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(54) **Casing of a turbo machine, method for manufacturing such a casing and gas turbine with such a casing**

(57) The invention relates to a casing (13) of a turbo machine (10), which extends along a machine axis (12) of said turbo machine (10) and coaxially surrounds a rotor (11) of said turbo machine (10) thereby defining an annular hot gas path.

Said casing (13) comprises at least one axial section, wherein a plurality of axially extending apertures (16) are provided in the wall of said casing (13) and distributed around its circumference in order to reduce the individual influence of said at least one axial section on an overall radial deformation by reducing thermally induced circumferential stresses in said at least one axial section.

Method for manufacturing such a casing and gas turbine comprising such a casing.

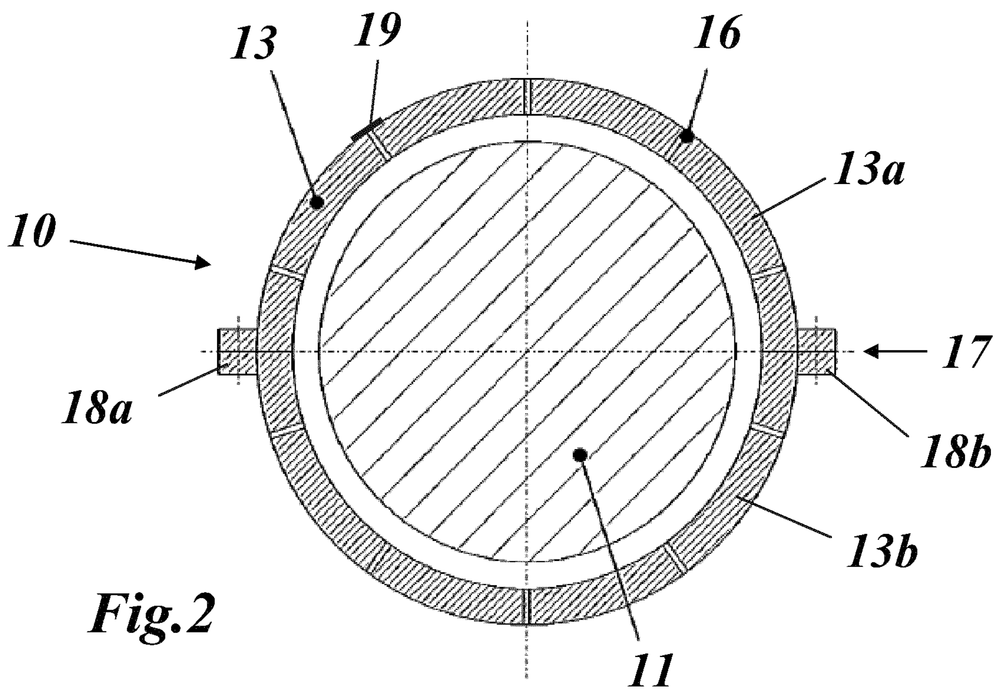

Fig.2

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to the technology of turbo machines. It refers to a casing of a turbo machine according to the preamble of claim 1.

[0002] It further relates to a method for manufacturing such a casing.

[0003] It finally relates to a gas turbine with such a casing.

PRIOR ART

[0004] Fig. 3 shows in a perspective view an example of a turbo machine in form of a gas turbine of the applicant of type GT24. The gas turbine 20 of Fig. 3 comprises a rotor 21 rotating about a machine axis and being enclosed by an (inner) casing 22. Arranged along the machine axis gas turbine 20 comprises an air intake 23, a compressor 24, a first combustor 25, a first, high pressure (HP) turbine 26, a second combustor 27, a second, low pressure (LP) turbine 28 and an exhaust gas outlet 29.

[0005] In operation, air enters the machine through air intake 23, is compressed by compressor 24, and is fed to first combustor 25 to be used to burn a fuel. The resulting hot gas drives HP turbine 26. As it still contains air, it is then reheated by means of second combustor 27, where fuel is injected into the hot gas stream. The reheated hot gas then drives LP turbine 28 and leaves the machine at exhaust gas outlet 29.

