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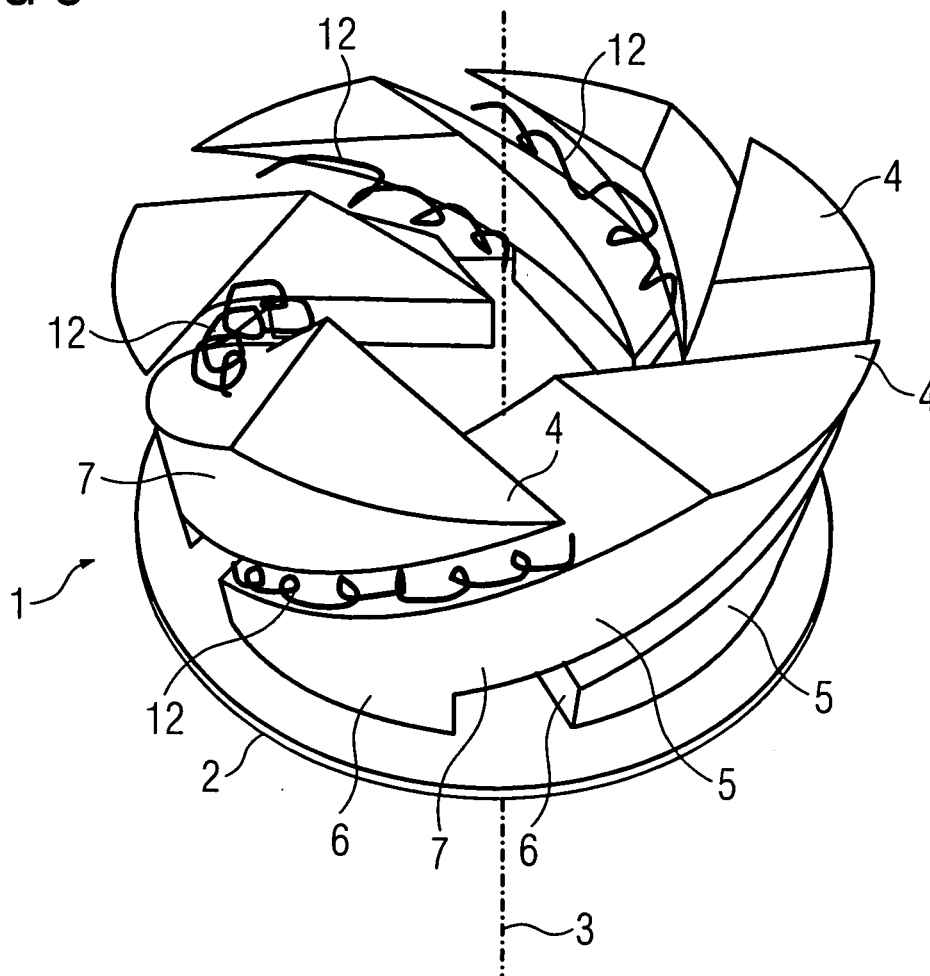
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(54) **Swirler**

(57) Disclosed is a swirler (1), comprising a plate (2) normal to a central axis (3) of the swirler (1), a plurality

of vane footprints (4) arranged on the plate (2) and radially positioned about the central axis (3) and a plurality of twisted vanes (5).

FIG 3



Description

Field of the Invention

[0001] The invention relates to a fuel injection system and improvements for the further diminishment of air pollutants such as nitrogen oxides (NO_x).

BACKGROUND OF THE INVENTION

[0002] Air pollution is a worldwide concern and many countries have enacted stricter laws further limiting the emission of pollutants from gas turbine engines or offer fiscal or other benefits for environmentally sound installations. Although the prior techniques for reducing the emissions of NO_x from gas turbine engines are steps in the right direction, the need for additional improvements remains.

[0003] There are two main measures by which reduction of the temperature of the combustion flame can be achieved. The first is to use a fine distribution of fuel in the air, generating a fuel/air mixture with a low fuel fraction. The thermal mass of the excess air present in the reaction zone of a lean premixed combustor absorbs heat and limits the temperature rise of the products of combustion to a level where thermal NO_x is not excessively formed. The second measure is to provide a thorough mixing of fuel and air prior to combustion. The better the mixing, the fewer regions exist where the fuel concentration is significantly higher than average, the fewer the regions reaching higher temperatures than average, the lower the fraction of thermal NO_x will be.

[0004] Usually the premixing of fuel and air in a gas turbine engine takes place by injecting fuel into an air stream in a swirling zone of a combustor which is located upstream from the combustion zone. The swirling produces a mixing of fuel and air before the mixture enters the combustion zone.

