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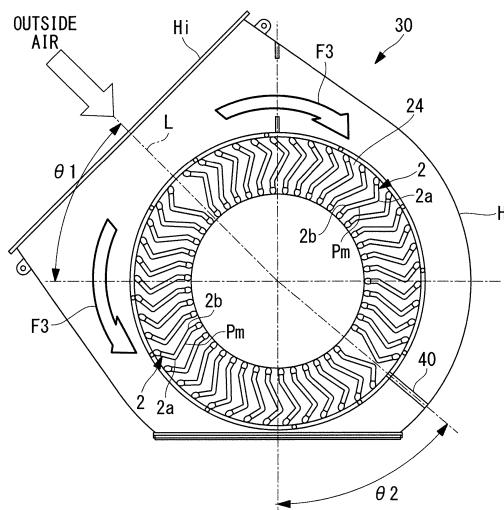
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(54) **SILENCER FOR SUPERCHARGER**

(57) This turbocharger silencer includes a suction housing (H) coupled to an outside-air introducing duct and that is attached to an air suction port of a turbocharger main body, to reduce noise of suction air introduced from radially outward with reference to a rotor shaft of the turbocharger main body, in which a plurality of sound absorbing splitters (2) are arranged radially with reference

to the rotor shaft of the turbocharger main body in the circumferential direction and are disposed such that the directions of apexes of some sound absorbing splitters (2) of the plurality of sound absorbing splitters (2) are different from those of apexes of the rest of the sound absorbing splitters (2).

FIG. 1



Description

{Technical Field}

[0001] The present invention relates to a turbocharger silencer to be applied to a turbocharger of a large bore diesel engine, such as a ship's engine, and particularly to the structure of a turbocharger silencer that is provided with a suction housing.

{Background Art}

[0002] Turbochargers that compress combustion air for an internal combustion engine and send high-density air to a combustion chamber have been conventionally known and are also widely used, for example, in ship diesel engines or large bore diesel engines for power plants. In such a turbocharger, a compressor for compressing combustion air and a turbocharger turbine serving as a driving source of the compressor are coaxially connected and accommodated in a casing and are rotated as a single unit. Note that the turbocharger turbine is driven by the energy of exhaust gas from the internal combustion engine.

[0003] In conventional turbochargers, a turbocharger silencer disclosed, for example, in PTL 1 is used in order to reduce noise produced by suction air. In this turbocharger silencer, sound absorbing splitters each having a double-bent shape (substantially Z-shape) are applied as silencer elements (sound absorbing bodies) to maintain the noise reduction performance and achieve a small pressure loss. The sound absorbing splitters are arranged in a suction air passage so that a plurality of the sound absorbing splitters are combined in the same direction.

[0004] Specifically, for example, in turbocharger silencers 1 and 1A shown in Figs. 4 and 5, sound absorbing splitters 2 are radially directed at an inlet portion of the suction air passage and arranged in a circumferential direction, with spaces therebetween.

[0005] Furthermore, in other turbocharger silencers, silencer elements obtained by combining sound absorbing splitters each having a curved shape (arc-like shape etc.) instead of a substantially Z-shape are employed.

[0006] Furthermore, a general turbocharger-silencer structure of a ship's engine has no air suction housing, as described in Fig. 4 illustrating a turbocharger silencer 1, for example. Thus, this silencer is of an inboard air suction type having a structure for suctioning air from radial directions with reference to a rotor shaft.

[0007] On the other hand, with a turbocharger-silencer structure of an outboard air suction type in which a duct for suctioning air is provided to suction air (outside air) directly from the outside of a ship, low-temperature air can be supplied from the outside of the ship to a turbocharger, thus increasing the combustion efficiency of the engine. In the silencer 1A of the outboard air suction type, a duct (not shown) through which suction air flows is con-

nected to a suction housing H that is provided so as to surround a silencer main body (the turbocharger silencer 1 shown in Fig. 4), for example, as shown in Fig. 5.

{Citation List}

{Patent Literature}

[0008] {PTL 1} Japanese Unexamined Patent Application, Publication No. H11-200969

{Summary of Invention}

{Technical Problem}

[0009] If silencer elements, such as the sound absorbing splitters 2 disclosed in the above-described PTL 1, are applied to the turbocharger silencer 1 of the inboard air suction type, which does not have the suction housing H as shown in Figs. 1 and 5 of this application, suction air passes from the same directions as suction-air flow directions of the silencer elements, as indicated by arrows F1 in Fig. 4. Thus, the turbocharger silencer 1 of the inboard air suction type allows almost uniform suctioning over the entire circumference of the silencer.

