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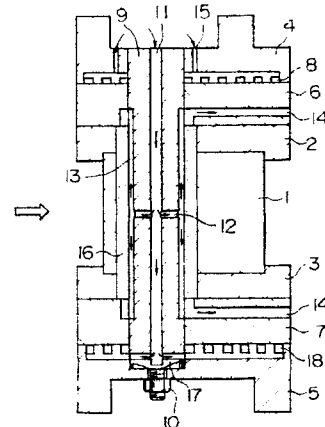
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Ceramic stator blade unit.

The ceramic stator blade unit includes a blade-shaped airfoil shell (1) of a ceramic material for rectifying the flow of the combustion gas, an outer segment (2, 4, 6) fixing an outer end portion of the blade-shaped airfoil shell (1) close to the retaining ring, and an inner segment (3, 5, 7) fixing an inner end portion of the blade-shaped airfoil shell (1) close to the support ring. As viewed from an upstream side of the flow of the combustion gas, front faces (A) of the outer and inner segments are disposed in a common plane perpendicular to the axis (0) of rotation of the turbine, and rear faces (B) of the outer and inner segments are disposed in a common plane substantially parallel to the front faces (A). Left side faces (C) of the outer and inner segments are disposed in a common plane whereas right side faces (D) of the outer and inner segments are disposed in a common plane. An internal angle formed by the intersection of the left side faces (C) and the right side faces (D) in a plane perpendicular to the

axis (0) of rotation of the turbine is substantially equal to a pitch angle (α) of a stator blade.

FIG. 3



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CERAMIC STATOR BLADE UNIT

BACKGROUND OF THE INVENTION

This invention relates generally to a ceramic stator blade for a gas turbine, and more particularly to a ceramic stator blade so designed as to improve the productivity and reliability.

In a conventional metallic stator blade, interior and exterior wall surfaces of the blade are cooled by the air so as to keep the temperature of the blade to below a temperature of heat resistance of the material of the blade. Since a ceramic stator blade, utilizing ceramic material whose heat-resistance temperature is high, requires less cooling air, it is considered that the use of such ceramic stator blade advantageously improves the efficiency of a gas turbine. For this reason, the development of ceramic stator blades has been attempted. Although such ceramic stator blade has not yet reached the stage of practical use, its basic construction is disclosed, for example, in Japanese Patent Unexamined Publication No. 61-89904. This prior publication describes a unit having one blade, and this unit comprises ceramic parts exposed directly to combustion gas, and metallic parts backing up the ceramic parts. For practical use, a plurality of such units are arranged in an annular configuration to constitute one stage of stator blades.

The above prior art discloses the basic construction of the ceramic stator blade, but is not directed a satisfactory annular arrangement of the units suited for practical use. More specifically, opposite side faces of the unit to be joined respectively to side faces of the adjoining units, as well as outer and inner wall surfaces forming a combustion gas flow passage, are flat and parallel, and therefore are not suitable for providing the annular arrangement.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to overcome the problems with the above prior art construction, and more particularly to provide a ceramic stator blade unit which has such a shape that such units can be assembled into an annular configuration suited for practical use, and is excellent in productivity and reliability.

According to the present invention, there is provided a ceramic stator blade unit wherein a plurality of the ceramic stator blade units are adapted to be disposed between a retaining ring, fixedly mounted within a casing and having an axis disposed in alignment with an axis of rotation of a

gas turbine, and a support ring disposed inwardly of the retaining ring in concentric relation thereto, and to be connected to one another in a radial manner to provide an annular configuration so as to direct combustion gas to rotor blades disposed adjacent to the ceramic stator blades units, the ceramic stator blade unit comprising:

- (a) a blade-shaped airfoil shell of a ceramic material for rectifying the flow of the combustion gas;
- (b) an outer segment fixed to said retaining ring and including an outer sidewall of a ceramic material fixing an outer end portion of the blade-shaped airfoil shell, and an outer shroud of metal connected to the outer sidewall through an outer heat-insulating plate;
- (c) an inner segment fixed to said support ring and including an inner sidewall of a ceramic material fixing an inner end portion of the blade-shaped airfoil shell, and an inner shroud of metal connected to the inner sidewall through an inner heat-insulating plate; and
- (d) a blade core extending through the outer segment, the blade-shaped airfoil shell and the inner segment and fastening them together; wherein, as viewed from an upstream side of the flow of the combustion gas, front faces of the outer and inner segments are disposed in a common plane perpendicular to the axis of rotation of the turbine, and rear faces of the outer and inner segments are disposed in a common plane substantially parallel to the front faces, left side faces of the outer and inner segments are disposed in a common plane whereas right side faces of the outer and inner segments are disposed in a common plane, and an internal angle formed by the intersection of the left side faces and the right side faces in a plane perpendicular to the axis of rotation of the turbine is substantially equal to a pitch angle of a stator blade.

Preferably, the blade core is disposed peripherally outwardly of the axis of rotation of the gas turbine, and a leading edge of the blade-shaped airfoil shell is disposed on one side of a plane which extends parallel to the direction of the height of the blade core and passes through the axis of rotation of the gas turbine whereas a trailing edge of the blade-shaped airfoil shell is disposed on the other side of the plane.

