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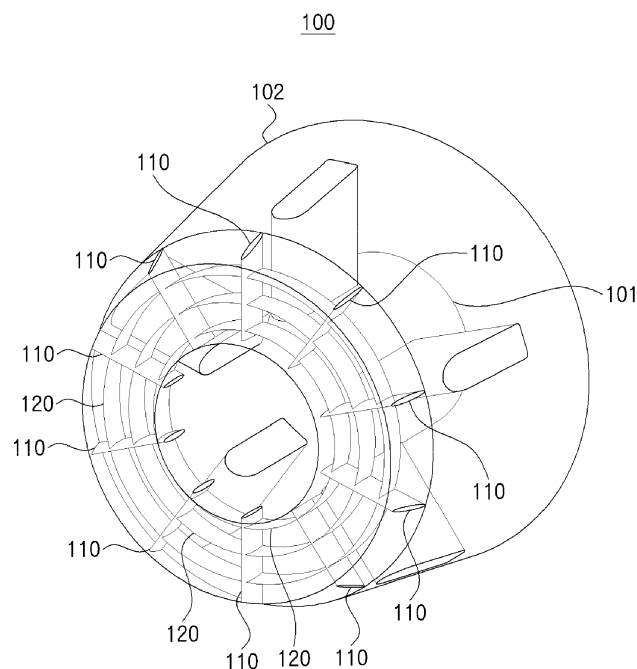
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(54) EXHAUST DIFFUSER OF A GAS TURBINE ENGINE HAVING VARIABLE GUIDE VANE RINGS

(57) An exhaust diffuser (100) according to an embodiment of the present disclosure is mounted at an outlet of a gas turbine to eject exhaust gas to the outside and includes hollow cylindrical internal diffuser guide (101) and external diffuser guide (102). The exhaust diffuser (100) includes: struts (110) disposed between the inter-

nal diffuser guide (101) and the external diffuser guide (102) to space the internal diffuser guide (101) and the external diffuser guide (102) at a predetermined distance from each other; and vanes (120) surrounding an outer side of the internal diffuser guide (101).

[FIG. 3]



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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Korean Patent Application No. 10-2017-0049791, filed April 18, 2017, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE DISCLOSURE

Field of the Disclosure

[0002] The present disclosure relates to an exhaust diffuser and a gas turbine having the same and, more particularly, to an exhaust diffuser having variable vanes.

Description of the Related Art

[0003] In general, a gas turbine 10 comprises, as shown in FIG. 1, a compressor 15, a combustor 25, and a turbine 40. Air suctioned through an air inlet 20 is compressed into high-temperature and high-pressure compressed air by the compressor 15, high-temperature and high-pressure combustion gas (working fluid) is produced by combusting the compressed air by supplying fuel to the compressed air in the combustor 25, the turbine 40 is operated by the combustion gas, and a power generator connected to the compressor 15 is operated.

[0004] One of important aerodynamic problems during normal operation of a gas turbine engine 10 is to efficiently discharge combustion gas flowing out with high momentum through the last stage 60 of a turbine 40.

[0005] It may be aerodynamically advantageous to configure a horizontal exhaust line, but axial exhaust may be substantially impossible due to influence on the entire footprint.

[0006] For this reason, it is standard in the field to use vertical and side exhaust stacks that change the flow of combustion gas from an axial turbine into the radial direction.

[0007] In detail, a radial diffuser may be used to guide combustion gas into the radial direction.

[0008] A radial diffuser 100', as shown in FIG. 2, generally includes a plurality of struts 140' mounted on an internal diffuser guide 150' and surrounded by an external diffuser guide 130'.

[0009] The radial diffuser 100' changes the kinetic energy of the combustion gas flowing out through the last stage of the turbine into potential energy of increased static pressure. Increasing the entire restoration of static pressure increases the performance and efficiency of the entire gas turbine engine.

[0010] Accordingly, it has been required to develop an improved diffuser and an improved exhaust system to be used for gas turbine engines. Several technologies of removing flow separation by controlling the boundary layer of the flow at the inlet of a diffuser have been developed

in correspondence to the requirement.

[0011] However, according to the technologies, it is impossible to remove flow separation between an internal diffuser guide and struts. Such flow separation causes a loss of pressure and consequently reduces the performance of the entire combustor.

[0012] Therefore, it is required to develop an exhaust diffuser that can solve the problems in the related art.

10 Documents of Related Art

[0013] (Patent Document 1) Korean Patent Application Publication No. 10-2015-0123950 (published on November 4, 2015)

15 SUMMARY OF THE DISCLOSURE

[0014] The present disclosure provides an exhaust diffuser of which performance is improved by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser, and a gas turbine having the exhaust diffuser.

[0015] An exhaust diffuser according to an aspect of the present disclosure is mounted at an outlet of a gas turbine to eject exhaust gas to the outside and includes hollow cylindrical internal diffuser guide and an external diffuser guide. The exhaust diffuser includes: struts disposed between the internal diffuser guide and the external diffuser guide to space the internal diffuser guide and the external diffuser guide at a predetermined distance from each other; and vanes surrounding an outer side of the internal diffuser guide.

[0016] The vanes may be formed in a ring shape surrounding the internal diffuser guide.

[0017] Three or more struts may be spaced at a predetermined angle from each other around the outer side of the internal diffuser guide, the vanes may connect adjacent struts, and the vanes may have a structure corresponding to the outer side of the internal diffuser guide.

[0018] The vanes may be sequentially mounted and form a ring-shaped structure in a vertical cross-section.

[0019] Two or more vanes may be mounted at a predetermined distance from each other on the struts.

[0020] The vane may be mounted on the strut through a hinge unit, and a driving unit operating with the hinge unit of the vane through a link may be disposed in the strut.

