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(54) **TURBINE ROTOR BLADE**

(57) It is possible to easily and rapidly slot a blade root of a final (last) turbine rotor blade into a blade groove on a turbine disc even when the plan-view shape of a shroud of the turbine rotor blade is complex. A turbine rotor blade (1) that is provided with a blade root (3) that is slotted into a blade groove formed on a circumferential portion of the turbine disc to hold the whole blade, a blade portion (4) that is exposed to high-temperature gas, a platform (5) that supports this blade portion (4), a shank (6) that connects the blade root (3) and the platform (5), and a shroud (7) that extends along the circumferential direction from the end of the blade portion (4) has a cut-out portion (8) cut out to a predetermined depth, either at the leading-edge or the trailing-edge of the blade root (3), along the lengthwise direction thereof from the end of the blade root (3) to an intermediate part of the shank (6).

FIG. 1A

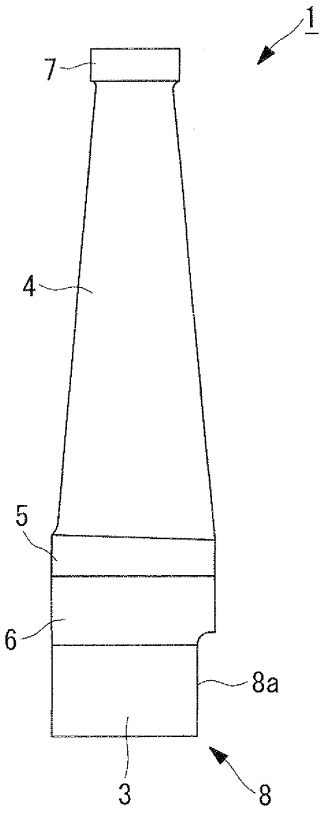

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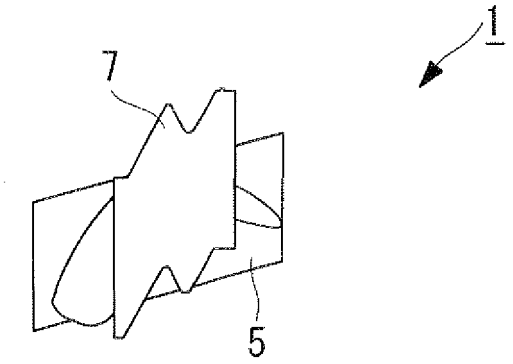
FIG. 1B



Description

Technical Field

[0001] The present invention relates to a turbine rotor blade applied to a gas turbine, a steam turbine, and the like.

Background Art

[0002] As a known turbine rotor blade applied to a gas turbine, a steam turbine, and the like, there is a turbine rotor blade that is provided with a blade root that is slotted into a blade groove formed on the circumferential portion of a turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends in the circumferential direction from the end of the blade portion (see, for example, Patent Citation 1).
Patent Citation 1: Japanese Unexamined Patent Application, Publication No. 2006-283681

Disclosure of Invention

[0003] In recent years, however, it has been required to reduce the leakage loss (leakage of gas) at the end of the blade portion to improve the turbine efficiency, and to make a blade frame of the blade portion smaller by reducing the vibration of the end of the blade portion. Therefore, the plan-view shape of a shroud has become complex, and with a method in which the blade roots of the turbine rotor blades are individually slotted into the blade grooves on the turbine disc, as in the art, there has been a problem in that it is difficult to slot the blade root of the final (last) turbine rotor blade into the blade groove on the turbine disc since the shroud of the final (last) turbine rotor blade interferes with the shrouds of the adjacent turbine rotor blades positioned at both sides when the blade root of the final (last) turbine rotor blade is slotted into the blade groove on the turbine disc.
There has been a further problem in that, if the length of the turbine rotor blade (blade height) is as short (low) as, for example, 200 mm or less (more specifically, if L (blade height) / D (chord length) is 1/3 or more), the blade root of the final (last) turbine rotor blade cannot be slotted into the blade groove on the turbine disc.

[0004] The present invention has been conceived in light of the circumstances described above, and an object thereof is to provide a turbine rotor blade with which the blade root of the final (last) turbine rotor blade can be slotted into the blade groove on the turbine disc easily and rapidly even if the plan-view shape of the shroud of the turbine rotor blade is complex.

