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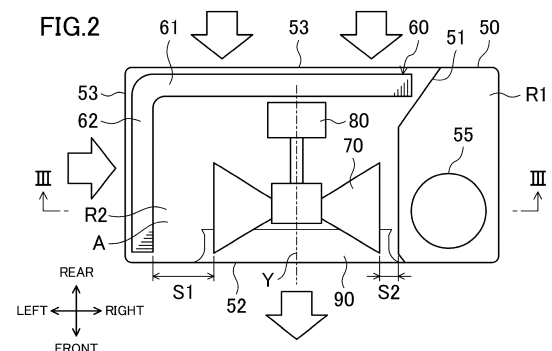
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(54) **HEAT SOURCE UNIT FOR REFRIGERATION DEVICE**

(57) A heat source unit (3) for a refrigeration apparatus (1) includes a casing (50), a heat exchanger (60), and a propeller fan (70). The casing (50) has a back surface and one side surface each having an inlet (53), and a front surface having an outlet (52). A partition plate (51) defining an air passage (A) faces the one side surface of the casing (50). The heat exchanger (60) is provided along the inlet (53). A first distance S1 and a second distance S2 satisfies the relationship " $6 \leq S1/S2$," where the first distance S1 is the shortest distance between an outer peripheral circle (V) of the propeller fan (70) and a second portion (62) of the heat exchanger (60), and the second distance S2 is the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the partition plate (51).



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a heat source unit for a refrigeration apparatus.

BACKGROUND ART

[0002] In a refrigeration apparatus, such as an air conditioner, a heat source unit to be installed outdoors has been known. Patent Document 1 discloses a heat source unit including a casing, an outdoor heat exchanger, and a fan (propeller fan). The outdoor heat exchanger has a substantially L-shape, and has a first portion extending along the left side surface of the casing and a second portion extending along the back surface of the casing.

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Publication No. 2009-204290

SUMMARY

TECHNICAL PROBLEM

[0004] In Patent Document 1 described above, the fan and the first portion of the outdoor heat exchanger are close to each other. Thus, the velocity of air flowing through the first portion of the outdoor heat exchanger into the fan is higher than that of air flowing through the second portion of the outdoor heat exchanger into the fan. If the air that has passed through the heat exchanger with such a shape is sucked into the fan, the flow rate of the air sucked into the fan varies significantly from area to area, resulting in noise generated by rotation of the fan.

[0005] It is an object of the present disclosure to reduce noise generated by rotation of a propeller fan.

SOLUTION TO THE PROBLEM

[0006] A first aspect of the present disclosure is directed to a heat source unit (3) for a refrigeration apparatus (1). The heat source unit (3) includes: a box-shaped casing (50) having a back surface and one side surface each having an inlet (53), and a front surface having an outlet (52); a partition plate (51) provided inside the casing (50) to face the one side surface of the casing (50), the partition plate (51) defining an air passage (A) that allows the inlet (53) and the outlet (52) to communicate with each other; a heat exchanger (60) provided in the air passage (A) and having a first portion (61) along the back surface of the casing (50) and a second portion (62) along the one side surface of the casing (50); and a propeller fan (70) provided in the air passage (A) to blow air toward

the outlet (52) of the casing (50). A first distance S1 and a second distance S2 satisfies a relationship " $6 \leq S1/S2$," where the first distance S1 is a shortest distance between an outer peripheral circle (V) of the propeller fan (70) and the second portion (62) of the heat exchanger (60), and the second distance S2 is a shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the partition plate (51).

[0007] According to the first aspect, the outer peripheral circle (V) of the propeller fan (70) is some distance away from the second portion (62) of the heat exchanger (60). Thus, this aspect can reduce noise produced by the rotation of the propeller fan (70).

[0008] A second aspect of the present disclosure is an embodiment of the first aspect. In the second aspect, the second distance S2 is shorter than or equal to 40 mm.

[0009] According to the second aspect, the second distance S2 is short enough. Thus, the first distance S1 can be set to be long.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 shows an external appearance of an air conditioner according to an embodiment of the present invention.

