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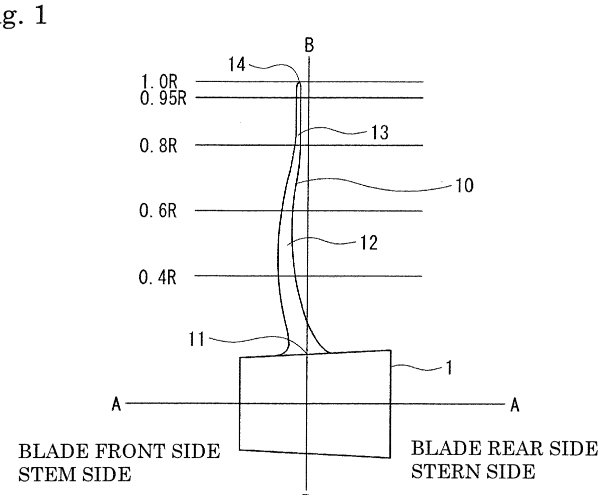
(54) ## MARINE PROPELLER

(57) Provided is a marine propeller that strikes a favorable balance between suppressing cavitation at a blade tip and avoiding stress concentration in a propeller blade. Two inflection points are provided in a rake distribution of a propeller blade (10) of a marine propeller, where a portion from a blade root section (11) to the first inflection point (12) has a backward rake and a portion from the first inflection point (12) to the second inflection point (13) has a forward rake. The portion from the second inflection point (13) to a blade tip (14) has zero rake so as to be orthogonal to the propeller shaft line A-A. The first inflection point (12) is preferably at a position that is 40 to 60% of the propeller radius, and the second inflection point (13) is preferably at a position that is 80 to 95% of the propeller radius.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a marine propeller, more specifically for a rake distribution of a marine propeller.

Background Art

[0002] Conventionally, various rake distributions of a propeller blade are proposed for a profile of a marine propeller. For example, a conventional propeller blade 100 for a marine propeller illustrated in Fig. 4 has a backward rake from a blade root section 101 to an inflection point 102 and a forward rake from the inflection point 102 to a blade tip 104, where the backward rake changes to the forward rake at the inflection point 102. This rake distribution is employed to relieve stress concentration on the blade surface, regarding the strength of the propeller.

[0003] But in the case of the propeller blade 100, as illustrated in Fig. 4, the density of circulation Γ at the blade tip 104 increases, and the induced velocity at this portion increases. As a result, negative pressure is likely to occur on the blade front side. The increase in the negative pressure is likely to produce cavitation on the blade front side, which is disadvantageous.

[0004] Contrarily, Patent Literature 1 and Patent Literature 2 disclose inventions to suppress the flow around the blade tip by bending the blade tip to provide a backward rake. Such technique suppresses the negative pressure occurring around the blade front side and thereby suppresses cavitation.

[0005] Further, Patent Literature 3 discloses an invention in which the entire rake distribution is formed to have a reversed S-shape to relieve overstress in a blade particularly during reverse rotation. Fig. 5 illustrates a propeller blade 200 having a rake distribution of a reverse S-shape similar to the propeller disclosed in Patent Literature 3. The propeller blade 200 has a backward rake in a portion from a blade root section 201 to a first inflection point 202, a forward rake in a portion from the first inflection point 202 to a second inflection point 203, and a backward rake in a portion from the second inflection point 203 to a blade tip 204. This configuration is also expected to provide an effect of suppressing cavitation at the blade tip 204, although not disclosed in Patent Literature 3.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent No. 3670811
Patent Literature 2: Japanese Patent No. 3416006
Patent Literature 3: Japanese Patent No. 2883006

Summary of Invention

Technical Problem

[0007] Techniques of bending only a blade tip to provide a backward rake at the blade tip as in the invention disclosed in Patent Literature 1 and Patent Literature 2 however have disadvantage of stress concentration at a root side.

[0008] Further, when a reverse S-shaped rake distribution is provided as in the invention disclosed in Patent Literature 3, stress concentration may occur at a portion in the middle of the first inflection point 202 and the second inflection point 203.