[0021] The vane may have a streamline structure or an airfoil structure in a vertical cross-section.

[0022] The strut may have a streamline structure or an airfoil structure in a vertical cross-section.

[0023] A guide projection extending in a flow direction of exhaust gas may be formed on an outer side of the vane.

[0024] The guide projection may have a streamline structure continuing from the outer side of the vane in a vertical cross-section.

[0025] An exhaust diffuser according to another aspect

of the present disclosure is mounted at an outlet of a gas turbine to eject exhaust gas to the outside and includes hollow cylindrical internal diffuser guide and external diffuser guide. The exhaust diffuser includes: struts disposed between the internal diffuser guide and the external diffuser guide and spaced at a predetermined angle from each other around an outer side of the internal diffuser guide to space the internal diffuser guide and the external diffuser guide at a predetermined distance from each other; and vanes disposed around the outer side of the internal diffuser guide, connecting adjacent struts, and rotatably mounted on the struts.

[0026] The vane may be mounted on the strut through a hinge unit, and a driving unit operating with the hinge unit of the vane through a link may be disposed in the strut.

[0027] The vane and the strut may have a streamline structure or an airfoil structure in a cross-section.

[0028] A gas turbine according to another aspect of the present disclosure includes the exhaust diffuser that is mounted at an outlet of a gas turbine to eject exhaust gas to the outside and includes a hollow cylindrical internal diffuser guide and an external diffuser guide. The exhaust diffuser includes: struts disposed between the internal diffuser guide and the external diffuser guide to space the internal diffuser guide and the external diffuser guide at a predetermined distance from each other; and vanes surrounding an outer side of the internal diffuser guide.

[0029] Three or more struts may be spaced at a predetermined angle from each other around the outer side of the internal diffuser guide, the vanes may connect adjacent struts, and the vanes may have a structure corresponding to the outer side of the internal diffuser guide.

[0030] The vanes may be sequentially mounted and form a ring-shaped structure in a cross-section.

[0031] As described above, according to the exhaust diffuser of the present disclosure, since there are provided struts and rotary vanes that are formed in a specific structure, it is possible to effectively remove flow separation on the outer side of the internal diffuser guide by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser. Accordingly, it is possible to provide an exhaust diffuser of which performance is improved, and a gas turbine having the exhaust diffuser.

[0032] Further, according to the exhaust diffuser of the present disclosure, since the exhaust diffuser includes three or more struts spaced at a predetermined angle from each other around the outer side of the internal diffuser guide and vanes connecting adjacent struts and formed in a ring shape in a cross-section, it is possible to easily control radial inlet flow generated in an operation area. Accordingly, it is possible to improve performance of the exhaust diffuser by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser.

[0033] Further, according to the exhaust diffuser of the

present disclosure, since the vanes and the struts have a streamline structure of an airfoil structure, it is possible to easily control the profile of a velocity field at an inlet of exhaust gas flowing in the exhaust diffuser.

[0034] Further, according to the exhaust diffuser of the present disclosure, since a guide projection is formed on the outer side of each vane, it is possible to effectively control the profile of a velocity field at an inlet of exhaust gas flowing in the exhaust diffuser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The above and other features of the present disclosure will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view showing the configuration of a gas turbine according to the related art;

FIG. 2 is a schematic view showing an exhaust diffuser according to the related art;

FIG. 3 is a perspective view showing an exhaust diffuser according to an embodiment of the present disclosure;

FIG. 4 is a cross-sectional view showing the exhaust diffuser according to an embodiment of the present disclosure;

FIG. 5 is a partial enlarged view showing a strut, a vane, and a driving unit according to an embodiment of the present disclosure;

FIG. 6 is a perspective view showing a vane and a guide projection according to another embodiment of the present disclosure; and

FIG. 7 is a cross-sectional view showing the vane and the guide projection shown in FIG. 6.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0036] Hereinafter, preferred embodiments of the present disclosure are described in detail with reference to the drawings. The terms and words used in the present specification and claims should not be interpreted as being limited to typical meanings or dictionary definitions, but should be interpreted as having meanings and concepts relevant to the technical scope of the present disclosure.

[0037] It should be understood that when an element is referred to as being "on" another element, the elements may be in contact with each other or there may be an intervening element present. Through the present specification, unless explicitly described otherwise, "comprising" any components will be understood to imply the inclusion of other components rather than the exclusion of any other components.

[0038] FIG. 3 is a perspective view showing an exhaust diffuser according to an embodiment of the present disclosure and FIG. 4 is a cross-sectional view showing the exhaust diffuser according to an embodiment of the

present disclosure.

[0039] Referring to the figures, an exhaust diffuser 100 according to the embodiment includes a hollow cylindrical internal diffuser guide 101 and an external diffuser guide 102 and further includes struts 110 and a rotary vane 120.

[0040] According to the present disclosure, since there are provided the struts 110 and the rotary vane 120 that have a specific structure, it is possible to effectively remove flow separation on the outer side of the internal diffuser guide 101 by controlling the profile of a velocity field at an inlet of exhaust gas flowing in the exhaust diffuser 100. Accordingly, it is possible to provide variable guide vanes that can improve performance of a diffuser, and a gas turbine having the vanes.

[0041] The components of the exhaust diffuser 100 according to the embodiment are described hereafter in detail with reference to the drawings.

[0042] The struts 110 according to the embodiment, as shown in FIGS. 3 and 4, are disposed between the internal diffuser guide 101 and the external diffuser guide 102 to space the internal diffuser guide 101 and the external diffuser guide 102 at a predetermined distance.

[0043] The struts 110 may have a streamline structure or an airfoil structure in a vertical cross-section.

