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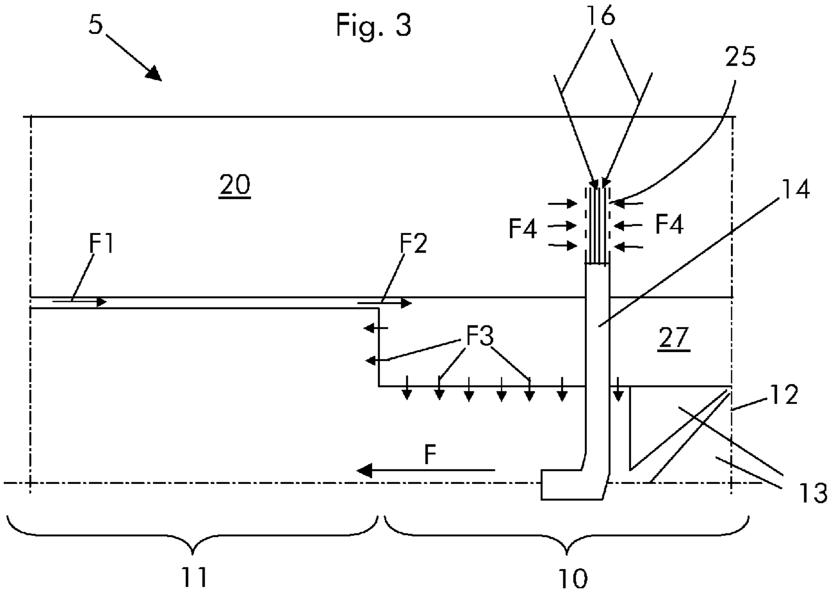
(54) Title: COMBUSTION DEVICE

Fig. 3



(57) Abstract: The combustion device (5) comprises a burner (10), a combustion chamber (11) downstream of the burner (10), a lance (14) projecting into the burner (10) for fuel and air injection, a plenum (20, 27) that at least partly houses the burner (10). The plenum (20, 27) is connected to the inside of the lance (14) to supply an oxidiser to it.

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COMBUSTION DEVICE

TECHNICAL FIELD

The present disclosure relates to a combustion device. In particular in the following reference to a gas turbine is made, for example a sequential combustion gas turbine, it is anyhow clear that the same device can be implemented also in different applications such as furnaces.

BACKGROUND

With reference to figure 1, gas turbines 1 have a compressor 2, a combustion device 3 and a turbine 4; the compressor 2 generates high pressure air that is supplied together with a fuel to the combustion device 3 where they are combusted to generate hot gases that are expanded in the turbine 4 (high pressure turbine); from the turbine 4 exhaust gases are discharged.

Sequential combustion gas turbines have a second combustion device 5 downstream of the high pressure turbine 4 where additional fuel is supplied into the exhaust gases and it is combusted to generate hot gases that are then expanded in a second turbine 6 (low pressure turbine).

Within the second combustion device 5, together with fuel, also air is injected; this air has mainly the functions of helping fuel penetration into the exhaust gases flowing through the second combustion device, and preventing an early fuel combustion immediately after injection.

Since the exhaust gases that pass through the second combustion device 5 have a large pressure (because only partial expansion occurs in the high pressure turbine 4), the air that is injected into the second combustion device 5 is drawn from the last stage of the compressor 2.

This cooling scheme has some drawbacks.

In fact, since at the last stage of the compressor 2 the air has a large pressure, drawing air (and thus preventing this air from combustion and expansion) has a large negative impact on the performances and efficiency of the gas turbine.

SUMMARY

An aspect of the disclosure includes providing a combustion device with improved performances and efficiency when compared to known combustion devices.

Another aspect of the disclosure is to provide a combustion device in which the negative impact of air drawing from the compressor can be reduced.

These and further aspects are attained by providing a combustion device in accordance with the accompanying claims.