[0009] Such problem of stress concentration causes the rise in cost due to increased blade thickness and deterioration in propeller performance.

[0010] The present invention is directed to solve the conventional problem described above. The object of the present invention is to provide a marine propeller that strikes a favorable balance between suppressing cavitation at a blade tip and avoiding stress concentration in a propeller blade.

Solution to Problem

[0011] In order to achieve the above-described problem, a marine propeller according to the present invention includes two inflection points in a rake distribution of a propeller blade, wherein a portion from a blade root section to a first inflection point has a backward rake, a portion from the first inflection point to a second inflection point has a forward rake, and a portion from the second inflection point to a blade tip has zero rake so as to be orthogonal to a propeller shaft line.

[0012] Further, it is preferable that the first inflection point is at a position that is 40 to 60% of a propeller radius and the second inflection point is at a position that is 80 to 95% of a propeller radius.

[0013] Further, it is preferable that a portion from the second inflection point to the blade tip is located in a rear side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

[0014] Further, it is preferable that a portion from the second inflection point to the blade tip is located on a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

[0015] Further, it is preferable that a portion from the second inflection point to the blade tip is located in a front side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

Advantageous Effects of Invention

[0016] A marine propeller according to the present invention includes two inflection points in a rake distribution of the propeller blade where a portion from a blade root section to a first inflection point has a backward rake and a portion from the first inflection point to a second inflection point has a forward rake. Therefore, the rake is distributed well-balanced along the propeller shaft, suppressing overstress in the blade.

[0017] Further, the portion from the second inflection point to a blade tip has zero rake so as to be orthogonal to the propeller shaft line. This configuration provides moderate increase in the density of circulation Γ around the blade tip compared with a configuration having a forward rake in the portion from the second inflection point to the blade tip. Thus, occurring of large negative pressure around the blade tip is prevented, and thereby cavitation around the blade tip can be suppressed. Moreover, compared with a configuration having a backward rake in the portion from the second inflection point to the blade tip, excessive stress concentration caused by local bending in the portion in the middle of the first inflection point and the second inflection point can be relieved.

[0018] Further, the marine propeller according to the present invention has the first inflection point at a position that is 40 to 60% of the propeller radius and the second inflection point at a position that is 80 to 95% of the propeller radius, which are provided well-balanced along the radial direction of the propeller. This configuration can cancel the bending moment produced by the centrifugal force and the overstress in the blade produced during forward and reverse rotation of the propeller.

[0019] Further, the marine propeller according to the present invention is configured that the portion from the second inflection point to the blade tip is located in the rear side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0020] Further, another marine propeller according to the present invention is configured that the portion from the second inflection point to the blade tip is located on a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0021] Further, another marine propeller according to the present invention is configured that the portion from the second inflection point to the blade tip is located in the forward side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0022] As described above, the present invention provides the marine propeller that can strike a favorable balance between suppressing cavitation at the blade tip and avoiding stress concentration in a propeller blade.

Brief Description of Drawings

[0023]

Fig. 1 illustrates a profile of a rake distribution of a marine propeller according to a first embodiment of the present invention.

Fig. 2 illustrates a profile of a rake distribution of a marine propeller according to a second embodiment of the present invention.

Fig. 3 illustrates a profile of a rake distribution of a marine propeller according to a third embodiment of the present invention.

Fig. 4 illustrates a profile of a rake distribution of a conventional marine propeller.

Fig. 5 illustrates a profile of a rake distribution of a conventional marine propeller.

Description of Embodiments

[0024] A marine propeller according to a first embodiment of the present invention will be described referring to Fig. 1. Fig. 1 illustrates a profile of a rake distribution of the marine propeller according to the first embodiment. In Fig. 1, the line A-A is a propeller shaft line and the line B-B is a blade reference line which passes a blade root section and is orthogonal to the propeller shaft line A-A. Reference sign R is used to express the location (distance from the propeller shaft line to a blade tip) along the radial direction of the propeller expressed in ratio. A second embodiment and a third embodiment are illustrated in similar manner.

[0025] The propeller blade 10 of a marine propeller according to the first embodiment has a blade root section 11 attached to a propeller boss 1. Two inflection points 12 and 13 are provided in the rake distribution of the propeller blade 10.

