(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 582 693 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.07.2025 Bulletin 2025/28

(21) Application number: **23859739.7**

(22) Date of filing: **23.05.2023**

(51) International Patent Classification (IPC):
F04B 39/06 *(2006.01)* ***F04B 41/00*** *(2006.01)*
F04C 29/04 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04B 39/00; F04B 39/06; F04B 41/00; F04C 29/04; F04C 29/06

(86) International application number:
PCT/JP2023/019183

(87) International publication number:
WO 2024/047969 (07.03.2024 Gazette 2024/10)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **31.08.2022 JP 2022137648**

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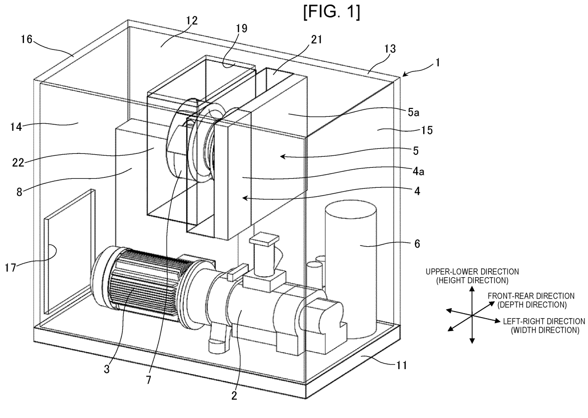
(54) PACKAGED GAS COMPRESSOR

(57) A packaged gas compressor includes a compressor body, a cooling fan, an air-cooling-type heat exchanger, and an enclosure for housing them. The enclosure has an intake port for cooling air in a side surface surrounding the components. The compressor body is arranged in a lower part of the enclosure. The cooling fan is arranged above the compressor body such that its rotation axis is orthogonal to the height direction of the enclosure. The heat exchanger is arranged at a position on the suction side of the cooling fan. The intake port is provided to overlap the compressor body in the height direction of the enclosure and is provided at a position closer to the cooling fan than to the heat exchanger. The compressor body is arranged to overlap, in the extending direction of the rotation axis of the cooling fan, an area between the heat exchanger and a facing surface of the side surface of the enclosure, the facing surface facing the inlet side of the heat exchanger into which the cooling air flows.

[FIG. 1]



EP 4 582 693 A1

Description

Technical Field

[0001] The present invention relates to a packaged gas compressor, and more specifically relates to a packaged gas compressor that air-cools components inside its package.

Background Art

[0002] A packaged gas compressor houses, inside its package, components such as a compressor body that compresses a gas, a prime mover that drives the compressor body, and a heat exchanger for cooling the compressed gas discharged from the compressor body or an oil to be supplied to the compressor body. In a packaged gas compressor, in order to prevent its components from overheating, cooling air induced by a cooling fan is often circulated inside the package to achieve heat dissipation.

[0003] For example, as a packaged gas compressor that causes cooling air to be distributed inside the package, there is one described in Patent Document 1. The package-type compressor described in Patent Document 1 has a first cooling air inlet and a second cooling air inlet that are formed respectively in one side surface and another side surface of the casing (the package), which accommodates a body unit integrating a compressor body and a motor at its lower part, and a cooling air outlet that is formed in the upper surface of the casing. In addition, a fan duct provided at an upper part of the casing accommodates a cooling fan, and the cooling fan is arranged such that its rotation shaft extends in a vertical direction. An air-cooling-type heat exchanger is arranged above the delivery port of the fan duct and below the cooling air outlet. The package-type compressor is configured such that the cooling fan induces the flow of cooling air taken in through the first and second cooling air inlets and discharged through the cooling air outlet.

Prior Art Document

Patent Document

[0004] Patent Document 1: WO 2017/195242

Summary of the Invention

Problem to be Solved by the Invention

[0005] In the package-type compressor described in Patent Document 1, it is to improve the cooling performance for cooling the body unit by forming a plurality of the cooling air inlets (intake ports) in the casing (the package) to increase the total opening area of the package However, as the total opening area of the intake ports increases, noise emitted from the intake ports also tends to increase. In the package-type compressor described in Patent Document 1, if the total opening area of the intake ports is reduced without changing the arrangement of its components inside the package in order to reduce noise, there is a concern that the cooling performance will be undesirably lowered due to the decrease in the flow rate of cooling air to be taken into the package. Because of this, it is demanded to achieve both noise reduction and cooling performance.

[0006] The present invention has been made to solve the problem described above, and an object thereof is to provide a packaged gas compressor that can maintain the integrity of the cooling performance while noise being reduced.

Means for Solving the Problem

[0007] The present application includes a plurality of means for solving the problem described above. An example thereof is a packaged gas compressor including: a compressor body that compresses a gas; a cooling fan that rotates around a rotation axis to induce cooling air; an air-cooling-type heat exchanger that cools a fluid introduced from the compressor body by passage of the cooling air; and an enclosure that houses the compressor body, the cooling fan, and the heat exchanger. The enclosure has an intake port for the cooling air through a side surface surrounding the compressor body, the cooling fan, and the heat exchanger. The compressor body is arranged in a lower part of the enclosure. The cooling fan is arranged above the compressor body such that the rotation axis is orthogonal to a height direction of the enclosure. The heat exchanger is arranged at a position on a suction side of the cooling fan. The intake port is provided to overlap the compressor body in the height direction of the enclosure, and is provided at a position closer to the cooling fan than to the heat exchanger. The compressor body is arranged to overlap, in an extending direction of the rotation axis of the cooling fan, an area between the heat exchanger and a facing surface of the side surface of the enclosure, the facing surface facing an inlet side of the heat exchanger into which the cooling air flows.

Advantages of the Invention

[0008] According to an example of the present invention, the cooling fan arranged above the compressor body is arranged such that the rotation axis is orthogonal to the height direction of the enclosure, the heat exchanger is arranged at a position on the suction side of the cooling fan, and the intake port is provided at the height of the compressor body and at a position closer to the cooling fan than to the heat exchanger. This causes the flow of the cooling air to be deflected so as to turn around in a U-shape from the lower side to the upper side inside the enclosure and flow into a large area of the heat exchanger. Furthermore, arranging the compressor body so as to overlap the area between the heat exchanger and the side surface of the enclosure causes the compressor body to be positioned in an area where the cooling air is caused to turn around in the U-shape. Thus, the cooling performance for the compressor body can be enhanced more than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the height direction of the enclosure and a heat exchanger is arranged downstream of the cooling fan. Accordingly, the integrity of the cooling performance can be maintained while noise being reduced by reducing the opening area of the intake port, or the like.

[0009] Problems, configurations, and advantages other than those described above are made clear by the following explanation of embodiments.

Brief Description of the Drawings

[0010]

FIG. 1 is a perspective view of a packaged gas compressor according to a first embodiment of the present invention as seen from the rear side.

FIG. 2 is a rear view of the packaged gas compressor according to the first embodiment depicted in FIG. 1.

FIG. 3 is a top view of the packaged gas compressor according to the first embodiment depicted in FIG. 1.

FIG. 4 is a figure of a cooling fan and intake/exhaust ducts configuring part of the packaged gas compressor according to the first embodiment depicted in FIG. 1 as seen from a side where a right side panel is present.

FIG. 5 is a top view depicting a packaged gas compressor according to a modification example of the first embodiment of the present invention.

FIG. 6 is a top view depicting a packaged gas compressor according to a second embodiment of the present invention.

Modes for Carrying Out the Invention

[0011] Hereinafter, embodiments of a packaged gas compressor according to the present invention are illustratively explained using the figures. In the present embodiments, a screw-type compressor is explained as an example of a gas compressor. However, the present invention can be applied also to a scroll-type, reciprocating-type, or turbo-type compressor.

[First Embodiment]

[0012] The configuration of a packaged gas compressor according to a first embodiment is explained using FIG. 1 to FIG. 4. FIG. 1 is a perspective view of the packaged gas compressor according to the first embodiment of the present invention as seen from the rear side. FIG. 2 is a rear view of the packaged gas compressor according to the first embodiment depicted in FIG. 1. FIG. 3 is a top view of the packaged gas compressor according to the first embodiment depicted in FIG. 1. FIG. 4 is a figure of a cooling fan and intake/exhaust ducts included as part of the packaged gas compressor according to the first embodiment depicted in FIG. 1 as seen from a side where a right side panel is present. In FIG. 1, a package and ducts are in a transparent state. In FIG. 2, a rear side panel and the ducts are in a transparent state. In FIG. 3, a top panel is in a transparent state. In FIG. 4, an exhaust duct is in a transparent state. Note that, in this explanation, the left-right direction represents the left-right direction of the packaged gas compressor as seen from the front side.