[0044] A specific number of struts 110 are shown in FIG. 3, but the number may be appropriately changed different from that shown in the figure in consideration of a pressure drop of the exhaust gas flowing in the exhaust diffuser 100.

[0045] The vanes 120 according to the embodiment surround the outer side of the internal diffuser guide 101 and are rotatably mounted on the struts 110. As shown in FIG. 3, two or more vanes 120 may be mounted on the struts 110 at predetermined distance from each other.

[0046] If necessary, the vanes 120 may be formed in a ring shape surrounding the internal diffuser guide 101.

[0047] The number and position of the vanes 120 may be appropriately changed in consideration of a pressure drop of the exhaust gas flowing in the exhaust diffuser 100.

[0048] Three or more struts 110 according to the embodiment may be spaced at a predetermined angle around the outer side of the internal diffuser guide 101. The vanes 120 connect adjacent struts 110 and may be formed to correspond to the outer side of the internal diffuser guide 101.

[0049] The vanes 120 may be sequentially mounted to form a ring-shaped structure in a vertical cross-section.

[0050] FIG. 5 is a partial enlarged view showing a strut 110, a vane 120, and a driving unit 111 according to an embodiment of the present disclosure.

[0051] Referring to FIGS. 4 and 5, the vane 120 according to the embodiment is mounted on the strut 110 through a hinge unit 121. The driving unit 111 that operates with the hinge unit 121 of the vane 120 through a link 112 may be disposed inside the strut 110.

[0052] According to the structure, the link 112 is moved

by forward and backward rotation of the driving unit 111, so the vane 120 mounted through the hinge unit 121 is rotated clockwise or counterclockwise in the figures. That is, the angle of the vane 120 to flow of exhaust gas is changed by the hinge unit 121 and the link 112.

[0053] FIG. 6 is a perspective view showing a vane and a guide projection according to another embodiment of the present disclosure and FIG. 7 is a cross-sectional view showing the vane and the guide projection shown in FIG. 6.

[0054] Referring to the FIGS. 3, 6, and 7, a guide projection 122 extending in the flow direction of exhaust gas is formed on an outer side of the vane 120 according to the embodiment.

[0055] In detail, the guide projection 122, as shown in FIG. 7, may form a streamline shape continuing from the outer side of the vane 120 in the vertical cross-section.

[0056] Since the guide projection 122 is positioned on the vane 120 in the flow direction of exhaust gas flowing, the exhaust gas splits to the left and right of the guide projection 122. As the exhaust gas is split by the guide projection 122, it is possible to suppress flow separation that is promoted by the viscosity of surrounding exhaust gas. Accordingly, the guide projection 122 contributes to controlling the profile of a velocity field of the exhaust gas at an inlet.

[0057] Although one guide projection 122 is shown on one vane 120 in the figures, several guide projections 122 may be provided on one vane 120. In order to form a plurality of guide projections 122, it may be considered to make the gaps between the guide projections 122 different in consideration of the profile of the exhaust gas.

[0058] As described above, according to the exhaust diffuser of the present disclosure, since there are provided struts and rotary vanes that are formed in a specific structure, it is possible to effectively remove flow separation on the outer side of the internal diffuser guide by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser. Accordingly, it is possible to provide an exhaust diffuser of which performance is improved, and a gas turbine having the exhaust diffuser.

[0059] Further, according to the exhaust diffuser of the present disclosure, since the exhaust diffuser includes three or more struts spaced at a predetermined angle from each other around the outer side of the internal diffuser guide and vanes connecting adjacent struts and formed in a ring shape in a vertical cross-section, it is possible to easily control radial inlet flow generated in an operation area. Accordingly, it is possible to improve performance of the exhaust diffuser by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser.

[0060] Further, according to the exhaust diffuser of the present disclosure, since the vanes and the struts have a streamline structure of an airfoil structure, it is possible to easily control the profile of a velocity field at an inlet of exhaust gas flowing in the exhaust diffuser.

[0061] Further, according to the exhaust diffuser of the present disclosure, since a guide projection is formed on the outer side of each vane, it is possible to easily control the profile of a velocity field at an inlet of exhaust gas flowing in the exhaust diffuser.

[0062] The present disclosure can also provide a gas turbine having the exhaust diffuser 100 of the present disclosure, so it is possible to improve performance of the exhaust diffuser by controlling the profile of a velocity field at an inlet where exhaust gas flows into the exhaust diffuser. Accordingly, it is possible to provide a gas turbine of which performance is improved.

[0063] Only specific embodiments of the present disclosure were described above. However, it should be understood that the present disclosure is not limited to the specific embodiments and all modifications, equivalents, and substitutions should be construed as being included in the scope of the present disclosure defined in claims.

[0064] That is, the present disclosure is not limited to the specific embodiments described above, those skilled in the art may change the present disclosure in various ways without departing from the spirit of the present disclosure defined in claims, and the modifications are included in the protective range of the present disclosure.

Claims

1. An exhaust diffuser (100) that is mounted at an outlet of a gas turbine to eject exhaust gas to outside of the turbine and includes a hollow cylindrical internal diffuser guide (101) and an external diffuser guide (102),
the exhaust diffuser (102) comprising:

struts (110) disposed between the internal diffuser guide (101) and the external diffuser guide (102) to space the internal diffuser guide (101) and the external diffuser guide (102) at a predetermined distance from each other; and
vanes (120) surrounding an outer side of the internal diffuser guide (101).