[0005] In order to solve the problems described above, the present invention employs the following solutions.
A turbine rotor blade according to one aspect of the present invention is a turbine rotor blade provided with a blade root that is slotted into a blade groove formed on a circumferential portion of a turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends along the circumferential direction from an end of the blade portion; the turbine rotor blade has a cut-out portion that is cut out to a predetermined depth, either at the leading edge or the trailing edge of the blade root, along the lengthwise direction thereof, from the end of the blade root to an intermediate part of the shank.

[0006] According to the turbine rotor blade of one aspect of the present invention, the turbine rotor blade can be set between a normal blade and a normal blade that have been slotted into the blade grooves on the turbine disc to a predetermined depth (for example, 5 mm) merely by moving the end surface that is formed by the cut-out portion and that extends in the lengthwise direction in a plane that includes the end surfaces forming the circumferential portion of the turbine disc (in other words, moving radially inward from radially outward), when the blade root is slotted into the blade groove formed on the circumferential portion of the turbine disc to be assembled.

[0007] In other words, even if the plan-view shape of the shrouds of the turbine rotor blade and the normal blades are complex (regardless of the plan-view shapes of the shrouds), by using the turbine rotor blade according to the above-mentioned aspect at least as the final (last) blade to be slotted into the turbine disc, the blade root of the turbine rotor blade and the blade roots of the normal blades can be slotted (are capable of being slotted) into the blade grooves on the turbine disc easily and rapidly. The turbine rotor according to one aspect of the present invention is provided with the turbine rotor blade with which, when the blade root is slotted into the blade groove formed on the circumferential portion of the turbine disc to be assembled, the end surface that is formed by the cut-out portion and that extends in the lengthwise direction can be moved in the plane that includes the end surfaces forming the circumferential portion of the turbine disc (in other words, moved radially inward from radially outward); therefore, simplification of the procedure for assembling the turbine rotor blade and the normal blades on the turbine disc can be achieved, a reduction in the time required for assembly can be achieved, and a reduction in production costs can be achieved.

[0008] A method for constructing the turbine rotor according to the above-mentioned aspect is a method for constructing a turbine rotor by slotting at least one turbine rotor blade provided with a blade root that is slotted into a blade groove formed on a circumferential portion of a turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, a shroud that extends along the circumferential direction from the end of the blade por-

tion, and a cut-out portion that is cut out to a predetermined depth, either at the leading edge or the trailing edge of the blade root, along the lengthwise direction thereof from the end of the blade root to an intermediate part of the shank; and a plurality of normal blades provided with a blade root that is slotted into a blade groove formed on the circumferential portion of the turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends along the circumferential direction from the end of the blade portion, into the turbine disc to complete the turbine rotor; the method for constructing the turbine rotor includes a step of positioning the turbine rotor blade between the normal blades by moving the turbine rotor blade radially inward from radially outward, between the normal blades whose blade roots have been slotted into the blade grooves on the turbine disc to a predetermined depth, and thereafter, slotting the blade roots of the turbine rotor blade and the normal blades into the blade grooves on the turbine disc by moving the turbine rotor blade and the normal blades in the axis line direction of the turbine rotor.

[0009] With the method for constructing the turbine rotor according to the above-mentioned aspect, the turbine rotor blade can be set between the normal blade and the normal blade that have been slotted into the blade grooves on the turbine disc to a predetermined depth (for example, 5 mm) merely by moving the end surface that is formed by the cut-out portion and that extends in the lengthwise direction in the plane that includes the end surfaces forming the circumferential portion of the turbine disc (in other words, moving radially inward from radially outward), when the blade root is slotted into the blade groove formed on the circumferential portion of the turbine disc to be assembled.

In other words, even if the plan-view shapes of the shrouds of the turbine rotor blade and the normal blades are complex (regardless of the plan-view shapes of the shrouds), by using the turbine rotor blade according to the one aspect of the present invention at least as the final (last) blade to be slotted into the turbine disc, the blade root of the turbine rotor blade and the blade roots of the normal blades can be slotted (are capable of being slotted) into the blade grooves on the turbine disc easily and rapidly.

Accordingly, simplification of the procedure for assembling the turbine rotor blade and the normal blades on the turbine disc can be achieved, a reduction in the time required for assembly can be achieved, and a reduction in production costs can be achieved.

[0010] The turbine rotor blade according to the present invention affords an advantage in that it is possible to easily and rapidly slot the blade root of the final (last) turbine rotor blade into the blade groove on the turbine disc, even if the plan-view shape of the shroud of the turbine rotor blade is complex.