[0026] A portion from the blade root section 11 to the first inflection point 12 has a backward rake. The rake changes direction at the first inflection point 12, and a portion from the first inflection point 12 to the second inflection point 13 has a forward rake. The rake then changes direction at the second inflection point 13, and a portion from the second inflection point 13 to a blade tip 14 has zero rake so as to be orthogonal to the propeller shaft line A-A.

[0027] The first inflection point 12 is preferably at a position that is 40 to 60% of the propeller radius. The second inflection point 13 is preferably at a position that is 80 to 95% of the propeller radius.

[0028] Further, the portion from the second inflection point 13 to the blade tip 14 is located in the rear side (stern side) of a blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A.

[0029] The marine propeller according to the first embodiment includes the two inflection points 12 and 13 in the rake distribution of the propeller blade 10, where the portion from the blade root section 11 to the first inflection point 12 has a backward rake and the portion from the first inflection point 12 to the second inflection point 13 has a forward rake. Therefore, the rake is distributed well-balanced along the propeller shaft, suppressing overstress in the blade.

[0030] Further, the portion from the second inflection point 13 to the blade tip 14 has zero rake so as to be orthogonal to the propeller shaft line A-A. This configuration provides moderate increase in the density of circulation Γ around the blade tip 14 compared with a configuration having a forward rake in the portion from the second inflection point 13 to the blade tip 14. Thus, occurring of large negative pressure around the blade tip 14 is prevented, and thereby cavitation around the blade tip 14 can be suppressed. Moreover, compared with a configuration having a backward rake in the portion from the second inflection point 13 to the blade tip 14, excessive stress concentration caused by local bending in the portion in the middle of the first inflection point 12 and the second inflection point 13 can be relieved.

[0031] Further, the first inflection point 12 is provided at a position that is 40 to 60% of the propeller radius and the second inflection point 13 is provided at a position that is 80 to 95% of the propeller radius, which are provided well-balanced along the radial direction of the propeller. This configuration can cancel the bending moment produced by the centrifugal force and the overstress in the blade produced during forward and reverse rotation of the propeller.

[0032] Further, the portion from the second inflection point 13 to the blade tip 14 is located in the rear side of the blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0033] Now, a marine propeller according to a second embodiment of the present invention will be described referring to Fig. 2. Fig. 2 illustrates a profile of a rake distribution of the marine propeller according to the second embodiment of the present invention.

[0034] A propeller blade 20 of a marine propeller according to the second embodiment has a blade root section 21 attached to a propeller boss 1. Two inflection points 22 and 23 are provided in the rake distribution of the propeller blade 20.

[0035] A portion from the blade root section 21 to the first inflection point 22 has a backward rake. The rake changes direction at the first inflection point 22, and a portion from the first inflection point 22 to the second inflection point 23 has a forward rake. The rake then changes direction at the second inflection point 23, and a portion from the second inflection point 23 to a blade tip 24 has zero rake so as to be orthogonal to a propeller shaft line A-A.

[0036] The first inflection point 22 is preferably at a position that is 40 to 60% of the propeller radius. The second inflection point 23 is preferably at a position that is 80 to 95% of the propeller radius.

[0037] Further, the portion from the second inflection point 23 to the blade tip 24 is located on a blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A.

[0038] The marine propeller according to the second embodiment includes the two inflection points 22 and 23 in the rake distribution of the propeller blade 20 where the portion from the blade root section 21 to the first inflection point 22 has a backward rake and the portion from the first inflection point 22 to the second inflection point 23 has a forward rake. Therefore, the rake is distributed well-balanced along the propeller shaft, suppressing overstress in the blade.

[0039] Further, the portion from the second inflection point 23 to the blade tip 24 has zero rake so as to be orthogonal to the propeller shaft line A-A. This configuration provides moderate increase in the density of circulation Γ around the blade tip 24 compared with a configuration having a forward rake in the portion from the second inflection point 23 to the blade tip 24. Thus, occurring of large negative pressure around the blade tip 24 is prevented, and thereby cavitation around the blade tip 24 can be suppressed. Moreover, compared with a configuration having a backward rake in the portion from the second inflection point 23 to the blade tip 24, excessive stress concentration caused by local bending in the portion in the middle of the first inflection point 22 and the second inflection point 23 can be relieved.