Advantageously, flashback margin is increased and NOx emissions are reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the combustion device, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 is a schematic view of a known gas turbine;

Figure 2 is a schematic view of a gas turbine in an embodiment of the invention;

Figures 3 and 4 show a particular of the gas turbine in different embodiments of the invention; and

Figure 5 is a particular of a lance;

Figure 6 shows a further embodiment with cooling air distribution.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

In the following reference to the attached drawings is made; the drawings include the same reference numbers for the same or similar parts throughout the several views.

The combustion device is preferably a part of a gas turbine, for example a sequential combustion gas turbine 1.

The sequential combustion gas turbine 1 includes a compressor 2, a first combustion device 3, a first turbine 4 (high pressure turbine), a second combustion device 5 and a second turbine 6 (low pressure turbine). These gas turbines are well known in the art.

During operation the compressor 2 compresses an oxidiser and supplies it to the first combustion device 3. The oxidiser is usually air and in the following reference to air is made. The first combustion device 3 receives the compressed air and a fuel and combusts them generating hot gases that are partly expanded in the first turbine 4. The exhaust gases from the first turbine 4 enter the second combustion device 5 wherein additional fuel is supplied and combusted generating hot gases that are then expanded in the second turbine 6.

The second combustion device 5 comprises a burner 10; during operation a flow F (exhaust gases from the turbine 4) flows through the burner 10. Naturally in different kinds of burners or gas turbines or applications of the combustion device the flow can also be a different flow from the exhaust gases.

Downstream of the burner 10 a combustion chamber 11 is provided.

The burner has an inlet 12 with vortex generators 13 (for example tetrahedral vortex generators) and a lance 14 projecting into the burner 2 for fuel and air injection.

Air injected through the lance 14 is mainly used for:

- helping fuel penetration into the exhaust gases flowing through the burner 10,
- shielding and protecting the fuel after injection, to prevent its immediate combustion after injection,
- cooling of the lance while flowing through it.

The lance 14 is connected to an air source and a fuel tank (reference 16 indicates pipes from fuel tanks).

In different examples the lance 14 can be arranged to supply different fuels, for example a liquid fuel such as oil and a gaseous fuel; in this case the lance 14 is connected to two or more fuel tanks, each for a kind of fuel.

The combustion device 5 has a plenum that houses the burner 10 and the combustion chamber 11; within the plenum the air is substantially still (i.e. motionless).

The plenum is connected to the inside of the lance 14 to supply air to it.

The plenum can include an outer plenum 20 and an inner plenum 27; the outer plenum 20 houses the inner plenum 27 that is connected to the burner 10 for supplying air to it. The inner plenum 27 and the outer plenum 20 are connected by a cooling path for the combustion chamber 11.

The lance 14 comprises a duct 21 for air and one or more ducts for fuel 23, 24 (for example the lance 14 can supply two different fuels, in this case each duct 23, 24 is connected to a fuel tank). The plenum 20 or 27 is connected to the duct 21 for air.

Preferably, the duct 21 for air encircles the ducts for fuel 23, 24 and the lance 14 has a portion housed in the plenum 20, 27. In addition, the duct 21 for air has one or more openings 25 connecting it to the plenum 20 or 27.

In particular, figure 3 shows an example in which the duct 21 for air is connected to the outer plenum 20.

Figure 4 shows an example in which the duct 21 for air is connected to the inner plenum 27.

Preferably the air pressure losses at the inlet of the duct 21 are minimised by proper shaping of that inlet geometry.

The embodiment of figure 4 (i.e. the embodiment with the duct 21 connected to the inner plenum 27) lets air with a lower pressure be supplied through the lance 14 and duct 21 (because air undergoes pressure drops to reach the inner plenum 27).

The connection of the duct 21 to the inner or outer plenum 27, 20 lets the air injected into the burner 10 have a pressure close to the pressure of the flow (exhaust gases) flowing through it.