Brief Description of Drawings

[0011]

[FIG. 1A] FIG. 1A is a side view showing a turbine rotor blade according to an embodiment of the present invention.

[FIG. 1B] FIG. 1B is a plan view showing a turbine rotor blade according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a perspective view of the turbine rotor blade shown in FIGS. 1A and 1B, viewed from the front side.

[FIG. 3A] FIG. 3A is a side view showing a normal blade without a cut-out portion shown in FIGS. 1A, 1B, and 2.

[FIG. 3B] FIG. 3B is a plan view showing a normal blade without a cut-out portion shown in FIGS. 1A, 1B, and 2.

[FIG. 4] FIG. 4 is a perspective view of the normal blade shown in FIGS. 3A and 3B viewed from the front side.

[FIG. 5] FIG. 5 is a perspective view for explaining an assembly procedure onto the turbine disc.

[FIG. 6] FIG. 6 is a perspective view for explaining an assembly procedure onto the turbine disc.

Explanation of Reference:

[0012]

1	turbine rotor blade
2	turbine disc
2a	blade groove
3	blade root
4	blade portion
5	platform
6	shank
7	shroud
8	cut-out portion
11	normal blade
13	blade root
20	turbine rotor

Best Mode for Carrying Out the Invention

[0013] An embodiment of a turbine rotor blade according to the present invention will be described below with reference to FIGS. 1A, 1B, and 2.

FIG. 1A is a side view showing the turbine rotor blade according to this embodiment, and FIG. 1B is a plan view showing the turbine rotor blade according to this embodiment. FIG. 2 is a perspective view of the turbine rotor blade according to this embodiment viewed from the front side.

[0014] The turbine rotor blade 1 according to this embodiment is applied to a gas turbine provided with, for example, a compression unit (not shown) that compress-

es combustion air, a combustion unit (not shown) that combusts fuel by injecting the fuel into the high-pressure air sent from this compression unit, generating high-temperature combustion gas, and a turbine unit (not shown) that is located downstream of this combustion unit and is driven by the combustion gas discharged from the combustion unit.

[0015] As shown in FIGS. 1A, 1B, and 2, the turbine rotor blade 1 is provided with a Christmas tree-shaped blade root (bottom) 3 that is slotted into a blade groove 2a (see FIGS. 5 and 6) formed on the circumferential portion of a turbine disc 2 (see FIGS. 5 and 6) to hold (support) the whole body of the turbine rotor blade 1, a blade portion 4 that is exposed to high-temperature gas, a platform 5 that supports this blade portion 4, a shank 6 that connects the blade root 3 and the platform 5, and a shroud 7 that extends along the circumferential direction from the end (tip) of the blade portion 4 and that prevents resonance of the turbine rotor blade 1 and reduces the leakage loss (leakage of gas) at the end of the blade portion 4.

[0016] As shown in FIGS. 1A and 2, the turbine rotor blade 1 according to this embodiment has, either at the leading edge or the trailing edge of the blade root 3, a cut-out portion 8 that is cut out uniformly (to a predetermined depth (for example, 5 mm)) along the lengthwise direction (vertical direction in FIGS. 1A and 2) of the turbine rotor blade 1 from the end (lower end) of the blade root 3 to an intermediate part of the shank 6. An end surface 8a that is formed by this cut-out portion 8 and extends in the lengthwise direction (vertical direction in FIGS. 1A and 2) is formed so as to become substantially parallel to end surfaces 2b formed on the circumferential portion of the turbine disc 2 when the turbine rotor blade 1 is assembled with the turbine disc 2; and the end surface 8a extends to the intermediate part of the shank 6.

[0017] In other words, the cut-out portion 8 of the turbine rotor blade 1 is formed so that, in a state where the blade root 13 of a turbine blade 11 without the cut-out portion 8 (hereinafter referred to as "normal blade"), such as those shown in FIGS. 3A, 3B, and 4, is slotted into the blade groove 2a on the turbine disc 2 to a predetermined depth (for example, 5 mm), as shown in FIG. 5, the turbine rotor blade 1 can be set between a normal blade 11 and a normal blade 11 by moving the end surface 8a that is formed by the cut-out portion 8 and that extends in the lengthwise direction in a plane that includes the end surfaces 2b forming the circumferential portion of the turbine disc 2.

