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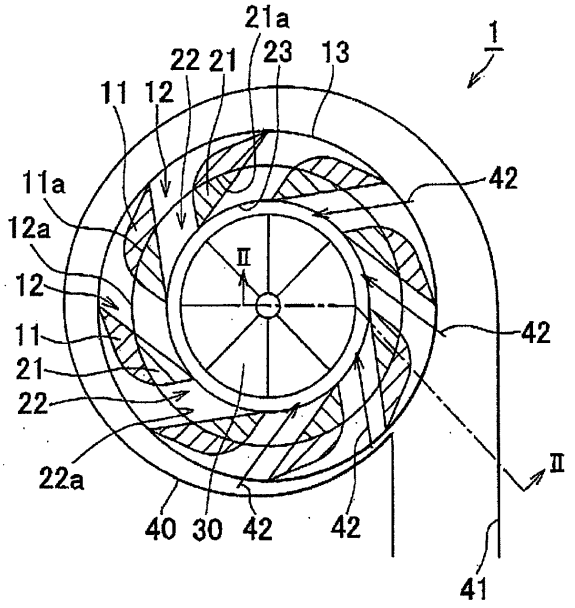
## (54) Flow rate control system for turbocharger

(57) A turbocharger 1 includes a turbine wheel 30, an inner peripheral member 23 provided outside the turbine wheel 30, and an outer peripheral member 13 provided outside the inner peripheral member 23 that can turn relative to the inner peripheral member 23 in the circumferential direction. The inner peripheral member 23 and the outer peripheral member 13 are provided with a plurality of inner guide portions 21 and a plurality of outer guide portions 11, respectively, that define gas passages 22 and 12 between successive guide portions 21, 11. The flow of gas to the turbine wheel 30 through the gas passages may be adjusted by turning one of the outer peripheral member 13 or the inner peripheral member 23 so that the inner guide portions 21 restrict the flow of gas through the gas passages 12 of the outer peripheral member 13.

FIG. 1

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## Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

**[0001]** The invention relates to a turbocharger, and more specifically, to a turbocharger that changes the flow rate of gas to a turbine wheel.

2. Description of the Related Art

**[0002]** Japanese Patent Application Publication No. 2000-199433 (JP-A-2000-199433) describes turbocharger in which a large-diameter disc portion is provided between two levers so as to abut against one of both the levers. The levers are turned synchronously with each other. The large-diameter disc portion comes into abutment on one of both the levers to thereby control the angle of a nozzle vane when fully open. In contrast, the large-diameter disc portion comes into abutment on the other of both the levers to thereby control the angle of the nozzle vane when fully closed.

**[0003]** Japanese Patent Application Publication No. 11-148364 (JP-A-11-148364), describes a turning center of a turbine-side movable nozzle vane that is provided on an inner edge portion of a vane support body, and a turning center of a scroll-side movable nozzle vane that is provided on an outer edge portion of the vane support body.

**[0004]** A nozzle vane that assumes a fully open position when a stopper hits one longitudinal end of a guide, and assumes a fully closed position when the stopper is in contact with the other longitudinal end of the guide is described in Japanese Patent Application Publication No. 10-37754 (JP-A-10-37754).

**[0005]** In JP-A-5-18258, there is described an art in which one of flow passage walls on both sides, which sandwich a nozzle vane, is a movable wall turnable around a turbine wheel shaft, and the other is a fixed wall facing the movable wall.

**[0006]** However, in the described variable nozzle turbochargers, there is a problem in that the flow of gas in a turbine wheel cannot be sufficiently reduced.

SUMMARY OF THE INVENTION

**[0007]** The invention provides a turbocharger capable of sufficiently reducing the flow of gas to a turbine wheel.

**[0008]** A turbocharger according to one aspect of the invention includes: a turbine wheel, an inner peripheral member that is provided outside the turbine wheel and that guides exhaust gas to the turbine wheel, an annular outer peripheral member that is provided adjacent to and outside of the inner peripheral member and that is rotatable relative to the inner peripheral member in a circumferential direction, a plurality of inner guide portions that is provided on the inner peripheral member and that define inner gas passages between successive inner guide portions, and a plurality of outer guide portions that is provided on the outer peripheral member and that define gas passages between successive outer guide portions. The flow of gas to the turbine wheel through the inner gas passages and the outer gas passages is adjusted by turning one of the outer peripheral member or the inner peripheral member with respect to the other of the outer peripheral member or the inner peripheral member so that the inner guide portions restrict the flow of the outer gas passages in accordance with the degree to which the outer peripheral member or the inner peripheral member is turned.