The duct 21 for air has nozzles 28 with sleeves 29 protruding outwardly from the duct 21 for air. This feature is not mandatory, but can help air and fuel penetration. Preferably in the embodiment of figure 4 the sleeves are longer than the sleeves of the embodiment of figure 3; the longer length helps penetration into the hot gases when the air pressure is lower.

As shown, the nozzles for the duct 21 for air are substantially coaxial (reference 34 indicates the axis of the nozzles 29, 30, 31) with the nozzles 30, 31 of the ducts 23, 24 for fuel.

The ducts 23, 24 for fuel have nozzles 30, 31 with sleeves protruding outwardly from the respective duct 23, 24 for fuel.

The operation of the combustion device is apparent from that described and illustrated and is substantially the following (with reference to figure 3).

Air is drawn from the compressor 2 at an intermediate part thereof, where the air pressure is close to the pressure of the exhaust gases F. This air is supplied into the outer plenum 20.

From the outer plenum 20 air enters the duct 21 via the openings 25 (arrows F4), passes through the duct 21 of the lance 14, reaches the nozzles 28 and is injected (arrows F5) through the nozzles 28 together with a fuel (arrow F6).

In the embodiment of figure 4 air is used to cool the combustion chamber walls (arrows F1) and it is then supplied into the inner plenum 27 (arrow F2). From the inner plenum 27 cooling air is supplied through the walls of the burner to cool them (arrow F3). In addition, air enters the duct 21 of the lance 14 through the openings 25 (arrows F4) and passes through the duct 21, reaching the nozzles 28. Then the air is injected into the burner 10 (arrow F5) through the nozzles 28 together with a fuel (arrows F6).

Surprisingly, it was ascertained that also when the air injected through the lance 14 has a pressure close to the given flow pressure, operation still occurs correctly in terms of fuel penetration and combustion.

Naturally the features described may be independently provided from one another.

In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

The embodiment of figure 6 is based on the embodiment of figure 3. In addition to the details shown in figure 3 the air supply to the plenum 20 and inner plenum 27 are shown. Further, the first turbine vane row 33 downstream of the combustion chamber 11 and outlet guide vanes upstream of the burner 10 as well as an outlet plenum 18 are shown.

The air supply to the plenum 20 and the inner plenum 27 is provided by a main distribution plenum 17. In this example the cooling air F7 required for cooling the first turbine vane row 33 is also provided by the main distribution plenum 17. A cooling air flow F0 is provided to the main distribution plenum 17. Typically cooling air flow F0 is medium pressure cooling air which can be taken from a compressor bleed (i.e. before the compressor exit).
According to one embodiment the cooling air flow F8 for the plenum 20 and the cooling air flow F1 for the inner plenum 27 are provided by the main distribution plenum 17.

The plena 17, 18, 20, and 27 can be annular plena concentrically surrounding the hot gas path of the gas turbine. The inlet plenum 18 can be arranged concentrically around the inlet guide vane row 32. The main distribution plenum 17 can be arranged concentrically around the first turbine vane row 33. The plenum 20 can be arranged concentrically around the combustion chamber 11 and the inner plenum 27.

In the embodiment shown in figure 6 also the cooling air flow F7 for the first turbine vane row 33 is provided by the main distribution plenum 17.

In the embodiment shown in figure 6 also the cooling air flow F9 for the inlet guide vane row 32 is provided by the main distribution plenum 17. In this case an additional outlet plenum 18 is arranged at the upstream end of the burner 27 for the cooling air supply of the inlet guide vane row 32. The cooling air flow F9 for the inlet guide vane row 32 is provided from the main distribution plenum F0 via the plenum 20.

The use of one main distribution plenum 17 reduces the need for cooling air supply lines and allows the use of medium pressure cooling air for the whole combustion chamber 11, and burner 10.

Depending on the embodiment also the cooling air of the first vane row 33 and the inlet guide vane 32 can be provided from the main distribution air plenum.

