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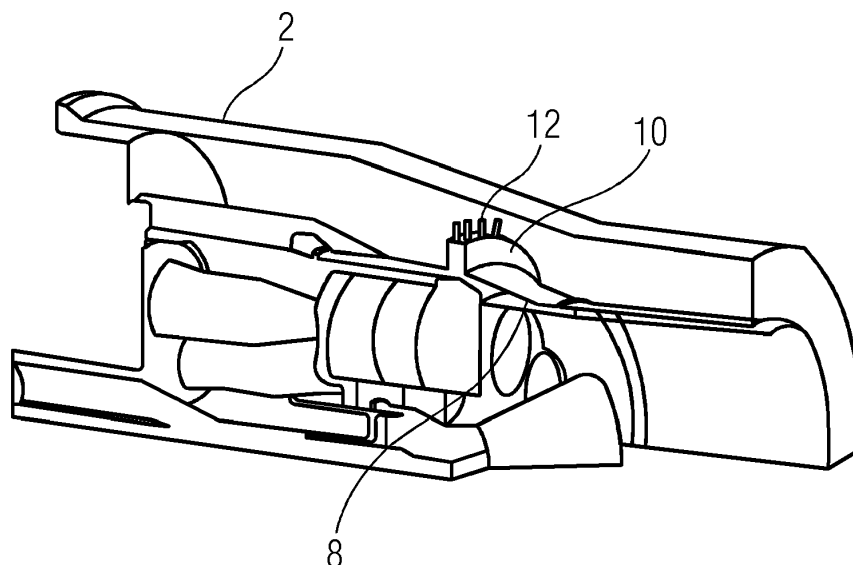
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(54) **Fuel injection assembly for a gas turbine**

(57) A gas turbine comprises a combustion unit (8), a flow sleeve (2) surrounding the combustion unit (8), wherein the flow sleeve (2) is positioned radially outward from the combustion unit (8). Further, the gas turbine includes a fuel injection assembly which is integrated with a flange means (4) which supports the combustion unit (8). The fuel injection assembly is provided with a hollow

fuel supply casing having an outer wall (10). The fuel injection assembly comprises a plurality of dispensing tubes (12) coupled to the outer wall (10). The plurality of dispensing tubes (12) is adapted to discharge fuel into the annular cavity. The fuel injection assembly is disposed in the annular cavity between the flow sleeve (2) and a combustion unit (2) of the gas turbine.

FIG 2



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Description

[0001] This invention relates to a gas turbine comprising a combustion unit, a flow sleeve surrounding the combustion unit, wherein the flow sleeve is positioned radially outward from the combustion unit. The gas turbine comprises a flange means for supporting the combustion unit and a fuel injection assembly provided with a hollow fuel supply casing having an outer wall.

[0002] In gas turbine engines, compressed air is discharged from a compressor section and fuel introduced from a source of fuel are mixed together and burned in a combustion section. The mixture is directed through a turbine section, where the mixture expands to provide rotation of a turbine rotor. In some gas turbines, a flow sleeve is provided to direct the compressed air to the combustion section.

[0003] During the flow of the compressed air from the compressor to the combustion section, fuel may be injected at many points to facilitate premixing of air and fuel. The premixing process provides a high degree of flexibility during engine tuning and is an important component for engine emissions and dynamics.

[0004] In the state of the art, the fuel injection is arranged around the flow sleeve of the gas turbine and injects fuel, through holes on the inner periphery, into the incoming compressed air. The arrangement is as shown in the FIG 1, which illustrates an embodiment of the state of the art. In FIG 1, the fuel injection 6 is attached to the flow sleeve 2 of the gas turbine. The fuel injection 6 includes a plurality of holes 5 along in the inner periphery of the fuel injection assembly 6. The fuel injection assembly 6 injects fuel in a radially inward direction. FIG 1 also illustrates the presence of a flange means 4 for supporting the combustion unit 8. The aforementioned arrangement of the fuel injection assembly leads to wear and tear of the fuel injection assembly due to mechanical vibrations at the position of the fuel injection assembly. According to the aforementioned state of the art, the fuel injection assembly is a hollow casing having circumferential holes 5 disposed around the flow sleeve 2, which injects fuel in a radially inwardly direction (towards the combustion unit 8) into the stream of compressed air flowing in a flow direction 3 within the flow sleeve. The fuel is delivered into the air stream through an array of apertures that are formed in the inner periphery of the fuel supply casing. The compressed air which is pre mixed with fuel passes through a perforated mesh into the combustion section, where the fuel-air mixture is ignited. After the combustion, the hot combustion gases flow along the direction 7 within the combustion unit 8.

[0005] Common problems associated with prior art fuel injection assembly assemblies include inadequate structural integrity. Inadequate structural integrity may lead to fuel leakage and degradation of parts of the gas turbine, thereby leading to decreased engine efficiency. The degradation of the parts also leads to increased maintenance costs and decreased revenue due to frequent shut-

downs.