[0010] However, in the turbocharger silencer 1A of the outboard air suction type having the suction housing H shown in Figs. 1 and 5 of this application, the suctioning state of suction air at the circumference of the silencer is non-uniform relative to an axial line L of a suction-air inlet Hi formed in the suction housing H. Specifically, because the flow direction of suction air is limited by the suction housing H, the relationships between the cross-sectional shapes of the sound absorbing splitters 2 and suction-air flow directions F2 at both sides relative to the axial line L are substantially opposite between the both sides of the axial line L. Thus, the suctioning state of suction air becomes non-uniform at the circumference of the turbocharger silencer 1. As a result, in the conventional turbocharger silencer 1A having the suction housing H, there is a risk that the pressure loss in the silencer is increased, thereby reducing the turbocharger performance.

[0011] Considering such circumstances, in the turbocharger silencer 1A having the suction housing H, it is desired to achieve an improvement in turbocharger performance by improving the arrangement structure of silencer elements, such as the sound absorbing splitters 2 having suction-air flow directions.

[0012] The present invention is made in view of the above-described circumstances, and an object thereof is to provide a turbocharger silencer of an outboard air suction type having a suction housing, which is capable of resolving a situation in which the suctioning state of suction air at the circumference of the silencer becomes non-uniform relative to the axial line of a suction air inlet.

{Solution to Problem}

[0013] In order to solve the above-described problems, the present invention employs the following solutions.

[0014] The present invention provides a turbocharger silencer that includes a suction housing coupled to an outside-air introducing duct and that is attached to an air suction port of a turbocharger main body, wherein the turbocharger silencer reduces noise of suction air introduced from a radially outward position with reference to a rotor shaft of the turbocharger main body, wherein a plurality of silencer elements are arranged radially with reference to the rotor shaft of the turbocharger main body and are disposed such that the directions of apexes of some silencer elements of the plurality of silencer elements are different from those of apexes of the rest of the silencer elements.

[0015] According to this turbocharger silencer, the plurality of silencer elements are arranged radially with reference to the rotor shaft of the turbocharger main body and are disposed such that the directions of apexes of some silencer elements of the plurality of silencer elements are different from those of apexes of the rest of the silencer elements. Thus, the number of the silencer elements whose cross-sectional shapes have directions opposite to the suction-air flow directions are reduced, thereby making it possible to prevent a situation in which the suctioning state of suction air becomes non-uniform.

[0016] In the above-described invention, it is preferable that the plurality of silencer elements be arranged such that the directions of the apexes of the plurality of silencer elements with reference to the rotor shaft are different between the two sides of an axial line of a suction-air inlet opening of the suction housing. With this arrangement, it is possible to reliably prevent or reduce situations in which the silencer elements whose cross-sectional shapes have directions opposite to the suction-air flow directions. Then, because the flow velocity distribution of suction air is made uniform, and the suction distribution of suction air in the silencer also becomes uniform, it is possible to control a reduction in performance caused by separation or vortices.

[0017] Furthermore, in the above-described invention, it is desirable to further include a partition plate for preventing interference of flows of suction air in the suction housing.

[0018] A turbocharger according to the present invention includes a turbocharger silencer according to any one of the aforementioned configurations. Therefore, the number of the silencer elements whose cross-sectional shapes have directions opposite to the suction-air flow directions are reduced, thereby making it possible to prevent a situation in which the suctioning state of suction air becomes non-uniform.

{Advantageous Effects of Invention}

[0019] According to the above-described present in-

vention, it is possible to resolve a situation in which the suction-air suctioning states produced on the right and left sides with reference to the axial line of an inlet of suction air become non-uniform in the turbocharger silencer having a suction housing, thus preventing an increase of pressure loss in the silencer and a reduction of turbocharger performance.

{Brief Description of Drawings}

[0020]

{Fig. 1} Fig. 1 is a longitudinal sectional view (cross-sectional view in a direction perpendicular to a rotor shaft) showing an example arrangement of silencer elements in a suction air passage of a turbocharger silencer according to an embodiment of the present invention.

{Fig. 2} Fig. 2 is a diagram of a test result showing the relationship between the efficiency (vertical axis) and the compressor pressure ratio (horizontal axis) of a turbocharger provided with the turbocharger silencer shown in Fig. 1, comparing the result with that of a conventional structure.

{Fig. 3} Fig. 3 is a longitudinal sectional view (cross-sectional view in the direction of the rotor shaft) showing an example structure of an exhaust gas turbine turbocharger provided with the turbocharger silencer of the present invention.

{Fig. 4} Fig. 4 is a longitudinal sectional view showing an example conventional silencer-element arrangement in a turbocharger silencer of an inboard air suction type (without an air suction housing).

{Fig. 5} Fig. 5 is a longitudinal sectional view showing an example conventional silencer-element arrangement in a turbocharger silencer of an outboard air suction type (with an air suction housing).