FIG. 2 illustrates the interior of an outdoor unit as viewed from above.

FIG. 3 is a cross-sectional view taken along line III-III shown in FIG. 2.

FIG. 4 is a graph showing the relationship between the frequency and sound power level of blower sound from the outdoor unit.

FIG. 5 is a graph showing the relationship between the ratio S1/S2 and the sound power level at 125 Hz.

FIG. 6 is a graph showing the relationship between a second distance S2 and the sound power level.

DESCRIPTION OF EMBODIMENTS

[0011] An embodiment will be described.

-Air Conditioner-

[0012] An air conditioner (1) is a refrigeration apparatus that performs a refrigeration cycle. The air conditioner (1) performs a cooling operation for lowering the indoor temperature, a heating operation for increasing the indoor temperature, and any other operations. As illustrated in FIG. 1, the air conditioner (1) includes an indoor unit (2), an outdoor unit (3), and a refrigerant pipe (4). The indoor unit (2) is attached to a wall surface in a room. The indoor unit (2) includes therein an indoor heat exchanger and a fan (which are not shown). The outdoor unit (3) is installed outdoors. The outdoor unit (3) includes therein an outdoor heat exchanger (60), which will be described below. The refrigerant pipe (4) connects the

indoor unit (2) and the outdoor unit (3) together.

-Outdoor Unit-

[0013] The outdoor unit (3) is a heat source unit. The outdoor unit (3) includes a casing (50), the outdoor heat exchanger (60) (hereinafter referred to as the "heat exchanger"), a propeller fan (70), a fan motor (80), and a bell mouth (90). Note that the terms "right," "left," "front," "rear," "back," "top," "bottom," in the following description refer to the directions illustrated in FIGS. 2 and 3.

<Casing>

[0014] The casing (50) has the shape of a substantially rectangular parallelepiped box. A partition plate (51) extending in a substantially vertical direction is provided inside the casing (50). The partition plate (51) partitions the interior of the casing (50) into a machine chamber (R1) and a blower chamber (R2). The partition plate (51) faces the left side surface of the casing (50). The partition plate (51) is substantially parallel to the left side surface of the casing (50). The partition plate (51) is inclined from an intermediate point thereof in the front-to-back direction toward the right side surface of the casing (50).

[0015] The machine chamber (R1) is formed on the right side of the partition plate (51). The machine chamber (R1) includes a compressor (55) and a control unit (not shown). The compressor (55) is used to compress a refrigerant flowing through the refrigerant pipe (4). The control unit houses a control board and electrical components for controlling driving of the compressor (55) and the fan motor (80). The blower chamber (R2) is formed on the left side of the partition plate (51). The blower chamber (R2) includes the heat exchanger (60), the propeller fan (70), the fan motor (80), and the bell mouth (90), which will be described below.

[0016] The casing (50) has an outlet (52) and inlets (53). The outlet (52) is formed in the front surface of the casing (50). The outlet (52) has a substantially circular shape. The respective inlets (53) are formed in the back (rear) and left side surfaces of the casing (50). The blower chamber (R2) forms an air passage (A) that allows the inlets (53) and the outlet (52) to communicate with each other. In other words, the air passage (A) is defined in the casing (50) by the partition plate (51) to allow the inlets (53) and the outlet (52) to communicate with each other.

<Heat Exchanger>

[0017] The heat exchanger (60) is a so-called cross-fin-type fin-and-tube heat exchanger. The heat exchanger (60) is used to allow the air sucked through the inlets (53) into the casing (50) to exchange heat with the refrigerant. The heat exchanger (60) is provided in the blower chamber (R2). In other words, the heat exchanger (60) is provided in the air passage (A).

[0018] As illustrated in FIG. 2, the heat exchanger (60) has a substantially L-shape in plan view (as viewed from above). The heat exchanger (60) is disposed along the back and left side surfaces of the casing (50). Specifically, the heat exchanger (60) has a first portion (61) extending along the back surface of the casing (50), and a second portion (62) extending along the left side surface of the casing (50).