Then, as shown in FIG. 6, after the turbine rotor blade 1 is set between the normal blade 11 and the normal blade 11, the turbine blade 1 and the normal blades 11 are moved, as a whole, along the axial direction of the turbine disc 2, thereby slotting all blade roots 3 and 13 of the turbine blade 1 and the normal blades 11 into the blade grooves 2a formed on the circumferential portion of the turbine disc 2.

In FIGS. 3A, 3B, and 4, reference signs 4, 5, 6, and 7 are a blade portion, a platform, a shank, and a shroud, respectively, and because descriptions thereof have been described using FIGS. 1A, 1B, and 2, the descriptions thereof will be omitted here.

The reference sign 20 in FIGS. 5 and 6 indicates a turbine rotor that is provided with at least one turbine rotor blade 1, a plurality of normal blades 11, and the turbine disc 2.

[0018] The thus-configured turbine rotor blade 1 can be set between the normal blade 11 and the normal blade 11 that have been slotted into the blade grooves 2a on the turbine disc 2 to a predetermined depth (for example, 5 mm) merely by moving the end surface 8a that is formed by the cut-out portion 8 and that extends in the lengthwise direction in the plane that includes the end surfaces 2b forming the circumferential portion of the turbine disc 2 (in other words, moving radially inward from radially outward), when the blade root 3 is slotted into the blade groove 2a formed on the circumferential portion of the turbine disc 2 to be assembled.

In other words, even if the plan-view shapes of the shrouds 7 of the turbine rotor blade 1 and the normal blades 11 are complex (regardless of the plan-view shapes), by using the turbine rotor blade 1 according to this embodiment at least as the final (last) blade to be slotted into the turbine disc 2, the blade root 3 of the turbine rotor blade 1 and the blade roots 13 of the normal blades 11 can be slotted (are capable of being slotted) into the blade grooves 2a on the turbine disc 2 easily and rapidly.

[0019] According to the turbine rotor 20 of this embodiment, the turbine rotor 20 is provided with the turbine rotor blade 1 with which, when the blade roots 3 and 13 are slotted into the blade grooves 2a formed on the circumferential portion of the turbine disc 2 to be assembled, the end surface 8a that is formed by the cut-out portion 8 of the turbine rotor blade 1 and extends in the lengthwise direction can be moved in the plane that includes the end surfaces 2b forming the circumferential portion of the turbine disc 2 (in other words, moved radially inward from radially outward); therefore, simplification of the procedure for assembling the turbine rotor blade 1 and the normal blades 11 on the turbine disc 2 can be achieved, a reduction in the time required for assembly can be achieved, and a reduction in production costs can be achieved.

[0020] The present invention is not only applicable to a gas turbine, but may also be applied to a steam turbine or a fluid rotary machine having other similar configurations.

The present invention is not limited to the embodiments described above; various modifications and alterations are permissible as required, so long as they do not depart from the technical idea of the present invention.

Claims

1. A turbine rotor blade provided with a blade root that

is slotted into a blade groove formed on a circumferential portion of a turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends along the circumferential direction from an end of the blade portion, the turbine rotor blade comprising:

a cut-out portion that is cut out to a predetermined depth, either at the leading-edge or the trailing-edge of the blade root, along the lengthwise direction thereof, from the end of the blade root to an intermediate part of the shank.

2. A turbine rotor comprising:

at least one turbine rotor blade according to Claim 1;
a plurality of normal blades provided with a blade root that is slotted into a blade groove formed on the circumferential portion of the turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends along the circumferential direction from the end of the blade portion; and
the turbine disc.

3. A method for constructing a turbine rotor by slotting:

at least one turbine rotor blade provided with a blade root that is slotted into a blade groove formed on a circumferential portion of a turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, a shroud that extends along the circumferential direction from the end of the blade portion, and a cut-out portion that is cut out to a predetermined depth, either at the leading edge or the trailing edge of the blade root, along the lengthwise direction thereof from the end of the blade root to an intermediate part of the shank; and
a plurality of normal blades provided with a blade root that is slotted into a blade groove formed on the circumferential portion of the turbine disc to hold the whole blade, a blade portion that is exposed to high-temperature gas, a platform that supports this blade portion, a shank that connects the blade root and the platform, and a shroud that extends along the circumferential direction from the end of the blade portion; into the turbine disc to complete the turbine rotor, the method for constructing the turbine rotor comprising,

a step of positioning the turbine rotor blade between the normal blades by moving the turbine rotor blade radially inward from radially outward, between the normal blades whose blade roots have been slotted into the blade grooves on the turbine disc to a predetermined depth, and thereafter, slotting the blade roots of the turbine rotor blade and the normal blades into the blade grooves on the turbine disc by moving the turbine rotor blade and the normal blades in the axis line direction of the turbine rotor.

