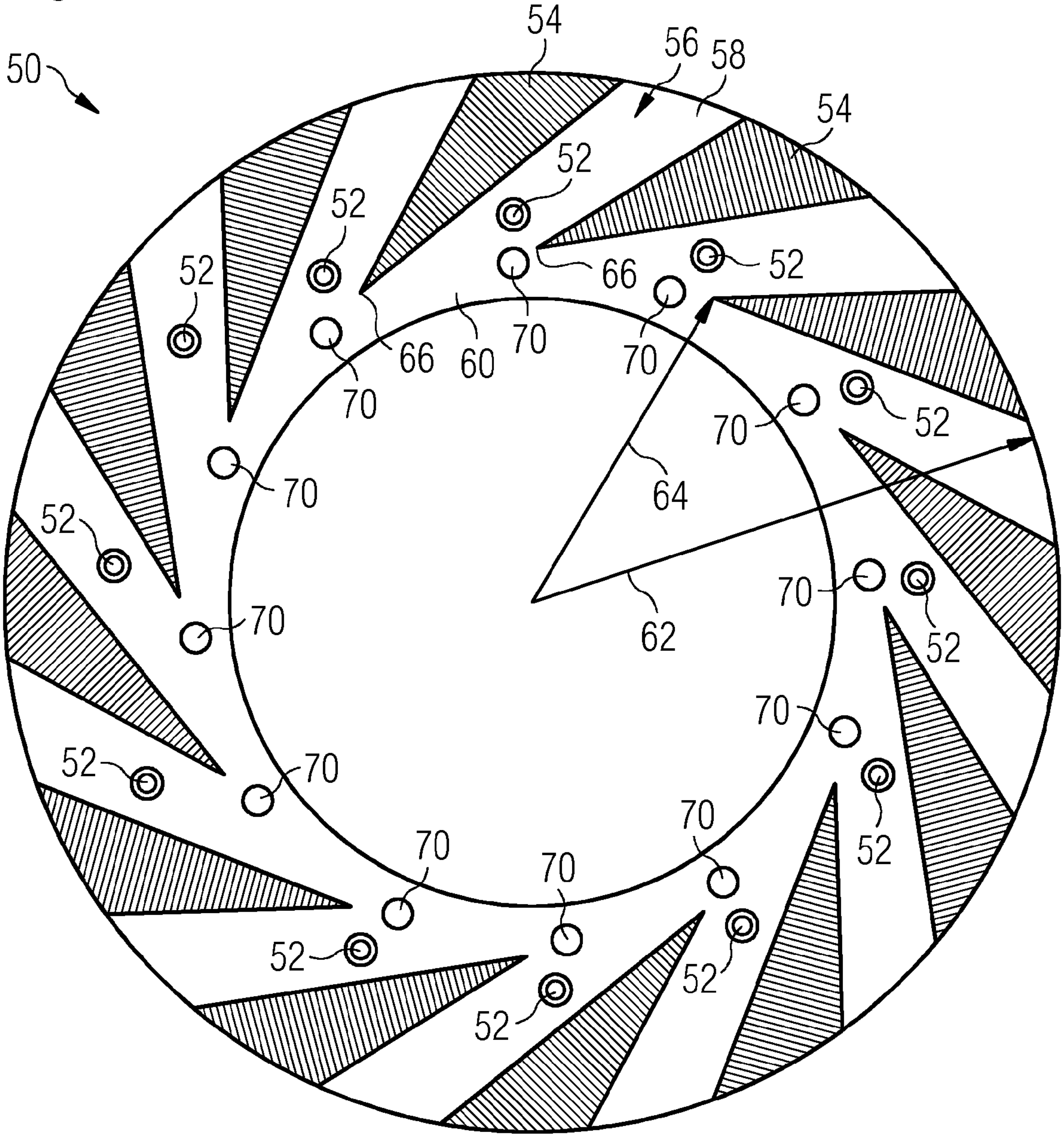
FIG 4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Application Number
EP 14 16 7655

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Place of search	Date of completion of the search	Examiner
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