{Description of Embodiment}

[0021] A turbocharger silencer according to an embodiment of the present invention will be described below with reference to Figs. 1 to 3.

[0022] Fig. 3 is a longitudinal sectional view showing an example structure of an exhaust gas turbine turbocharger provided with the turbocharger silencer of the present invention, and the turbocharger silencer of the present invention can be applied to such an exhaust gas turbine turbocharger 10.

[0023] The exhaust gas turbine turbocharger 10, shown in the figure, is an apparatus to be mounted, for example, on a ship diesel engine (for example, a low-speed two-cycle diesel engine) (not shown) to supply compressed air to an air supply manifold (not shown) that communicates with the inside of cylinder liners (not shown) that constitute the ship diesel engine.

[0024] As shown in Fig. 3, the exhaust gas turbine turbocharger 10 is constituted by integrally-fastening a gas

inlet casing 11, a gas outlet casing 12, a bearing housing 13, and a compressor-side air guiding casing 14 with bolts (not shown). A rotor shaft 15 is rotatably supported in the bearing housing 13 by a thrust bearing 16 and radial bearings 17 and 18, one end of the rotor shaft 15 is fixedly coupled to a turbine 19 that constitutes a turbine section, and the other end thereof is fixedly coupled to a compressor impeller (impeller) 20 that constitutes a compressor section.

[0025] The turbine 19, which is located at the one end of the rotor shaft 15, has a number of blades 19a on its outer periphery. The blades 19a are located between an exhaust-gas introduction passage 22 that is provided in the gas inlet casing 11 and an exhaust-gas discharge passage 23 that is provided in the gas outlet casing 12.

[0026] On the other hand, the compressor impeller 20, which is located at the other end of the rotor shaft 15, has a number of blades 20a on its outer periphery. The blades 20a are located at the downstream position of a suction-air introduction passage (suction air passage) 24 that is provided in the air guiding casing 14. The suction-air introduction passage 24 is connected to a scroll chamber 25 via the compressor impeller 20. Furthermore, the scroll chamber 25 is connected to a combustion chamber of the engine via a suction-air introduction passage (not shown).

[0027] The above-described exhaust gas turbine turbocharger 10 is provided with a turbocharger silencer 30 at an upstream side of the suction-air introduction passage 24. The turbocharger silencer 30 is an apparatus to be mounted at a stage (at an upstream side) before suction air to be compressed by the compressor section is suctioned into the suction-air introduction passage 24, specifically, at an upstream side of the inlet of the suction-air introduction passage 24, and has a filtering function for rectifying an airflow by making suction air pass there-through and a noise reduction function for absorbing noise produced by introducing air.

[0028] Furthermore, in the turbocharger silencer 30, an outside-air introducing duct (not shown) for introducing low-temperature air from the outside of the ship is connected to a suction housing (air suction housing) H that is provided so as to surround the outer periphery of a silencer main body 31. Therefore, the turbine turbocharger 10 serves as a turbocharger silencer of an out-board air suction type having the suction housing H.

[0029] As described above, the turbocharger silencer 30, shown in Fig. 1, is provided with the suction housing H, which is connected to the outside-air introducing duct, and is attached to an air suction port of the exhaust gas turbine turbocharger (turbocharger main body) 10, thereby reducing noise of suction air introduced from the radially outward with reference to the rotor shaft of the turbocharger main body via the suction-air introduction passage 24.

[0030] In the turbocharger silencer main body 31 of this embodiment, a plurality of sound absorbing splitters 2 serving as silencer elements are installed at an inlet

portion of the suction air passage 24.

[0031] Outer peripheries of the sound absorbing splitters 2 that are located along the axial direction of the rotor shaft 15 and that are not opposed to wall surfaces 32 and 33 of the silencer main body 31 are made of metal such as aluminum, and the sound absorbing splitters 2 are respectively surrounded with outer periphery walls Pm made of punching metal in which a number of through-holes are formed. Furthermore, the outer periphery walls Pm of the sound absorbing splitters 2 each have two bent portions 2a and 2b that are formed so as to be bent in opposite directions from each other. Therefore, the sound absorbing splitters 2 each have a substantially Z-shape in cross section as a whole.

[0032] These sound absorbing splitters 2 are arranged so as to reduce passage resistance with respect to the suction-air flow directions.

[0033] Specifically, when the sound absorbing splitters 2 of this embodiment are used, compared with a case in which apexes 2a of the bent portions (each of the apexes 2a is the convex-shaped portion of the radially-outside bent portion of the two bent portions 2a and 2b) in the substantially Z-shape in cross section are arranged so as to be all pointing in one direction (more specifically, as shown in Fig. 5, the apexes 2a of the bent portions of all of the sound absorbing splitters 2 are arranged so as to point to the left when viewed from the rotor shaft (in another example, the apexes 2a of the bent portions of all of the sound absorbing splitters 2 are arranged so as to point to the right when viewed from the rotor shaft), the passage resistance is reduced in a case in which the apexes 2a of the bent portions of the sound absorbing splitters 2 are arranged so as to point to downstream sides in the suction-air flow directions (that is, in the directions of arrows F3 shown in Fig. 1).