[0006] Therefore, it is an object of the invention to provide a gas turbine having adequate structural integrity to prevent fuel leakage and achieving a required level of unmixedness. The unmixedness is the extent of non-uniformity of fuel & air mixture at a particular plane in combustion system.

[0007] The invention solves the object by integrating the fuel injection assembly with the flange means. As the fuel injection assembly no more connected to the flow sleeve of the turbine, the effect of mechanical vibration on the fuel injection assembly is reduce thereby increasing the life of the fuel injection assembly.

[0008] According to the invention, the gas turbine comprises a combustion unit, a flow sleeve surrounding the combustion unit, wherein the flow sleeve is positioned radially outward from the combustion unit. An annular cavity extends between the flow sleeve and the combustion unit. A fuel injection assembly is disposed circumferentially surrounding the combustion unit.

[0009] The fuel injection assembly is provided with a hollow fuel supply casing having an outer wall. A plurality of dispensing tube is coupled to the outer wall. The plurality of dispensing tube is adapted to communicate between the hollow fuel supply casing and a space between the combustion unit and the flow sleeve. The plurality of dispensing tube injects fuel in a radially outward direction.

[0010] In accordance with the invention, the fuel injection assembly is disposed circumferentially surrounding the combustion unit of the gas turbine. The circumferential placement of the fuel injection assembly enables the fuel injection assembly to support the combustion unit 8, thereby functioning as the flange means.

[0011] The advantage of this embodiment of the invention is that the plurality of dispensing tube injects fuel into the stream of compressed air passing through the passage. This improves the premixing the fuel with the compressed air.

[0012] According to an aspect of the invention, the gas turbine comprises a space between the flow sleeve and the fuel injection assembly for directing the compressed air. The fuel injection assembly is adapted to discharge fuel into the compressed air passing through the annular cavity.

[0013] In an embodiment of the invention, the gas turbine comprises a fuel supply pipe for providing fuel to the fuel injection assembly. The gas turbine further comprises at least one valve for controlling a fuel input to the fuel injection assembly. For example, the valve can be used to control the amount of fuel delivered to the fuel injection assembly.

[0014] In an advantageous embodiment of the invention, the plurality of dispensing tubes is detachable from the cavities on the casing wall. This feature of the invention enables a user to change the fuel dispensing tube based on a requirement.

[0015] In another advantageous embodiment, the length of the plurality of dispensing tube is adjustable.

The length of the plurality of dispensing tube is adjusted to control an unmixedness of a mixture of compressed air and fuel. Further, the length of the plurality of fuel dispensing tube is adjusted to split the fuel between main and the pilot nozzles.

[0016] In an embodiment of the invention, an angle of the plurality of dispensing tubes with respect to a surface of the outer wall is also adjustable. The advantage of the flexibility in the positioning of the dispensing tubes enables in maintaining a required level of unmixedness.

[0017] The figures illustrate in a schematic manner further examples of the embodiments of the invention, in which:

FIG 1 illustrates a gas turbine with a flow sleeve and a fuel injection assembly in accordance with a state of the art;

FIG 2 illustrates a perspective view of an exemplary gas turbine with the flow sleeve and a fuel injection assembly in accordance with the invention;

FIG 3 illustrates another perspective view of the fuel injection assembly, without the flow sleeve, in accordance with the invention.

FIG 4 illustrates a front view of the gas turbine with the fuel injection assembly in accordance with the invention;

FIG 5 illustrates a top view of a cross-section of the gas turbine with the fuel injection assembly in accordance with the invention;

FIG 6 illustrates an exemplary welding scheme for affixing the fuel injection assembly to the gas turbine; and

FIG 7 illustrates a longitudinal cross-sectional view of a dispensing tube of the fuel injection assembly in accordance with the invention; and

[0018] FIG 1 illustrates a gas turbine with a flow sleeve and a fuel injection assembly in accordance with a state of the art. In accordance with the state of the art, the gas turbine comprises a flow sleeve 2, which directs a stream of compressed air into the combustion unit 8. The flow sleeve is an annular structure surrounding the combustion unit. The flow sleeve is disposed at a radial distance from the combustion unit 8, thereby forming an annular cavity. A fuel injection assembly 6 is integrated with the flow sleeve 2, which injects fuel into the stream of compressed air flowing through the flow sleeve 2. The gas turbine further includes a flange means 4 for supporting the combustion unit 8. The aforementioned arrangement of the fuel injection assembly 6 results in excessive wear and tear of the fuel injection assembly due to mechanical

vibrations.