[0013] In FIG. 1, the packaged gas compressor houses various components including a compressor body 2 inside an enclosure 1 as the package. The components of the packaged gas compressor includes: the compressor body 2 that compresses a gas; a prime mover 3 that drives the compressor body 2; an air cooler 4 that cools a compressed gas (a fluid) discharged from the compressor body 2; an oil cooler 5 that cools a lubricant (a fluid) to be supplied to the compressor body 2; an oil tank 6 that temporarily stores the lubricant (the fluid) to be supplied to the compressor body 2; a cooling fan 7 that induces cooling air inside the enclosure 1; a starting panel 8 having a control circuit that controls driving of the prime mover 3 and the cooling fan 7; and the like. The compressor body 2 is a screw-type compressor including a screw rotor with twisted lobes, for example. The prime mover 3 is an electric motor that rotates around a rotation axis Am (see FIG. 2 and FIG. 3), for example. The air cooler 4 is an air-cooling-type heat exchanger that cools a compressed gas introduced from the compressor body 2 by passage of the cooling air, and has an inlet surface 4a through which the cooling air flows in. The oil cooler 5 is an air-cooling-type heat exchanger that cools a lubricant introduced from the compressor body 2 by passage of the cooling air, and has an inlet surface 5a through which the cooling air flows in. The cooling fan 7 is a centrifugal fan that rotates around a rotation axis Af (see FIG. 2 and FIG. 3), and contains therein a fan motor, for example.

[0014] The enclosure 1 has: a base 11; a side panel with a tubular shape, which rises from the periphery of the base 11 and surrounds the components 2, 3, 4, 5, 6, 7, and 8; and a top panel 12 that closes the upper end opening of the side panel, for example. The base 11 is formed in a rectangular shape as seen from the upper side, for example. The side panel includes; a front side panel 13; a rear side panel 14 facing the front side panel 13; a left side panel 15 connected to a left end of the front side panel 13 and a left end of the rear side panel 14; and a right side panel 16 connected to a right end of the front side panel 13 and a right end of the rear side panel 14, for example. On the front side panel 13 are arranged an operation switch, a monitor, and the like which are not depicted.

[0015] The compressor body 2 and the electric motor 3 are integrated such that their axial directions are parallel to each other to configure one body unit. The body unit 2 and 3 is arranged on the lower side in the enclosure 1, for example, on the base 11, as depicted in FIG. 1 and FIG. 2. The body unit 2 and 3 is installed horizontally such that the axial direction of the compressor body 2 and the rotation axis Am of the electric motor 3 are approximately parallel to the installation surface of the base 11. The body unit 2 and 3 is arranged to extend in the left-right direction (the width direction of the enclosure 1) between the left side panel 15 and the right side panel 16, and arranged at a position closer to the rear side panel 14 than to the front side panel 13 in the enclosure 1 (on a side where the rear side panel 14 is present), as depicted in FIG. 1 and FIG. 3. The body unit 2 and 3 is arranged such that the compressor body 2 is positioned on a side where the left side panel 15 is present and the electric motor 3 is positioned on a side where the right side panel 16 is present.

[0016] On a side where the front side panel 13 is present in the enclosure 1, as depicted in FIG. 1 and FIG. 3, the oil tank 6 and the starting panel 8 are arranged, for example. The oil tank 6 is arranged on a side where the left side panel 15 is present, so as to be adjacent to the compressor body 2, for example. The oil tank 6 is a container extending in the upper-lower direction, and is installed on the base 11, for example, as depicted in FIG. 1 and FIG. 2. The starting panel 8 is installed on the base 11 and is arranged on a side where the right side panel 16 is present, so as to be adjacent to the electric motor 3 along the front side panel 13, for example, as depicted in FIG. 1 to FIG. 3.

[0017] The cooling fan 7, the air cooler 4, and the oil cooler 5 are arranged on the upper side in the enclosure 1, as depicted in FIG. 1 and FIG. 2. That is, the cooling fan 7, the air cooler 4, and the oil cooler 5 are positioned above the body unit 2 and 3. The cooling fan 7 is arranged such that the rotation axis Af is orthogonal to the height direction of the enclosure 1 and is approximately parallel to the rotation axis Am of the electric motor 3 (the axial direction of the compressor body 2), as depicted in FIG. 1 to FIG. 3. That is, the cooling fan 7 is arranged such that the rotation axis Af extends in the left-right direction (the width direction of the enclosure 1). The cooling fan 7 is arranged such that its position in the left-right direction (the width direction of the enclosure 1) overlaps part of the electric motor 3, and such that its suction side faces the compressor body 2 (the left side panel 15), for example.

[0018] The air cooler 4 and the oil cooler 5 are arranged on the suction side of the cooling fan 7 (on the upstream side of the flow of cooling air). The air cooler 4 and the oil cooler 5 are connected to the cooling fan 7 via a fan intake duct 21. The fan intake duct 21 rectifies the flow of the cooling air from the air cooler 4 and the oil cooler 5 to the cooling fan 7. The air cooler 4 and the oil cooler 5 are each arranged such that the inlet surface 4a and the inlet surface 5a for the cooling air are orthogonal to the rotation axis Af of the cooling fan 7. The air cooler 4 and the oil cooler 5 are arranged side by side relative to the rotation axis Af of the cooling fan 7, and their inlet surfaces 4a and 5a form one inlet surface for the cooling air, for example. The air cooler 4 and the oil cooler 5 are arranged such that their positions in the left-right direction (the width direction of the enclosure 1) overlap part of the compressor body 2, for example, as depicted in FIG. 2 and FIG. 3. Specifically, the compressor body 2 is arranged so as to overlap, in the extending direction of the rotation axis Af of the cooling fan 7, an area between the air cooler 4 and oil cooler 5 and the left side panel 15 (a side panel in the extending direction of the rotation axis Af of the cooling fan 7 among the side panels of the enclosure 1, the side panel facing the inlet side of the air cooler 4 and the oil cooler 5 in which the cooling air flows in), as depicted in FIG. 2 and FIG. 3. In addition, the air cooler 4 and the oil cooler 5 are arranged such that the rotation axis Af of the cooling fan 7 is placed at a position closer to the oil cooler 5.

[0019] The cooling fan 7 is housed inside an exhaust duct 22 arranged in the enclosure, for example, as depicted in FIG. 1. An outlet of the exhaust duct 22 is connected to an exhaust port 19 of the top panel 12 of the enclosure 1, and the exhaust duct 22 introduces the cooling air delivered from the cooling fan 7 to the exhaust port 19 described later. The exhaust duct 22 is a square duct whose flow-path cross-section is rectangular, for example, and is configured such that the centerline Cd of the exhaust duct 22 extends in the height direction (the upper-lower direction) of the enclosure 1. The cooling fan 7 is configured to rotate counterclockwise as seen from a side where the right side panel 16 is present, for example, as depicted in FIG. 4. The cooling fan 7 is arranged in the exhaust duct 22 such that the rotation axis Af does not cross the centerline Cd of the exhaust duct 22, but is offset toward the front side panel 13, as depicted in FIG. 3 and FIG. 4. That is, the cooling fan 7 is arranged in the exhaust duct such that the rotation axis Af is offset from the centerline Cd of the exhaust duct 22 toward an area where the rotation direction of the cooling fan 7 is a downward direction in the height direction of the enclosure as seen from one side of the extending direction of the rotation axis Af.

[0020] The right side panel 16 among the side panels of the enclosure 1 is provided, at a portion on the lower side and on a side where the rear side panel 14 is present, with an intake port 17 for taking external air (cooling air) into the enclosure 1, as depicted in FIG. 1 to FIG. 3. That is, the intake port 17 is provided to overlap the body unit 2 and 3 in the height direction (the upper-lower direction) of the enclosure 1, and to be positioned in the extending direction of the rotation axis Af of the cooling fan 7. In addition, the intake port 17 is provided closer to the electric motor 3 of the body unit 2 and 3. That is, the intake port 17 is provided at a position closer to the cooling fan 7 than to the air cooler 4 and the oil cooler 5. The enclosure 1 of the present embodiment has only one intake port 17 formed therein. The top panel 12 of the enclosure 1 is provided with the exhaust port 19 for exhausting the cooling air to the outside of the enclosure 1.