The flow velocities in the plena 17, 18 and 20 are small compared to the flow velocities of cooling air along the liner (flow F1) of the combustion chamber and in the vanes 32, 33. In particular cross section of the plenum 20 is kept large to reduce the flow velocity in the plenum 20 in order to keep the pressure drop across the plenum 20 small. According to one embodiment the flow velocity can be kept below 30 m/s. According to a further embodiment the flow velocity can be kept below 15 m/s.

In contrast the flow velocity of the air flow F1 along the liner of the combustion chamber 11 can be higher than 30 m/s or even higher than 50 m/s.

As a result, even so the air flow F1 and the air flow F8 are feed from the same main distribution plenum the pressure for feeding the air flow 4 to the lance 14 is higher than the pressure in the inner plenum 27.

Due to the low pressure drop in the plenum 20 and the inlet plenum 18 the pressure in the inlet plenum 18 is sufficient that cooling air to the outlet guide vanes 32 can be supplied.

REFERENCE NUMBERS

1 gas turbine

2 compressor

3 combustion device

4 high pressure turbine

5 combustion device

6 low pressure turbine

10 burner

11 combustion chamber

12 inlet

13 vortex generator

14 lance

16 pipe

17 main distribution plenum

18 outlet plenum

20 plenum

21 duct for air

23, 24 duct for fuel

25 opening

27 inner plenum

28 nozzles

29 sleeve

30, 31 nozzle

32 outlet guide vane row

33 first turbine vane row

34 axis

F flow of exhaust gases

F0, F1, F2, F3, F7, F8, F9 air

F4, F5 oxidiser (air)

F6 fuel

CLAIMS

1. A combustion device (5) comprising

a burner (10),

a combustion chamber (11) downstream of the burner (10),

a lance (14) projecting into the burner (10) for fuel and air injection,

a plenum (20, 27) that at least partly houses the burner (10),

characterised in that the plenum (20, 27) is connected to the inside of the lance (14) to supply an oxidiser to it.

2. The combustion device (5) according to claim 1, characterised in that the lance (14) comprises a duct (21) for oxidiser and at least a duct (23, 24) for fuel, wherein the plenum (20, 27) is connected to the duct (21) for oxidiser.

3. The combustion device (5) according to claim 2, characterised in that the duct (21) for oxidiser encircles the at least a duct (23, 24) for fuel.

4. The combustion device (5) according to claim 2, characterised in that the lance (14) has a portion housed in the plenum (20, 27), wherein the duct (21) for oxidiser has at least an opening (25) connecting it to the plenum (20, 27).

5. The combustion device (5) according to claim 4, characterised by comprising an outer plenum (20) and

an inner plenum (27) that are connected by a cooling path for the combustion chamber.

6. The combustion device (5) according to claim 5, characterised in that the duct (21) for oxidiser is connected to the outer plenum (20).

7. The combustion device (5) according to claim 5, characterised in that the duct (21) for oxidiser is connected to the inner plenum (27).

8. The combustion device (5) according to claim 5, characterised in that the outer plenum (20) at least partly houses the inner plenum (27).

9. The combustion device (5) according to claim 2, characterised in that the duct (21) for oxidiser has nozzles (28) with sleeves (29) protruding outwardly from the duct (21) for oxidiser.

10. The combustion device (5) according to claims 2, characterised in that
the at least a duct (23, 24) for fuel has nozzles (30, 31),
the nozzles (28) for the duct (21) for oxidiser are substantially coaxial with the nozzles (30, 31) of the at least a duct (23, 24) for fuel.

11. The combustion device (5) according to claim 10, characterised in that the at least a duct (23, 24) for fuel has nozzles (30, 31) with sleeves protruding outwardly from the duct (23, 24) for fuel.