[0019] FIG 2 illustrates a perspective view of a combustion section of the gas turbine. In accordance with the exemplary gas turbine combustion section shown in FIG 2, the gas turbine comprises a combustion unit 8, a flow sleeve 2 surrounding the combustion unit, wherein the flow sleeve 2 is disposed at a radial distance from the combustion unit 8. As a result, an annular cavity extends between the flow sleeve 2 and the combustion unit 8. The gas turbine, as shown in FIG 2, comprises a fuel injection assembly integrated with the flange ring 4 (shown in FIG 1), which circumferentially surrounds the combustion unit 8. In other words, the fuel injection unit also supports the combustion unit 8 within the flow sleeve 2. The fuel injection assembly also acts as flange means 4. The fuel injection assembly includes a hollow fuel supply casing having an outer wall 10. The outer wall 10 comprises a plurality of dispensing tube, wherein the plurality of dispensing tube is adapted to dispense a fluid in a radially outward direction. The fuel injection assembly is disposed in an annular cavity between the flow sleeve and a combustion unit of the gas turbine.

[0020] Further, the plurality of dispensing tube 12 is adapted to communicate between the hollow fuel supply casing and a space between the combustion unit 8 and the flow sleeve 2. The dispensing tube 12 injects fuel into a stream of compressed air flowing in a direction 3 into the combustion unit 8. The stream of compressed air and fuel mixture is directed, after being blocked by a cover plate, into the combustion unit 8 through a perforated mesh positioned towards a posterior end of the flow sleeve 2. Thereafter, the air and fuel mixture is ignited in the combustion unit 8.

[0021] In a preferred embodiment, the fuel supply casing is circular in structure and surrounds the combustion unit circumferentially. FIG 3 illustrates another perspective view of the fuel injection assembly, without the flow sleeve, in accordance with the invention. FIG 3 shows the upper surface 20 of the outer wall 10 of the fuel injection assembly. In some embodiments, the fuel supply casings may be having other polygonal structures like a pentagon, hexagon, octagon and the like. In an exemplary embodiment, the fuel supply casing can have a cross section such a circle, a square, a rectangle and the like. Further the fuel supply casing has an outer wall 10. In an exemplary embodiment, the outer casing may be firmly attached to an inner strip of the same material to constitute the fuel supply casing. Further, the outer wall 10 may accommodate one or more dispensing tubes such as dispensing tube 12, for injecting fuel into the annular cavity. In an exemplary embodiment, the outer wall 10 includes a plurality of cavities along the circumference to accommodate the dispensing tubes 12. In a preferred embodiment, the fuel supply casing has 36 cavities equally spaced from one another. The cavities have a diameter in the range of 2-3 mm. The size of the holes is adjusted based on a pressure drop observed in fuel supply pipe in order to ensure adequate dispensing of

the fuel. In another embodiment, the fuel supply casing and the dispensing tubes may be casted as a single metallic unit and fitted on to the combustion unit. Further, the fuel supply casing is hollow and is adapted to supply fuel to one or more dispensing tubes 12. A fuel supply pipe (not shown in figures) of the gas turbine may be connected to the fuel supply casing. The fuel supply pipe may supply fuel to be dispensed in the stream of compressed air flowing through the annular cavity.

[0022] FIG 4 illustrates a front view of the gas turbine with the fuel injection assembly in accordance with the invention. The fuel injection assembly circumferentially surrounds the combustion unit, as illustrated in FIG 4. The combustion unit includes a plurality of main burners 14 and a pilot burner 16. The outer wall 10 of the fuel injection assembly is adapted to supply fuel to the plurality of dispensing tube 12, which sprays the fuel into the cavity between the combustion unit 8 and the flow sleeve 2 (not shown in FIG 4). The compressed air, premixed with fuel, is supplied to the main and pilot burners for facilitating the combustion.

[0023] FIG 5 illustrates a top view of a cross-section of the gas turbine combustion system with the fuel injection assembly in accordance with the invention. FIG 5 clearly illustrates the annular cavity 18, inside the outer wall 10 of the fuel injection assembly. In the preferred embodiment, the cross section of the annular cavity is rectangular. However, the annular cavity can have other cross sections such as, circular, triangular and other polygons based on the requirement. In an exemplary embodiment, the fuel supply casing is connected with a fuel supply pipe for providing fuel to the fuel injection assembly. The fuel is then delivered into the compressed air passing through the flow sleeve 2, thereby premixing fuel with compressed air.

[0024] FIG 6 illustrates a longitudinal cross-sectional view of the fuel injection assembly in accordance with the invention. In FIG 6, the outer casing wall 10 of the fuel injection assembly includes the hollow cavity 18 in order to provide fuel the dispensing tube 12. The dispensing tube 12 has a tube like structure for dispensing the fuel. The dispensing tube may be one or more of, but is not limited to, jet nozzle and a spray nozzle. Further, the dispensing tube may be one or more of, a cone nozzle, a bell nozzle and a spike nozzle. In an exemplary embodiment of the invention, the angle of the dispensing tubes with respect to the surface of the outer casing wall may also be changed for achieving a desired unmixedness of the fuel and compressed air.