[0021] Next, operation and effects and advantages of the packaged gas compressor according to the first embodiment are explained using FIG. 1 to FIG. 4. Note that, in FIG. 2, broken-line arrows represent the flow of cooling air. In FIG. 3, broken-line thick arrows represent the flow of cooling air.

[0022] In the packaged gas compressor with the configuration described above, the compressor body 2 depicted in FIG. 1 is driven by the electric motor 3 to compress a gas and the high-temperature compressed gas is discharged from the compressor body 2 to be introduced into the air cooler 4. At this time, the compressor body 2 itself is heated due to the compression of the gas and the electric motor 3 itself also generates heat. In addition, an oil in the oil tank 6 is supplied to the compressor body 2 via the oil cooler 5 and the oil whose temperature has been raised by the compressor body 2 returns to the oil tank 6.

[0023] At this time, the cooling fan 7 is driven to induce cooling air in the enclosure 1. This cooling air cools the compressor body 2 and the electric motor 3, and cools the compressed gas flowing in the air cooler 4 and the oil flowing in the oil cooler 5.

[0024] Specifically, as depicted in FIG. 2 and FIG. 3, the cooling air (external air) flows in through the intake port 17 provided on the lower side of the right side panel 16 of the enclosure 1, and flows toward the left side panel 15. The cooling air having flowed in through the intake port 17 first flows through the area of the electric motor 3 and starting panel 8 that are at a height similar to that of the intake port 17, and thereafter flows through the area of the compressor body 2 and oil tank 6. That is, the cooling air flows, on the lower side in the enclosure 1, along the axial directions of the compressor body 2 and electric motor 3 (the extending direction of the body unit). This cools the electric motor 3, the starting panel 8, the compressor body 2, and the oil tank. This cooling air changes in its flow direction near the left side panel 15 so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1, passes through the air cooler 4 and the oil cooler 5, and then is sucked in into the cooling fan 7. The cooling air having been sucked into the cooling fan 7 is exhausted from the exhaust port 19 of the top panel 12 of the enclosure 1 via the exhaust duct 22.

[0025] In the present embodiment, the cooling fan 7 is installed such that the rotation axis Af of the cooling fan 7 is parallel to the installation surface of the base 11 of the enclosure 1, and the air cooler 4 and the oil cooler 5 as heat exchangers are arranged on the suction side of the cooling fan 7. This configuration causes the flow of the cooling air to change in its direction so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1, and to pass through large areas of the inlet surface 4a of the air cooler 4 and the inlet surface 5a of the oil cooler 5. Thereby, the flow of cooling air on an upstream side of the cooling fan 7 is rectified such that the imbalance of speed distribution (pressure loss) of the cooling air is reduced. Because of this, the radius of the cooling air flow that changes in its direction from the lower side to the upper side in the enclosure 1 becomes smaller than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the upper-lower direction of the enclosure 1, and the cooling air on the upstream side of the cooling fan 7 flows over an area larger than an area in the case of a configuration in which the air cooler 4 and the oil cooler 5 are arranged on the delivery side of the cooling fan 7. Because of this, the cooling air that is deflected from the lower side to the upper side in the enclosure 1 and that heads toward the air cooler 4 and the oil cooler 5 gets to flow to the vicinity of the position of an end of the compressor body 2 on a side where the left side panel 15 is present, and to the vicinity of the arrangement position of the oil tank 6, thereby efficiently cooling the compressor body 2 and the oil tank 6.

[0026] In addition, in the case of this configuration, the speed of cooling air in an area where the cooling air turn around in a U-shape from the lower side to the upper side in the enclosure 1 is faster than the speed of cooling air at the time when it flows on the lower side in the enclosure 1. In view of this, in the present embodiment, most part of the compressor body 2 and the oil tank 6 are arranged between the oil cooler 5 and the left side panel 15 (a side panel positioned in the extending direction of the rotation axis Af of the cooling fan 7 and on the suction side of the cooling fan 7), as seen from the upper side of the enclosure 1. In this case, at the positions of the compressor body 2 and the oil tank 6, the cooling air is deflected so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1. Accordingly, the compressor body 2 and the oil tank 6 are cooled efficiently by the cooling air at a relatively high speed.

[0027] In addition, as described above, the cooling fan 7 is installed such that the rotation axis Af is parallel to the installation surface of the base 11 of the enclosure 1. In the case of this configuration, it is possible to make the opening area of the exhaust port 19 smaller than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the upper-lower direction of the enclosure 1. Because of this, it is possible to reduce noise through the exhaust port 19 by reducing the opening area of the exhaust port 19.

[0028] In addition, in the present embodiment, the air cooler 4 and the oil cooler 5 positioned on the suction side of the cooling fan 7 are arranged side by side. In the case of this configuration, the area of cooling air rectified by the air cooler 4 and the oil cooler 5 located upstream of the cooling fan 7 becomes large. This increases the degree of freedom of the arrangement of the cooling fan 7.

[0029] In addition, in the present embodiment, as seen from one side of the extending direction of the rotation axis Af of the cooling fan 7, the cooling fan 7 is arranged inside the exhaust duct 22 such that the rotation axis Af is offset, relative to the centerline Cd of the exhaust duct 22 extending in the upper-lower direction, toward an area where the rotation direction of the cooling fan 7 is a downward direction. In the case of this configuration, the flow path of cooling air delivered from the cooling fan 7 and flowing to the upper side toward the exhaust port 19 is larger than the flow path of cooling air flowing toward the lower side. Accordingly, the pressure loss of cooling air decreases, and the amount of cooling air can be increased.

[0030] In addition, in the present embodiment, the cooling fan 7 is arranged such that the rotation axis Af of the cooling fan 7 is positioned closer to the oil cooler 5 in comparison between the air cooler 4 and the oil cooler 5 arranged side by side. Due to this configuration, it is possible to make greater the amount of cooling air for the oil cooler 5 whose heat exchange amount is greater than that of the air cooler 4, than the amount of cooling air for the air cooler 4.

[0031] Meanwhile, in a packaged gas compressor, a side surface of a package provided with an intake port needs to have a certain distance from a wall that is present in an installation location, so as to prevent intake air from being obstructed. That is, the packaged gas compressor has a restriction of its installation position depending on the intake port of the package. In the present embodiment, the only one intake port 17 is provided for the enclosure 1. Because of this, the side panels 13, 14, and 15 of the enclosure 1 other than the right side panel 16 provided with the intake port 17 are need not to have predetermined distances from walls that are present in an installation location of the packaged gas compressor. Accordingly, there are not so many constraints on the installation location of the packaged gas compressor, the degree of freedom of the installation location of the packaged gas compressor is high, and it is possible to save space of the installation location.

[0032] Note that, in the present embodiment, a configuration is possible in which the rotation direction of the electric motor 3 and the rotation direction of the cooling fan 7 are made opposite directions. In this case, vibrations of the electric motor 3 and vibrations of the cooling fan 7 cancel out each other, overall vibrations of the packaged gas compressor can be reduced.

[0033] As described above, the packaged gas compressor according to the first embodiment includes: the compressor body 2 that compresses a gas; the cooling fan 7 that rotates around the rotation axis Af to induce cooling air; the air-cooling-type air cooler 4 and oil cooler 5 (the heat exchangers) that cools a compressed gas and a lubricant (fluids) introduced from the compressor body 2 by passage of the cooling air; and the enclosure 1 that houses the compressor body 2, the cooling fan 7, the air cooler 4 and the oil cooler 5 (the heat exchangers). The enclosure 1 has the intake port 17 for the cooling air through the side surface 13, 14, 15, and 16 surrounding the compressor body 2, the cooling fan 7, the air cooler 4 and the oil cooler 5 (the heat exchangers). The compressor body 2 is arranged in a lower part of the enclosure 1. The cooling fan 7 is arranged above the compressor body 2 and is arranged such that the rotation axis Af is orthogonal to the height direction of the enclosure 1. The air cooler 4 and the oil cooler 5 (the heat exchangers) are arranged at positions on the suction side of the cooling fan 7. The intake port 17 is provided so as to overlap the compressor body 2 in the height direction of the enclosure 1, and is provided at a position closer to the cooling fan 7 than to the air cooler 4 and the oil cooler 5 (the heat exchangers). The compressor body 2 is arranged to overlap, in the extending direction of the rotation axis Af of the cooling fan 7, an area between the air cooler 4 and oil cooler 5 (the heat exchangers) and the left side panel 15 which is a facing surface of the side surface 13, 14, 15, and 16 of the enclosure 1 facing the inlet side of the air cooler 4 and the oil cooler 5 (the heat exchangers) into which the cooling air flows.