Preferably, the blade core is disposed radially of the axis of rotation of the gas turbine, and, in a plane perpendicular to the axis of rotation of the gas turbine, an angle formed by the left side face and the blade core and an angle formed by the

right side face and the blade core are a half of the pitch angle of the stator blade.

Preferably, an upper surface of the outer shroud, a lower surface of the outer sidewall, an upper surface of the inner sidewall and a lower surface of the inner shroud are defined respectively by parts of cylindrical surfaces having their centers disposed on the axis of rotation of the gas turbine, and a surface of joining between the outer shroud and the outer heat-insulating plate, a surface of joining between the outer heat-insulating plate and the outer sidewall, a surface of joining between the inner sidewall and the inner heat-insulating plate and a surface of joining between the inner heat-insulating plate and the inner shroud are either flat or are defined respectively by parts of cylindrical surfaces having their centers disposed on the axis of rotation of the gas turbine.

Each of the blade-shaped airfoil shell and the blade core may be reduced in cross-sectional area progressively toward the axis of rotation of the gas turbine.

Preferably, the blade core has a first air passage formed in an axial portion thereof and extending downward from its upper end, and the air passage branches off to the outer peripheral surface of the blade core at a central portion of the blade core, and the blade core also has a second air passage formed in the outer peripheral surface thereof and extending along the axis of the blade core, and the first air passage leads to the second air passage, and an upper portion of the second air passage communicates with a discharge hole, formed in the inner heat-insulating plate, via an air passage formed in the outer heat-insulating plate, and a lower portion of the second air passage communicates with a discharge hole, formed in the inner heat-insulating plate, via an air passage formed in the inner heat-insulating plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view showing the appearance of a first embodiment of a ceramic stator blade unit of the invention;

Fig. 2 is a schematic view showing the appearance of a portion of an annular arrangement of the stator units;

Fig. 3 is a schematic cross-sectional view of the first embodiment;

Fig. 4 is a top plan view of an outer sidewall of the stator blade unit of Fig. 1;

Fig. 5 is a front-elevational view showing the relation between the angle of inclination of each of left and right faces of the outer sidewall and a pitch angle;

Fig. 6 is a front-elevational view showing one

example of outer sidewall;

Fig. 7 is a front-elevational view of the outer sidewall in the first embodiment;

Fig. 8 is a view showing the appearance of a second embodiment of the invention; and

Fig. 9 is a schematic cross-sectional view of a third embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the invention will now be described with reference to the drawings.

Fig. 1 is a view showing the appearance of a ceramic stator blade unit including one blade, and Fig. 2 is a fragmentary view of a plurality of ceramic stator blade units assembled in an annular configuration. A retaining ring is fixedly mounted within a casing of a gas turbine, and has an axis or centerline disposed in alignment with the axis of rotation of the gas turbine, and a support ring is provided inwardly of this retaining ring in concentric relation thereto. The ceramic stator blades units are incorporated between the above retaining ring and support ring in an annular configuration.

As shown in Fig. 1, the stator blade unit comprises a blade-shaped airfoil shell 1 of a ceramic material for directing a flow of combustion gas to rotor blades (not shown) of the gas turbine, an outer sidewall 2 of a ceramic material mounted on the side of the retaining ring, and an inner sidewall 3 of a ceramic material mounted on the side of the support ring, the blade-shaped airfoil shell 1 being interposed between the outer and inner sidewalls 2 and 3. A passage or path of flow of the combustion gas is formed by a space defined by a lower surface E of the outer sidewall 2 and an upper surface F of the inner sidewall 3. The upper surface of the outer sidewall 2 is supported by an outer shroud 4 of metal through an outer heat-insulating plate 6 of a ceramic material. The lower surface of the inner sidewall 3 is supported by an inner shroud 5 of metal through an inner heat-insulating plate 7 of a ceramic material. Namely, the ceramic stator blade unit has the blade-shaped airfoil shell 1 at its central portion, and also has the sidewall, the heat-insulating plate and the shroud at each of the upper and lower portions of the unit, and the outer shroud is fixedly secured to the retaining ring whereas the inner shroud is fixedly secured to the support ring.

An integral block (hereinafter referred to as "outer segment") is constituted by the outer shroud 4, the outer heat-insulating plate 6 and the outer sidewall 2, and similarly another integral block (hereinafter referred to as "inner segment") is constituted by the inner sidewall 3, the inner heat-insulating plate 7 and the inner shroud 5. A front

face A of the ceramic stator blade unit is defined by the front faces of the inner and outer segments. Similarly, a rear face B of the blade unit is defined by the rear faces of the inner and outer segments. Also, similarly, left and right side faces C and D of the blade unit are defined by one side faces of the inner and outer segments and the other side faces of these segments, respectively. The front face A and the rear face B (not shown) are disposed respectively in planes perpendicular to the axis of rotation of the gas turbine, and are parallel to each other. The left side face C (not shown) and the right side face D are disposed respectively in planes, and these two planes are so disposed that the distance between the two side faces C and D becomes smaller progressively toward the inner side. The lower surface E of the outer sidewall 2 and the upper surface F of the inner sidewall 3 are defined respectively by parts of cylindrical surfaces disposed in concentric relation to each other.