[0025] In an exemplary embodiment of the invention, dispensing tubes, such as dispensing tube 12, are detachable from the outer casing 10 of the fuel injection assembly. A user can select an appropriate length of the dispensing tube for achieving a right measure of unmixedness of the fuel-air mixture. The unmixedness is the extent of non-uniformity of fuel and air mixture at a particular location in the flow sleeve. The length of the dispensing tube 12 may also be chosen such that the fuel

is dispensed in a region outside a recirculation zone. The recirculation zone is a region where there is an accumulation of air and fuel mixture. When the air and fuel mixture in the recirculation zone starts flowing suddenly, it results in a flashback. The flashback is reduced by creating Computer Aided analysis of the fluid motion within the annular cavity where the fuel is injected.

[0026] In an exemplary embodiment of the invention, the fuel injection assembly is fixed to the gas turbine combustion section by welding techniques. The welding techniques may include, for example, laser welding and electron beam welding. FIG 7 illustrates an exemplary welding scheme for affixing the fuel injection assembly to the gas turbine combustion section. In the welding scheme, the weld joints, such as weld joints 17, are shifted away from the combustion unit 8. Another weld joint coupling the fuel supply pipe and the fuel supply casing is moved away from the surface of the outer wall 10, towards a cover plate 13. Moving the weld joints away from the surface of the combustion unit reduces the mechanical and thermal stress acting on the weld joints thereby increasing the life of the weld joint. In an embodiment of the invention, the components of the combustion section of the gas turbine may be fabricated so as to enable the joints to be welded as shown in FIG 7. Further, the direction of flow 21 indicates the direction of flow of compressed air within the flow sleeve (not shown in the figure). Furthermore, direction of flow 23 indicates the direction in which hot gases originating from the combustion unit 8 is adapted to flow. The welding scheme disclosed herein reduces the thermal and mechanical stresses acting on the weld joints which in turn increase the life of the welded joints.

[0027] The arrangement of the fuel injection assembly as disclosed hereinbefore, has improved resistance towards mechanical vibrations and thermal stress. Therefore, the fuel injection assembly has improved durability and performance characteristics. Further, the positioning of the fuel injection assembly is towards a cover plate of the gas turbine, which renders the fuel injection assembly less prone to cracks and mechanical stress. Further, the fuel injection assembly is flexible in construction and can be adapted to deliver the fuel into a stream of compressed air so as to maintain an optimum unmixedness.

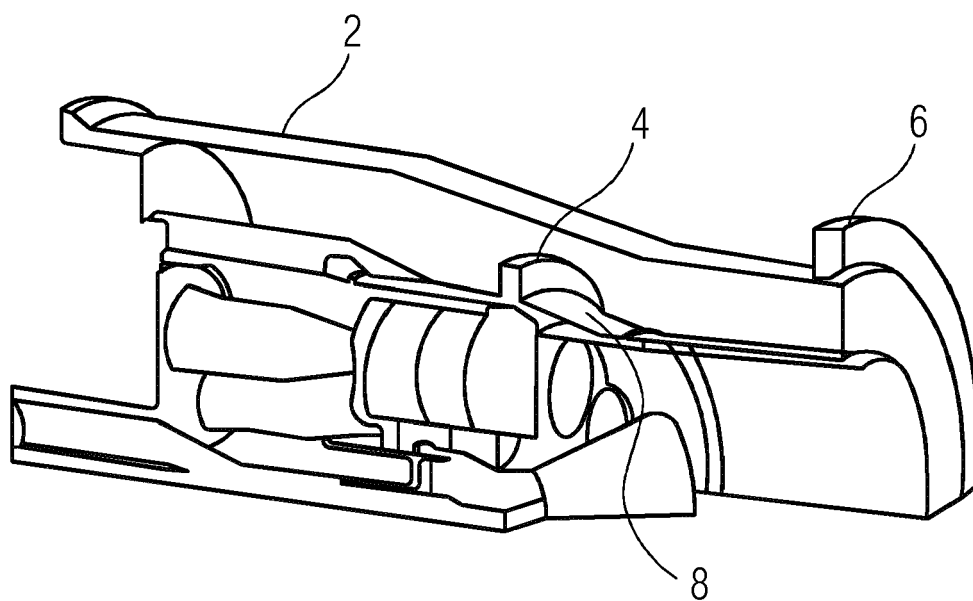
[0028] Though the invention has been described herein with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various examples of the disclosed embodiments, as well as alternate embodiments of the invention, will become apparent to persons skilled in the art upon reference to the description of the invention. It is therefore contemplated that such modifications can be made without departing from the embodiments of the invention as defined.