[0034] According to this configuration, the cooling fan 7 arranged above the compressor body 2 is arranged such that its rotation axis Af is orthogonal to the height direction of the enclosure 1, the air cooler 4 and the oil cooler 5 (the heat exchangers) are arranged at positions on the suction side of the cooling fan 7, and the intake port 17 is provided at the height of the compressor body 2 and at a position closer to the cooling fan 7 than to the air cooler 4 and the oil cooler 5 (the heat exchangers). This causes the flow of cooling air to be deflected so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1 and flow into a large area of the air cooler 4 and the oil cooler 5 (the heat exchangers). Furthermore, arranging the compressor body 2 to overlap the area between the air cooler 4 and oil cooler 5 (the heat exchangers) and the left side panel 15 (the side surface) of the enclosure 1 causes the compressor body 2 to be positioned in an area where the cooling air is caused to turn around in a U-shape. Thus, the cooling performance for the compressor body 2 can be enhanced more than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the height direction of the enclosure 1 and heat exchangers are arranged downstream of the cooling fan. Accordingly, the integrity of the cooling performance can be maintained while noise being reduced by reducing the opening area of the intake port 17, or the like.

[0035] In addition, in the packaged gas compressor according to the present embodiment, the enclosure 1 is provided with the only one intake port 17. According to this configuration, constraints on the installation of the packaged gas compressor are reduced. This can enhance the degree of freedom of the installation of the packaged gas compressor, and reduce the installation space for the packaged gas compressor.

[0036] In addition, in the present embodiment, the intake port is provided at a portion positioned in the extending direction of the rotation axis Af of the cooling fan 7 in the side surface 13, 14, 15, and 16 of the enclosure 1, which portion is the right side panel 16.

According to this configuration, the flow of cooling air heading to the cooling fan 7 from the intake port 17 flows along the extending direction of the rotation axis Af of the cooling fan 7. This allows a large area inside the enclosure 1 to be cooled from one end side to the other end side in the extending direction of the rotation axis Af of the cooling fan 7.

[0037] In addition, the compressor body 2 according to the present embodiment is of a screw-type, and is arranged such that its axial direction is parallel to the rotation axis Af of the cooling fan 7. According to this configuration, the axial direction of the compressor body 2 is arranged so as to lie along the flow of the cooling air. Accordingly, the compressor body 2 is cooled over its entire length, and can be cooled efficiently.

[0038] In addition, in the packaged gas compressor according to the present embodiment, the cooling fan 7 is a centrifugal fan, and the exhaust port 19 for cooling air is formed through the top panel 12 (an upper surface) of the enclosure 1. According to this configuration, the opening area of the exhaust port 19 can be made smaller than that in a case where an exhaust port is provided in the axial direction of the cooling fan 7, so that noise can be reduced.

[0039] In addition, the packaged gas compressor according to the present embodiment includes, in the enclosure 1, the exhaust duct 22 that introduces the cooling air to the exhaust port 19 of the enclosure 1. The exhaust duct 22 is configured such that its centerline Cd extends in the height direction of the enclosure 1. The cooling fan 7 is housed inside the exhaust duct 22, and is arranged such that the rotation axis Af is offset from the centerline Cd of the exhaust duct 22 toward an area where the rotation direction of the cooling fan 7 is a downward direction in the height direction of the enclosure 1.

[0040] According to this configuration, the rotation axis Af of the cooling fan 7 is offset from the centerline Cd of the exhaust duct 22. This can reduce pressure loss of the imbalanced flow by the centrifugal fan 7 inside the exhaust duct 22.

[0041] In addition, the packaged gas compressor according to the present embodiment includes, inside the enclosure 1, the oil tank 6 (a tank) that stores a lubricant (a fluid) to be supplied to the compressor body 2. The oil tank 6 (the tank) is arranged to overlap, in the extending direction of the rotation axis Af of the cooling fan 7, an area between the air cooler 4 and oil cooler 5 (the heat exchangers) and the left side panel 15 as a facing surface of the enclosure 1.

[0042] According to this configuration, the oil tank 6 (the tank) is positioned in an area where the cooling air is caused to turn around in a U-shape. This can enhance the cooling performance for the compressor body 2 more than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the height direction of the enclosure 1 and heat exchangers are arranged downstream of the cooling fan.

[Modification Example of First Embodiment]

[0043] Next, a packaged gas compressor according to a modification example of the first embodiment is illustratively explained using FIG. 5. FIG. 5 is a top view depicting the packaged gas compressor according to the modification example of the first embodiment. In FIG. 5, a top panel is in a transparent state. Note that reference characters in FIG. 5 that are the same as reference characters depicted in FIG. 1 to FIG. 4 denote similar portions, and accordingly, detailed explanations thereof are omitted.

[0044] Differences of the packaged gas compressor according to the modification example of the first embodiment depicted in FIG. 5 from the packaged gas compressor (see FIG. 3) according to the first embodiment are that the position of an intake port 18 formed through an enclosure 1A is different, and that an electric motor 3A has a self-cooling fan 31 corresponding to the change in the position of the intake port 18. Specifically, the enclosure 1 of the first embodiment depicted in FIG. 3 has the intake port 17 on the lower side of the right side panel 16. In contrast, the enclosure 1A according to the present modification example does not have an intake port through the right side panel 16, but has the intake port 18 on the lower side of the rear side panel 14. The intake port 18 is provided through the rear side panel 14, which is a side panel positioned in a direction orthogonal to the extending direction of the rotation axis Af of the cooling fan 7. Because of this, the flow of cooling air induced by the cooling fan 7 needs to be deflected in an area where the cooling air has flowed in through the intake port 18 toward the extending direction of the rotation axis Af of the cooling fan 7. In view of this, the electric motor 3A has the self-cooling fan 31 in this configuration. The self-cooling fan 31 has a function of sucking in cooling air having flowed in through the intake port 18 to deflect the cooling air along the extending direction of the body unit 2 and 3 (the extending direction of the rotation axis Af of the cooling fan 7). Note that the intake port 18 is formed such that its opening center 18a is positioned closer to the right side panel 16 than to the self-cooling fan 31 of the electric motor 3A.

[0045] The present modification example is effective in a case where an intake port cannot be provided through the right side panel 16 due to constraints on the installation position of the packaged gas compressor. In this configuration, the flow of cooling air near an area where the cooling air has flowed in through the intake port 18 of the rear side panel 14 is different from the flow of the cooling air in the case of the first embodiment. Thereby, although the amount of cooling air flowing around the electric motor 3A and the starting panel 8 changes, the flow on the downstream side of an area on a side where the compressor body 2 and the oil tank 6 are present is almost the same.

[0046] According to the modification example of the first embodiment described above, similarly to the case of the first embodiment, the flow of cooling air is deflected so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1A and flow into a large area of the air cooler 4 and the oil cooler 5 (the heat exchangers). Furthermore, arranging the compressor body 2 to overlap the area between the air cooler 4 and oil cooler 5 (the heat exchangers) and the left side panel 15 (the side surface) of the enclosure 1A causes the compressor body 2 to be positioned in an area where the cooling air is caused to turn around in a U-shape. Accordingly, the cooling performance for the compressor body 2 can be enhanced more than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the height direction of the enclosure 1A and heat exchangers are arranged downstream of the cooling fan. Thus, the integrity of the cooling performance can be maintained while noise being reduced by reducing the opening area of the intake port 18, or the like.

[0047] In addition, in the packaged gas compressor according to the present modification example, the intake port 18 is provided through the rear side panel 14, which is a portion positioned in a direction orthogonal to the rotation axis Af of the cooling fan 7 in the side surface 13, 14, 15, and 16 of the enclosure 1A. This configuration is a configuration that can be adopted in a case where it is not possible to provide an intake port through the right side panel 16 positioned in the extending direction of the rotation axis Af of the cooling fan 7 as in the first embodiment, due to constraints on the installation of the packaged compressor.