[0034] Thus, in the turbocharger silencer 30, which is provided with the suction housing H, the sound absorbing splitters 2 are arranged such that the directions of the apexes 2a of the bent portions of at least some of the sound absorbing splitters 2 are different from those of the other sound absorbing splitters 2, when viewed from the rotor shaft.

[0035] Here, a specific description will be given for an example arrangement of the sound absorbing splitters 2 of this embodiment. The sound absorbing splitters 2 shown in Fig. 1 are arranged such that the directions of the apexes 2a of the bent portions of the sound absorbing splitters 2 are different with reference to the rotor shaft, between the two sides of an axial line L of a suction-air inlet opening Hi of the suction housing H (for example, an axial line passing through an axial line of the rotor shaft and the center of the suction-air inlet opening). In other words, the sound absorbing splitters 2 are arranged such that the directions of the apexes 2a of the bent portions of the sound absorbing splitters 2 are substantially symmetric in cross section with respect to the axial line L. In this case, the axial line L of the suction-air inlet opening Hi is provided at an axial-line inclination angle $\theta 1$ from

a horizontal line. This axial-line inclination angle θ_1 falls within the range from 0 to 90 degrees, and an angle θ_2 on an outlet side falls within the range from 0 degrees to θ_1 . Therefore, when the axial-line inclination angle θ_1 is almost 0 degree, the arrangement of the apexes 2a of the bent portions of the sound absorbing splitters 2 may be apparently substantially symmetric in the vertical direction and with respect to the axial line L.

[0036] Furthermore, the turbocharger silencer 30 of this embodiment may be provided with a partition plate such that the flows of suction air do not interfere with each other in the suction housing. More preferably, a partition plate 40 may be provided on the axial line L of the suction-air inlet opening Hi and at a position in the suction housing that is opposite to the position of the suction-air inlet opening Hi, to prevent the flows of suction air from interfering.

[0037] Note that, in the example structure shown in the figure, although the numbers of sound absorbing splitters 2 on the right and left sides with respect to the axial line L are 23 and 22, which are different, such an arrangement in which the numbers of sound absorbing splitters that are directed differently are different from each other can also be considered to be substantially symmetric.

[0038] Specifically, on the right and left sides of the silencer 30 with respect to the axial line L, the sound absorbing splitters 2 are arranged such that the apexes 2a thereof are all pointing to the downstream sides in the suction-air flow directions and are radially directed at the inlet portion of the suction air passage 24 and arranged in a circumferential direction, with spaces between the sound absorbing splitters 2.

[0039] Note that it is desired that all sound absorbing splitters 2 existing in an area where the flow direction of suction air is opposite to a predetermined air flow direction be arranged such that the apexes 2a thereof point to the downstream side in the suction-air flow direction.

[0040] In this way, when the sound absorbing splitters 2 are arranged such that the directions of the apexes 2a of the bent portions of the sound absorbing splitters 2 become line-symmetric with respect to the axial line L, suction air (see the arrows F3 in Fig. 1) introduced into the suction housing H flows in the predetermined flow and is subjected to almost the same pressure loss regardless of whether the suction air flows through the right or left passage with respect to the axial line L. Therefore, the pressure loss is almost the same when suction air passes through either passage, and, as a result, it is possible to avoid a situation in which the suctioning state of suction air becomes non-uniform relative to the axial line L. Thus, it is possible to prevent an increase in pressure loss in the silencer and a reduction in turbocharger performance.

[0041] Therefore, when the silencer elements are symmetrically arranged with respect to the axial line L, the flow velocity distribution and the suction distribution of suction air in the suction housing H in a circumferential direction of the turbocharger silencer 30 are made uni-

form, thereby making it possible to prevent a reduction in turbocharger performance caused by flow separation or vortices.

[0042] As described above, the turbocharger to which the silencer of this embodiment is applied has improved supercharging efficiency at the time of low load compared with a conventional structure, as is clear from the test results shown in Fig. 2.

[0043] In the above-described embodiment, although a description has been given for the sound absorbing splitters 2 as example silencer elements, the present invention is not limited thereto, and it is needless to say that the present invention can be applied to other silencer elements having predetermined flow directions, such as those having arc-like cross sections, for example.

[0044] Note that the present invention is not limited to the above-described embodiment and can be appropriately changed without departing from the scope thereof.