[0040] Further, the first inflection point 22 is provided at a position that is 40 to 60% of the propeller radius and the second inflection point 23 is provided at a position that is 80 to 95% of the propeller radius, which are provided well-balanced along the radial direction of the propeller. This configuration can cancel the bending moment produced by the centrifugal force and the overstress in the blade produced during forward and reverse rotation of the propeller.

[0041] Further, the portion from the second inflection point 23 to the blade tip 24 is located on the blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0042] Now, a marine propeller according to a third embodiment of the present invention will be described referring to Fig. 3. Fig. 3 illustrates a profile of a rake distribution of the marine propeller according to the third embodiment of the present invention.

[0043] A propeller blade 30 of a marine propeller according to the third embodiment has a blade root section 31 attached to a propeller boss 1. Two inflection points 32 and 33 are provided in the rake distribution of the propeller blade 30.

[0044] A portion from the blade root section 31 to the first inflection point 32 has a backward rake. The rake changes direction at the first inflection point 32, and a portion from the first inflection point 32 to the second inflection point 33 has a forward rake. The rake then changes direction at the second inflection point 33, and a portion from the second inflection point 33 to a blade tip 34 has zero rake so as to be orthogonal to a propeller shaft line A-A.

[0045] The first inflection point 32 is preferably at a position that is 40 to 60% of the propeller radius. The second inflection point 33 is preferably at a position that is 80 to 95% of the propeller radius.

[0046] Further, the portion from the second inflection point 33 to the blade tip 34 is located in the front side (stem side) of a blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A.

[0047] The marine propeller according to the third embodiment includes the two inflection points 32 and 33 in the rake distribution of the propeller blade 30 where the portion from the blade root section 31 to the first inflection point 32 has a backward rake and the portion from the first inflection point 32 to the second inflection point 33 has a forward rake. Therefore, the rake is distributed well-balanced along the propeller shaft, suppressing overstress in the blade.

[0048] Further, the portion from the second inflection point 33 to the blade tip 34 has zero rake so as to be orthogonal to the propeller shaft line A-A. This configuration provides moderate increase in the density of circulation Γ around the blade tip 34 compared with a configuration having a forward rake in the portion from the second inflection point 33 to the blade tip 34. Thus, occurring of large negative pressure around the blade tip 34 is prevented, and thereby cavitation around the blade tip 34 can be suppressed. Moreover, compared with a configuration having a backward rake in the portion from the second inflection point 33 to the blade tip 34, excessive stress concentration caused by local bending in the portion in the middle of the first inflection point 32 and the second inflection point 33 can be relieved.

[0049] Further, the first inflection point 32 is provided at a position that is 40 to 60% of the propeller radius and the second inflection point 33 is provided at a position that is 80 to 95% of the propeller radius, which are provided well-balanced along the radial direction of the propeller. This configuration can cancel the bending moment produced by the centrifugal force and the overstress in the blade produced during forward and reverse rotation of the propeller.

[0050] Further, the portion from the second inflection point 33 to the blade tip 34 is located in the front side of a blade reference line B-B which passes the blade root section and is orthogonal to the propeller shaft line A-A. This provides a preferable rake distribution for certain conditions regarding the skew angle and the pitch of the propeller.

[0051] As described above, according to the embodiment, the marine propeller configured to strike a favorable balance between suppressing cavitation at a blade tip and avoiding stress concentration in a propeller blade can be provided.