SUMMARY OF THE INVENTION

[0005] An object of the invention is to provide a swirler, allowing for a better pre-mixing of gaseous fuel and compressor air to provide a homogeneous fuel/air mixture and thereby reduce formation of NO_x . Another objective is to provide a burner with an improved swirler. Still another objective is to provide a gas turbine with an improved swirler.

[0006] These objectives are achieved by the claims. The dependent claims describe advantageous developments and modifications of the invention.

[0007] An inventive swirler incorporates a modified radial swirler assembly. The modification is best described by a partly twisted radial swirler.

[0008] Unlike axial swirlers where the air inflow is predominantly entering the swirler and being deflected by the action of an aerofoil, air is admitted to the swirler over the entire length of the swirl slot or vane section, where

it is deflected into a swirling motion.

[0009] The added advantage of such a configuration is that the twisted vane ensures that the air entry flow is 'tumbled' and hence provides a means for enhanced fuel air mixing.

[0010] None of the prior art is targeting the generation of turbulent secondary flows along the swirl vanes with the specific aim of assisting fuel air mixing.

[0011] In an advantageous arrangement the twisted vanes comprise straight parts at the base portions of the twisted vanes. This feature provides a well defined shear layer region for any reverse flow into the swirler assembly. This is advantageous because it increases the stability of any flame in that region. The height of the straight parts should not exceed 50% of the twisted vanes' height in order to benefit from the turbulent secondary flows generated in the twisted parts. Therefore it is also advantageous to twist the vanes by an angle of up to 120° . However, twisted vanes with angles differing considerably from 120° will also provide desirable turbulent secondary flows.

[0012] By such a design a better pre-mixing of gaseous fuel with compressor air and a homogeneous fuel/air mixture is achieved to reduce formation of NO_x .

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention will now be further described with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a prior art radial swirler,

Figure 2 shows a perspective view of a swirler in accordance with the present invention, and

Figure 3 shows another perspective view of a swirler with twisted vanes in accordance with the present invention.

[0014] In the drawings like references identify like or equivalent parts.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to Figure 1, a typical prior art radial swirler 1 is shown. The turning vanes 9 of a radial swirler 1 are arranged on a first plate 2 that is normal to the central axis 3 of the swirler 1 body. The vanes 9 are of pie slice type with substantially triangular footprints 4 (see Figure 3) and rectangular side faces 13 and a slightly curved outer surface 10. The turning vanes 9 are fixed to a second plate 8 with their sides showing away from the first plate 2. Swirler passages 14 are formed by opposing side faces 13 of swirler vanes 9, by the surface of the first plate 2 and by a surface of the second plate 8. The second plate 8 is connected to a combustion pre-chamber 11.

[0016] This configuration of the swirler 1 forces the air-flow (as shown by the arrows) to move within the pas-

sages 14 radially inwardly towards the central axis 3 of the swirler 1 body. Already with this simple prior art straight vane geometry, a radial swirler 1 is capable of creating strong swirl and thorough mixing with little concern of the problem of aerodynamic wake flows.

[0017] Figure 2 shows the view of an embodiment of the inventive swirler 1. Respective base portions 6 of the turning vanes 9 are arranged on a first plate 2 that is normal to the central axis 3 of the swirler 1 body and the footprints 4 (see Figure 3) of the vanes 9 are of substantially triangular shape. Unlike prior art, the vanes 9 are twisted and will be referred to as twisted vanes 5. The embodiment of Figure 2 comprises twisted vanes 5 with straight base portions 6 and twisted parts 7. The straight base portions 6 have a shape described by a translation of the vane footprints 4 (see Figure 3) parallel to the central axis 3 of the swirler 1, whereas the twisted parts 7 have a shape described by a further translation of the vane footprints 4 along the central axis 3 superimposed by a rotation of the vane footprints 4 about the central axis 3.

[0018] With reference to Figure 3, an inventive swirler 1 is shown without second plate 8 and combustor pre-chamber 11 (see Figures 1 and 2) where the twisted vanes 5 are arranged on a first plate 2. The substantially triangular vane footprints 4 can be seen very clearly in this view. Figure 3 shows the turbulent secondary flows 12 generated along the twisted vanes 5, improving fuel/air mixing.

wherein an angle of rotation is up to 120°.

6. The swirler (1) as claimed in claim 2 or claim 3, wherein the straight base portions (6) have a height less than 50% of a twisted vane height.
7. A burner comprising a swirler (1) as claimed in any of the preceding claims.
8. A turbine engine with a burner as claimed in claim 7.