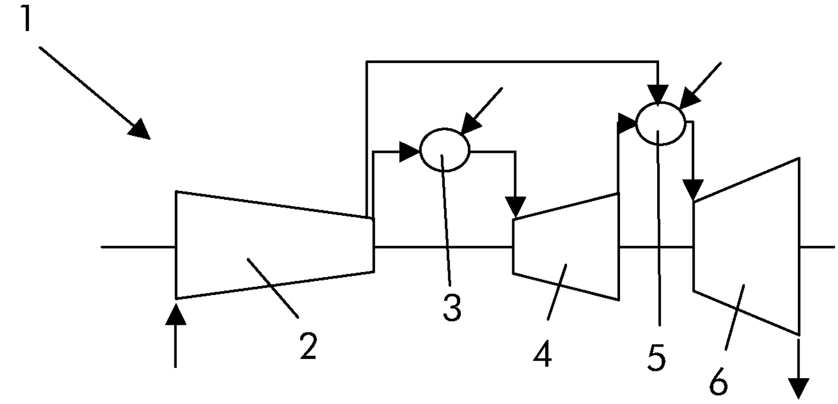


Fig. 1
Prior art

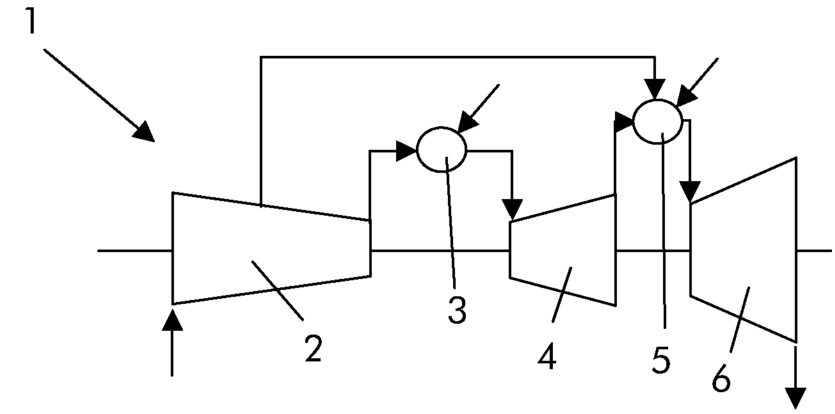
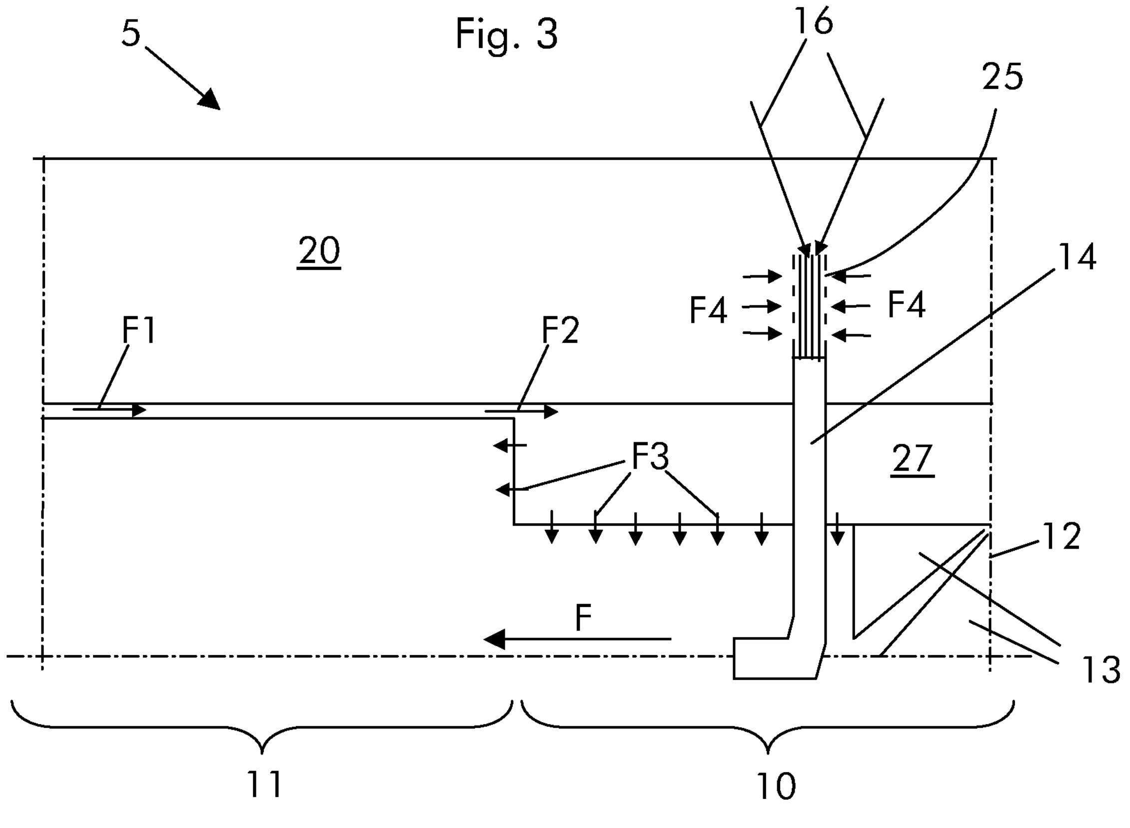