[0006] Due to temperature gradients or temperature profiles along the axis of the casing a distinct radial, thermal deflection arises. Due to the fact that the hotter and the colder sections of the casing are connected together, the radial deflection is influenced by both. Reasons for the temperature gradient could be different temperatures of the surrounding flows in different sections of the casing.

[0007] The root cause for the radial, thermal deformation is circumferential stresses in the casing coming from different temperatures in the casing. The hotter part, which tries to expand, is under pressure, but it is held back by the adjacent colder part, which tries to contract, and is therewith under tension. The result is radial deformation of the casing between ideal, independent deformation of the colder and ideal, independent deformation of the hotter section as they are linked together.

[0008] Document US 4,522,559 deals with a compressor section of a gas turbine engine, comprising a double wall casing, wherein a nonstructural inner wall is removably attached to a thin, structural outer casing. The inner wall isolates the thin stator outer casing during transient turbine operations of throttle burst and throttle chop. During throttle burst and chop, the nonstructural inner wall delays rapid heating and cooling of the relatively thin-walled outer casing, and reduces radial misalignment between the stator casing and rotor due to uneven thermal expansion and contraction. The non structural inner wall evens-out thermal expansion and contraction of the stator casing with respect to the rotor. To fine tune the actual clearances between stator and rotor and prevent the casing outer wall from overheating, thermal insulation material is used between the nonstructural inner wall and outer casing.

[0009] However, such a double wall casing is of high structural complexity and requires a substantial additional amount of work during assembly and disassembly.

SUMMARY OF THE INVENTION

[0010] It is an object of the present invention to provide in a casing comparably simple means for reducing the influence of either the hotter or the colder section on the overall radial, thermal deflection of the casing of a turbo machine, especially a gas turbine, via reducing the circumferential, thermal stresses as root cause for the deflection.

[0011] It is another object of the invention to provide a method for manufacturing such a casing.

[0012] It is just another object of the invention to provide a gas turbine with such casing.

[0013] These and other objects are obtained by a turbo machine according to Claim 1, a method according to Claim 10, and a gas turbine according to Claim 11.

[0014] A casing of a turbo machine according to the invention extends along a machine axis of said turbo machine and coaxially surrounds a rotor of said turbo machine, thereby defining an annular hot gas path.

[0015] The casing is characterized in that it comprises at least one axial section, wherein a plurality of axially extending apertures are provided in the wall of said casing and distributed around its circumference in order to reduce the individual influence of said at least one axial section on an overall radial deformation by reducing thermally induced circumferential stresses in said at least one axial section.

[0016] According to an embodiment of the invention said axially extending apertures have the form of axial slots, each said slot having an axial length and a width.

[0017] Specifically, each of said slots has a width between 0,5mm and 10 mm and an axial length between 1 mm and 400mm, preferably between 1 mm and 200mm.

[0018] According to another embodiment of the invention the number of said apertures that are distributed around the circumference of said casing in said at least one axial section is between 1 and 50.

[0019] According to a further embodiment of the invention said axially extending apertures are machined apertures.

[0020] According to just another embodiment of the invention said at least one section with said plurality of axially extending apertures is a separate element, which is axially connected to the remaining part of said casing.

[0021] According to a further embodiment of the invention each of said apertures is equipped with a seal.

[0022] Specifically, each of said apertures is sealed with a sealing plate, especially in form of a sheet metal plate.

[0023] According to another embodiment of the invention the width of said apertures is defined in such a way as to achieve a minimum width in the apertures during targeted, thermally stable conditions of said turbo machine.

[0024] The inventive method for manufacturing a casing according to the invention is characterized in that said at least one section is equipped with said axial apertures when being separated from said remaining part of said casing, and is then connected to said remaining part of said casing.

[0025] The gas turbine according to the invention comprises a rotor, which rotates around a machine axis and is surrounded by an axially extending casing in a coaxial arrangement. It is characterized in that said casing is a casing according the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The present invention is now to be explained more closely by means of different embodiments and with reference to the attached drawings.