{Reference Signs List}

[0045]

2 sound absorbing splitters (silencer elements)

2a, 2b apexes

10 exhaust gas turbine turbocharger

15 rotor shaft

20 compressor impeller

24 suction-air introduction passage

30 turbocharger silencer

31 silencer main body

32, 33 wall surfaces

H suction housing

Hi suction-air inlet opening

L axial line

Claims

1. A turbocharger silencer that comprises a suction housing coupled to an outside-air introducing duct and that is attached to an air suction port of a turbocharger main body, wherein the turbocharger silencer reduces noise of suction air introduced from a radially outward position with reference to a rotor shaft of the turbocharger main body, wherein a plurality of silencer elements are arranged radially with reference to the rotor shaft of the turbocharger main body and are disposed such that the directions of apexes of some silencer elements of the plurality of silencer elements are different from those of apexes of the rest of the silencer elements.
2. The turbocharger silencer according to claim 1, wherein the plurality of silencer elements are arranged such that the directions of the apexes of the plurality of silencer elements with reference to the rotor shaft are different between the two sides of an

axial line of a suction-air inlet opening of the suction housing.

3. The turbocharger silencer according to claim 1 or 2, further comprising a partiton plate for preventing interference of flows of suction air in the suction housing. 5
4. A turbocharger comprising a turbocharger silencer according to any one of claims 1 to 3. 10