2. The exhaust diffuser (100) of claim 1, wherein the vanes (120) are formed in a ring shape surrounding the internal diffuser guide (101).
3. The exhaust diffuser (100) of claim 1, wherein three or more struts (110) are spaced at a predetermined angle from each other around the outer side of the internal diffuser guide (101),
the vanes (120) connect adjacent struts (110), and
the vanes (120) have a structure corresponding to the outer side of the internal diffuser guide (101).
4. The exhaust diffuser (100) of claim 3, wherein the vanes (120) are sequentially mounted and form a ring-shaped structure in a vertical cross-section.

5. The exhaust diffuser (100) of claim 1, wherein two or more vanes (120) are mounted at a predetermined distance from each other on the struts (110).

6. The exhaust diffuser (100) of claim 1, wherein the vane (120) is mounted on the strut (110) through a hinge unit (121), and
a driving unit (111) operating with the hinge unit (121) of the vane (120) through a link (112) is disposed in the strut (110).

7. The exhaust diffuser (100) of claim 1, wherein the vane (120) has a streamline structure or an airfoil structure in a vertical cross-section.

8. The exhaust diffuser (100) of claim 1, wherein the strut (110) has a streamline structure or an airfoil structure in a vertical cross-section.

9. The exhaust diffuser (100) of claim 1, wherein one or more guide projections (122) extending in a flow direction of exhaust gas are formed on an outer side of the vane (120).

10. The exhaust diffuser (100) of claim 9, wherein the guide projection (122) has a streamline structure continuing from the outer side of the vane (120) in a vertical cross-section.

11. An exhaust diffuser (100) that is mounted at an outlet of a gas turbine to eject exhaust gas to outside of the turbine and includes a hollow cylindrical internal diffuser guide (101) and an external diffuser guide (102),
the exhaust diffuser (100) comprising:

struts (110) disposed between the internal diffuser guide (101) and the external diffuser guide (102) and spaced at a predetermined angle from each other around an outer side of the internal diffuser guide (101) to space the internal diffuser guide (101) and the external diffuser guide (102) at a predetermined distance from each other; and
vanes (120) disposed in a ring shape around the outer side of the internal diffuser guide (101), connecting adjacent struts (110), and rotatably mounted on the struts (110).

12. The exhaust diffuser (100) of claim 11, wherein the vane (120) is mounted on the strut (110) through a hinge unit (121), and
a driving unit (111) operating with the hinge unit (121) of the vane (120) through a link (112) is disposed in the strut (110).

13. The exhaust diffuser (100) of claim 11, wherein the vane (120) and the strut (110) have a streamline

structure or an airfoil structure in a vertical cross-section.

14. A gas turbine having an exhaust diffuser (100) including a hollow cylindrical internal diffuser guide (101) and an external diffuser guide (102), wherein the exhaust diffuser (100) includes:

struts (110) disposed between the internal diffuser guide (101) and the external diffuser guide (102) to space the internal diffuser guide (101) and the external diffuser guide (102) at a predetermined distance from each other; and vanes (120) surrounding an outer side of the internal diffuser guide (101).

15. The gas turbine of claim 14, wherein the vanes (120) disposed in a ring shape around the outer side of the internal diffuser guide (101), connecting adjacent struts (110), and rotatably mounted on the struts (110), the vane (120) is mounted on the strut (110) through a hinge unit (121), and a driving unit (111) operating with the hinge unit (121) of the vane (120) through a link (112) is disposed in the strut (110).