Fig. 1 shows two different views (a) and (b) of a detail of a turbo machine according to an embodiment of the invention;

Fig. 2 shows a section through a turbo machine according to another embodiment of the invention perpendicular to the machine axis; and

Fig. 3 shows in a perspective view an example of a turbo machine in form of a gas turbine of the applicant of type GT24 (with sequential combustion).

DETAILED DESCRIPTION OF DIFFERENT EMBODIMENTS OF THE INVENTION

[0027] The invention comprises (in one embodiment) the "slotting" of the casing of an axial turbo machine, especially a gas turbine, in areas with a temperature profile or a temperature gradient in axial direction.

[0028] Fig. 1 (a) shows a part of such a turbo machine 10 comprising a rotor 11 with rotating blades 14, which extends along and rotates around a machine axis 12, and is coaxially surrounded by a casing 13, which is equipped on its inner side with stationary guiding vanes 15. At the right end of machine the casing 13 shows a temperature gradient with temperature T2 at the right end being higher than temperature T1 at a distance to the left (T2 > T1) or vice versa.

[0029] Due to this temperature gradient the hotter part of the casing 13 tries to expand whereas the colder part tries to contract. The root cause therefore is circumferential, thermal stresses induced by the temperature gradient. These circumferential stresses lead to a radial deflection as the casing 13 is behaving like a ring.

[0030] The result is an "overall average deflection" between hotter and colder section as they are not decoupled from each other. By preventing the circumferential stresses via slots 16, which extend in axial direction with a width W and an axial length L, distributed around the circumference of casing 13, either in the hotter part of the casing 13 (as shown in Fig. 1) or the colder part of the casing, the overall radial deflection is driven by the "non-slotted" part of the casing.

[0031] As shown in Fig. 2, the casing 13, which is assembled from an upper half-shell 13a and a lower half-shell 13b in a parting plane by means of flanges 18a and 18b, comprises an equally distributed plurality of slots 16 (the embodiment of Fig. 2 has 5 slots 16 in upper half-shell 13a and 5 slots 16 in the lower half-shell 13b).

[0032] To close the slots 16 against a bleeding of gas from an inner flow path, e.g. the annular hot gas path between casing 13 and rotor 11, each slot 16 is sealed with a sealing plate 19 (see Figs. 1(b) and 2). This sealing plate 19 may especially be a sheet metal plate.

[0033] There are various options and features possible within the scope of the invention:

- The circumferentially distributed apertures can be easily achieved in connection with an axial split of the casing between hotter and colder sections. Either the hotter or colder, axially separated part is provided with the apertures (slots) before the segments (parts) are reconnected at the axial split.
- Dependent on the surrounding fluid flows and their pressures, it is possible to equip the apertures with additional seals to reduce leakages.
- Dependent on the interfacing parts, the number and the design of the apertures (slots) can be adjusted in such a way to meet the geometrical requirements of the interfacing parts as well as the requirements of the slotted casing itself.
- The apertures can be designed in such a way, to achieve a minimum width in the apertures during targeted, thermally stable conditions.
- Slots can be additionally equipped with additional features, e.g. stress relief bores to improve the lifetime of the casing.

[0034] Thus, the casing 13 of a turbo machine 10 receives at distinct sections a distinct number of axial apertures, especially slots 16, over its entire height/wall thickness, distributed around its circumference, with the purpose to prevent the individual influence of said sections on the overall radial deformation by reducing circumferential stresses in said section.

[0035] Said sections influence the overall radial deformation of said casing 13 due to thermally induced stresses.

[0036] Preferably, said axially extending apertures around the circumference of solid casing are machined.

[0037] Preferably, said section with said apertures is axially separated from the remaining part of said casing 13. Moreover the axially separated section is first equipped with said axial apertures around its circumference and then reconnected to the casing 13.

[0038] The width W of said apertures (slots) is defined in such a way to achieve a minimum width in the apertures during targeted, thermally stable conditions.