[0019] The first portion (61) extends substantially parallel to a direction substantially orthogonal to the center axis (Y) of rotation of the propeller fan (70). The second portion (62) extends substantially parallel to the center axis (Y) of rotation of the propeller fan (70).

<Propeller Fan>

[0020] The propeller fan (70) is used to send air in the blower chamber (R2) to the outside of the outdoor unit (3). The propeller fan (70) is provided in the blower chamber (R2). In other words, the propeller fan (70) is provided in the air passage (A). The propeller fan (70) is disposed near the outlet (52) (near the front surface of the casing (50)). The propeller fan (70) is disposed between the second portion (62) of the heat exchanger (60) and the partition plate (51) as viewed from the front. The center axis (Y) of rotation of the propeller fan (70) is generally orthogonal to the front and back surfaces of the casing (50).

[0021] The propeller fan (70) has a plurality of blades (71). The propeller fan (70) blows air toward the outlet (52) of the casing (50). The propeller fan (70) is positioned to correspond to the outlet (52) of the casing (50).

[0022] The propeller fan (70) rotated by the fan motor (80) produces an air flow so that air that has exchanged heat in the heat exchanger (60) flows toward the front surface of the casing (50).

[0023] Here, the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the inner surface of the second portion (62) of the heat exchanger (60) is defined as a "first distance S1," and the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the inner surface of the partition plate (51) is defined as a "second distance S2." For the outdoor unit (3) of the present embodiment, $S1/S2 = 6$. Thus, the outdoor unit (3) of this embodiment satisfies the relationship " $6 \leq S1/S2$." Here, as illustrated in FIG. 3, the outer peripheral circle (V) of the propeller fan (70) is an imaginary circle passing through portions of the blades (71) of the propeller fan (70) that are farthest from the center axis (Y) of rotation of the propeller fan (70). The center of the outer peripheral circle (V) of the propeller fan (70) is located on the center axis (Y) of rotation of the propeller fan (70).

[0024] The second distance S2, which is the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the inner surface of the partition plate (51), is 40 mm. The outdoor unit (3) of the present embodiment satisfies the condition where the second distance S2 is shorter than or equal to 40 mm.

<Fan Motor)

[0025] The fan motor (80) is provided in the blower chamber (R2). In other words, the fan motor (80) is provided in the air passage (A). The fan motor (80) is a rotational drive source of the propeller fan (70). The fan motor (80) is fixed to a fan motor base (not shown) attached to the back surface of the casing (50).

[0026] An output shaft of the fan motor (80) is connected to the propeller fan (70). The center axis of the output shaft of the fan motor (80) substantially coincides with the center axis (Y) of rotation of the propeller fan (70). If the fan motor (80) rotates in response to a drive control signal output from the control board of the control unit, this rotation is transmitted via the output shaft of the fan motor (80) to the propeller fan (70), which thus rotates.

<Bell Mouth)

[0027] The bell mouth (90) is provided in the blower chamber (R2). The bell mouth (90) has an annular shape. The bell mouth (90) surrounds the whole circumference of the propeller fan (70). The bell mouth (90) is positioned to correspond to the propeller fan (70) and the outlet (52) of the casing (50). The bell mouth (90) is fixed to the casing (50).

[0028] The bell mouth (90) has an opening (not shown) for guiding the air flow produced by the propeller fan (70) to the outside of the casing (50). A meshed outlet grille (not shown) is attached to the front surface of the casing (50) to cover the opening.

-Operation of Outdoor Unit-

[0029] Next, an operation of the outdoor unit (3) will be described.

[0030] While the outdoor unit (3) is operating, the propeller fan (70) is driven by the fan motor (80), and air is sucked through the inlets (53) into the casing (50). The air sucked into the casing (50) passes through the heat exchanger (60) facing the inlets (53), and exchanges heat with the refrigerant. The air that has passed through the heat exchanger (60) flows toward the front of the casing (50), and is delivered forward by the blades (71) of the propeller fan (70). The delivered air is discharged through the outlet (52) to the outside of the casing (50).