Reference Signs List

[0052]

1	propeller boss
10	propeller blade
11	blade root section
12	first inflection point
13	second inflection point
14	blade tip
20	propeller blade
21	blade root section
22	first inflection point
23	second inflection point
24	blade tip
30	propeller blade
31	blade root section
32	first inflection point
33	second inflection point
34	blade tip
100	propeller blade
101	blade root section
102	inflection point
104	blade tip
200	propeller blade
201	blade root section
202	first inflection point
203	second inflection point
204	blade tip

Claims

1. A marine propeller, comprising:

    two inflection points in a rake distribution of a propeller blade,
    wherein a portion from a blade root section to a first inflection point has a backward rake,
    a portion from the first inflection point to a second inflection point has a forward rake, and
    a portion from the second inflection point to a blade tip has zero rake so as to be orthogonal to a propeller shaft line.

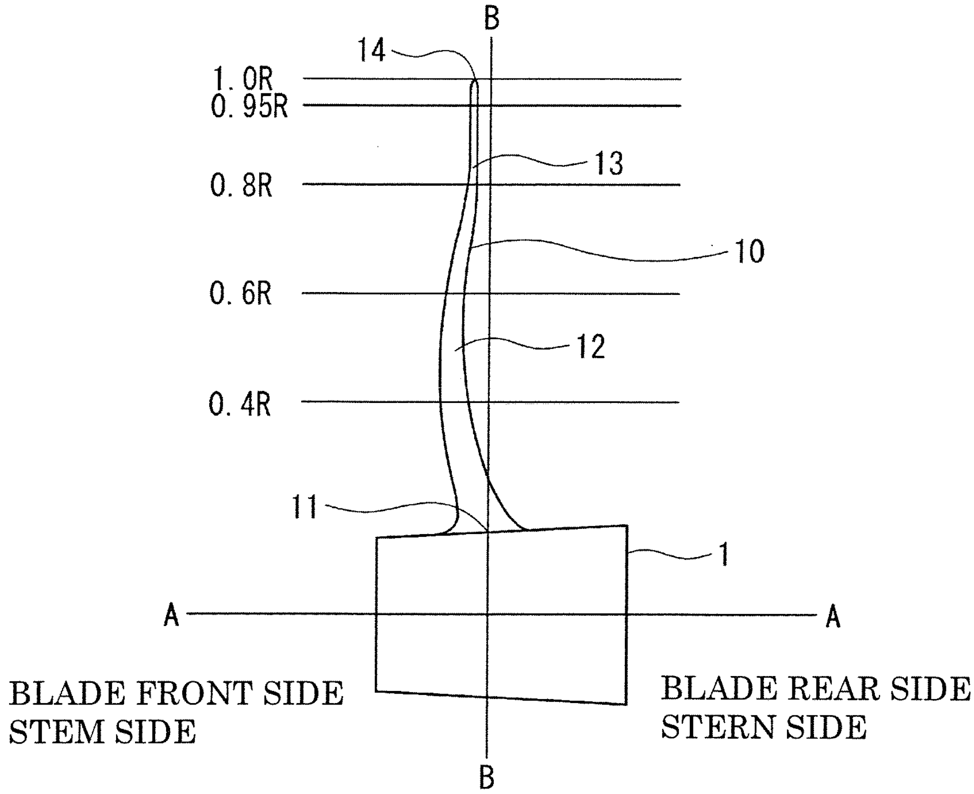
2. The marine propeller according to claim 1, wherein the first inflection point is at a position that is 40 to 60% of a propeller radius and the second inflection point is at a position that is 80 to 95% of a propeller radius.

3. The marine propeller according to claim 1 or 2, wherein a portion from the second inflection point to the blade tip is located in a rear side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

4. The marine propeller according to claim 1 or 2, wherein a portion from the second inflection point to the blade tip is located on a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

5. The marine propeller according to claim 1 or 2, wherein a portion from the second inflection point to the blade tip is located in a front side of a blade reference line which passes the blade root section and is orthogonal to the propeller shaft line.