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FIG. 1

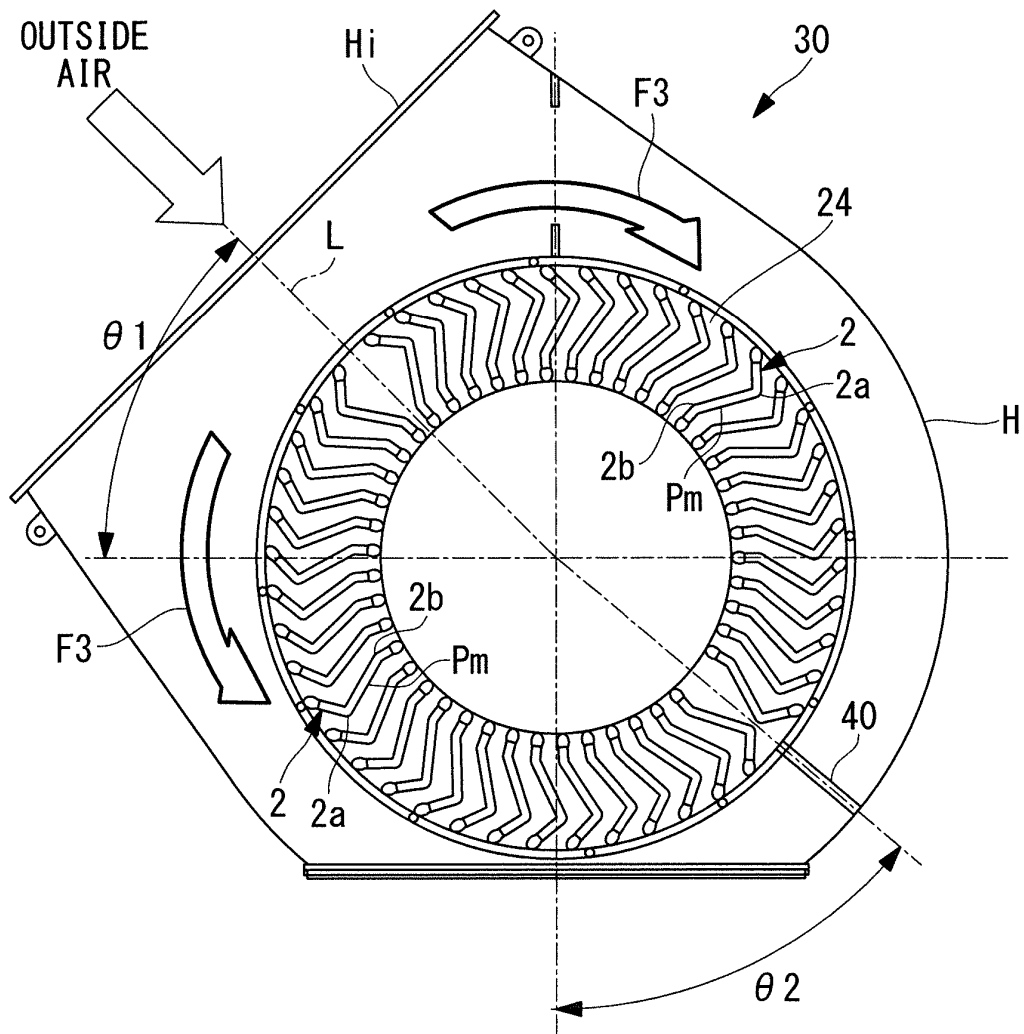


FIG. 2

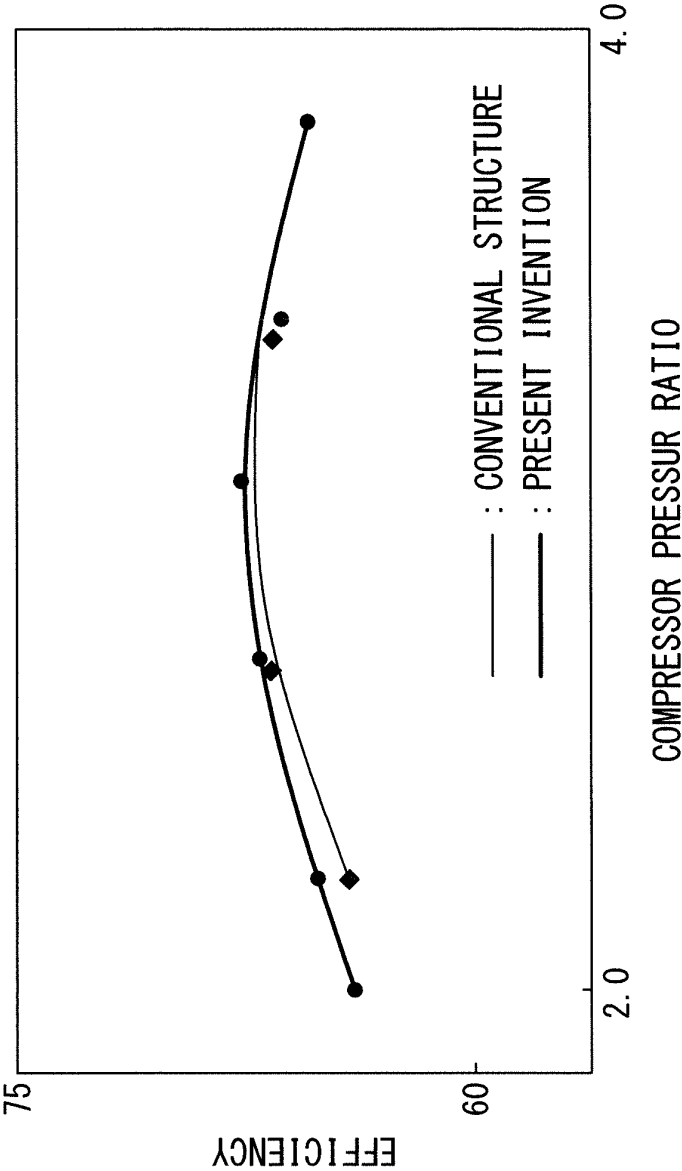


FIG. 3

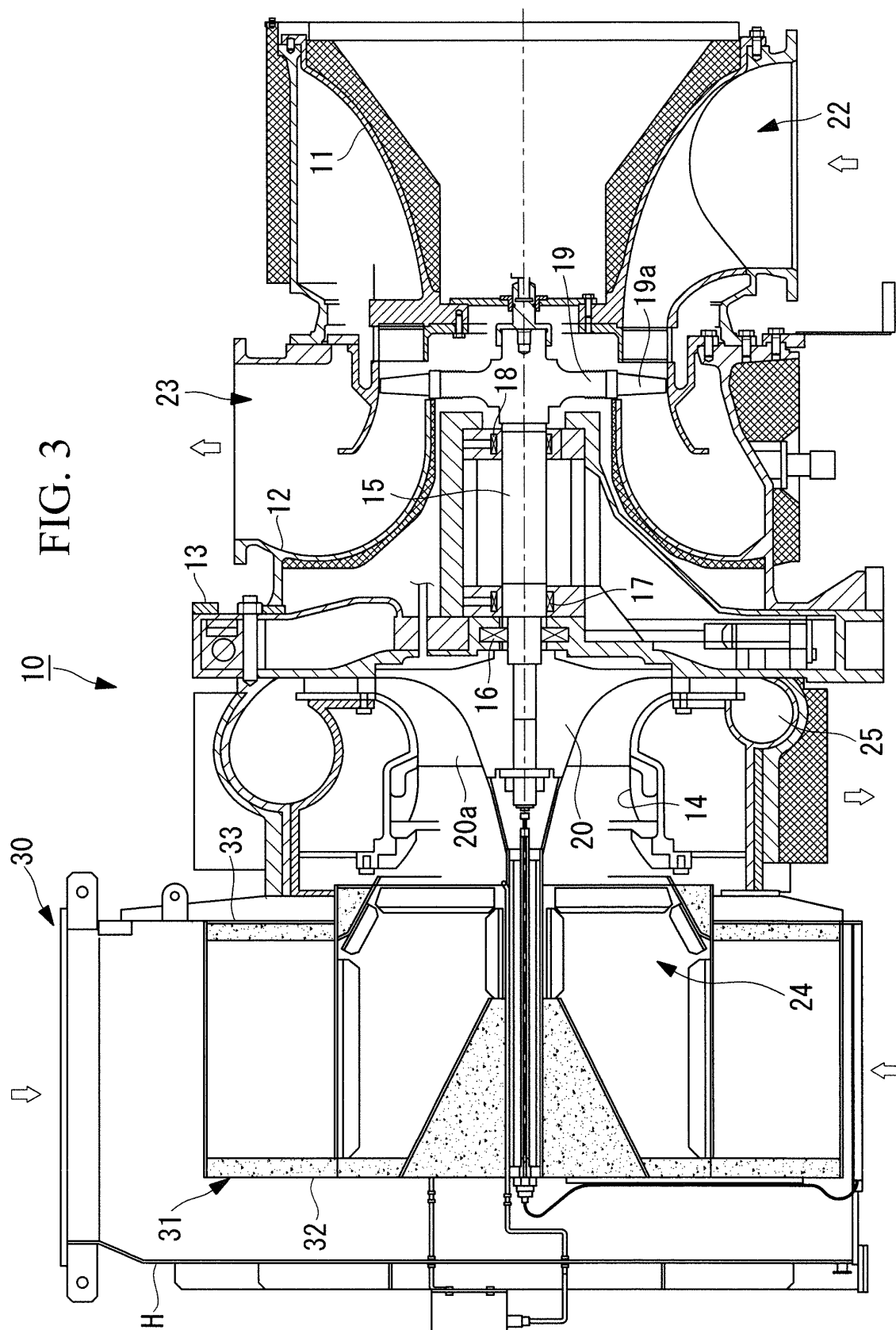


FIG. 4

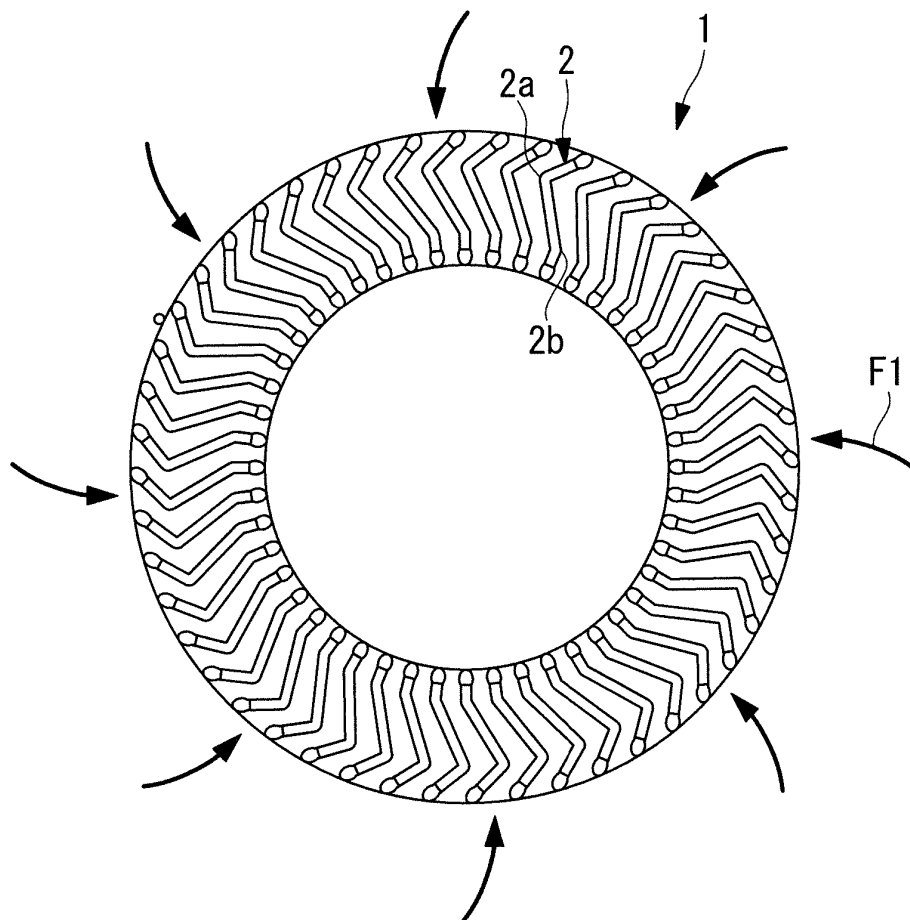
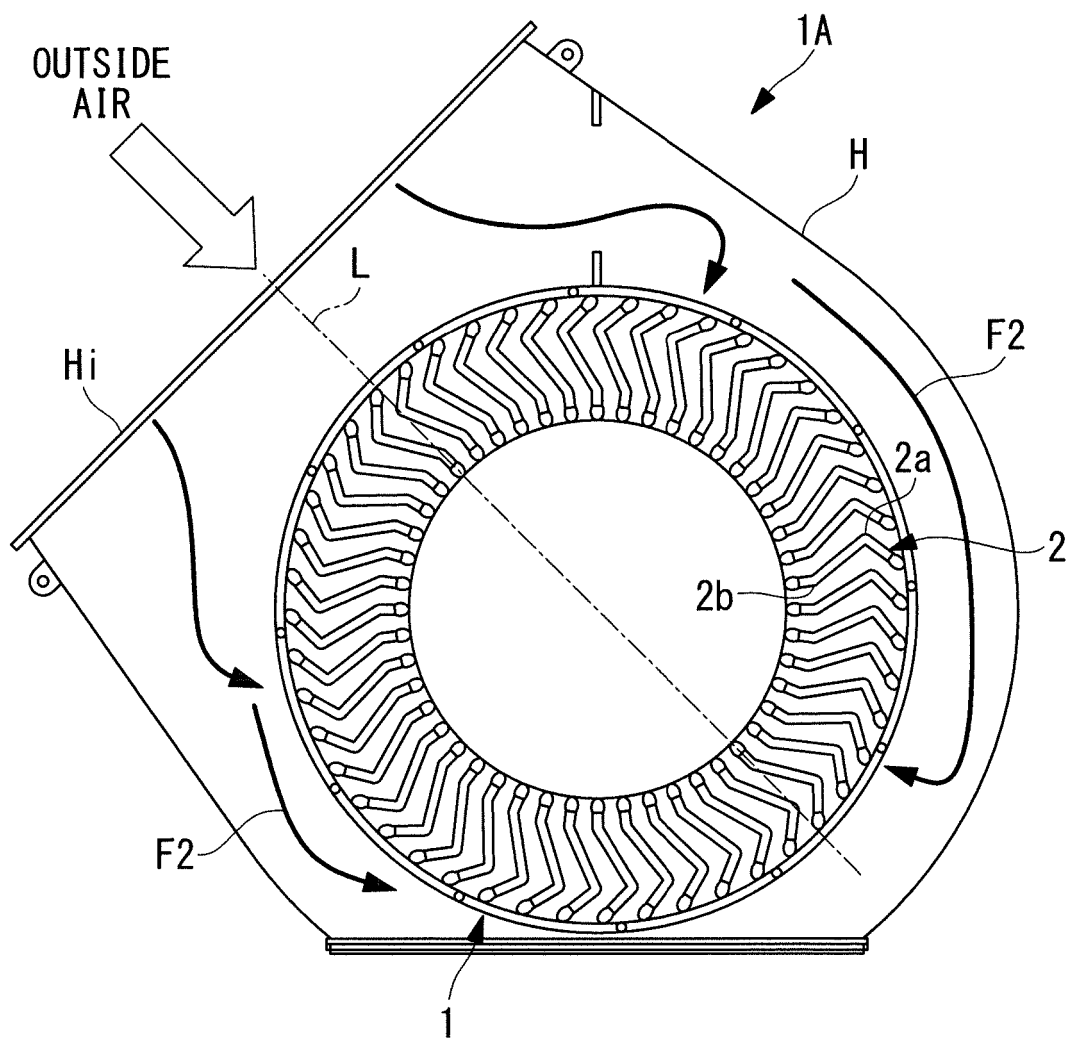


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/068001

A. CLASSIFICATION OF SUBJECT MATTER

F02M35/12(2006.01)i, F02B37/00(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)

F02M35/12, F02B37/00

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 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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 2006-194161 A (Mitsubishi Heavy Industries, Ltd.), 27 July 2006 (27.07.2006), paragraphs [0027] to [0034]; fig. 1 to 2 (Family: none)	1-4
A	JP 11-200969 A (Mitsubishi Aluminum Co., Ltd., Arupatec Kabushiki Kaisha, Mitsubishi Heavy Industries, Ltd.), 27 July 1999 (27.07.1999), paragraphs [0027] to [0049]; fig. 1 to 3 (Family: none)	1-4

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

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Date of the actual completion of the international search
01 September, 2014 (01.09.14)Date of mailing of the international search report
09 September, 2014 (09.09.14)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/068001

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 61-200372 A (MAN B & W Diesel GmbH), 04 September 1986 (04.09.1986), page 3, lower left column, line 3 to page 4, lower right column, line 12; fig. 1 to 8 & DE 3506452 A1 & FR 2577999 A1 & SU 1438622 A & US 4667769 A	1-4
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REFERENCES CITED IN THE DESCRIPTION

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