-First Experimental Example-

[0031] FIG. 4 is a graph showing the relationship between the frequency and sound power level of blower sound from the outdoor unit (3). Specifically, FIG. 4 is a graph showing the sound power levels at different frequencies of the blower sound produced from the outdoor unit (3) in a situation where the rotational speed of the propeller fan (70) is 650 rpm. The second distance S2 in this experiment was 10 mm.

[0032] The solid line connecting the diamonds shown

in the figure together indicates the results obtained when $S1/S2 = 2$. The alternate long and short dash line connecting the triangles shown in the figure together indicates the results obtained when $S1/S2 = 6$. The dash-dot-dot line connecting the squares shown in the figure together indicates the results obtained when $S1/S2 = 11$.

[0033] The same figure showed that the sound power level of sound at 125 Hz obtained when $S1/S2 = 6$ was less than that obtained when $S1/S2 = 2$. The same figure further showed that the sound power level of sound at 125 Hz obtained when $S1/S2 = 11$ was less than that obtained when $S1/S2 = 6$. This showed that changing $S1/S2$ could reduce the sound at 125 Hz produced from the outdoor unit (3).

[0034] FIG. 5 is a graph showing the relationship between $S1/S2$ and the sound power level at 125 Hz. Specifically, FIG. 5 is a graph obtained by plotting the sound power levels of sound at 125 Hz produced from the outdoor unit (3) at $S1/S2$ of 2, 6, and 11 in a situation where the rotational speed of the propeller fan (70) is 650 rpm.

[0035] In the same figure, when $S1/S2$ was changed from 2 to 6, the sound power level decreased by 6.3 dB (A). In contrast, when the ratio $S1/S2$ was changed from 6 to 11, the sound power level decreased by 1.2 dB (A). The same figure showed that satisfying the relationship " $6 \leq S1/S2$ " could reduce noise at 125 Hz.

-Second Experimental Example-

[0036] FIG. 6 is a graph showing the relationship between the second distance S2 and the sound power level. Specifically, FIG. 6 is a graph obtained by plotting the sound power levels of the blower sound from the outdoor unit at second distances S2 of 10 mm, 35 mm, and 60 mm in a situation where the rotational speed of the propeller fan (70) is 650 rpm.

[0037] In the same figure, when the second distance S2 was changed from 60 mm to 35 mm, the sound power level decreased by 1.3 dB (A). In contrast, when the second distance S2 was changed from 35 mm to 10 mm, the sound power level decreased by 0.1 dB (A). The same figure showed that a second distance S2 of shorter than or equal to 40 mm could reduce noise associated with the fan rotation.

-Advantages of Embodiment-

[0038] In this embodiment, an outdoor unit (3) of an air conditioner (1) includes: a box-shaped casing (50) having a back surface and left side surface each having an inlet (53), and a front surface having an outlet (52); a partition plate (51) provided inside the casing (50) to face the left side surface of the casing (50), the partition plate (51) defining an air passage (A) that allows the inlet (53) and the outlet (52) to communicate with each other; a heat exchanger (60) provided in the air passage (A) and having a first portion (61) along the back surface of the casing (50) and a second portion (62) along the left side surface

of the casing (50); and a propeller fan (70) provided in the air passage (A) to blow air toward the outlet (52) of the casing (50). A first distance S1 that is the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the second portion (62) of the heat exchanger (60) and a second distance S2 that is the shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the partition plate (51) satisfy the relation " $6 \leq S1/S2$."

[0039] Thus, the outer peripheral circle (V) of the propeller fan (70) is some distance away from the second portion (62) of the heat exchanger (60). This allows the difference in air velocity between an area closer to the first portion (61) of the heat exchanger (60) and an area closer to the second portion (62) of the heat exchanger (60) to be smaller than in the known art. This can reduce noise produced by the rotation of the propeller fan (70).

[0040] In the outdoor unit (3) of this embodiment, the second distance S2 is shorter than or equal to 40 mm.

[0041] This shows that the second distance S2 is short enough. Thus, the first distance S1 can be set to be long. This allows the difference in air velocity between the area closer to the first portion (61) of the heat exchanger (60) and the area closer to the second portion (62) of the heat exchanger (60) to be smaller than in the known art. This can reduce noise produced by the rotation of the propeller fan (70).