Claims

1. A gas turbine comprising:

- a combustion unit (8);
 a flow sleeve (2) surrounding the combustion unit (8),
 wherein the flow sleeve (2) is positioned radially outward from the combustion unit (8); 5
 a flange means (4) supporting the combustion unit (8);
 a fuel injection assembly provided with a hollow fuel supply casing having an outer wall (10),
characterized in that, the fuel injection assembly is integrated with the flange means (2) . 10
2. The gas turbine according to claim 1 comprising, a plurality of dispensing tube (12) which is adapted to communicate with the hollow fuel supply casing and a space between the combustion unit (8) and the flow sleeve (2). 15
 3. The gas turbine according to any one of the claims 1-2, wherein the fuel injection assembly is disposed in between the flow sleeve (2) and the combustion unit (8) of the gas turbine. 20
 4. The gas turbine according to any one of the claims 1-3, wherein the fuel injection assembly is disposed circumferentially surrounding the combustion unit (8) of the gas turbine. 25
 5. The gas turbine according to any one of the claims 1-4, wherein the flow sleeve (2) and the combustion unit (8) define a space for directing compressed air. 30
 6. The gas turbine according to any one of the claims 1-5, further comprising a fuel supply pipe configured for providing fuel to the fuel injection assembly. 35
 7. The gas turbine according to any one of the claims 1-6, further comprising at least one valve for controlling the operation of the fuel injection assembly. 40
 8. The gas turbine according to claim 2, wherein the plurality of dispensing tubes (12) is detachable.
 9. The gas turbine according to claim 2 or 8, wherein the plurality of dispensing tube (12) is adapted to communicate with a compressed air passing through the annular cavity. 45
 10. The gas turbine according to any one of the claims 2, 8 and 9, wherein the length of the plurality of dispensing tubes (12) is adjustable. 50
 11. The gas turbine according to any one of the claims 2 and 8-10, wherein an angle of the plurality of dispensing tubes (12) with respect to a surface of the outer wall (10) is adjustable. 55