[Second Embodiment]

[0048] Next, a packaged gas compressor according to a second embodiment of the present invention is illustratively explained using FIG. 6. FIG. 6 is a top view depicting the packaged gas compressor according to the second embodiment. In FIG. 6, a top panel is in a transparent state. Note that reference characters in FIG. 6 that are the same as reference characters depicted in FIG. 1 to FIG. 5 denote similar portions, and accordingly detailed explanations thereof are omitted.

[0049] Differences of the packaged gas compressor according to the second embodiment depicted in FIG. 6 from that according to the first embodiment (see FIG. 3) are that the number of intake ports of an enclosure 1B is increased from one to two, and that a sound insulation plate 24 is arranged corresponding to the increase in the number of intake ports. Specifically, the enclosure 1B has the intake port 18 formed on the lower side of the rear side panel 14 of the enclosure 1B in addition to the intake port 17 formed through the right side panel 16. That is, the enclosure 1B has the two intake ports 17 and 18 formed at different positions. The added intake port 18 is formed closer to the right side panel 16 on the rear side panel 14, and is arranged at a position corresponding to an end of the body unit 2 and 3 closer to the electric motor 3. The intake port 18 of the rear side panel 14 is formed such that its opening area is smaller than the opening area of the intake port 17 of the right side panel 16, for example. The sound insulation plate 24 is arranged between the intake port 17 of the right side panel 16 and the electric motor 3 of the body unit 2 and 3. The sound insulation plate 24 is arranged to face the intake port 17 of the right side panel 16, and reduces noise to be emitted from the intake port 17.

[0050] In the present embodiment, even if the amount of cooling air flowing in through the intake port 17 of the right side panel 16 decreases due to obstruction by the sound insulation plate 24 or the like, cooling air flowing in through the intake port 18 of the rear side panel 14 compensates for the decrease. Thereby, the necessary amount of cooling air flowing around the electric motor 3 can be ensured.

[0051] Note that a sound insulation plate is arranged near the intake port 18 of the rear side panel 14 in another possible configuration in the present embodiment.

[0052] According to the packaged gas compressor according to the second embodiment described above, similarly to the case of the first embodiment, the flow of cooling air is deflected so as to turn around in a U-shape from the lower side to the upper side in the enclosure 1B and flow into a large area of the air cooler 4 and the oil cooler 5 (the heat exchangers). Furthermore, arranging the compressor body 2 to overlap the area between the air cooler 4 and oil cooler 5 (the heat exchangers) and the left side panel 15 (the side surface) of the enclosure 1B causes the compressor body 2 to be positioned in an area where the cooling air is caused to turn around in a U-shape. Thus, the cooling performance for the compressor body 2 can be enhanced more than that in the case of a configuration in which a cooling fan is arranged such that its rotation axis extends in the height direction of the enclosure 1B and heat exchangers are arranged downstream of the cooling fan. Accordingly, the integrity of the cooling performance can be maintained while noise being reduced by reducing the opening area of the intake ports 17 and 18, or the like.

[0053] In addition, in the packaged gas compressor according to the present embodiment, a plurality of the intake ports 17 and 18 are formed through the enclosure 1B. In addition, the sound insulation plate 24 is arranged to face at least one of the intake ports 17 and 18 inside the enclosure 1.

[0054] According to this configuration, it is possible to reduce noise by using the sound insulation plate 24 while enhancing the cooling performance by increasing the total opening area of the intake ports 17 and 18.

[Other Embodiments]

[0055] Note that the present invention is not limited to the embodiments described above, and includes various modification examples. The embodiments described above are explained in detail for explaining the present invention in an easy-to-understand manner, and the present invention is not necessarily limited to those including all constituent elements explained. That is, it is possible to replace some of the constituent elements of an embodiment with constituent elements of another embodiment, and it is also possible to add constituent elements of an embodiment to the constituent elements of another embodiment. In addition, some of the constituent elements of each embodiment can also have other constituent elements additionally, be deleted, or be replaced.

[0056] For example, in examples of configurations explained in the embodiments described above and modification examples thereof, the cooling fan 7 is a centrifugal fan. However, the cooling fan is an axial fan or a mixed flow fan, in another possible configuration.

[0057] In addition, in examples depicted in the embodiments described above and modification examples thereof, the enclosure 1 is formed in a rectangular parallelepiped shape, and the side panel includes the front side panel 13, the rear side panel 14, the left side panel 15, and the right side panel 16. However, the shape of the package can be any shape, and the side panel of the package forms a polygonal tubular shape or a cylindrical shape, in another possible configuration.

[0058] In addition, in examples of configurations depicted in the embodiments described above and modification examples thereof, the air cooler 4 and the oil cooler 5 are arranged side by side relative to the rotation axis Af of the cooling fan 7. However, in a case where it is not possible to house the air cooler 4 and the oil cooler 5 in the enclosure 1 if they are arranged side by side or in other cases, the air cooler 4 and the oil cooler 5 are arranged in tandem (in series) with respect to the rotation axis Af of the cooling fan 7, in another possible configuration.

[0059] In addition, the arrangement of the components 2, 3, 4, 5, 6, 7, and 8 in the enclosure 1 and the formation positions of the intake port 17 and the exhaust port 19 of the enclosure 1 in the embodiments described above and modification examples thereof are reversed in the front-rear direction (the depth direction of the enclosure 1) or the left-right direction (the width direction of the enclosure 1), in another possible configuration.

[0060] In addition, in the first embodiment described above and a modification example thereof, a sound insulation plate or a dryer is arranged in the enclosures 1 and 1A, in another possible configuration. The dryer removes moisture in a compressed gas discharged from the compressor body 2. In addition, in the first embodiment described above, similarly to a modification example thereof, the electric motor 3 has a self-cooling fan, in another possible configuration.

Description of Reference Characters

[0061]

1, 1A, 1B: Enclosure
2: Compressor body
3, 3A: Electric motor
4: Air cooler (heat exchanger)
5: Oil cooler (heat exchanger)
6: Oil tank (tank)
7: Cooling fan
13: Front side panel (side surface)
14: Rear side panel (side surface)
15: Left side panel (side surface, facing surface)
16: Right side panel (side surface)
17: Intake port
18: Intake port
19: Exhaust port
22: Exhaust duct
Af: Rotation axis
Cd: Centerline

Claims

1. A packaged gas compressor comprising:

a compressor body that compresses a gas;
a cooling fan that rotates around a rotation axis to induce cooling air;
an air-cooling-type heat exchanger that cools a fluid introduced from the compressor body by passage of the cooling air; and
an enclosure that houses the compressor body, the cooling fan, and the heat exchanger, wherein
the enclosure has an intake port for the cooling air through a side surface surrounding the compressor body, the cooling fan, and the heat exchanger,
the compressor body is arranged in a lower part of the enclosure,
the cooling fan is arranged above the compressor body, and is arranged such that the rotation axis is orthogonal to a height direction of the enclosure,
the heat exchanger is arranged at a position on a suction side of the cooling fan,
the intake port is provided to overlap the compressor body in the height direction of the enclosure, and is provided at a position closer to the cooling fan than to the heat exchanger, and
the compressor body is arranged to overlap, in an extending direction of the rotation axis of the cooling fan, an area between the heat exchanger and a facing surface of the side surface of the enclosure, the facing surface facing an inlet side of the heat exchanger into which the cooling air flows.

2. The packaged gas compressor according to claim 1, wherein
the only one intake port is formed through the enclosure.

3. The packaged gas compressor according to claim 2,

wherein
the intake port is provided at a portion of the side surface of the enclosure, the portion being positioned in the extending direction of the rotation axis of the cooling fan.

4. The packaged gas compressor according to claim 2, wherein
the intake port is provided at a portion of the side surface of the enclosure, the portion being positioned in a direction orthogonal to the rotation axis of the cooling fan.

5. The packaged gas compressor according to claim 3, wherein
the compressor body is of a screw-type, and is arranged such that an axial direction of the compressor body is parallel to the rotation axis of the cooling fan.

6. The packaged gas compressor according to claim 1, wherein

a plurality of the intake ports are formed through the enclosure, and
a sound insulation plate is arranged inside the enclosure so as to face at least one of the intake ports.