Fig. 1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12
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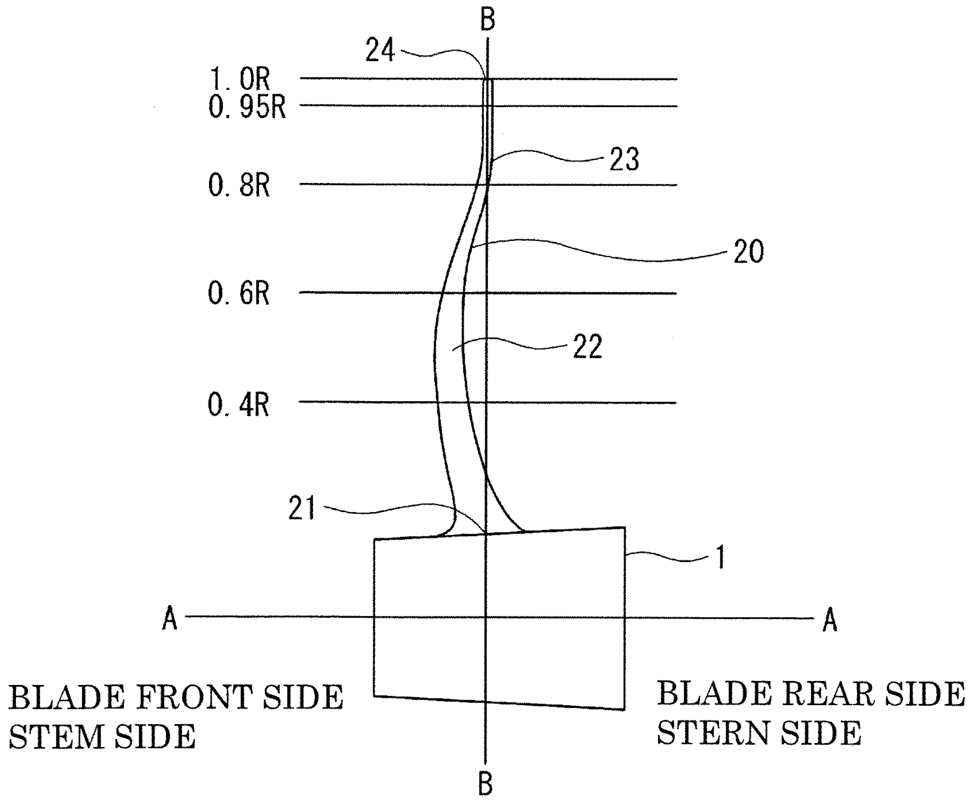
STEM SIDE
BLADE REAR SIDE
STERN SIDE
B

Fig. 2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A
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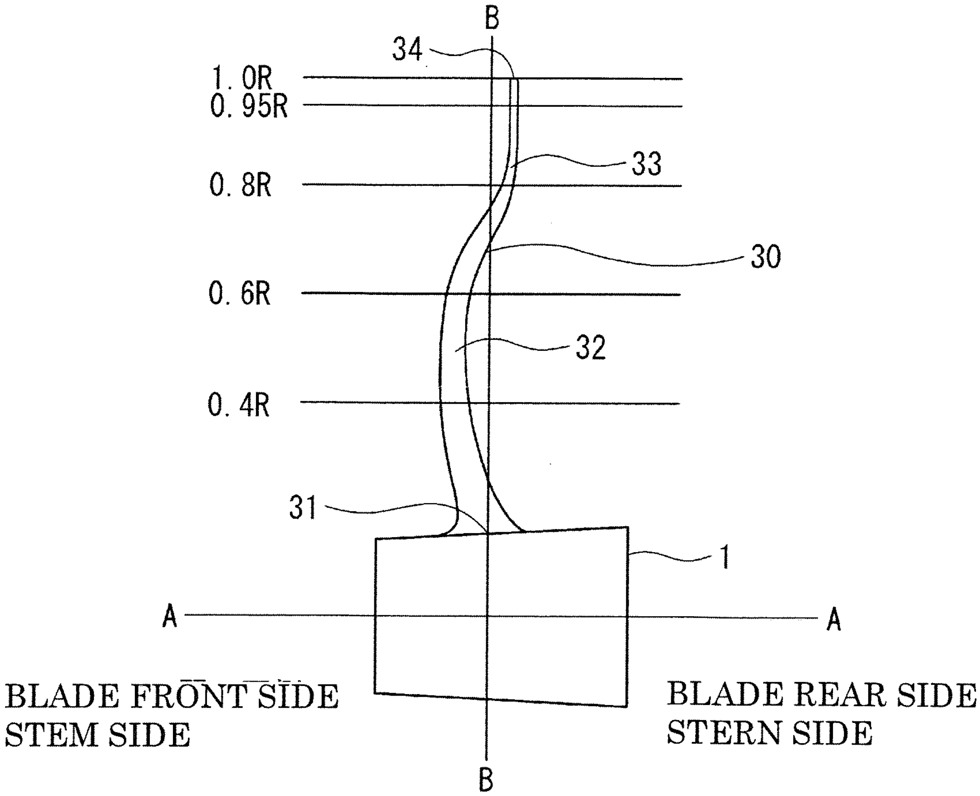
STEM SIDE
BLADE REAR SIDE
STERN SIDE
B