FIG. 1A

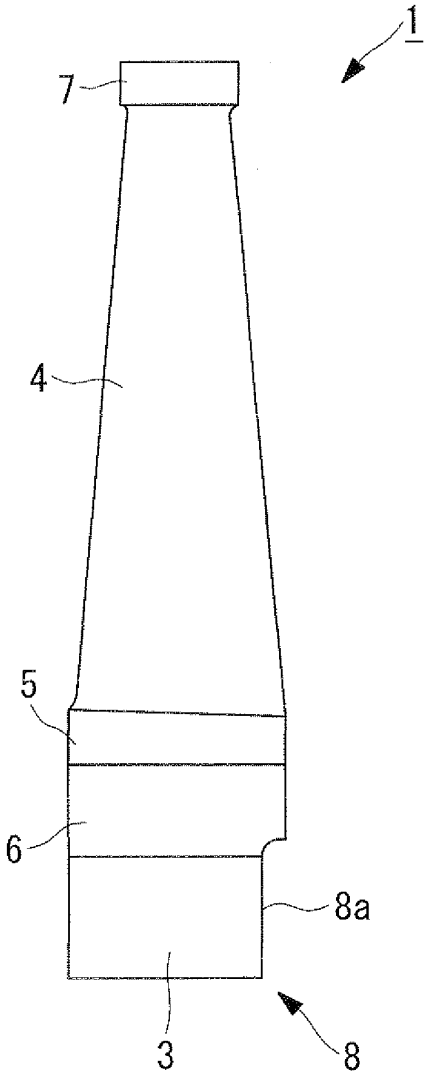


FIG. 1B

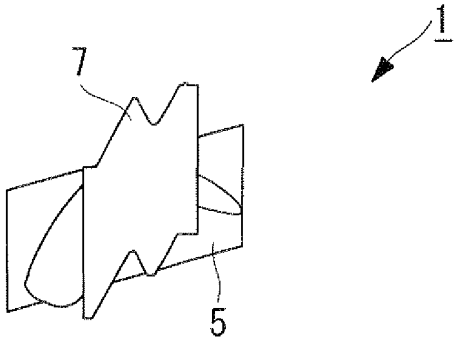


FIG. 2

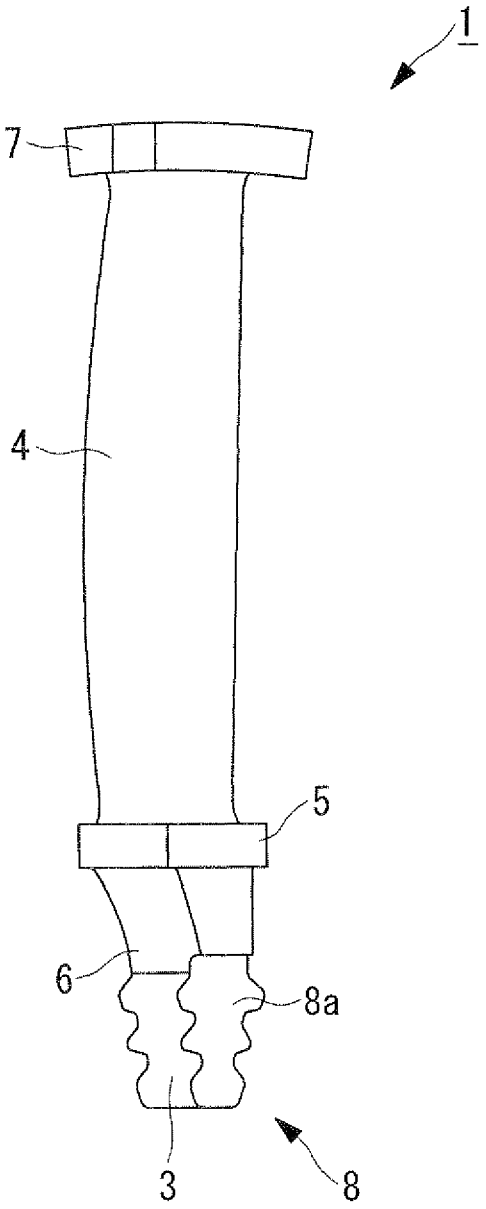


FIG. 3A

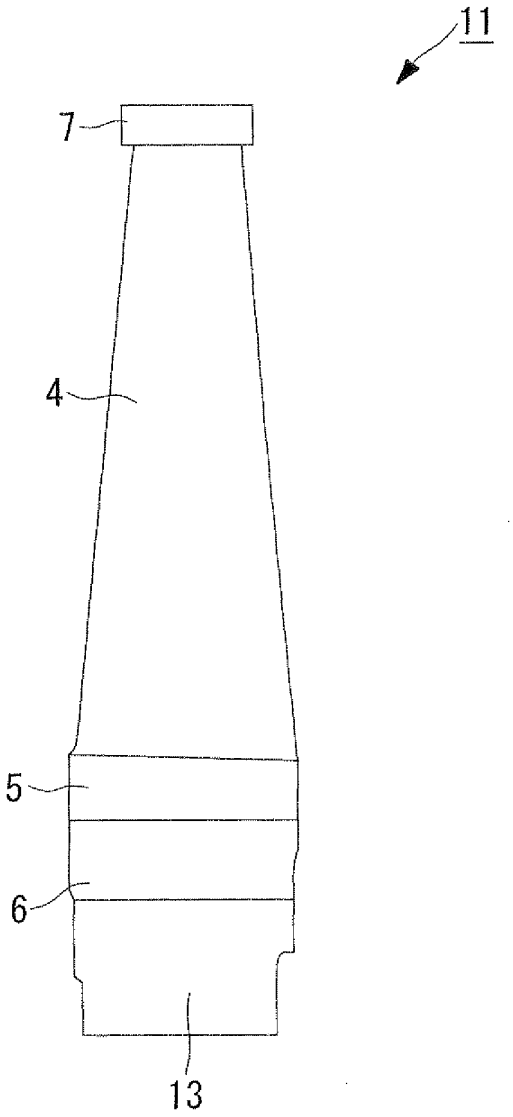


FIG. 3B

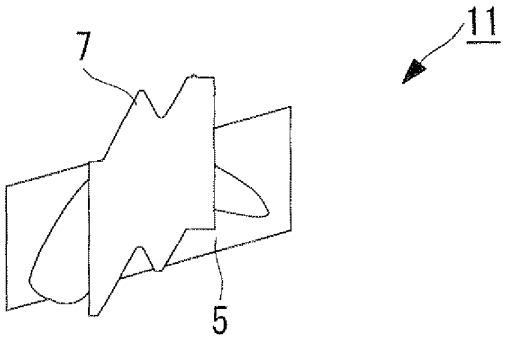


FIG. 4

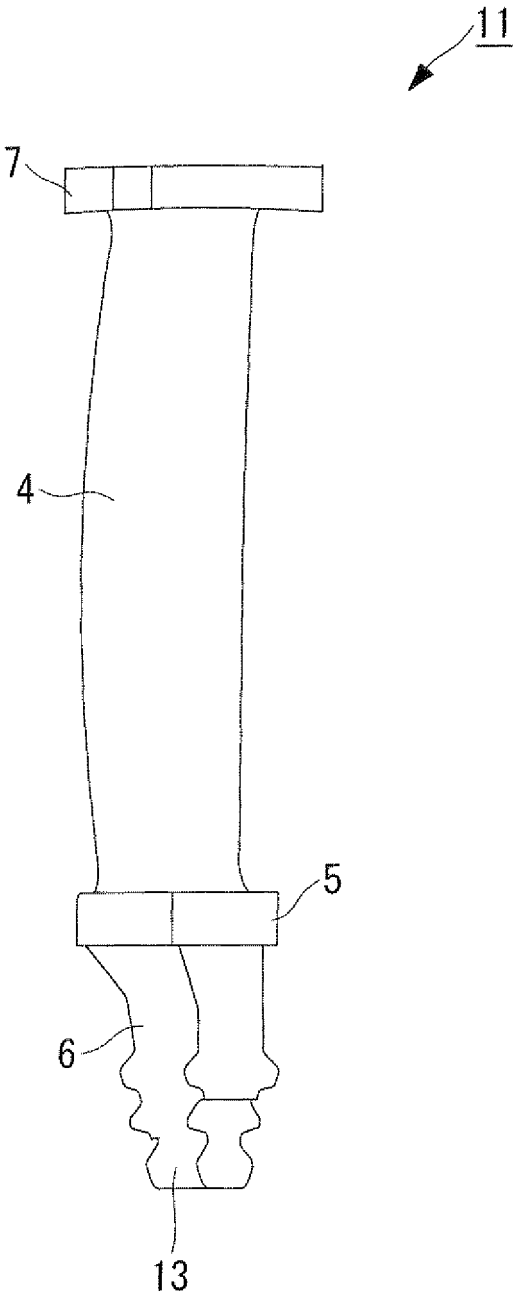


FIG. 5