Fig. 2 shows a portion of one stage of the stator blades in which the ceramic stator blade units are annularly arranged at a pitch angle α .

Fig. 3 is a cross-sectional view of the ceramic stator blade unit taken in a direction of flow of the combustion gas. A blade core 9 of a bar-like shape extends through the axial central portion of the ceramic stator blade unit in an upward/downward direction, and the parts of the ceramic stator unit are assembled, using the blade core as a core. The blade core 9 is made of metal, and its upper portion is welded or integrally molded to the outer shroud 4. The lower portion of the blade core 9 is connected to the inner shroud 5 by a nut 10 and a bolt formed on the blade core 9.

The blade-shaped airfoil shell 1 and the outer and inner sidewalls 2 and 3 are held against lateral movement by the blade core 9 through a heat-insulating sleeve 16 mounted on the outer periphery of the blade core 9. The heat-insulating plates 6 and 7 are also held against lateral movement by the blade core 9. The direction of flow of the cooling air is indicated by smaller arrows, and the direction of flow of the combustion gas is indicated by greater arrows.

First, the cooling air, fed to the lower surface of the outer shroud 4 via introduction holes 15 extending downward from the upper surface of the upper shroud 4, passes through discharge holes 8, formed in the lower surface of the outer shroud 4, to cool the outer shroud 4, and then flows into the combustion gas flow passage. Next, the cooling air, fed to the surface of the blade core 9 via an introduction hole 11, formed in the blade core 9 along its axis, and transverse holes 12 formed radially in the central portion of the blade core 9, passes through grooves 13, formed in the surface of the blade core 9 and extending upwardly and

downwardly, to cool the blade core 9, and then flows into the combustion gas flow passage via transverse holes 14 formed in the heat-insulating plates 6 and 7. Also, the cooling air, fed to the upper surface of the inner shroud 5 via the introduction hole 11 of the blade core 9 and a transverse hole 17 formed in the lower portion of the blade core 9, passes through discharge holes 18 formed in the upper surface of the inner shroud 5, to cool the inner shroud 5, and then flows into the combustion gas flow passage.

Since the blade-shaped airfoil shell 1 and the outer and inner sidewalls 2 and 3 are exposed directly to the combustion gas, they are made of a ceramic material excellent in heat resistance. A preferred example of the ceramic material is silicon carbide having an excellent strength at high temperatures and an excellent oxidation-resistance, and particularly silicon carbide sintered at normal pressure is suitable in view of the complicated shape of each of the above parts. Sialon and silicon nitride, though slightly inferior in heat resistance and environmental resistance, may be used because of its excellent strength and toughness, depending on the conditions of use. Each of the heat-insulating plates 6 and 7 must be excellent in heat resistance and must have a low Young's modulus, that is, a sufficiently high elastic deformability to absorb a difference in thermal deformation amount between the blade core 9 and the ceramic parts. A soft inorganic material is suitable for the heat-insulating plates 6 and 7, and for example, they may be made of a woven fabric of ceramic fibers or a ceramic fiber-reinforcing ceramic. The sleeve 16 must have the same properties as the heat-insulating plates 6 and 7 and also must be filled in the narrow space, and therefore the sleeve 16 is made by a combination of an inorganic filler (e.g. alumina) silica compound and a soft inorganic material (e.g. ceramic fiber). The outer and inner shrouds 4 and and the blade core 9 are made of metal; however, since the ceramic stator blade of the present invention is superior in heat insulation than the conventional metallic stator blade, a metal material having a relatively low heat-resistance temperature, such as stainless steel, may be used, which facilitates the manufacture.

As described above, the left and right side faces C and D (see Figs. 1 and 2) of the ceramic stator blade unit are defined by flat surfaces, respectively. The configuration of the two side faces will now be described with reference to Figs. 4 and 5, taking the outer sidewall 2 (i.e., one of the constituents of the blade unit) as an example. Fig. 4 is a top plane view of the outer sidewall 2, and Fig. 5 is a front-elevational view thereof. In Fig. 4, an axis Z-Z is oriented in a direction parallel to the axis of rotation of the gas turbine, and is a center-

line of the width (2W) of the outer sidewall 2 in the circumferential direction. When viewed from the upstream side of the direction of flow of the combustion gas, the front face A and the rear face B are respectively flat surfaces perpendicular to the axis Z-Z, and also the left and right side faces C and D are respectively flat surfaces inclined at an angle β with respect to the axis Z-Z.

The value of β satisfies the following conditions. Firstly, this value must be small to prevent chipping of the ceramic part. Secondly, this value must be so determined as to enable the provision of a groove (indicated by a broken line) for fitting the blade-shaped airfoil shell 1 therein. Those portions of the groove corresponding respectively to the leading and trailing edges of the blade-shaped airfoil shell 1 are indicated by points h and i, respectively, and the portion extending between the points h and i on the circumference is indicated by X. Apexes are indicated by \underline{a} , \underline{b} , \underline{c} and \underline{d} , respectively.