Fig. 3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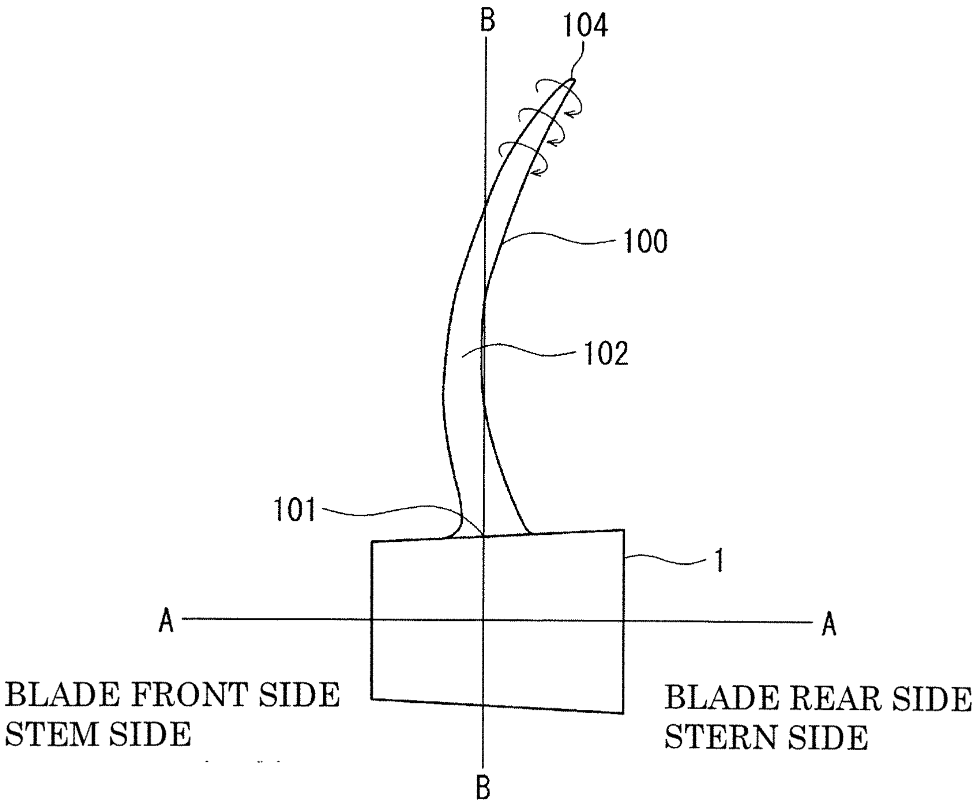
STEM SIDE
BLADE REAR SIDE
STERN SIDE
B