FIG 1



STATE OF ART

FIG 2

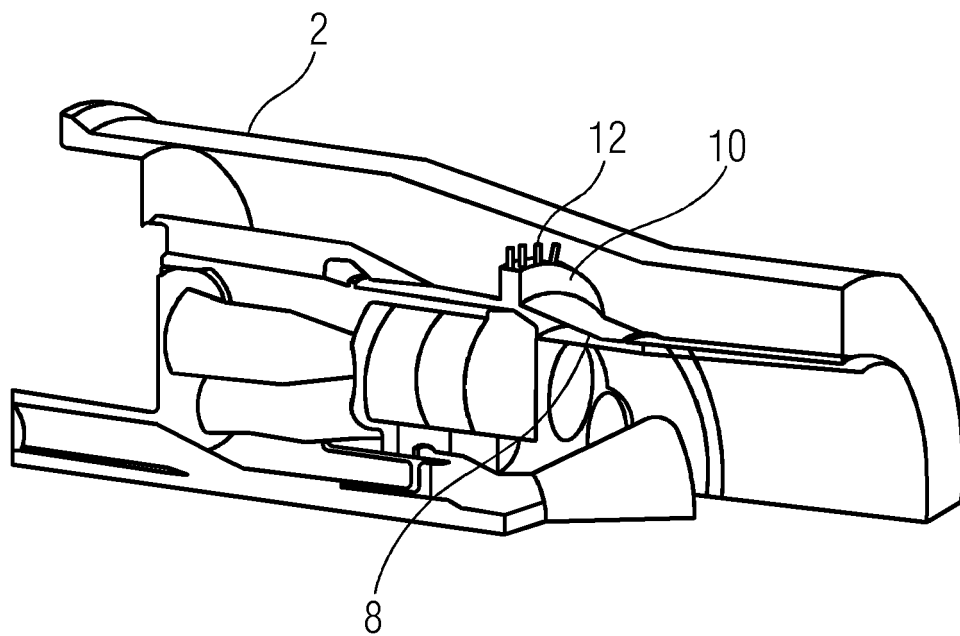


FIG 3

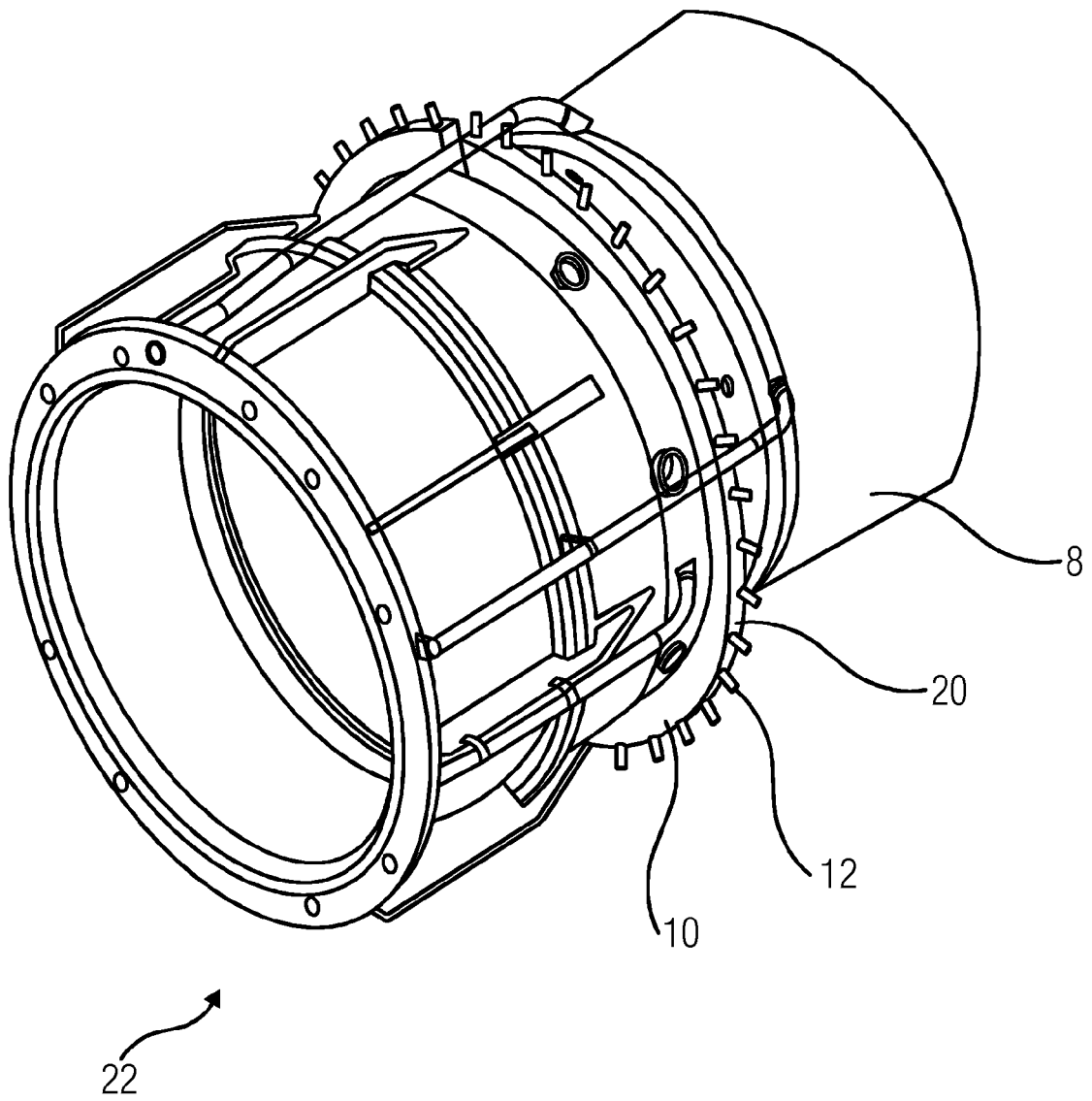


FIG 4

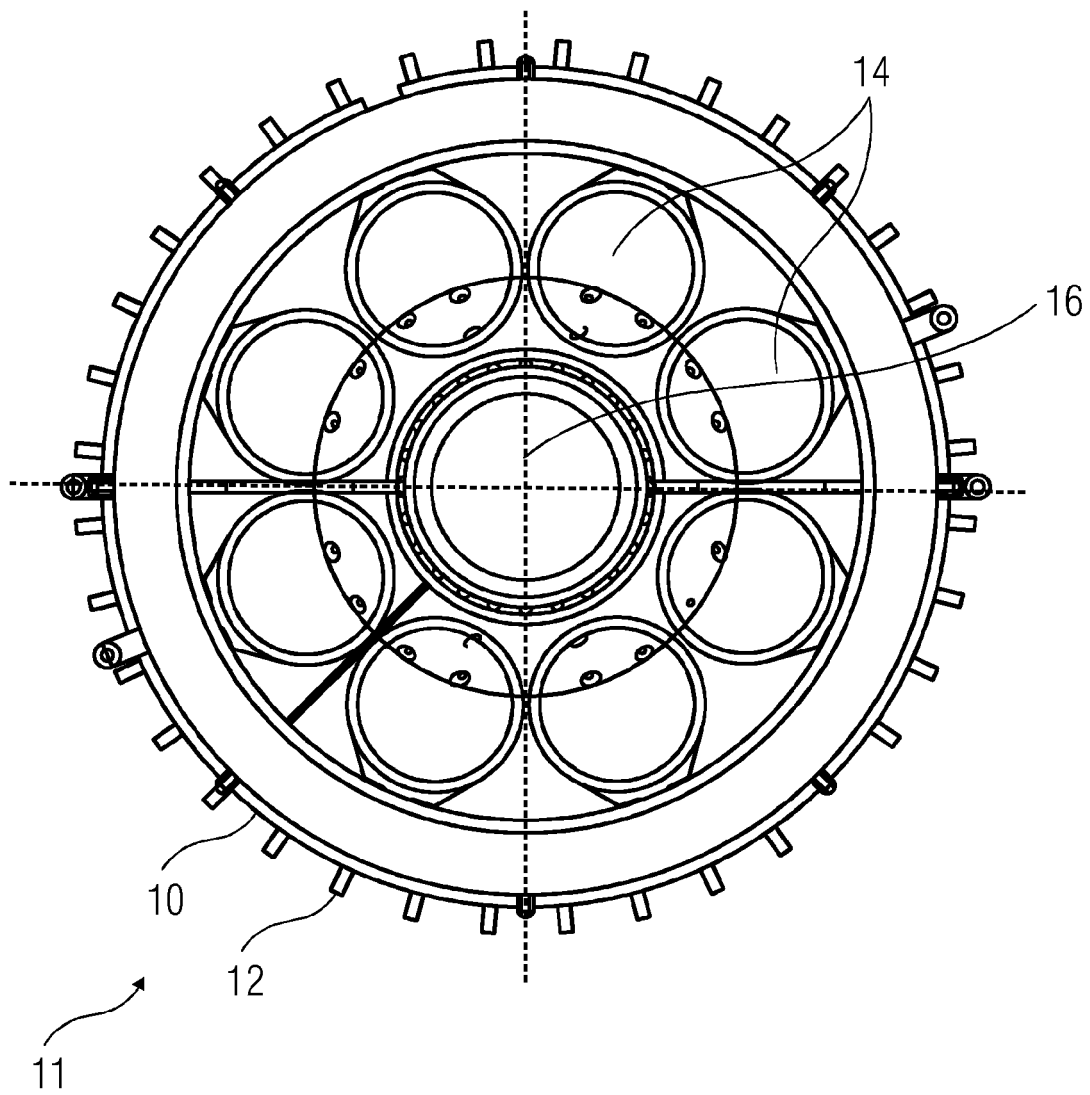


FIG 5

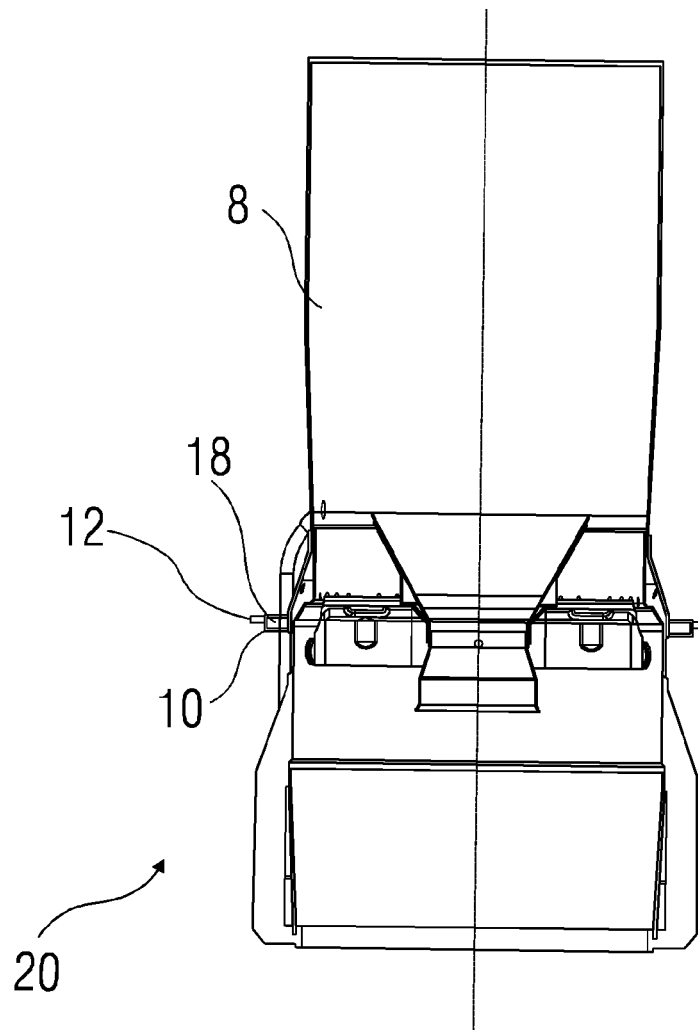


FIG 6