7. The packaged gas compressor according to claim 1, wherein

the cooling fan is a centrifugal fan, and
an exhaust port for the cooling air is formed through an upper surface of the enclosure.

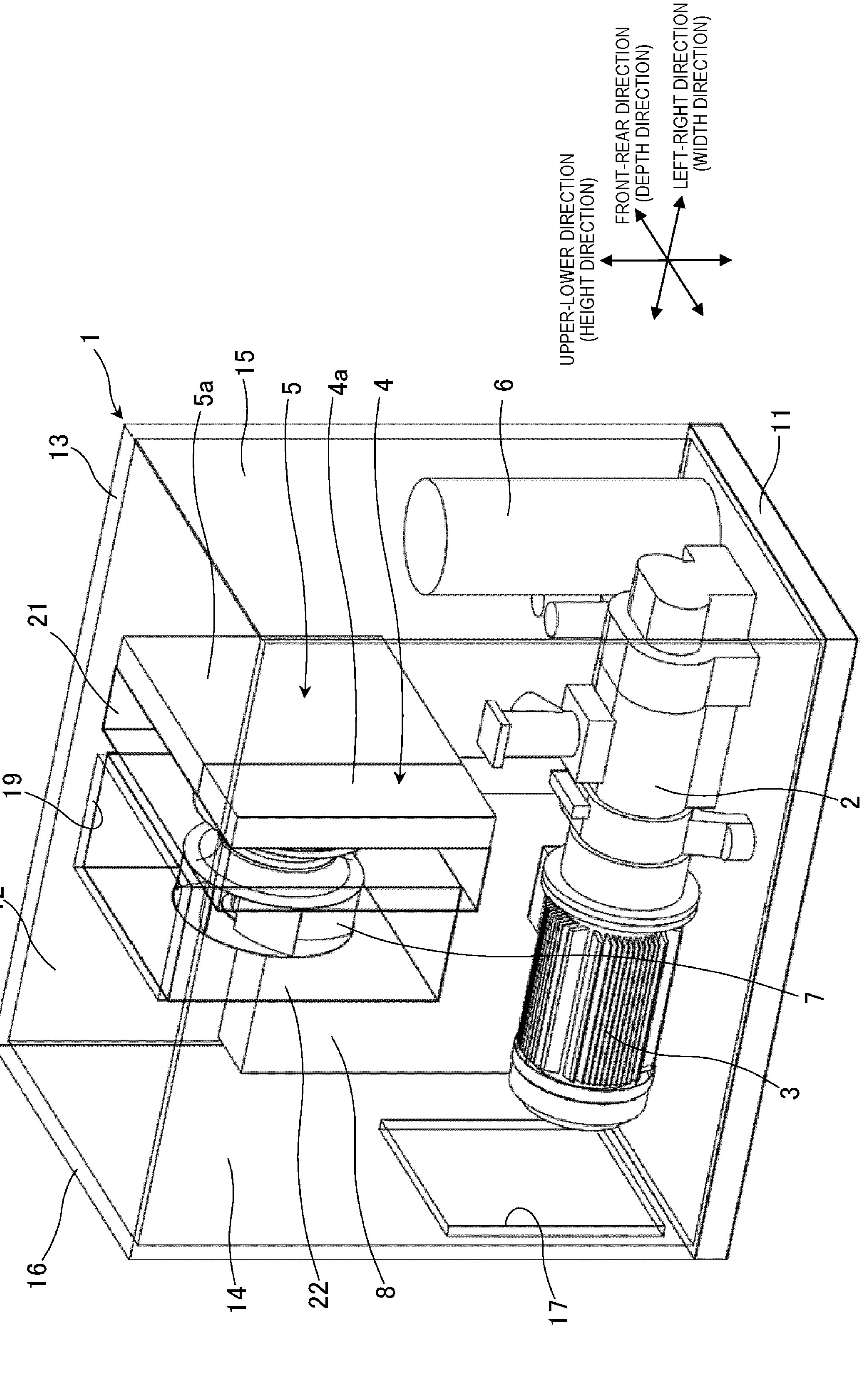
8. The packaged gas compressor according to claim 7, wherein

the packaged gas compressor includes, inside the enclosure, an exhaust duct that introduces the cooling air to the exhaust port of the enclosure,
the exhaust duct is configured such that a centerline of the exhaust duct extends in the height direction of the enclosure,
the cooling fan is housed in the exhaust duct, and
the cooling fan is arranged such that the rotation axis is offset, relative to the centerline of the exhaust duct, toward an area where a rotation direction of the cooling fan is a downward direction in the height direction of the enclosure.

9. The packaged gas compressor according to claim 1, wherein

the packaged gas compressor includes, inside the enclosure, a tank that stores a fluid to be supplied to the compressor body, and
the tank is arranged to overlap the area between the heat exchanger and the facing surface of the side surface of the enclosure in the extending direction of the rotation axis of the cooling fan.