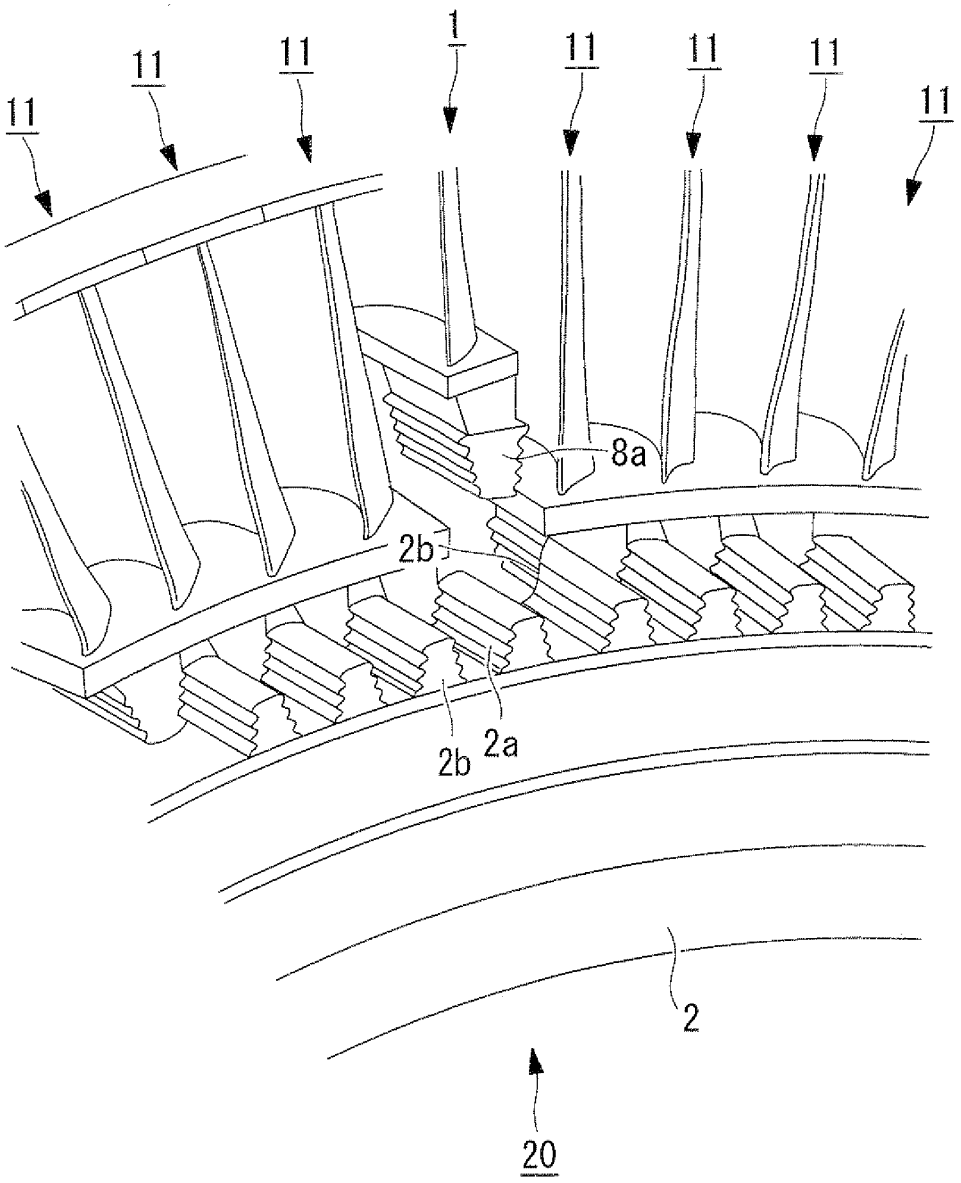
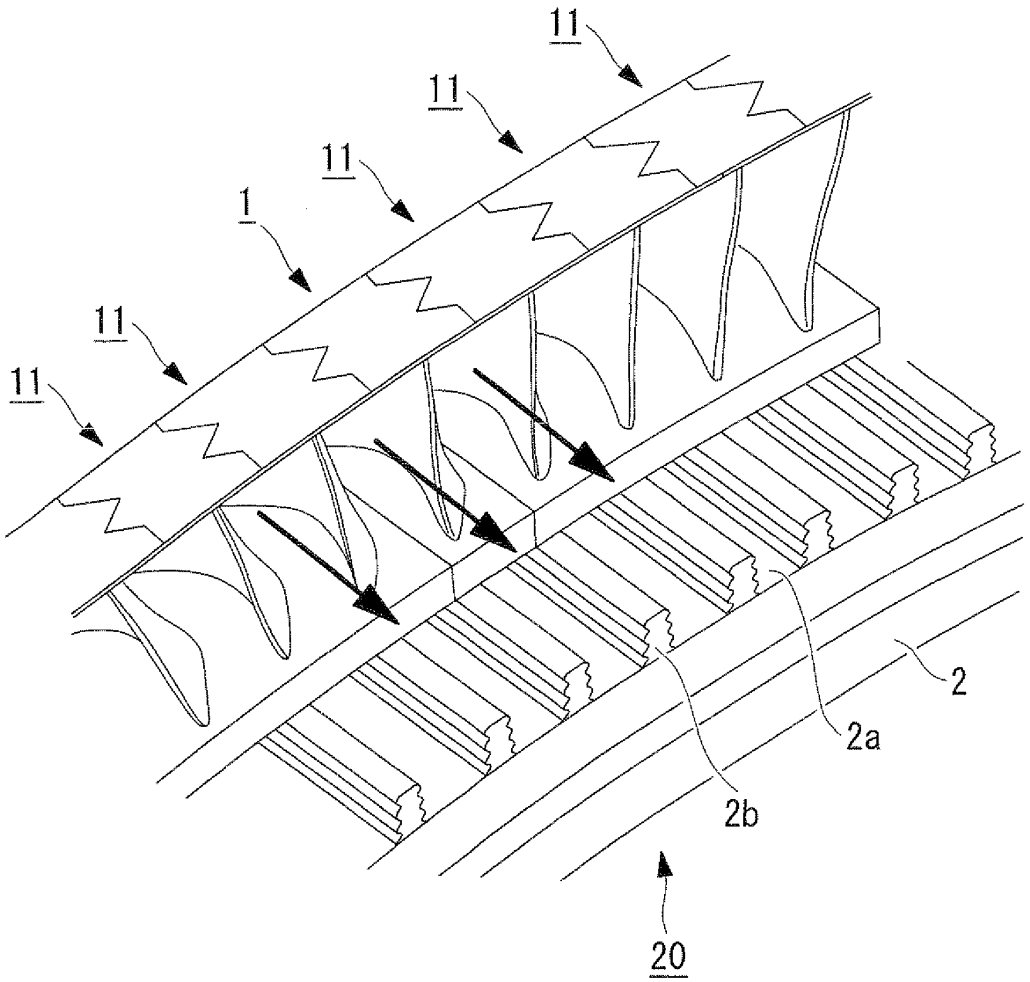


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/050160

A. CLASSIFICATION OF SUBJECT MATTER
F01D5/30(2006.01)i

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)
F01D5/30, F01D5/32, F04D29/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 48-37530 A (Westinghouse Electric Corp.), 02 June, 1973 (02.06.73), Full text; all drawings & US 3748060 A	1 2-3
Y	JP 11-36806 A (Honda Motor Co., Ltd.), 09 February, 1999 (09.02.99), Par. Nos. [0003] to [0004], [0010] to [0011]; Figs. 1 to 2, 11 to 12 & US 6061886 A	2-3
Y	JP 55-78103 A (Hitachi, Ltd.), 12 June, 1980 (12.06.80), Page 2, lower left column, line 1 to page 3, upper right column, line 16; Figs. 4 to 9 (Family: none)	3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 March, 2009 (04.03.09)	17 March, 2009 (17.03.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006283681 A **[0002]**