Fig. 2

Fig. 3



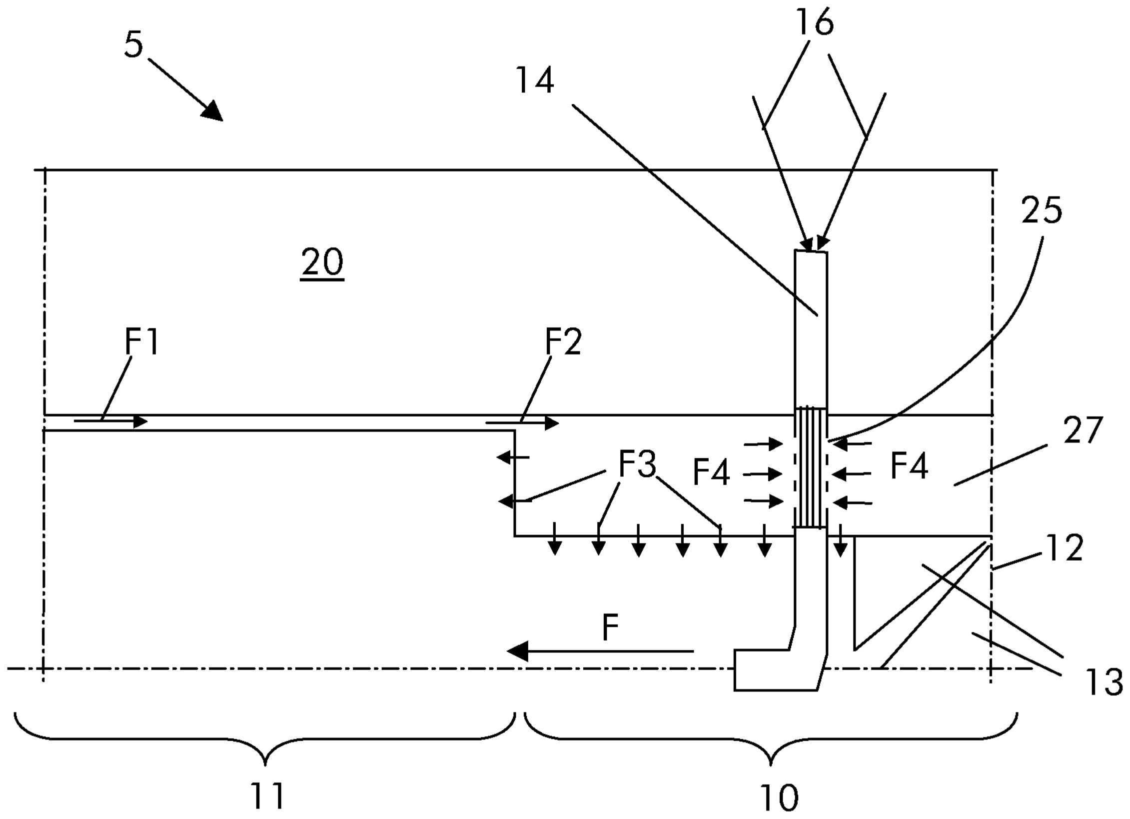