**[0009]** In the turbocharger constructed as described above, the inner guide portions close the outer gas passages in accordance with the turning position of the outer peripheral member with respect to the inner peripheral member. Thus, the flow of gas to the turbine wheel through the gas passages may be restricted or shut off. As a result, a turbocharger with a simple construction that can reliably regulate the flow of gas to the turbine wheel is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** The features, advantages, and technical and industrial significance of this invention will be described in the following detailed description of example embodiments of the invention with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a plan view of a turbocharger according to the first embodiment of the invention;

FIG. 2 is a sectional view taken along a line II-II in FIG. 1;

FIG. 3 is a view showing the turbocharger of the first embodiment in which an inner peripheral member is rotated to a position relative to an outer peripheral member where the flow of gas is shut off;

FIG. 4 is a graph showing a relationship between a relative rotational angle between the inner peripheral member and the outer peripheral member and the area of a nozzle throat;

FIG. 5 is a perspective view showing part of a turbocharger according to the second embodiment of the invention;

FIG. 6 is a view showing a region surrounded by VI in FIG. 5 on an enlarged scale;

FIG 7 is a perspective view of the turbocharger when fully closed;

FIG. 8 is a plan view showing a region surrounded by VIII in FIG. 7 on an enlarged scale;

FIG. 9 is a sectional view of a turbocharger according to the third embodiment of the invention; and

FIG. 10 is a plan view of the turbocharger according to the third embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

**[0011]** The embodiments of the invention will be described hereinafter with reference to the drawings. In the following embodiments of the invention, like or equivalent components are denoted by like reference symbols, and the description thereof will not be repeated. Further, it is also possible to combine the respective embodiments of the invention with one another.

**[0012]** FIG. 1 is a plan view of a turbocharger according to the first embodiment of the invention. Referring to FIG. 1, a turbocharger 1 has a turbine wheel 30, and a turbine housing 40 in which the turbine wheel 30 is accommodated. An inner peripheral member 23 and an outer peripheral member 13 are accommodated in the turbine housing 40 and disposed outside the turbine wheel 30.

**[0013]** Both the inner peripheral member 23 and the outer peripheral member 13 are ring shaped, and are slidably in contact with each other. The inner peripheral member 23 may be fixed in position, and the outer peripheral member 13 may be turnably provided. Conversely, the outer peripheral member 13 may be fixed in position, and the inner peripheral member 23 may be a turnably provided.

**[0014]** The inner peripheral member 23 and the outer peripheral member 13 are provided with inner guide portions 21 and outer guide portions 11 respectively, which define gas passages 22 and gas passages 12 provided between the respective inner guide portions 21 and outer guide portions 11. The sides of each inner guide portions 21 are curved. The inner guide portions 21 are disposed at regular intervals on the inner peripheral member 23 such that the outer peripheral edges 21a of the inner guide portions 21 extend along the outer peripheral edge of the inner peripheral member 23. Similarly, the sides of each outer guide portions 11 are curved. The outer guide portions 11 are disposed at regular intervals on the outer peripheral member 13 such that the inner peripheral edges 11a extend along the inner peripheral edge of the outer peripheral member 13. Further, when the inner peripheral member 23 and the outer peripheral member 13 turn, the inner guide portion 21 and the outer guide portions 11 are designed to,slide with respect to each other as well. The gas passages 22 and 12 are concave, and exhaust gas supplied from a gas passage 41 of the turbine housing 40 flows toward the turbine wheel 30 in directions indicated by arrows 42 via the gas passages 12 and 22. Thus, the turbine wheel 30 is rotated.

**[0015]** The turbine wheel 30 is connected to a turbine shaft, and the turbine shaft is, in turn, connected to a compressor. The compressor compresses mixture or intake air.

**[0016]** FIG. 2 is a sectional view taken along a line II-II in FIG. 1. Referring to FIG. 2, the turbine wheel 30 is held rotatable around a centerline 31. The turbine housing 40 is provided on an outer periphery of the turbine wheel 30, and the turbine housing 40 is provided with the gas passage 41, which assumes a spiral shape.

**[0017]** The outer guide portions 11 and inner guide portions 21, which serve to supply gas toward the turbine wheel 30 and adjust the flow rate of the gas, are disposed on an outer peripheral portion of the turbine wheel 30. The inner guide portions 21 are mounted on the inner peripheral member 23, and the outer guide portions 11 are mounted on the outer peripheral member 13.

**[0018]** In this example, each outer guide portion 11 and the corresponding inner guide portion 21 are in contact with each other. However, the invention is not limited to this construction. Each of the guide portions 11 and a corresponding one of the guide portions 21 may be slightly spaced apart from each other.