Claims

1. A swirler (1), comprising:
 - a plate (2) normal to a central axis (3) of the swirler (1); a plurality of vane footprints (4) arranged on the plate (2) and radially positioned about the central axis (3); and
 - a plurality of twisted vanes (5) arranged on the vane footprints (4).
2. The swirler (1) as claimed in claim 1, further comprising straight base portions (6) arranged on the footprints (4) and included in the twisted vanes (5).
3. The swirler (1) as claimed in claim 2, wherein straight base portions (6) have a shape described by a translation of the vane footprints (4) parallel to the central axis (3).
4. The swirler (1) as claimed in claim 1, wherein twisted parts (7) of the twisted vanes (5) have a shape described by a translation of the vane footprints (4) along the central axis (3) superimposed by a rotation about the central axis (3).
5. The swirler (1) as claimed in claim 1 or claim 4,

FIG 1
(PRIOR ART)

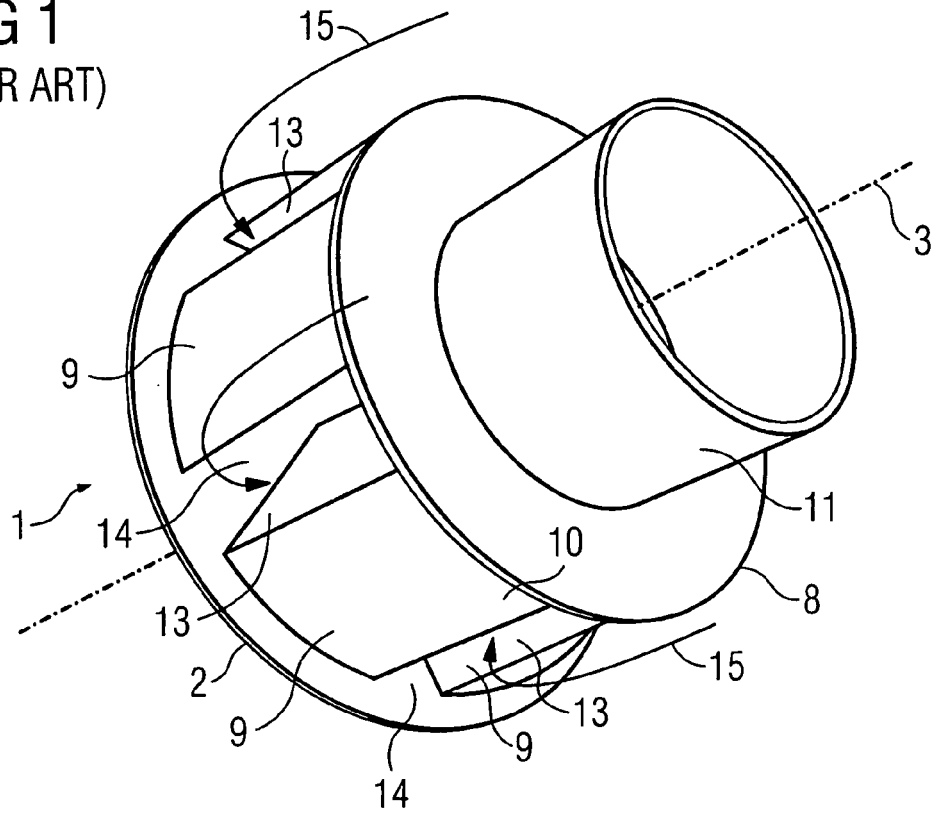


FIG 2

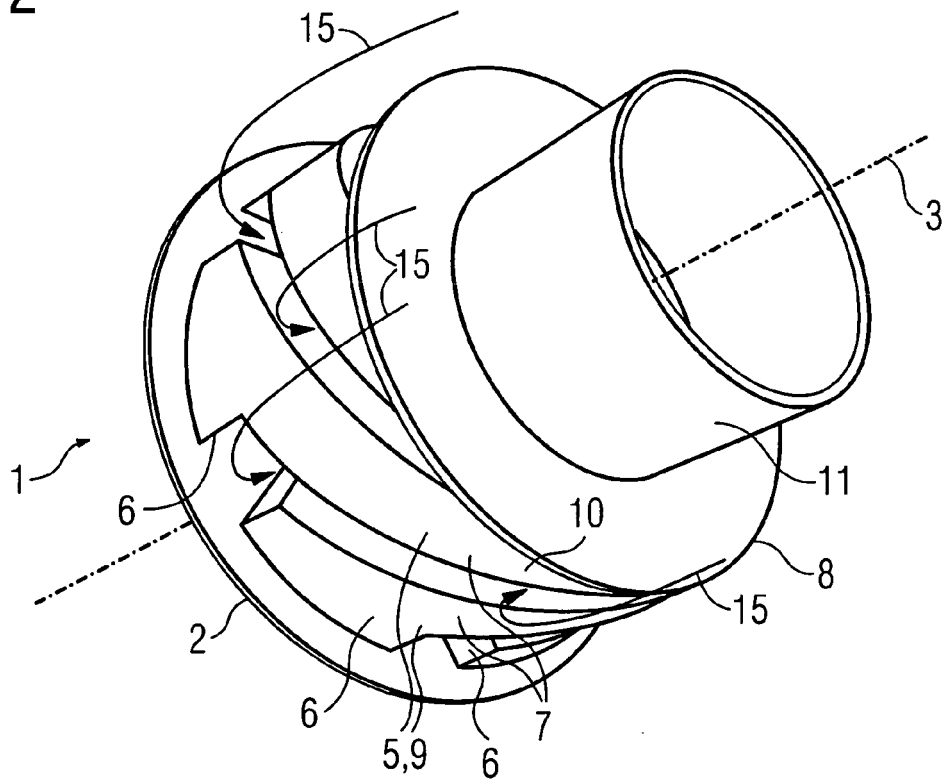
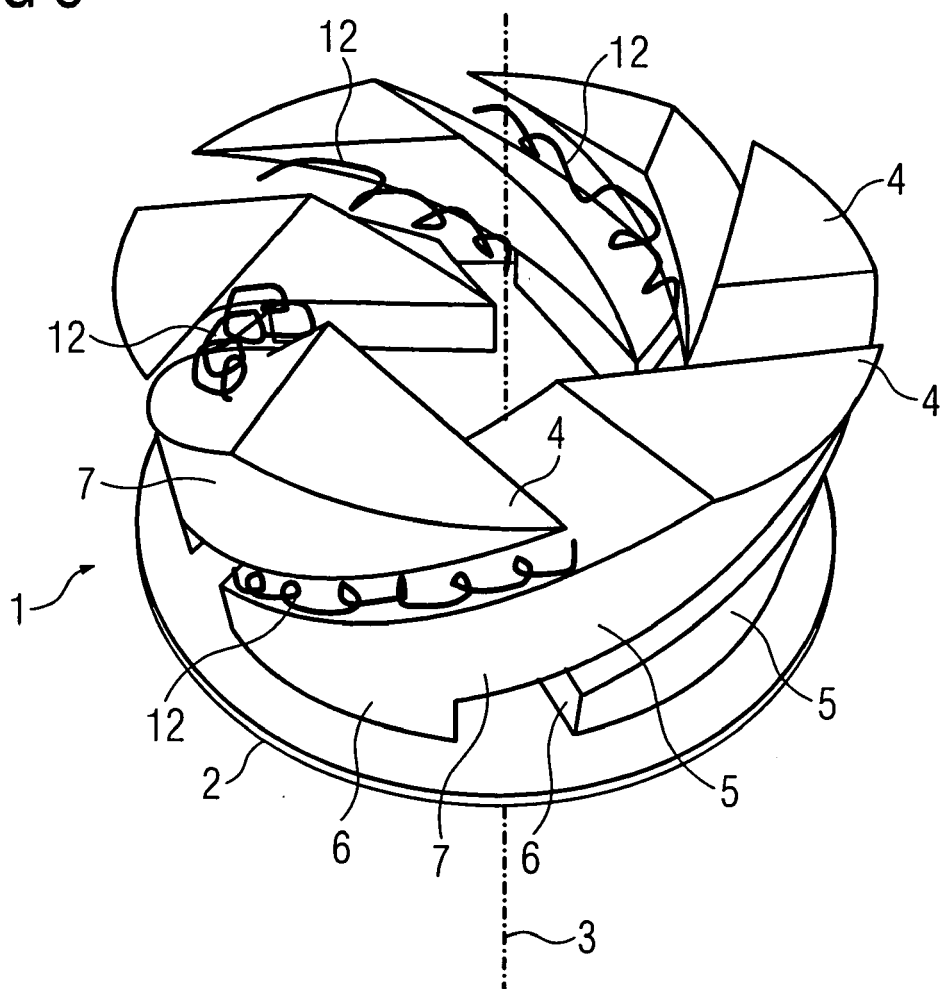


FIG 3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 8236

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* column 4, line 36 - line 52 * * column 5, line 58 - line 68 * * figures 3,4 *	4,5	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 October 2007	Examiner Gavriliu, Costin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 00 8236

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