[0039] Furthermore, said apertures are defined in such a way as to meet also the geometrical requirements of interfacing parts.

[0040] The number of said apertures (slots) around the circumference of said casing 13 may vary between 1 and 50. The width W is preferably between 0,5mm and 10mm and an axial length L between 1 mm and 200mm.

[0041] Said apertures may additionally be equipped with seals. Especially, they may be sealed with sheet metal plates.

[0042] Said apertures are especially used to influence asymmetric deformations of said casing during transient and stead state conditions.

LIST OF REFERENCE NUMERALS

[0043]

10	turbo machine (e.g. gas turbine)
11	rotor
12	machine axis (of rotation)
13	casing (stator)
13a,b	half-shell
14	blade
15	vane
16	slot (axial)
17	parting plane
18a,b	flange
19	sealing plate
20	gas turbine (z.B. GT24)
21	rotor
22	(inner) casing
23	air intake
24	compressor
25	combustor (z.B. EV)
26	turbine (HP)
27	combustor (z.B. SEV)
28	turbine (LP)
29	exhaust gas outlet
L	length (axial)
W	width (slot)
T1,T2	temperature

Claims

1. A casing (13) of a turbo machine (10), which extends along a machine axis (12) of said turbo machine (10) and coaxially surrounds a rotor (11) of said turbo machine (10) thereby defining an annular hot gas path, **characterized in that** said casing (13) comprises at least one axial section, wherein a plurality of axially extending apertures (16) are provided in the wall of said casing (13) and distributed around its circumference in order to reduce the individual influence of said at least one axial section on an overall radial deformation by reducing thermally induced circumferential stresses in said at least one axial section.

2. A casing as claimed in Claim 1, **characterized in that** said axially extending apertures have the form of axial slots (16), each said slot (16) having an axial length (L) and a width (W).

3. A casing as claimed in Claim 2, **characterized in that** each of said slots (16) has a width (W) between 0,5mm and 10mm and an axial length (L) between 1 mm and 400mm, preferably between 1 mm and 200mm.

4. A casing as claimed in Claim 1, **characterized in that** the number of said apertures (16) that are distributed around the circumference of said casing in said at least one axial section, is between 1 and 50.

5. A casing as claimed in Claim 1, **characterized in that** said axially extending apertures (16) are machined apertures.

6. A casing as claimed in Claim 1, **characterized in that** said at least one section with said plurality of axially extending apertures (16) is a separate element, which is axially connected to the remaining part of said casing.

7. A casing as claimed in Claim 1, **characterized in that** each of said apertures (16) is equipped with a seal (19).

8. A casing as claimed in Claim 7, **characterized in that** each of said apertures (16) is sealed with a sealing plate (19), especially in form of a sheet metal plate.

9. A casing as claimed in Claim 2, **characterized in that** the width (W) of said apertures (16) is defined in such a way as to achieve a minimum width in the apertures during targeted, thermally stable conditions of said turbo machine.

10. Method for manufacturing a casing as claimed in Claim 6, **characterized in that** said at least one section is equipped with said axial apertures (16) when being separated from said remaining part of said casing, and is then connected to said remaining part of said casing.

11. A gas turbine comprising a rotor (11), which rotates around a machine axis (12) and is surrounded by an axially extending casing (13) in a coaxial arrangement, **characterized in that** said casing (13) is a casing according to one of the Claims 1 to 9.