**[0019]** FIG. 3 is a view showing the turbocharger in which the inner peripheral member is relative to the outer peripheral member where the flow of gas is shut off. Referring to FIG. 3, when the inner peripheral member is turned relative to the outer peripheral member, the inner guide portions 21 block the outer gas passages 12. Thus, gas cannot be supplied from the out gas passages 12 to the inner gas passages 22. As a result, gas (exhaust gas) cannot be introduced from the outer periphery side to the inner periphery side, thereby significantly restricting the flow of gas toward the turbine wheel 30.

**[0020]** FIG. 4 is a graph showing a relationship between a relative rotational angle between the inner peripheral member and the outer peripheral member and an area of a nozzle throat. The axis of ordinate "AREA OF NOZZLE THROAT" represents the flow rate of gas through the turbine wheel 30 via the outer gas passage 12 and the inner gas passage 22. When the relative rotational angle is 0° (at a position of the left end in FIG 4), a "fully open" state, in which the area of the nozzle throat is at its maximum, is established. Thus, the resistance against the flow of gas is at a minimum.

**[0021]** On the other hand, if the relative rotational angle is at a position of the right end in FIG. 4, a "fully closed" state, in which the gas flow passages are closed, is established. As a result, the supply of gas to the turbine wheel 30 is stopped.

**[0022]** By changing the relative rotational angle between the inner peripheral member 23 and the outer peripheral member 13, the flow rate of gas through the gas passages may be changed in a continuous manner.

**[0023]** That is, the turbocharger 1 according to the first embodiment of the invention is equipped with the turbine wheel 30; the annular inner peripheral member 23 that is located outside the turbine wheel 30 and that guides gas to the turbine wheel 30; and the outer peripheral member 13 that is located to the outside of and adjacent to the inner peripheral member 23 and that turns with respect to the inner peripheral member 23 in a circumferential direction. The inner peripheral member 23 and the outer peripheral member 13 are provided respectively with the plurality of the outer guide portions 11 and inner guide portions 21 that guide gas inward from the outer periphery, and the outer gas passages 12 and inner gas

passages 22 are provided between the plurality of the respective outer guide portions 11 and inner guide portions 21. The inner guide portions 21 close the outer gas passages 12 in accordance with the turning position of the outer peripheral member 13 with respect to the inner peripheral member 23, so that the flow of gas to the turbine wheel 30 through the gas passages may be restricted or shut off.

**[0024]** In the turbocharger 1, the ring-like inner peripheral member 23 and the ring-like outer peripheral member 13 are rotated relative to each other, and the area of the nozzle throat may thereby be adjusted. Furthermore, the nozzle throat may be closed fully so that the flow of gas is shut off.

**[0025]** FIG. 5 is a perspective view showing part of a turbocharger according to the second embodiment of the invention. FIG. 6 is a view showing a region surrounded by VI in FIG. 5 on an enlarged scale. Referring to FIGS. 5 and 6, the turbocharger 1 according to the second embodiment of the invention differs from the turbocharger 1 according to the first embodiment of the invention in that the radial thickness of the inner guide portions 21 is smaller than in the first embodiment of the invention. By reducing the thickness of the inner guide portions 21, the distance between the outer edge portion of the inner peripheral member 23 and the turbine wheel may be reduced. Thus, the area of the throat in the traveling direction of gas may be changed smoothly.

**[0026]** FIG. 7 is a perspective view of the turbocharger when the nozzle throat is fully closed. FIG 8 is a view showing a region surrounded by VIII in FIG. 7 on an enlarged scale. Referring to FIGS. 7 and 8, when the nozzle throat is fully closed, the inner guide portions 21 block off the respective outer gas passages 12. Thus, the flow of gas from the outer peripheral portion toward the inner peripheral portion can be shut off.

**[0027]** In the turbocharger according to the second embodiment of the invention, an effect similar to that of the turbocharger according to the first embodiment of the invention is achieved.

**[0028]** FIG. 9 is a sectional view of a turbocharger according to the third embodiment of the invention. FIG. 10 is a plan view of the turbocharger according to the third embodiment of the invention. Referring to FIGS. 9 and 10, in the turbocharger 1 according to the third embodiment of the invention, the turbine housing 40 is provided with a drill path 45 as a waste gate.

**[0029]** The drill path 45 is a passage for discharging gas in the gas passage 41 provided in the turbine housing 40 without the intermediary of the turbine wheel 30. As shown in FIG. 10, when the inner guide portions 21 are positioned to fully close all the outer gas passages 12, the drill path 45 is closed by the outer guide portions 11, so that no gas flows through the drill path 45.

**[0030]** However, when fully opened, the inlet of the drill path 45 is not closed by the outer guide portions 11, and gas in the gas passage 41 is discharged via the drill path 45.

**[0031]** In the turbocharger constructed as described above, even when the flow rate of exhaust gas increases under high engine speeds, the exhaust gas can be quickly discharged via the drill path 45. As a result, the matching with the rotational characteristic of the engine and the flow rate of exhaust gas can be improved.