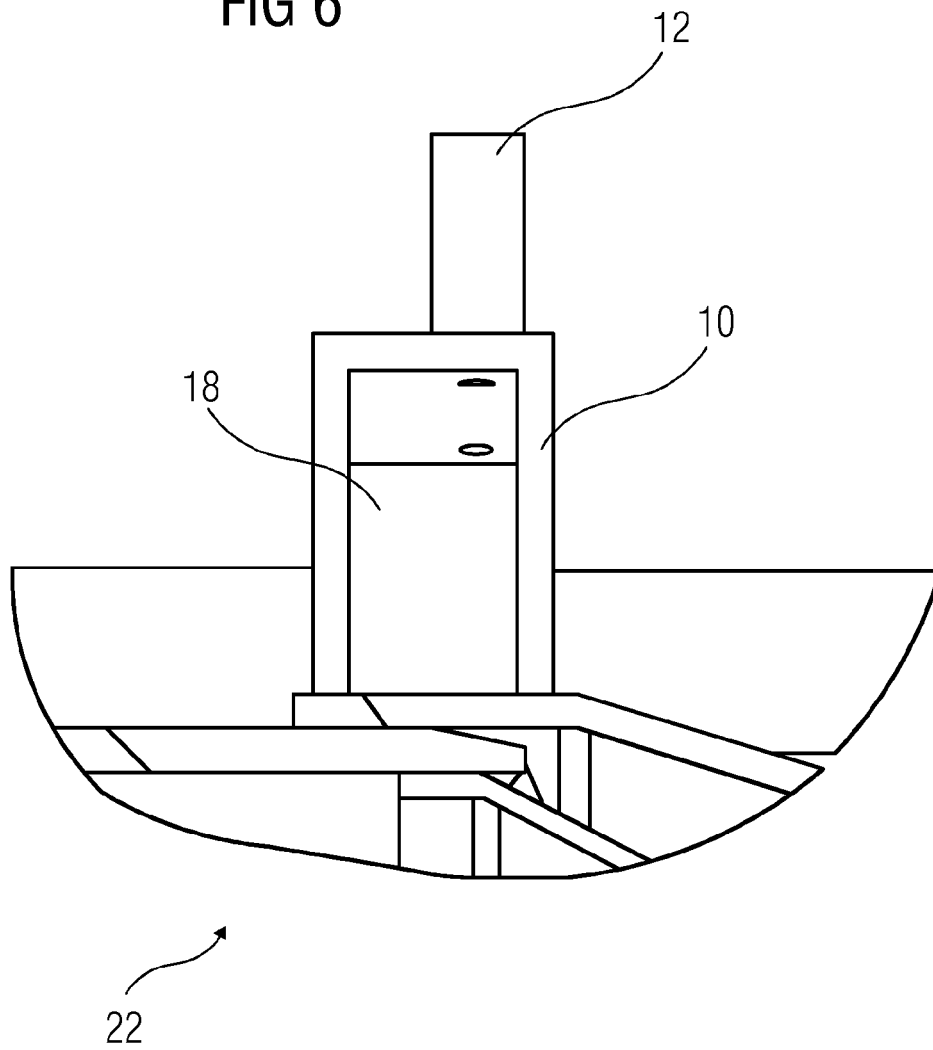
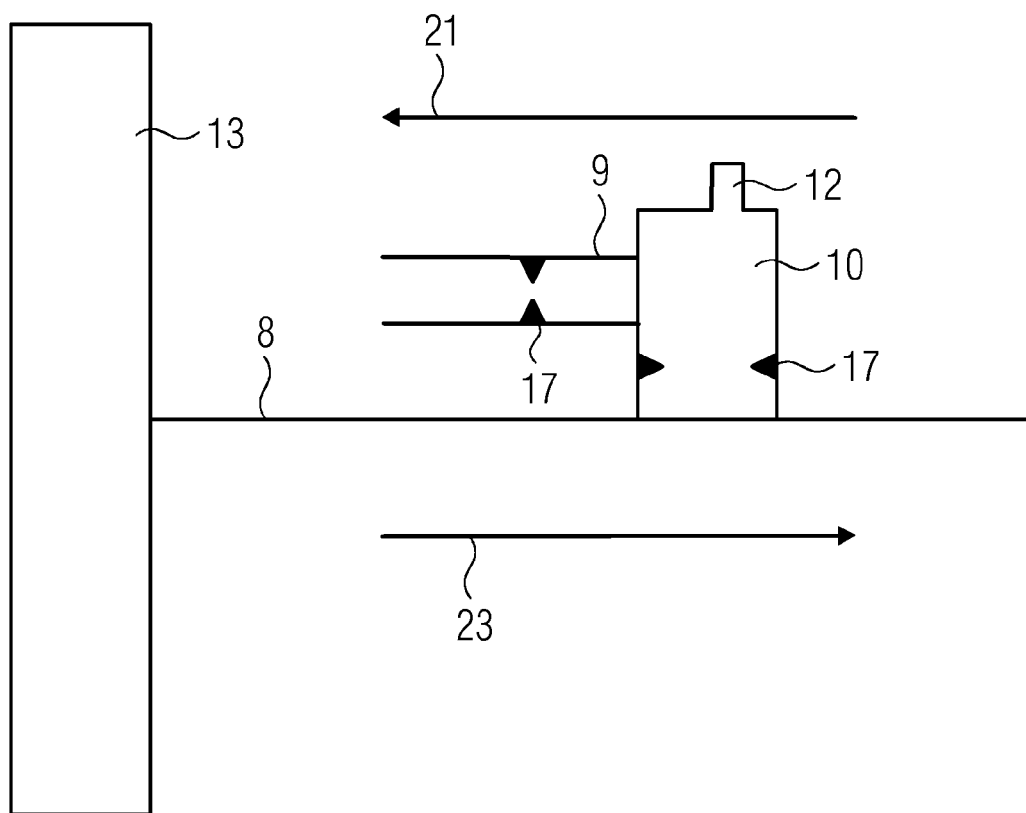


FIG 7





EUROPEAN SEARCH REPORT

Application Number
EP 14 17 0275

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			TECHNICAL FIELDS SEARCHED (IPC)
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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 July 2014	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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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