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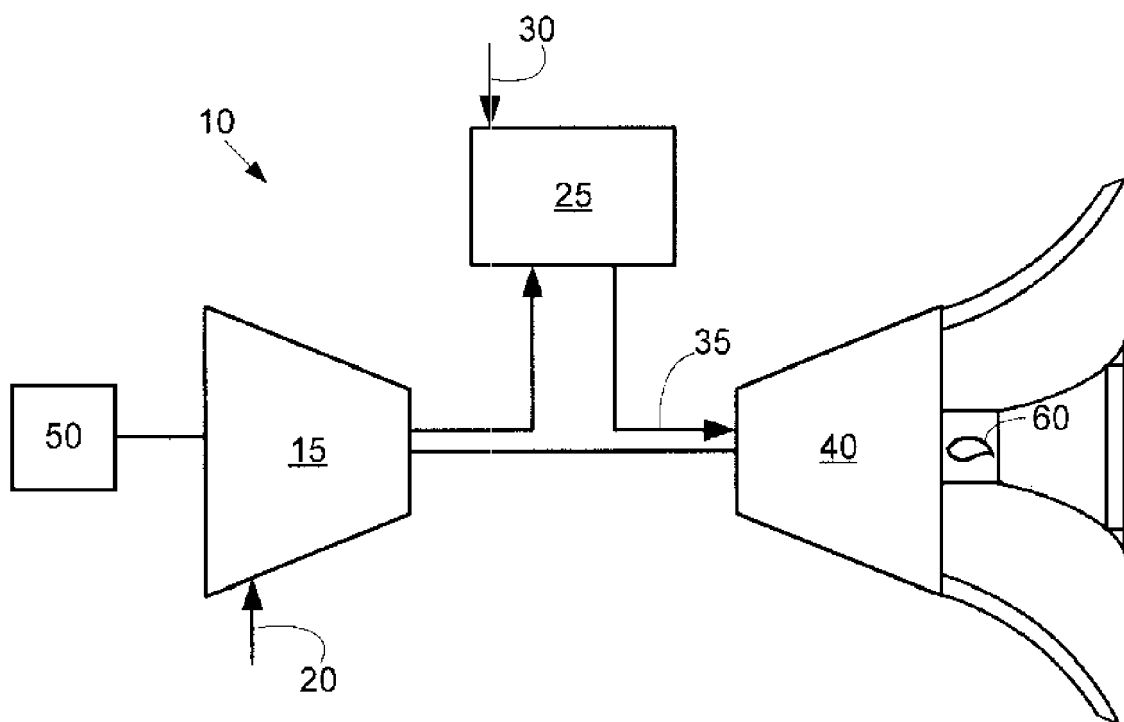
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