An upper surface G is a flat surface disposed radially outwardly, and the lower surface E is part of the cylindrical surface having the center disposed at the axis (centerline) O of rotation of the gas turbine. A plane R (perpendicular to the sheet of Fig. 5) includes the axis of rotation of the gas turbine, and is parallel to the blade core 9. The leading and trailing edges of the blade-shaped airfoil shell 1 are indicated by dots-and-dash lines h-j and i-k, respectively. An arc e-f is defined by the line of intersection between the front face A and the lower surface E, and the angle between a line e-O (passing through the point e and the point O) and a line f-O is the pitch angle α (shown in Fig. 2) of the stator blade. The angle formed between the line a-e of intersection between the front face A and the left side face C (not shown) and the line b-f of intersection between the front face A and the right side face D is equal to the pitch angle α so that the adjacent stator blade units can be arranged with no gap therebetween. Namely, assuming that the angle between the plane R and the intersection line a-e and the angle between the plane R and the intersection line b-f are represented by θ_1 and θ_2 , respectively, the following formula is established:

$$\theta_1 + \theta_2 = \alpha \quad (1)$$

In the conventional metallic stator blade, the leading and trailing edges of the airfoil are distorted relative to each other so as to coincide radial lines passing through the center O of the cylindrical surface E defining the lower surface of the outer sidewall 2 (for example, the trailing edge i-k in Fig. 5 is disposed in a direction k-l). Thus, the airfoil of the conventional metallic stator blade has a complicated three-dimensional shape. On the other hand, the ceramic stator blade unit is required to have a simple shape to enable easy molding and

working. For this reason, in this embodiment, the leading edge (indicated by the line h-j in Fig. 5) and the trailing edge (indicated by the line i-k) of the blade-shaped airfoil shell 1 are disposed substantially parallel to each other, so that the blade-shaped airfoil shell 1 has a two-dimensional shape. In this case, the outer sidewall 2 is shaped in such a manner that the plane R for determining the position of the center of the cylindrical surface E passes the area X between the point h and the point i, thereby preventing the leading and trailing edges of the blade-shaped airfoil shell 1 from being much displaced from radial lines passing through the center O.

Next, to reduce the amount of working or processing of the sidewall, that is, a thickness difference Y, to a minimum is effective in the cost reduction. For this reason, the plane R is arranged to coincide with the Z-Z axis shown in Fig. 4.

Fig. 6 shows a specific example thereof in which the angle θ_1 of inclination of the left side face C (not shown) is equal to the pitch angle α , and the angle θ_2 of the right side face D is 0° (that is, 90° with respect to the surface G). The same effect can be achieved if this relation between the inclinations of the left and right side faces is reversed. Fig. 7 shows another example in which the inclination angle of each of the left and right side faces C and D is equal to a half of α . The angle between the surface G and the side face C, D can be the maximum (with respect to Fig. 6, this is the angle at the point a), and this configuration is advantageous in working and handling of the sidewall made of a brittle ceramic material.

In this embodiment, since the shape of each part is simple, the molding and working can be made easier. This is quite advantageous particularly with respect to the ceramic parts which can not be worked easily. Also, to eliminate the provision of sharp corners in the sidewall made of a ceramic material is advantageous in handling of the part and reliability. Further, since the separate or independent air passage is provided for cooling the blade core, the cooling efficiency is enhanced, thereby improving the heat resistance of the ceramic stator blade unit. The provision of the air discharge holes in the heat-insulating plates avoids damage due to thermal stress, thereby enabling the provision of the ceramic stator blade excellent in reliability.

Fig. 8 shows another embodiment of the invention. In a ceramic stator blade unit of this embodiment, the surfaces of joining between adjacent parts (including outer and inner sidewalls 2 and 3, outer and inner heat-insulating plates 6 and 7, and outer and inner shrouds 4 and 5) are defined respectively by parts of cylindrical surfaces having a common axis. The side faces are all flat, and the

angle of inclination of the left side face C (not shown) as well as the angle of inclination of the right side face D is the same as described above in the above-mentioned embodiment. In this embodiment, although the molding and working of each part become complicated, the positions of the corresponding parts in the radial direction of the turbine coincide with each other at the mated side faces of each adjacent stator blade units. This is advantageous in that the thickness of each part can be determined in view of its characteristics such as heat-resistance properties.

Fig. 9 shows a third embodiment of the invention. A blade-shaped airfoil shell 1 is reduced in cross-sectional area progressively toward the inner side, and a blade core 9 is correspondingly reduced in cross-sectional area progressively toward its lower end. Left and right side faces (not shown) are flat, and the angle of inclination of each of the left and right side faces is the same as described in the first embodiment. According to this embodiment, in the ceramic stator blade unit in which the stator blade has an increased size, and each of an inner sidewall 3, an inner heat-insulating plate 7 and an inner shroud 5 has a smaller width, the width of the blade-shaped airfoil shell 1 can be properly determined.