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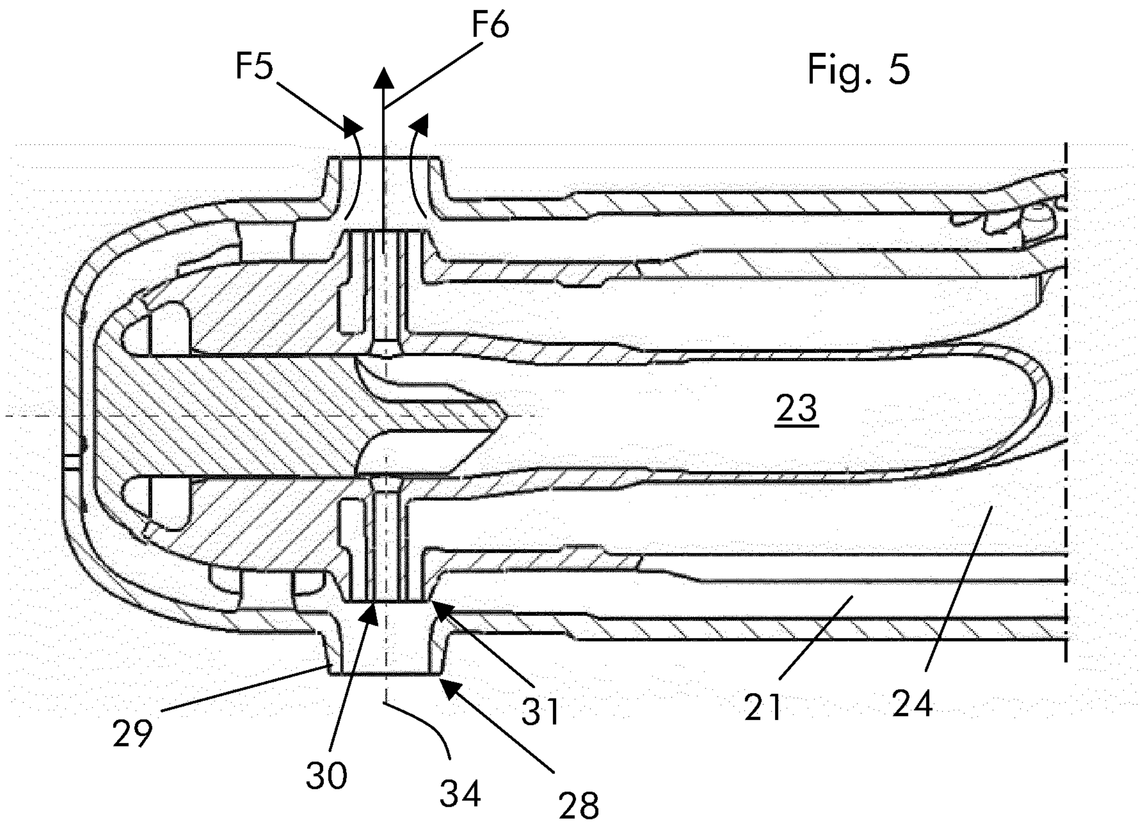
Fig. 4