<<Other Embodiments>>

[0042] The foregoing embodiment may be modified as follows.

[0043] The casing (50) of the foregoing embodiment may have its blower chamber (R2) formed on the right side of the partition plate (51). In other words, one of the inlets (53) may be formed in the right side surface of the casing (50), and the second portion (62) of the heat exchanger (60) may be formed along the right side surface of the casing.

[0044] While the embodiment and variations thereof have been described above, it will be understood that various changes in form and details may be made without departing from the spirit and scope of the claims. The embodiment and the variations thereof may be combined and replaced with each other without deteriorating intended functions of the present disclosure.

INDUSTRIAL APPLICABILITY

[0045] As can be seen from the foregoing description, the present disclosure is useful for a heat source unit for a refrigeration apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0046]

1 Air Conditioner (Refrigeration Apparatus)

3 Outdoor Unit (Heat Source Unit)
50 Casing
51 Partition Plate
52 Outlet
53 Inlet
60 Heat Exchanger
61 First Portion
62 Second Portion
70 Propeller Fan
10 A Air Passage
V Outer Peripheral Circle

Claims

1. A heat source unit for a refrigeration apparatus, the heat source unit comprising:

a box-shaped casing (50) having a back surface and one side surface each having an inlet (53), and a front surface having an outlet (52);

a partition plate (51) provided inside the casing (50) to face the one side surface of the casing (50), the partition plate (51) defining an air passage (A) that allows the inlet (53) and the outlet (52) to communicate with each other;

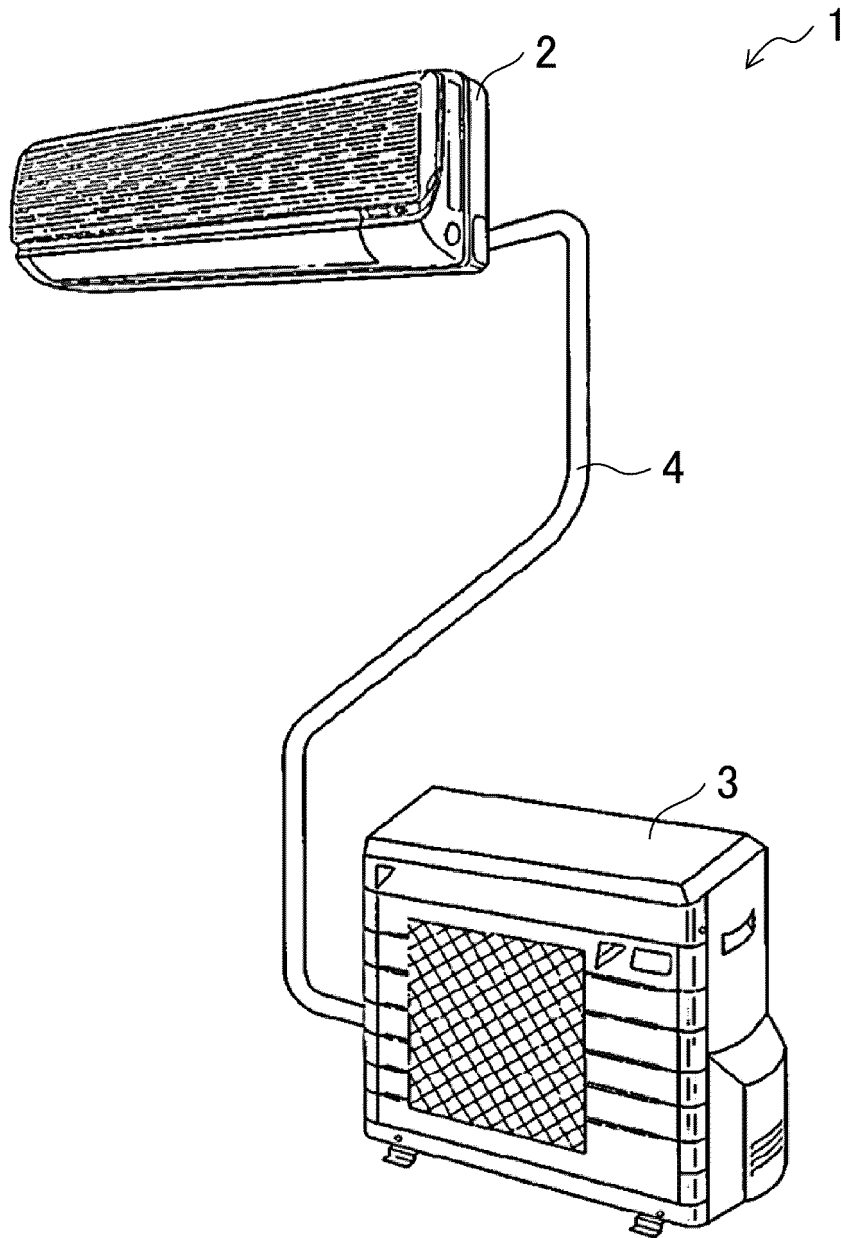
a heat exchanger (60) provided in the air passage (A) and having a first portion (61) along the back surface of the casing (50) and a second portion (62) along the one side surface of the casing (50); and