**[0032]** A single drill path 45 may be provided as shown in FIG. 10. Alternatively, a plurality of drill paths 45 may be provided. Furthermore, although the opening portion of the drill path 45 is shown formed above the outer guide portions 11, but may be formed above the inner guide portions 21 instead.

**[0033]** The embodiments of the invention have been described above, but can be modified in various manners.

**[0034]** In each of the embodiments of the invention, the inner peripheral edge 11a of each outer guide portions 11 is the same with the inner peripheral edge 12a of each outer gas passages 12. However, the width of the inner peripheral edge 11a of each outer guide portions 11 may differ from that of each outer gas passages 12.

**[0035]** Further, in each embodiment of the invention, the inner peripheral edge 12a of each outer gas passages 12 is the same with as the outer peripheral edge 21a of each inner guide portions 21. However, the width of the outer peripheral edge 21a of each inner guide portions 21 may be longer than that of the inner peripheral edge 12a of each gas passages 12.

**[0036]** Further, the inner peripheral edge 11a of each outer guide portions 11 and the outer peripheral edge 21a of each inner guide portions 21 may be equal in width to each other or different in width from each other.

**[0037]** In each embodiment of the invention, the internal combustion engine may be a gasoline engine or a diesel engine.

**[0038]** Furthermore, as for the type of the engine, a rotary engine as well as a reciprocal engine may be employed.

**[0039]** Further, the invention is applicable to various forms of engines such as inline engines, V-type engines, horizontally-opposed engines, W-type engines, and the like.

**[0040]** Furthermore, the mechanism for turning the turbine wheel 30 is not limited to mechanisms utilizing exhaust gas only. A motor may be used to assist the rotation of the turbine wheel 30.

**[0041]** Further, by employing an exhaust gas recirculation (EGR) system between exhaust valves of the engine and the turbocharger 1 to create a fully closed state in the turbocharger according to the invention, the function of EGR can be improved.

**[0042]** The embodiments of the invention disclosed herein should be considered illustrative in all respects and not limitative. The scope of the invention is not defined by the foregoing description but by the claims. The invention is intended to cover all the modifications that are equivalent in significance and range to the claims.

A turbocharger 1 includes a turbine wheel 30, an inner peripheral member 23 provided outside the turbine wheel 30, and an outer peripheral member 13 provided outside the inner peripheral member 23 that can turn relative to the inner peripheral member 23 in the circumferential direction. The inner peripheral member 23 and the outer peripheral member 13 are provided with a plurality of inner guide portions 21 and a plurality of outer guide portions 11, respectively, that define gas passages 22 and 12 between successive guide portions 21, 11. The flow of gas to the turbine wheel 30 through the gas passages may be adjusted by turning one of the outer peripheral member 13 or the inner peripheral member 23 so that the inner guide portions 21 restrict the flow of gas through the gas passages 12 of the outer peripheral member 13.

## Claims

**1.** A turbocharger **characterized by** comprising:

a turbine wheel (30);
an annular inner peripheral member (23) that is provided outside the turbine wheel and that guides exhaust gas to the turbine wheel; and
an annular outer peripheral member (13) that is provided adjacent to and outside the inner peripheral member, wherein the outer peripheral member is rotatable relative to the inner peripheral member in a circumferential direction,
a plurality of inner guide portions (21) that is provided on the inner peripheral member (23) and define inner gas passages (22) between successive inner guide portions; and
a plurality of outer guide portions (11) that is provided on the outer peripheral member (13) and define gas passages (12) between successive outer guide portions,

wherein the flow of gas to the turbine wheel through the inner gas passages and the outer gas passages is adjusted by turning one of the outer peripheral member or the inner peripheral member with respect to the other of the outer peripheral member or the inner peripheral member so that the inner guide portions restrict the flow of the outer gas passages in accordance with the degree to which the outer peripheral member or the inner peripheral member is turned.

**2.** The turbocharger according to claim 1, wherein a flow rate of gas flowing through the inner gas passages (22) and the outer gas passages (12) changes in a continuous manner depending on the position of the outer peripheral member with respect to the inner peripheral member.

**3.** The turbocharger according to claim 1 or 2, wherein the flow of gas to the turbine wheel is shut off when the outer peripheral member (13) turns relative to the inner peripheral member (23) so that the inner guide portions (21) completely close the outer gas passages (12).

**4.** The turbocharger according to any one of claims 1 to 3, wherein the inner guide portions (21) are disposed on the inner peripheral member (23) such that outer peripheral edges (21a) of the inner guide portions (21) extend along an outer peripheral edge of the inner peripheral member (23), and
the outer guide portions (11) are disposed on the outer peripheral member (13) such that inner peripheral edges (11a) of the outer guide portions (11) extend along an inner peripheral edge of the outer peripheral member (13).