Fig. 5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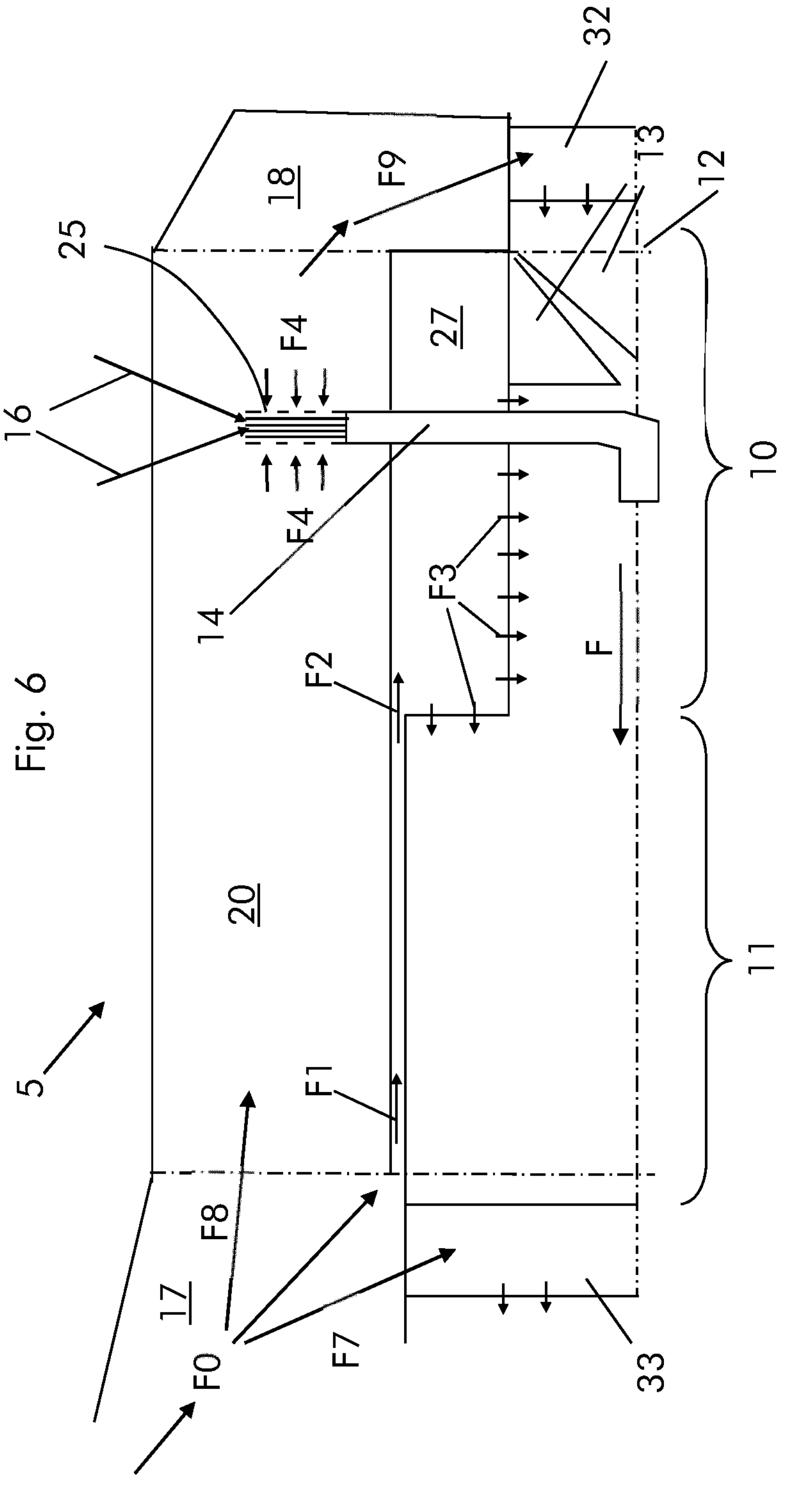

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/055940

A. CLASSIFICATION OF SUBJECT MATTER
INV. F23R3/18 F23R3/34 F23C3/00 F23G7/06 F23R3/28
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F23R F23C F23G F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP 2 211 110 A1 (ALSTOM TECHNOLOGY LTD [CH]) 28 July 2010 (2010-07-28) paragraph [0015] - paragraph [0028]; figures 1,3	1-11
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
19 April 2013	03/05/2013

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/055940

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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