Claims

1. A ceramic stator blade unit wherein a plurality of said ceramic stator blade units are adapted to be disposed between a retaining ring, fixedly mounted within a casing and having an axis disposed in alignment with an axis (0) of rotation of a gas turbine, and a support ring disposed inwardly of said retaining ring in concentric relation thereto, and to be connected to one another in a radial manner to provide an annular configuration so as to direct combustion gas to rotor blades disposed adjacent to said ceramic stator blades units, said ceramic stator blade unit comprising:

(a) a blade-shaped airfoil shell (1) of a ceramic material for rectifying the flow of said combustion gas;

(b) an outer segment fixed to said retaining ring and including an outer sidewall (2) of a ceramic material fixing an outer end portion of said blade-shaped airfoil shell (1), and an outer shroud (4) of metal connected to said outer sidewall (2) through an outer heat-insulating plate (6);

(c) an inner segment fixed to said support ring and including an inner sidewall (3) of a ceramic material fixing an inner end portion of said blade-shaped airfoil shell (1), and an inner shroud (5) of metal connected to said inner sidewall (3) through an inner heat-insulating plate (7); and

(d) a blade core (9) extending through said outer segment (2, 4, 6), said blade-shaped airfoil shell (1) and said inner segment (3, 5, 7) and fastening them together;

5 characterized in that, as viewed from an upstream side of the flow of said combustion gas, front faces (A) of said outer and inner segments (2, 4, 6; 3, 5, 7) are disposed in a common plane perpendicular to the axis (0) of rotation of said turbine, and rear faces (B) of said outer and inner segments (2, 4, 6; 3, 5, 7) are disposed in a common plane substantially parallel to said front faces (A), left side faces (C) of said outer and inner segments (2, 4, 6; 3, 5, 7) are disposed in a common plane whereas right side faces (D) of said outer and inner segments (2, 4, 6; 3, 5, 7) are disposed in a common plane, and an internal angle formed by the intersection of said left side faces (C) and said right side faces (D) in a plane perpendicular to the axis (0) of rotation of said turbine is substantially equal to a pitch angle (α) of a stator blade.

2. A ceramic stator blade unit according to claim 1, in which said blade core (9) is disposed peripherally outwardly of the axis (0) of rotation of said gas turbine, a leading edge (h-j) of said blade-shaped airfoil shell (1) being disposed on one side of a plane (R) which extends parallel to the direction of the height of said blade core (9) and passes through the axis (0) of rotation of said gas turbine whereas a trailing edge (i-k) of said blade-shaped airfoil shell (1) is disposed on the other side of said plane (R).

3. A ceramic stator blade unit according to claim 1, in which said blade core (9) is disposed radially of the axis (0) of rotation of said gas turbine, in a plane perpendicular to the axis (0) of rotation of said gas turbine, an angle formed by said left side face (C) and said blade core and an angle formed by said right side faces (D) and said blade core (9) being a half of the pitch angle (α) of the stator blade.

4. A ceramic stator blade unit according to claim 1, in which an upper surface of said outer shroud (4), a lower surface (E) of said outer sidewall (2), an upper surface (F) of said inner sidewall (3) and a lower surface of said inner shroud (5) are defined respectively by parts of cylindrical surfaces having their centers disposed on the axis (0) of rotation of said gas turbine, and a surface of joining between said outer shroud (4) and said outer heat-insulating plate (6), a surface of joining between said outer heat-insulating plate (6) and said outer sidewall (2), a surface of joining between said inner sidewall (3) and said inner heat-insulating plate (7) and a surface of joining between said inner heat-insulating plate (7) and said inner shroud (5) being flat.

5. A ceramic stator blade unit according to claim 1, in which an upper surface of said outer shroud (4),

a lower surface (E) of said outer sidewall (2), an upper surface (F) of said inner sidewall (3) and a lower surface of said inner shroud (5) are defined respectively by parts of cylindrical surfaces having their centers disposed on the axis (0) of rotation of said gas turbine, a surface of joining between said outer shroud (2) and said outer heat-insulating plate (6), a surface of joining between said outer heat-insulating plate (6) and said outer sidewall (4), a surface of joining between said inner sidewall (3) and said inner heat-insulating plate (7) and a surface of joining between said inner heat-insulating plate (7) and said inner shroud (5) being defined respectively by parts of cylindrical surfaces having their centers disposed on the axis (0) of rotation of said gas turbine.

6. A ceramic stator blade unit according to claim 1, in which air passage means for passing cooling air is provided in each of said outer shroud (4), said outer heat-insulating plate (6), said outer sidewall (2), said inner sidewall (3), said inner heat-insulating plate (7), said inner shroud (5) and said blade core (9).

7. A ceramic stator blade unit according to claim 1, in which each of said blade-shaped airfoil shell (1) and said blade core (9) is reduced in cross-sectional area progressively toward the axis (0) of rotation of said gas turbine.