**5.** The turbocharger according to claim 4, wherein the outer guide portions (11) are disposed at regular intervals on the outer peripheral member (13).

**6.** The turbocharger according to claim 4 or 5, wherein the inner peripheral edge (12a) of each outer gas passages (12) is approximately the same with the outer peripheral edge (21a) of each inner guide portions (21).

**7.** The turbocharger according to claim 4 or 5, wherein the width of the outer peripheral edge (21a) of each inner guide portions (21) is longer than that of the inner peripheral edge (12a) of each outer gas passages (12).

**8.** The turbocharger according to any one of claims 4 to 6, wherein the width of the inner peripheral edge (11a) of each outer guide portions (11) is approximately the same with that of the inner peripheral edge (12a) of each outer gas passages (12).

**9.** The turbocharger according to any one of claims 1 to 8, wherein at least one of the inner peripheral member (23) and the outer peripheral member (13) turns.

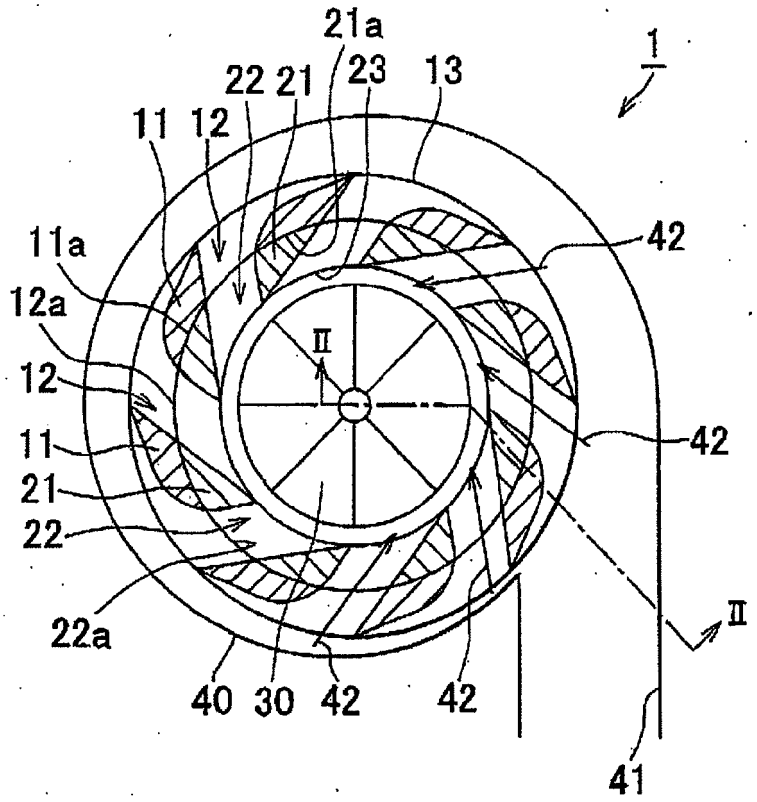
**10.** The turbocharger according to any one of claims 1 to 9, further comprising:

a housing (40) in which the turbine wheel (30) is accommodated,

wherein
a through hole (45) is formed in the housing that traverses the housing from a side that faces the inner guide portions (21) or the outer guide portions (11) to a side that faces a gas passage located downstream of the turbine wheel to bypass the turbine wheel, and

one end of the through-hole is closed by either the inner guide portions (21) or the outer portions (11) when the outer gas passages (12) are fully closed by the inner guide portions respectively, and the one end of the through-hole is not closed by the inner guide portions or the outer guide portions when the outer gas passages are fully open.

FIG. 1


21a
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22 21
23
13
11 12
11a
42
12a
II
12
42
11
21
22
II
22a
40 30 42
42
41