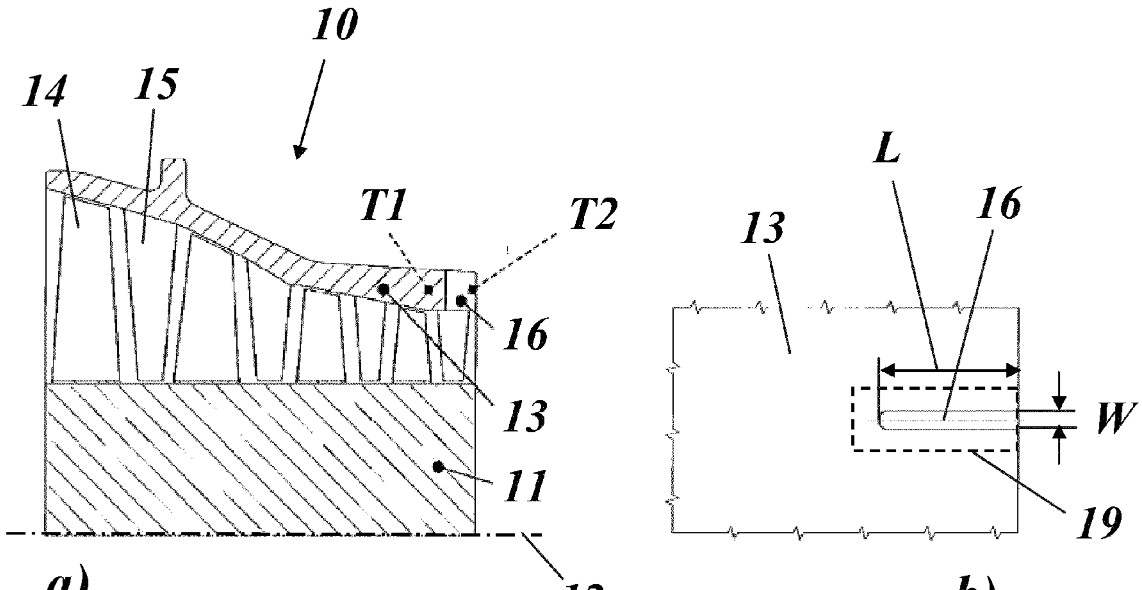
10
14
15
T1
T2
16
13
11
12
a)
L
16
13
W
19
b)