8. A ceramic stator blade unit according to any one of claims 1 to 7, in which said blade core (9) has a first air passage (11) formed in an axial portion thereof and extending downward from its upper end, said air passage branching off to the outer peripheral surface of said blade core (9) at a central portion of said blade core (9), said blade core (9) also having a second air passage (13) formed in the outer peripheral surface thereof and extending along the axis of said blade core (9), said first air passage (11) leading to said second air passage (13), an upper portion of said second air passage (13) communicating with a discharge hole (14), formed in said outer heat-insulating plate (6), via an air passage formed in said outer heat-insulating plate, and a lower portion of said second air passage (13) communicating with a discharge hole (14), formed in said inner heat-insulating plate (7), via an air passage formed in said inner heat-insulating plate.

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FIG. 1

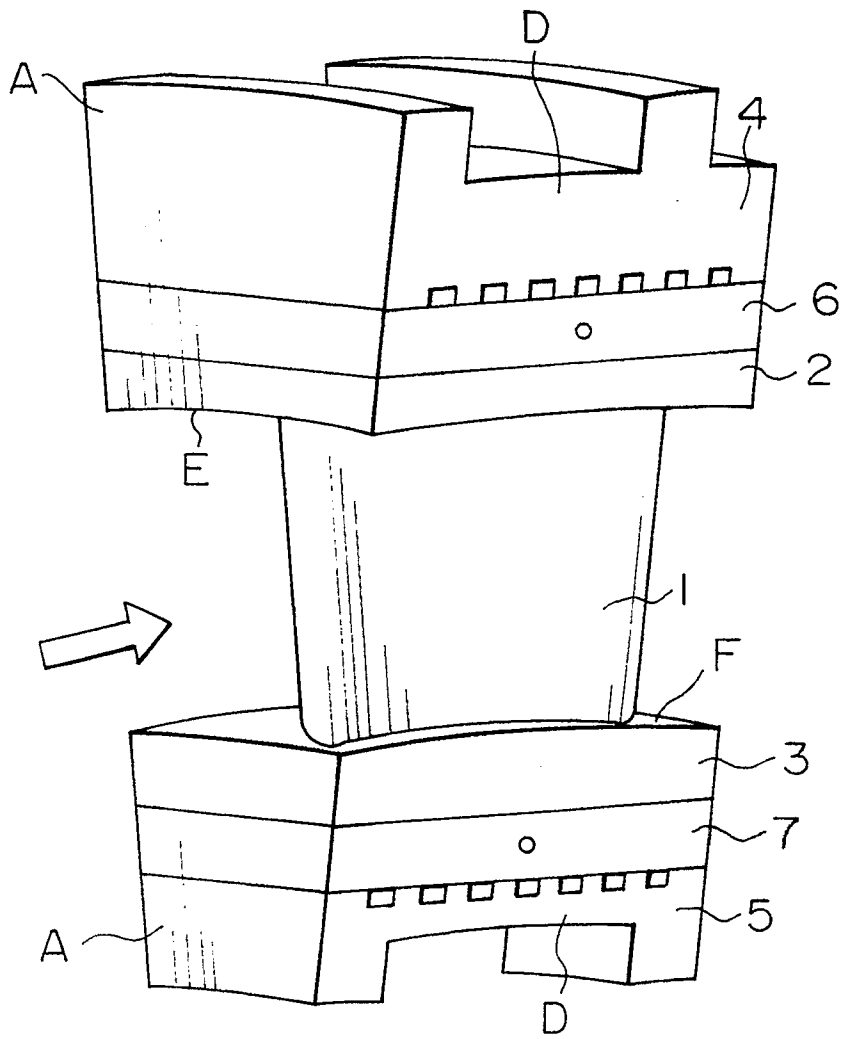


FIG. 2

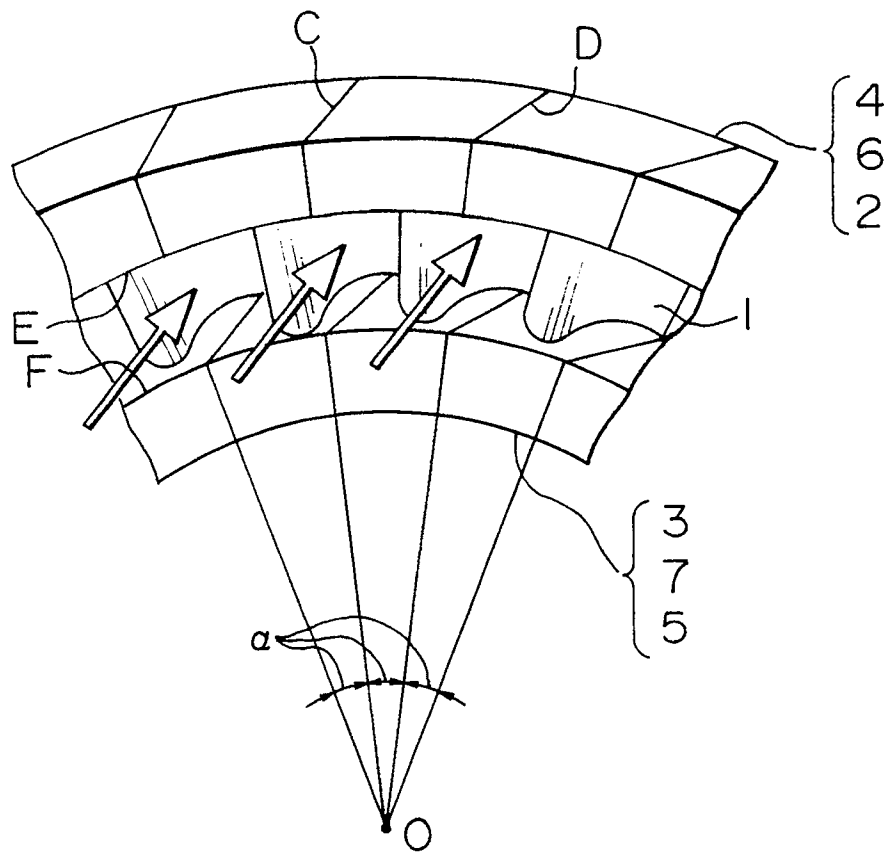


FIG. 3

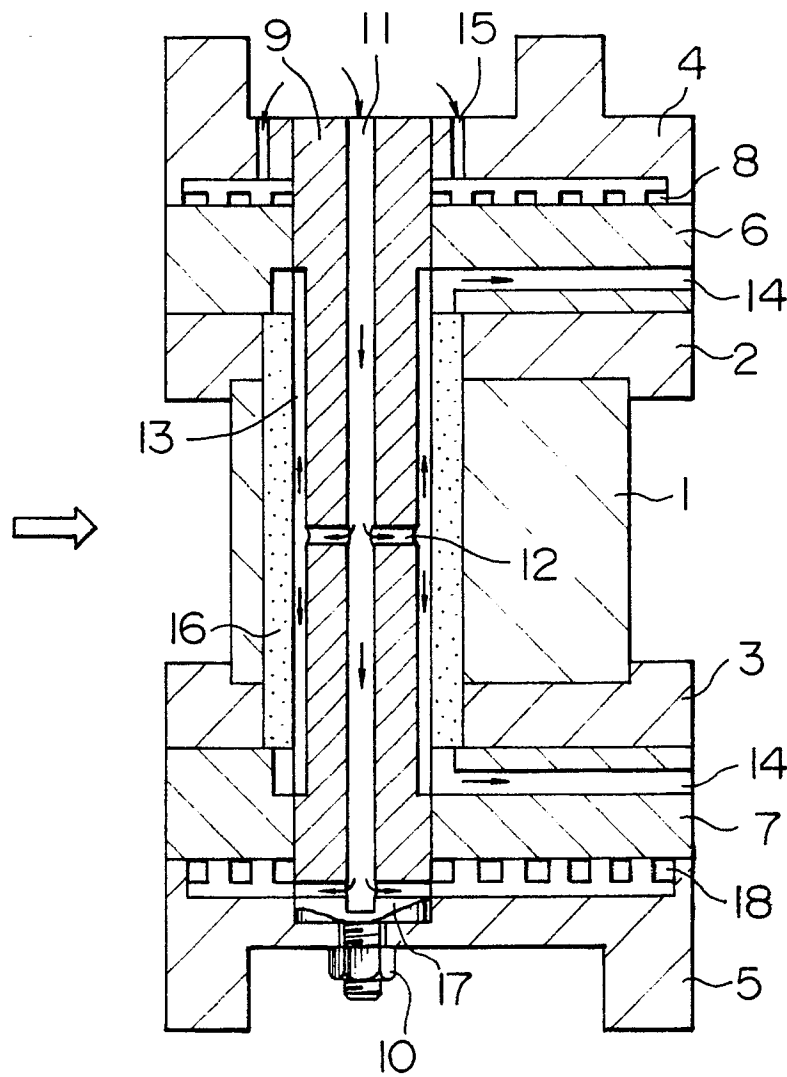


FIG. 6

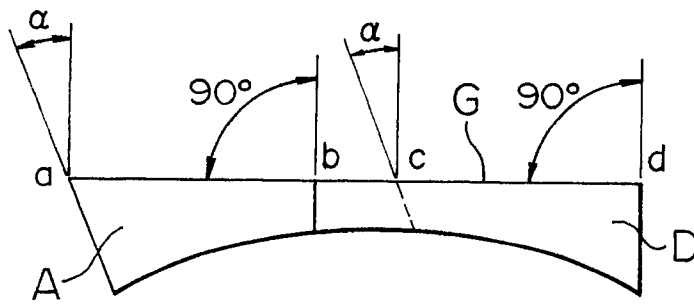


FIG. 7