FIG. 2

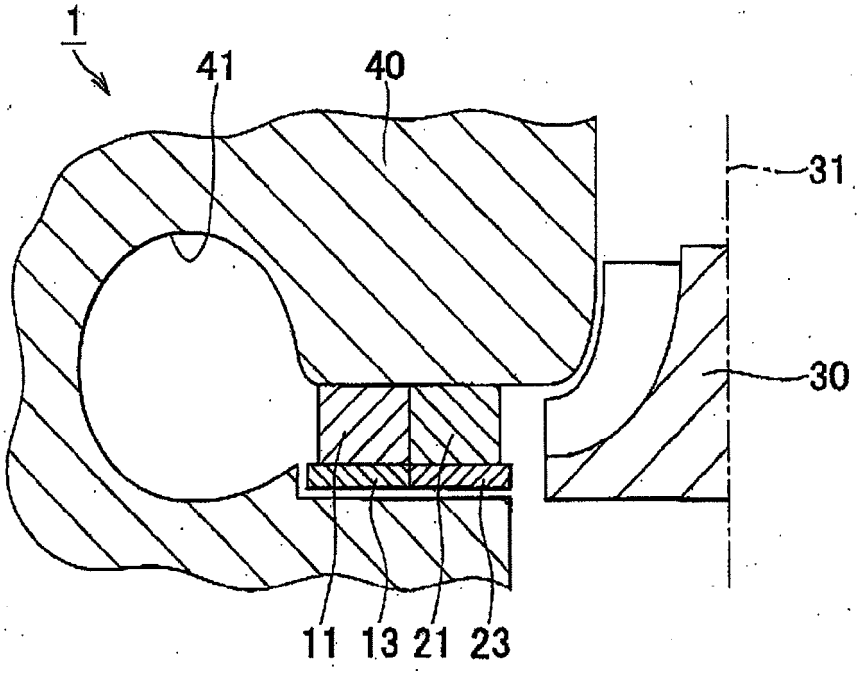
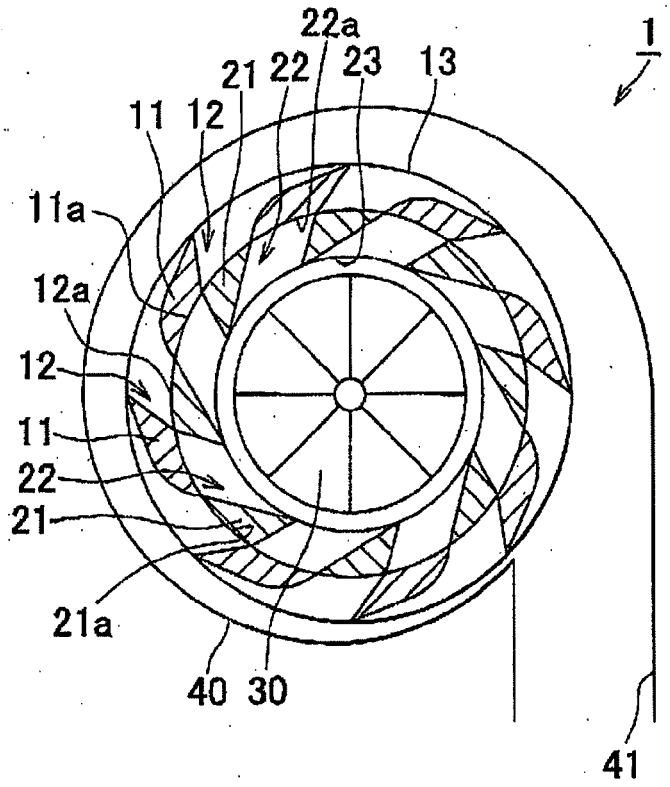

1
41
40
31
30
11 13 21 23

FIG. 3


22a
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13
11
12
11a
12a
12
11
22
21
21a
40
30
41