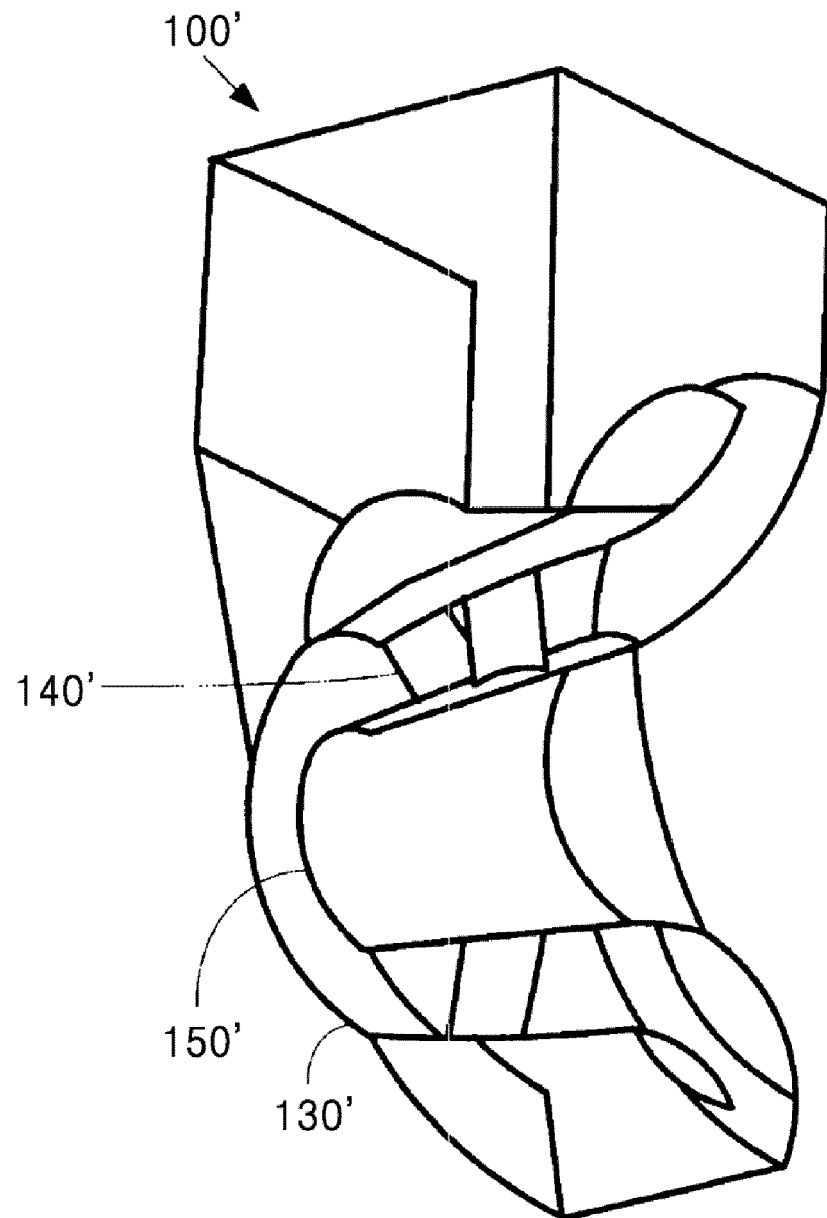
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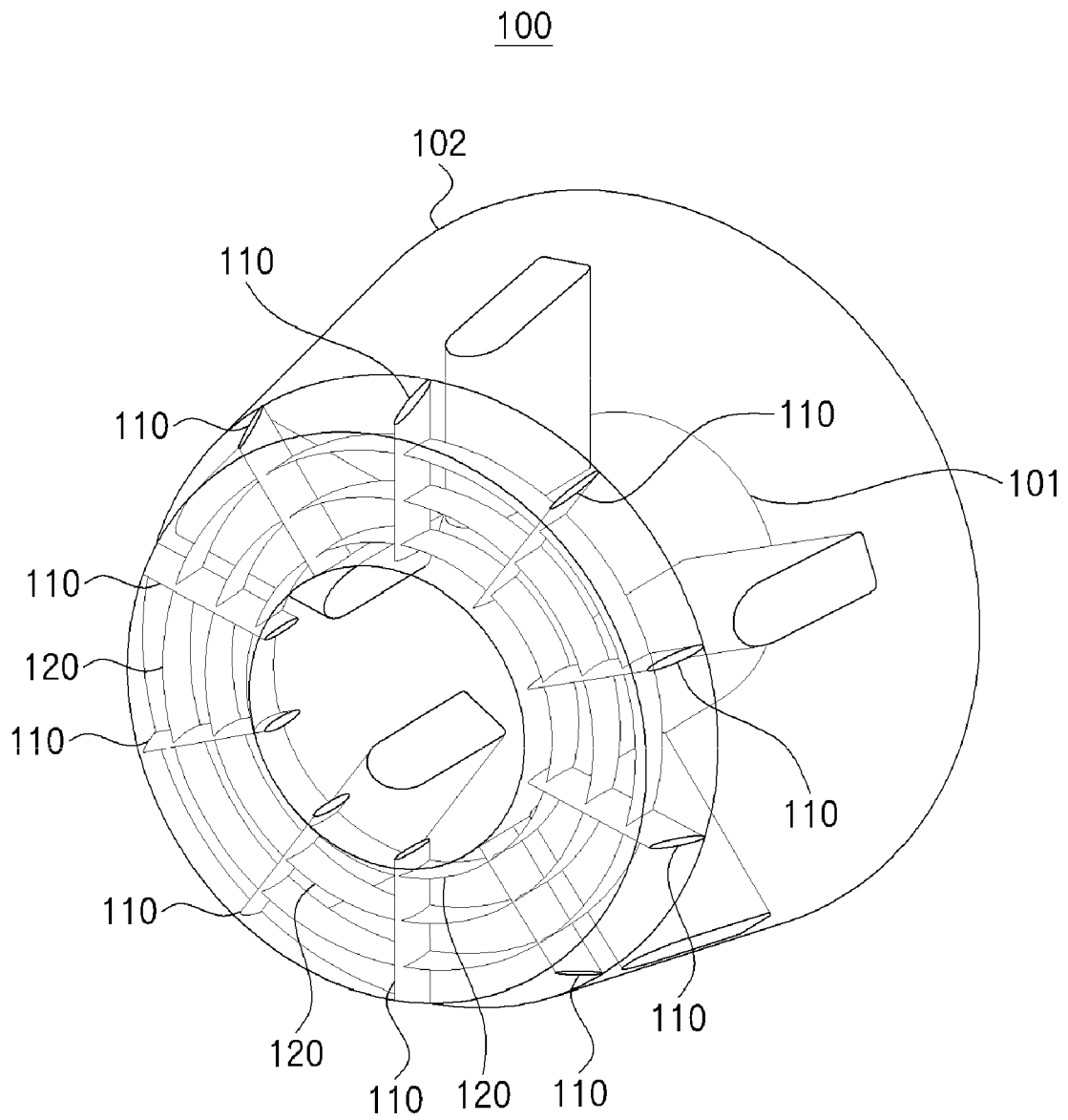
【FIG. 1】