Fig.1

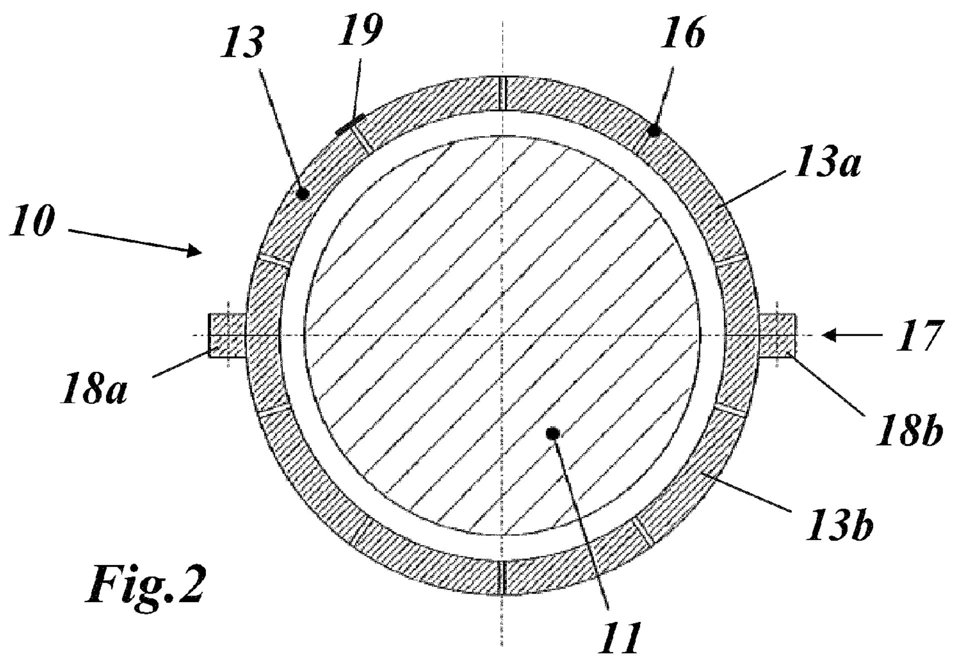
13
19
16
13a
10
17
18a
18b
13b
11

Fig.2

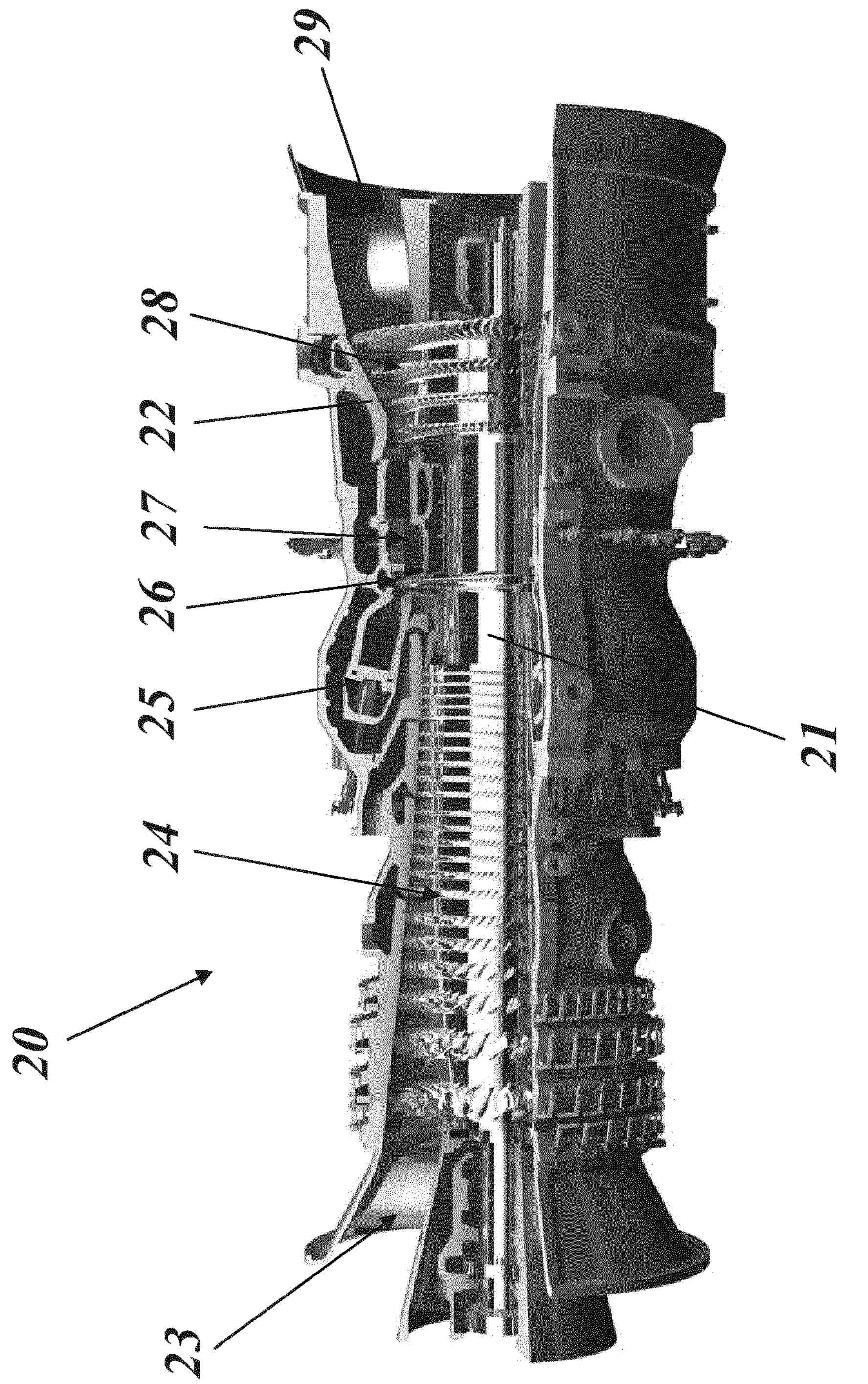

Fig.3

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 6851

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TECHNICAL FIELDS SEARCHED (IPC)

F01D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 March 2015	Delaitre, Maxime

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 18 6851

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REFERENCES CITED IN THE DESCRIPTION

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