FIG. 4

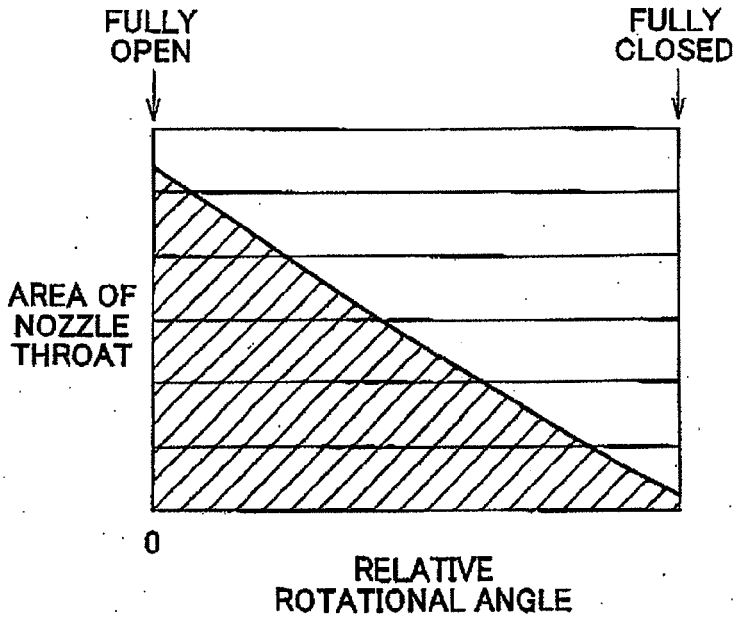

FULLY OPEN
FULLY CLOSED
AREA OF NOZZLE THROAT
0
RELATIVE ROTATIONAL ANGLE

FIG. 5

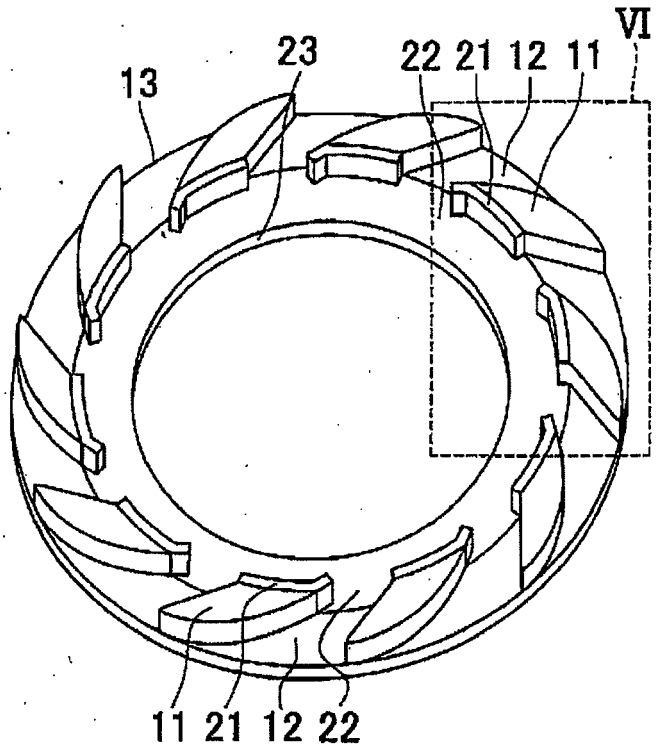

VI
23
22 21 12 11
13
11 21 12 22

FIG. 6

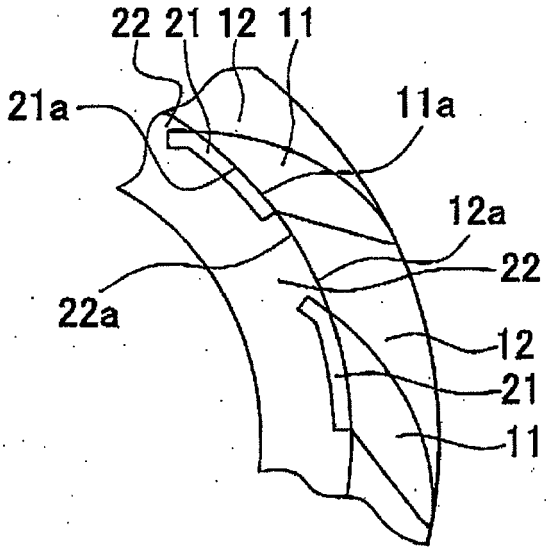

22 21 12 11
21a
11a
12a
22
22a
12
21
11

FIG. 7

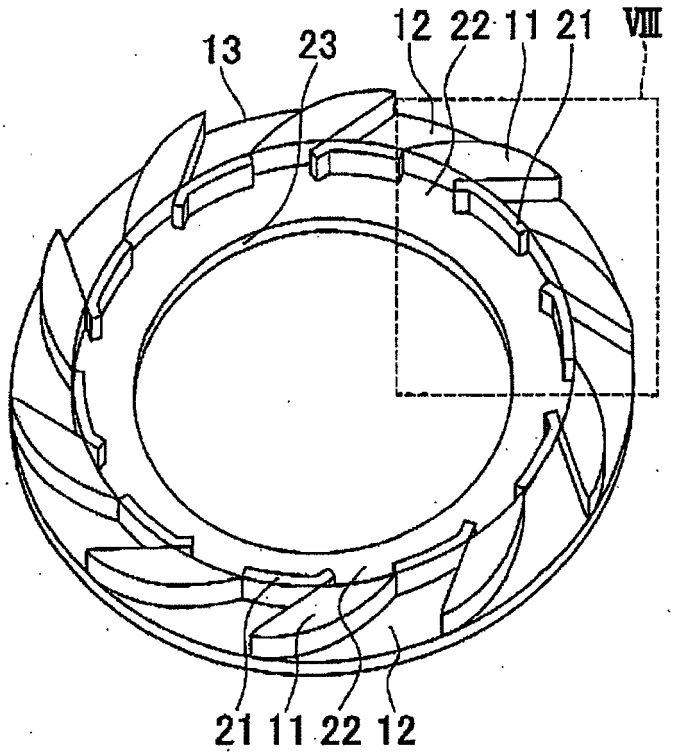
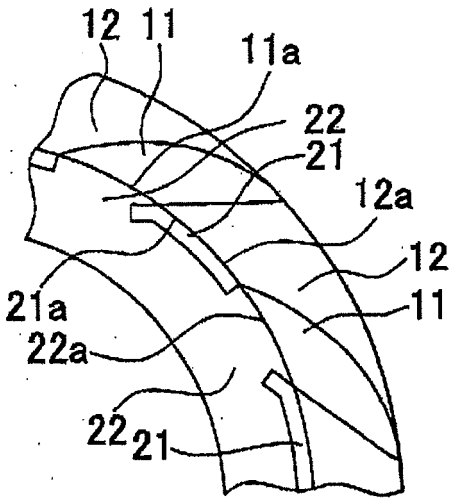