[FIG. 1]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(DEPTH DIRECTION)
LEFT-RIGHT DIRECTION
(WIDTH DIRECTION)
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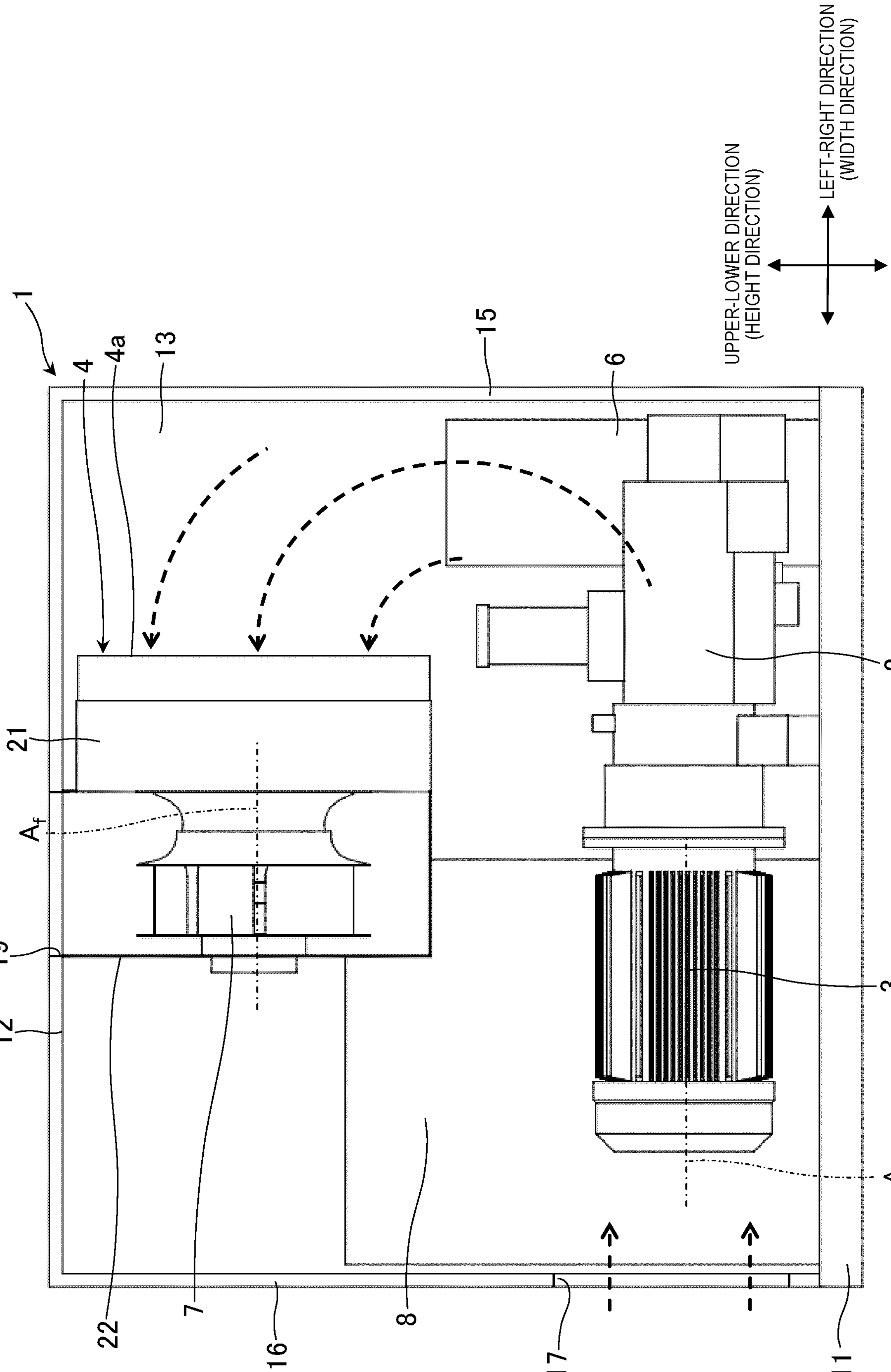
[FIG. 2]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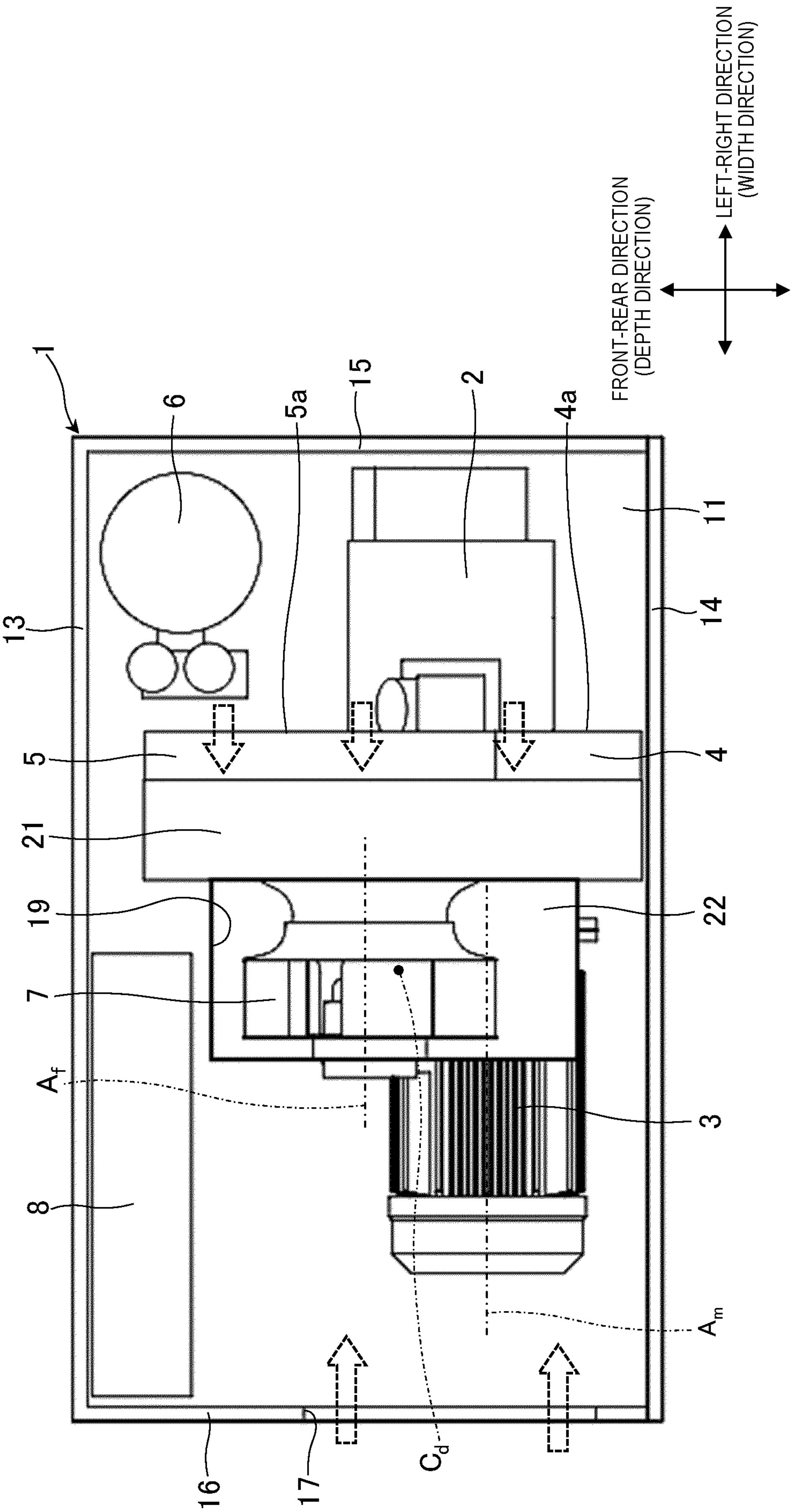
[FIG. 3]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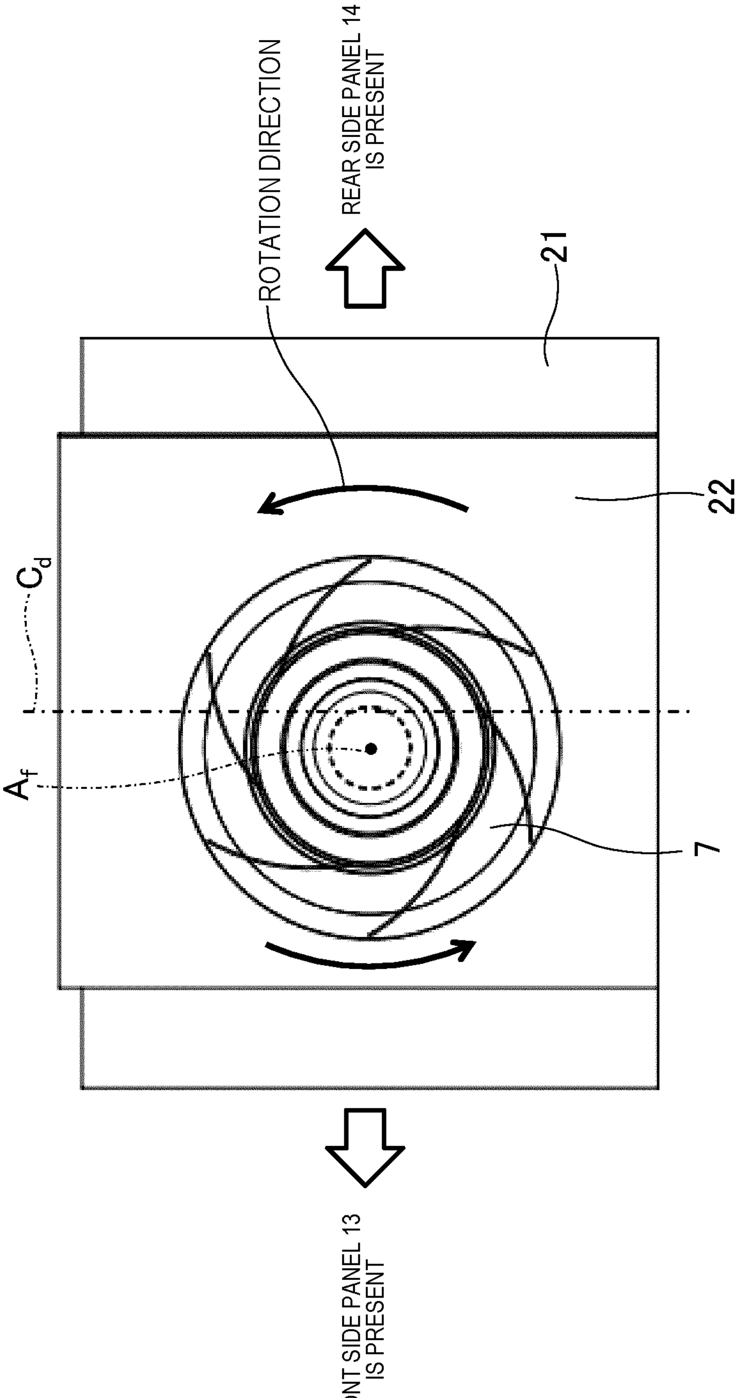
[FIG. 4]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FRONT SIDE PANEL 13 IS PRESENT
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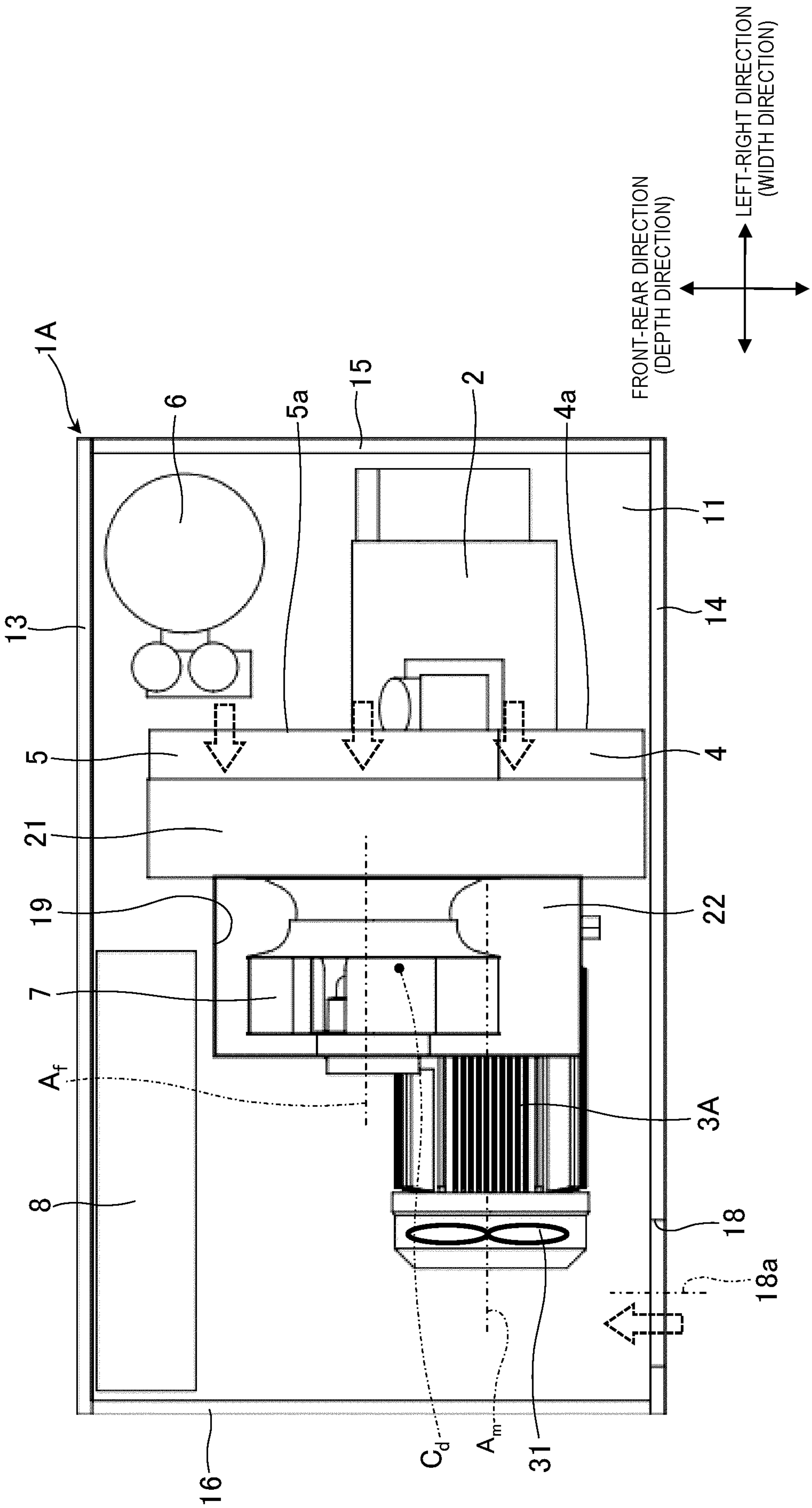
A_f