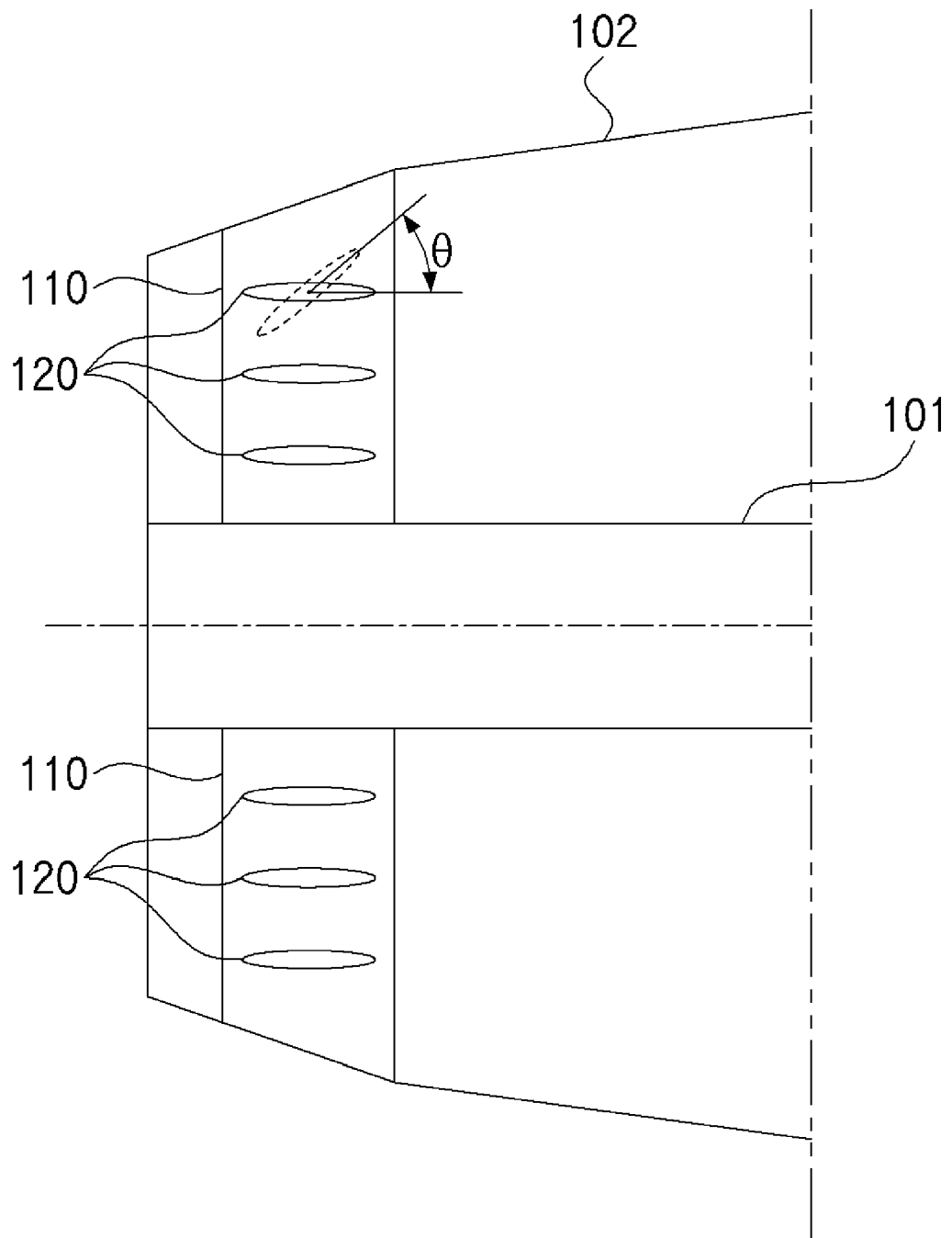
【FIG. 2】



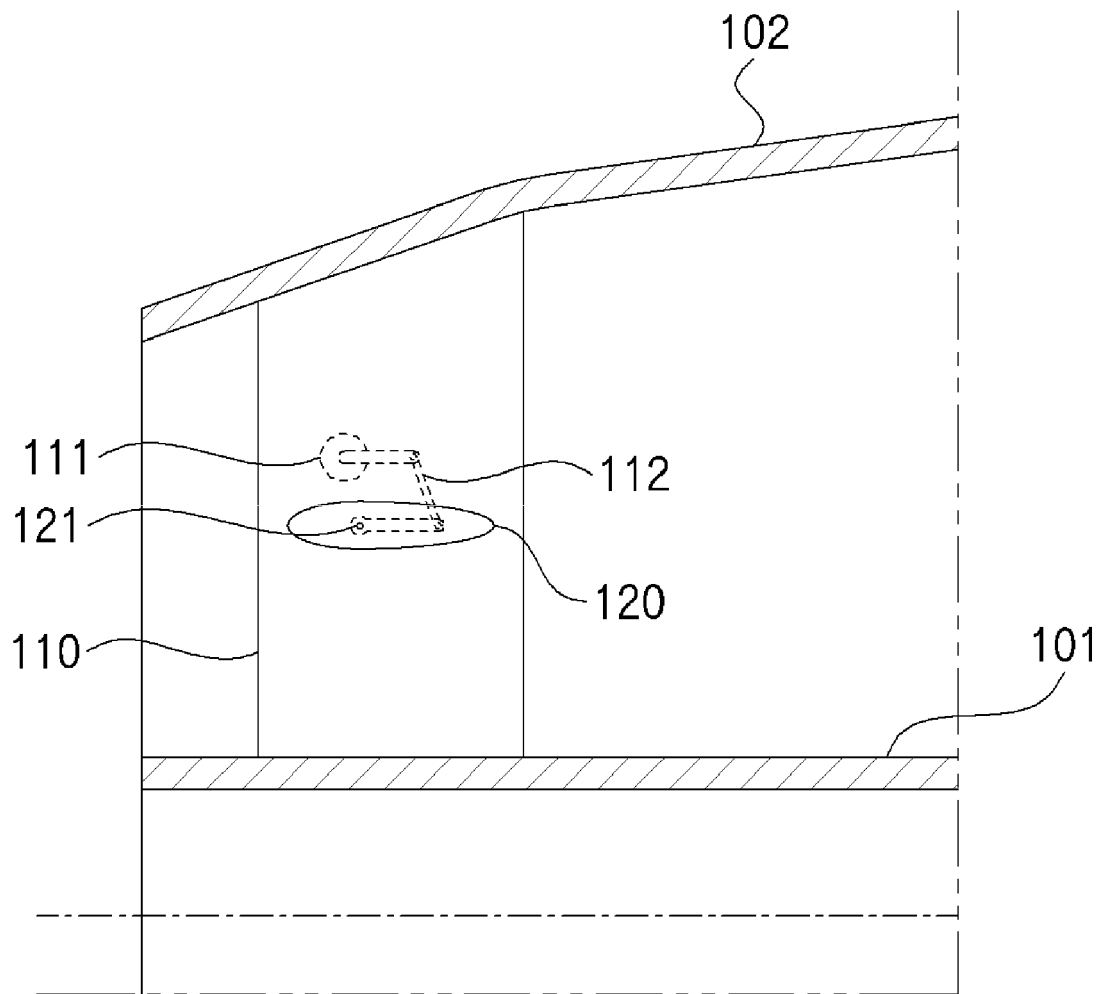
【FIG. 3】



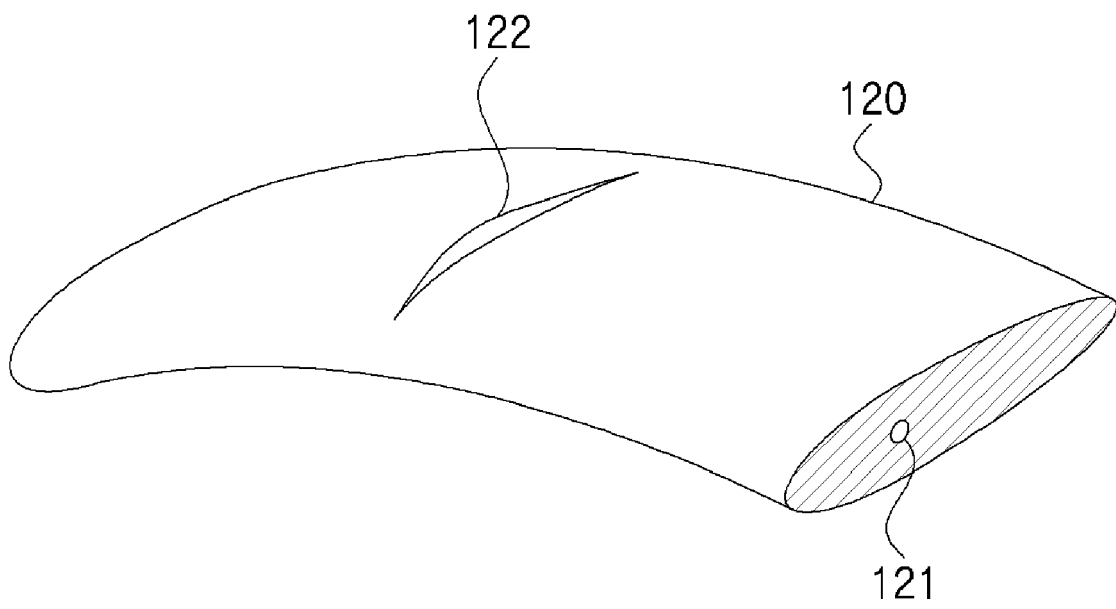
【FIG. 4】



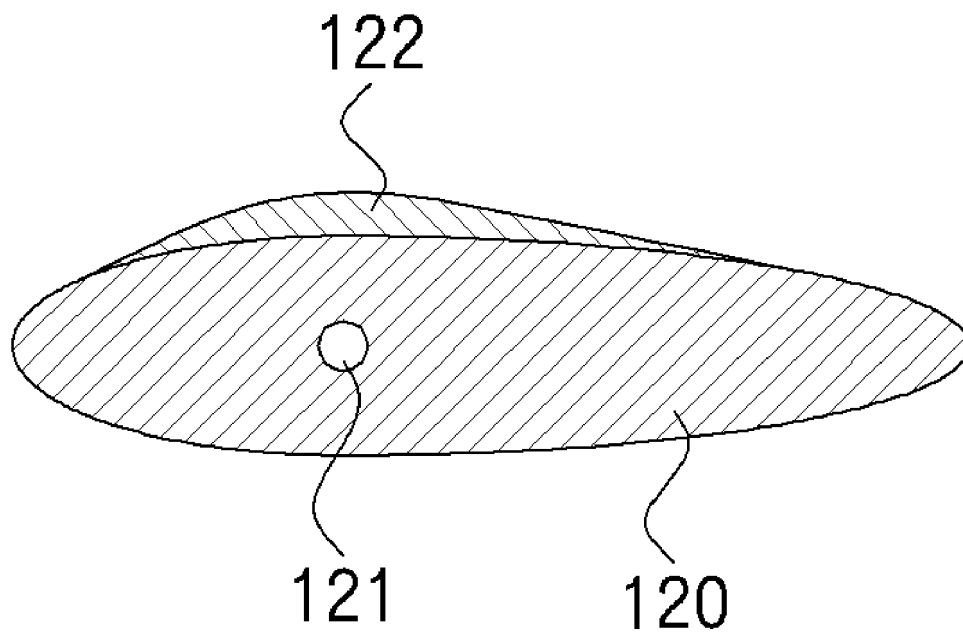
【FIG. 5】



【FIG. 6】



【FIG. 7】





EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 8 776 527 B1 (SOKHEY JAGDISH [US] ET AL) 15 July 2014 (2014-07-15)	1-8, 11-15	INV. F01D17/16
Y	* figures 2-6 *	9,10	F01D25/30 F04D29/54 F04D29/68
X	US 2013/152592 A1 (OROSA JOHN A [US] ET AL) 20 June 2013 (2013-06-20)	1-3,7,8, 11,13,14	
Y	* paragraphs [0043], [0044]; figures 2-5 *	4-6,9, 10,12,15	
X	US 2013/265848 A1 (WURZ DIETER [DE] ET AL) 10 October 2013 (2013-10-10)	1-3,6-15	
Y	* paragraphs [0084], [0105]; figures 1-19 *	1-3,6-15	
X	EP 0 970 292 A1 (NORRIS THOMAS R [US]) 12 January 2000 (2000-01-12)	1-5,7,8	
Y	* figures 1,2b,4,7 *	11,13,14	
Y	US 2014/314549 A1 (PAKKALA SRINIVAS RAO [IN] ET AL) 23 October 2014 (2014-10-23)	1-8, 11-15	
Y	* paragraph [0037]; figure 13 *		TECHNICAL FIELDS SEARCHED (IPC)
Y	US 4 175 640 A (BIRCH STANLEY F [US] ET AL) 27 November 1979 (1979-11-27)	1-3,6-15	F01D F02C F02K F04D
Y	EP 3 061 920 A1 (HONEYWELL INT INC [US]) 31 August 2016 (2016-08-31)	1-3,5,7, 8,11,13, 14	
Y	* paragraphs [0024], [0032], [0040] - [0048]; figures 2-4 *		
Y	US 4 215 536 A (RUDOLPH PETER K C [US]) 5 August 1980 (1980-08-05)	1-5, 7-11,13, 14	
	* figures 9,13-15 *		