13
23
12 22 11 21
VIII
21 11 22 12

FIG. 8


12 11
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22 21

FIG. 9

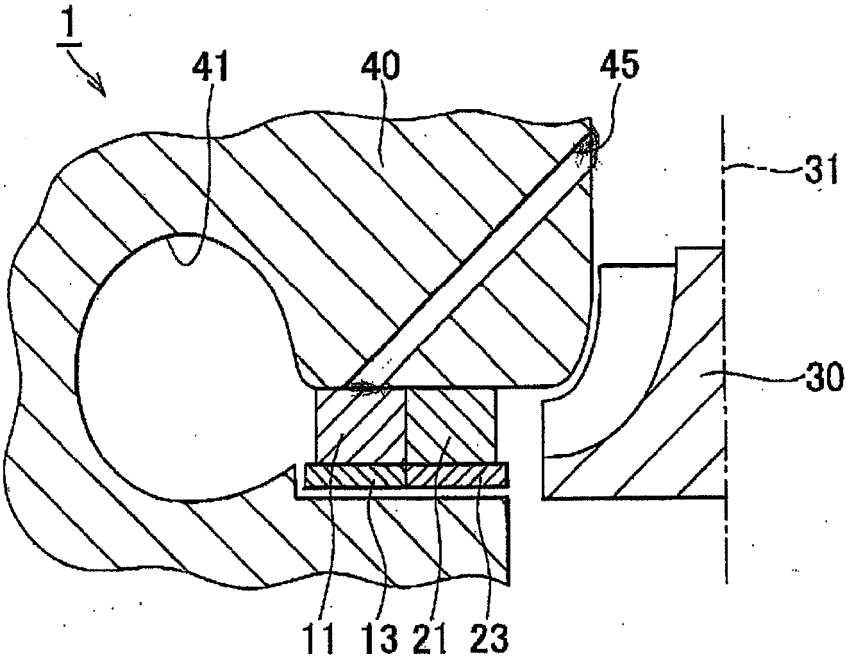
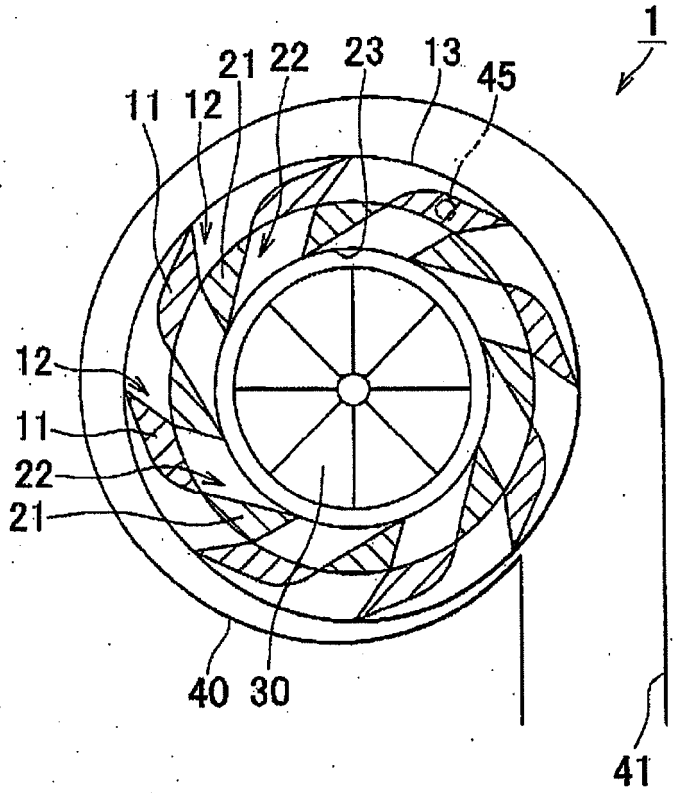



FIG. 10



## REFERENCES CITED IN THE DESCRIPTION

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- JP 11148364 A **[0003] [0003]**
- JP 10037754 A **[0004] [0004]**
- JP 5018258 A **[0005]**