[FIG. 5]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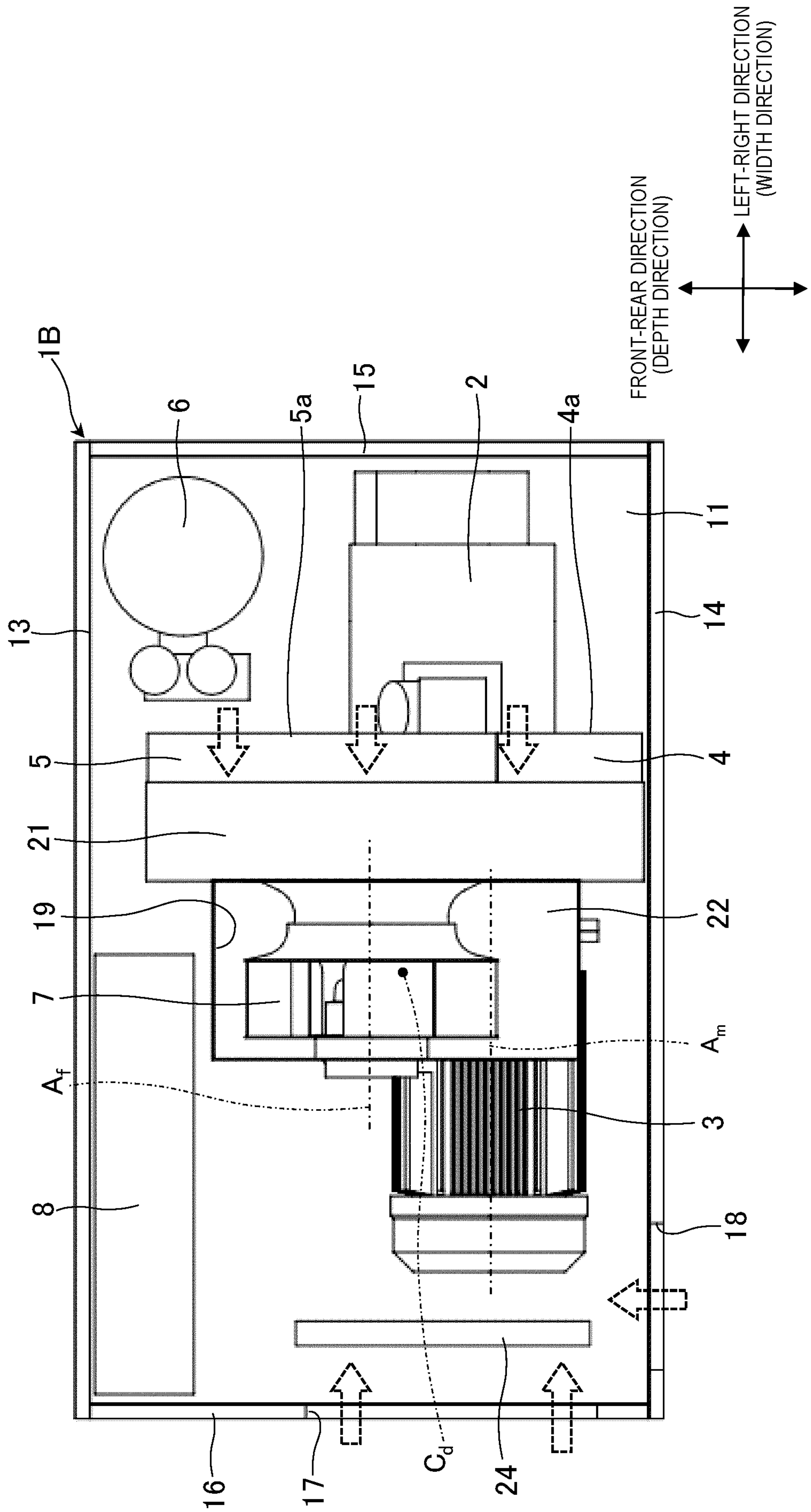
FRONT-REAR DIRECTION
(DEPTH DIRECTION)

[FIG. 6]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C_d
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FRONT-REAR DIRECTION
(DEPTH DIRECTION)
LEFT-RIGHT DIRECTION
(WIDTH DIRECTION)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/019183

A. CLASSIFICATION OF SUBJECT MATTER

F04B 39/06(2006.01)i; ***F04B 41/00***(2006.01)i; ***F04C 29/04***(2006.01)i
FI: F04B39/06 G; F04C29/04 E; F04B41/00 A

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)

F04B39/00-39/16; F04B25/00-37/20;41/00-41/06; F04C29/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 1-134084 A (HITACHI LTD) 26 May 1989 (1989-05-26) p. 2, upper left column, line 18 to p. 2, lower left column, line 15, drawings	1, 6-9
A		2-5

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2023	**08 August 2023**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/019183

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 1-134084 A	26 May 1989	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2017195242 A **[0004]**