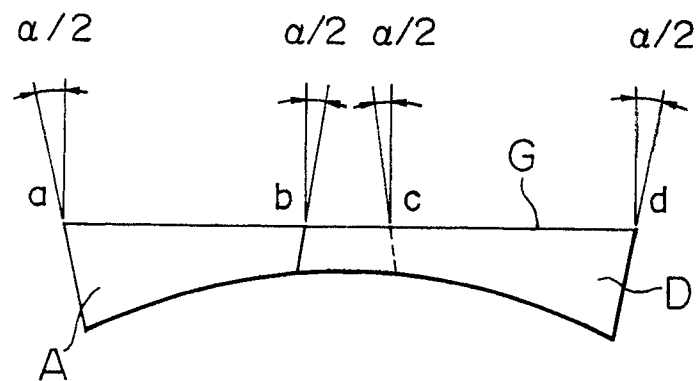


FIG. 8

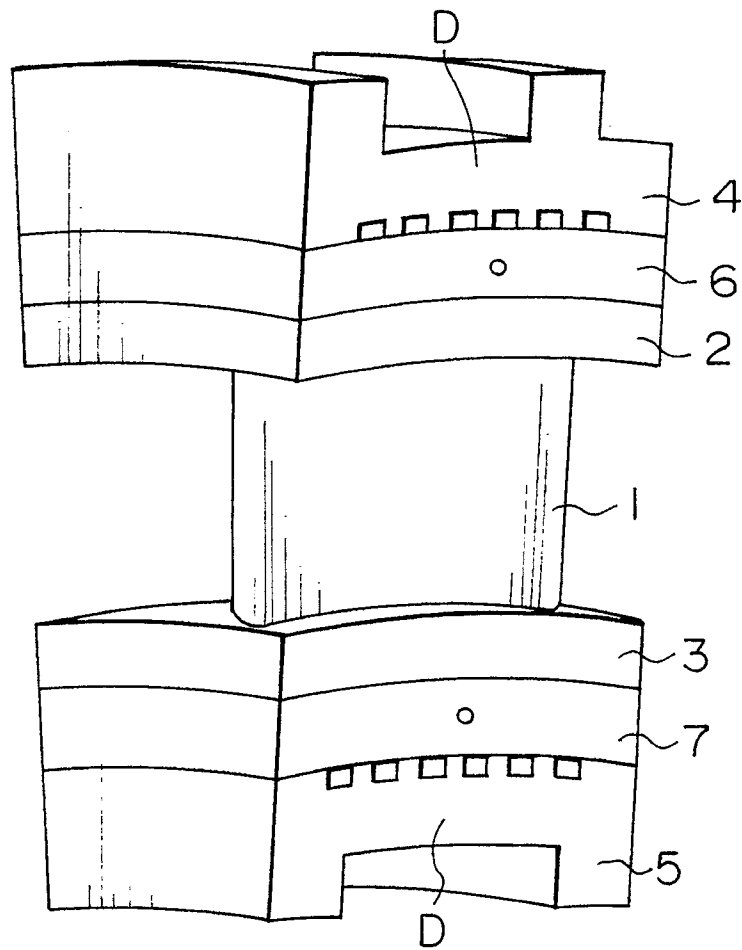
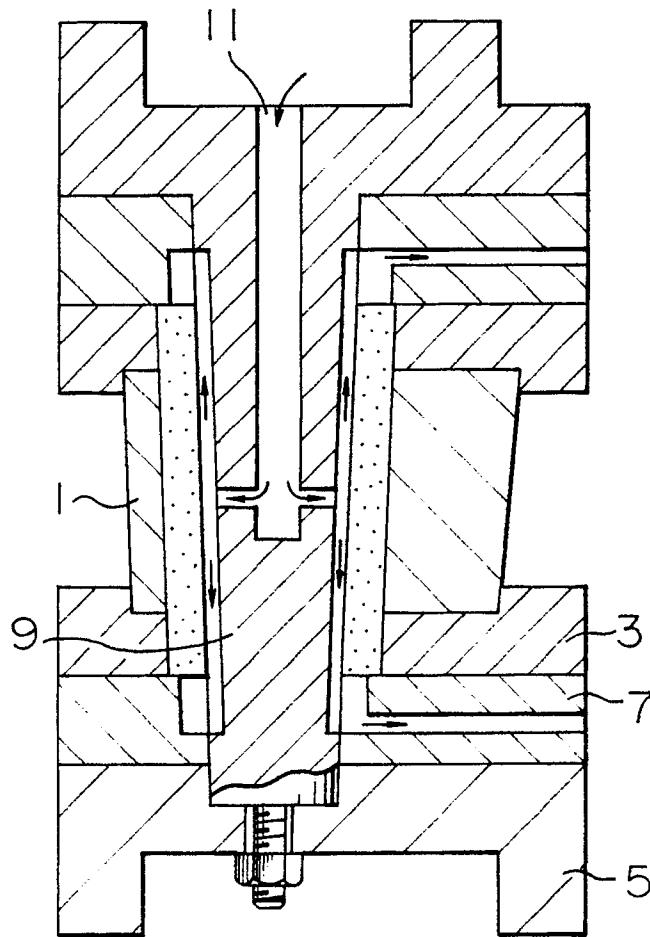


FIG. 9





**EUROPEAN SEARCH
REPORT**

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-D-5 520 06 (C.R. BOOHER) * column 2, line 58 - column 3, line 23 * * figures 2, 7 * - - -	1-6,8,7	F 01 D 5/30 F 01 D 9/04
Y	FR-E-5 742 6 (GEORGES BOLZIAN) * the whole document * - - -	1-6,8	
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Place of search		Date of completion of search	Examiner
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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	