Fig. 4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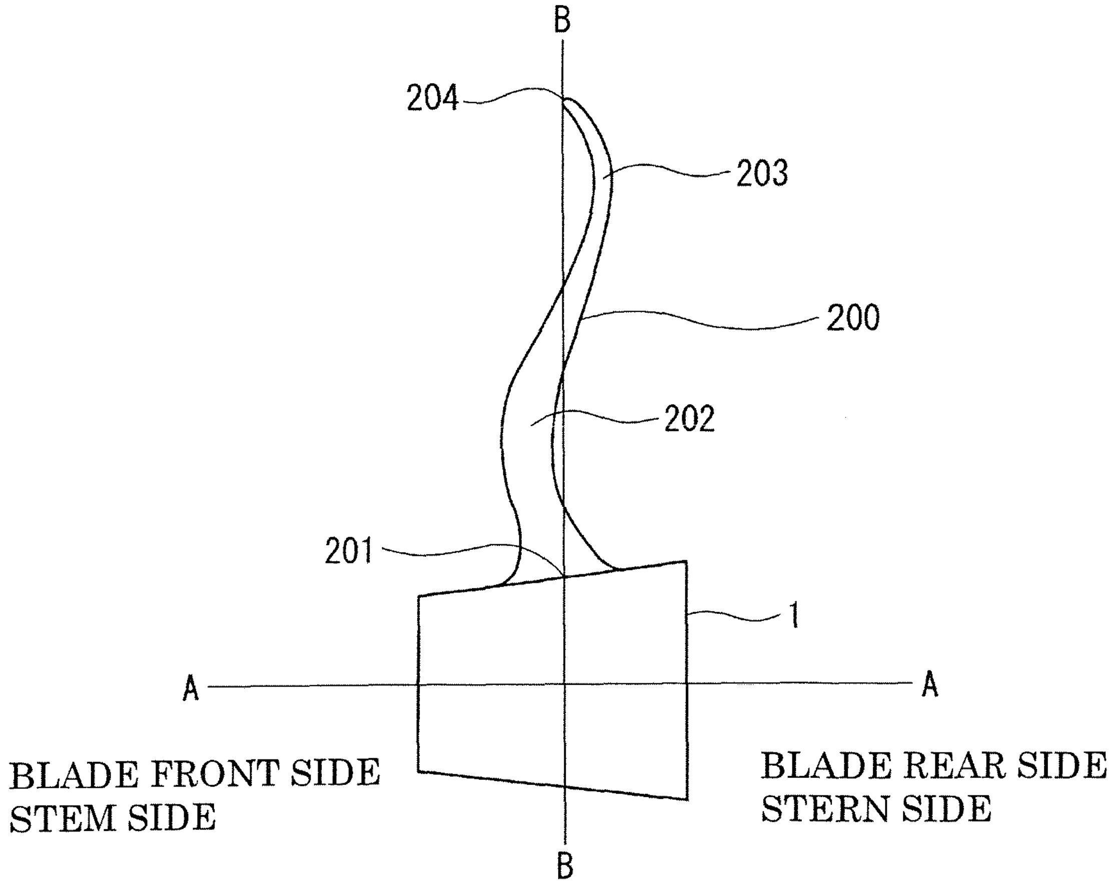
BLADE FRONT SIDE
STEM SIDE
BLADE REAR SIDE
STERN SIDE
B

Fig. 5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STEM SIDE
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/057107

A. CLASSIFICATION OF SUBJECT MATTER
B63H1/26(2006.01)i, *B63H1/18*(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)
B63H1/26, B63H1/18

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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.
A	JP 11-43096 A (Mitsubishi Heavy Industries, Ltd.), 16 February 1999 (16.02.1999), paragraphs [0028] to [0030]; fig. 11 (Family: none)	1-5
A	JP 10-129590 A (Hitachi Zosen Corp.), 19 May 1998 (19.05.1998), abstract; fig. 1 to 5 (Family: none)	1-5
A	JP 8-11786 A (Mitsubishi Heavy Industries, Ltd.), 16 January 1996 (16.01.1996), paragraphs [0003], [0012] to [0014]; fig. 1, 8 (Family: none)	1-5

☒ 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 26 April, 2013 (26.04.13)	Date of mailing of the international search report 14 May, 2013 (14.05.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/057107

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-1212 A (Akishima Laboratories (Mitsui Zosen) Inc.), 08 January 2009 (08.01.2009), paragraph [0005]; fig. 9 to 11 (Family: none)	1-5
A	JP 1-32992 A (Attwood Corp.), 02 February 1989 (02.02.1989), page 6, upper left column, line 4 to page 7, upper right column, line 6; fig. 1 to 6 & US 4789306 A & EP 0300683 A1	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3670811 B **[0006]**
- JP 3416006 B **[0006]**
- JP 2883006 B **[0006]**