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 March 2018	Examiner Koch, Rafael
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			

EPO FORM 1503 03.82 (P04C01)

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ON EUROPEAN PATENT APPLICATION NO.**

EP 17 19 3245

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15

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45

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55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 8776527 B1	15-07-2014	NONE	
US 2013152592 A1	20-06-2013	CN 103998725 A EP 2791477 A2 US 2013152592 A1 WO 2013090144 A2	20-08-2014 22-10-2014 20-06-2013 20-06-2013
US 2013265848 A1	10-10-2013	EP 2577071 A2 US 2013265848 A1 WO 2011151323 A2	10-04-2013 10-10-2013 08-12-2011
EP 0970292 A1	12-01-2000	AT 233862 T AU 6563298 A CA 2287308 A1 DE 69811869 D1 DE 69811869 T2 EP 0970292 A1 US 5813828 A WO 9841739 A1	15-03-2003 12-10-1998 24-09-1998 10-04-2003 04-12-2003 12-01-2000 29-09-1998 24-09-1998
US 2014314549 A1	23-10-2014	CH 708006 A2 CN 203891945 U DE 102014104318 A1 JP 2014211159 A US 2014314549 A1	31-10-2014 22-10-2014 23-10-2014 13-11-2014 23-10-2014
US 4175640 A	27-11-1979	NONE	
EP 3061920 A1	31-08-2016	CN 105909320 A EP 3061920 A1 KR 20160103934 A US 2016245157 A1	31-08-2016 31-08-2016 02-09-2016 25-08-2016
US 4215536 A	05-08-1980	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 1020170049791 [0001]
- KR 1020150123950 [0013]