a propeller fan (70) provided in the air passage (A) to blow air toward the outlet (52) of the casing (50),

a first distance S1 and a second distance S2 satisfying a relationship " $6 \leq S1/S2$," where the first distance S1 is a shortest distance between an outer peripheral circle (V) of the propeller fan (70) and the second portion (62) of the heat exchanger (60), and the second distance S2 is a shortest distance between the outer peripheral circle (V) of the propeller fan (70) and the partition plate (51).

2. The heat source unit of claim 1, wherein the second distance S2 is shorter than or equal to 40 mm.

FIG.1



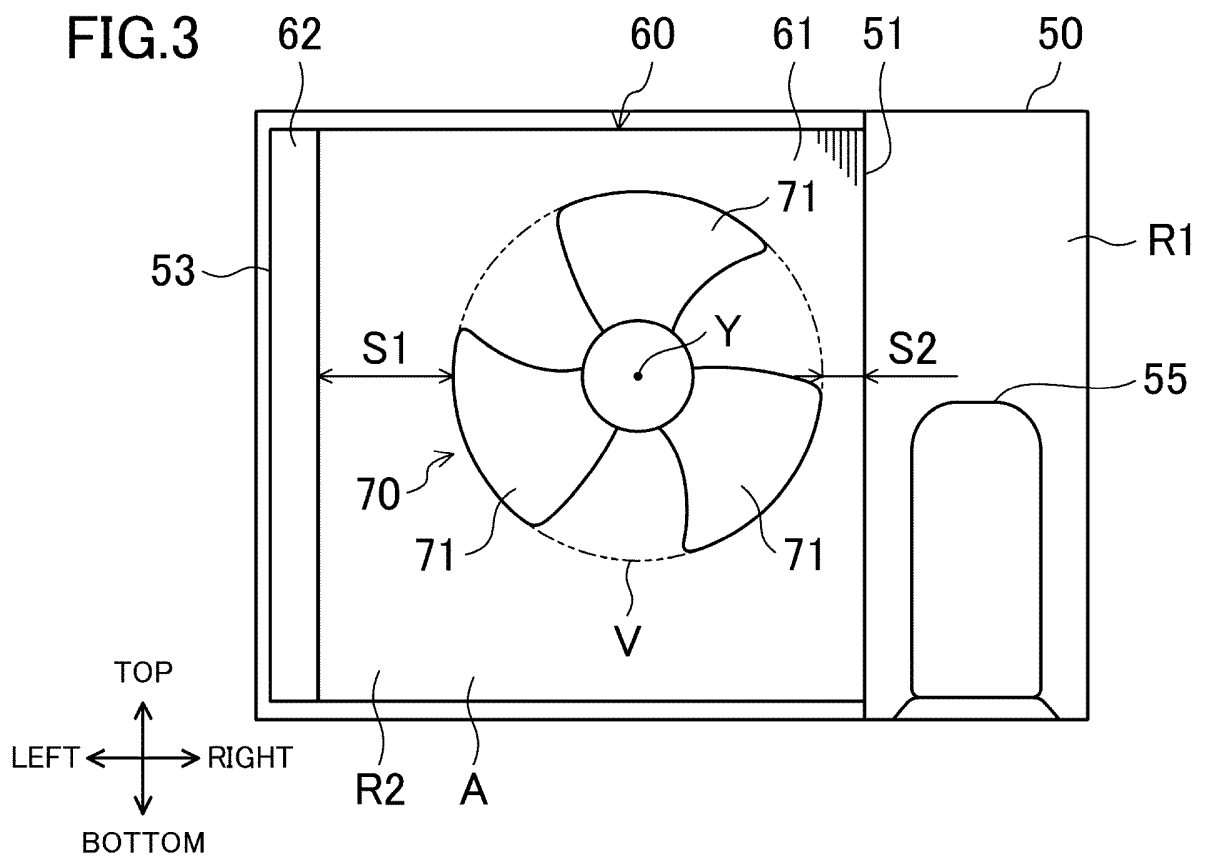
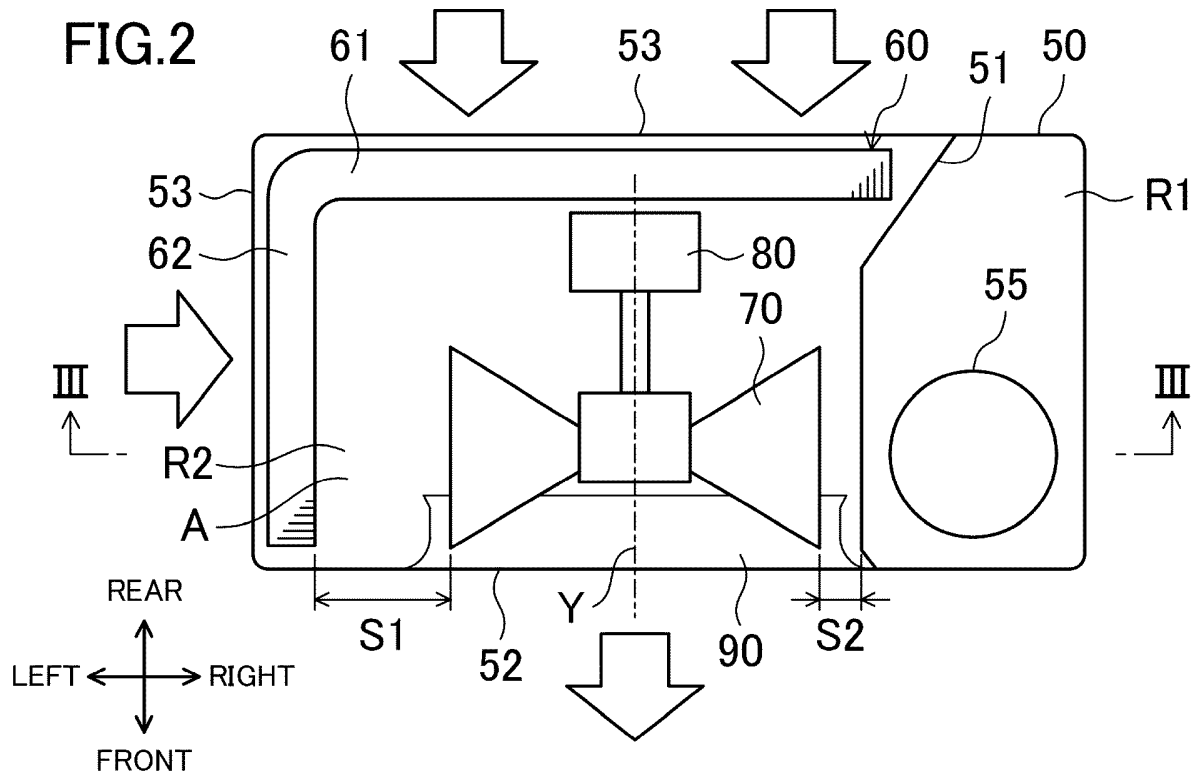


FIG.4

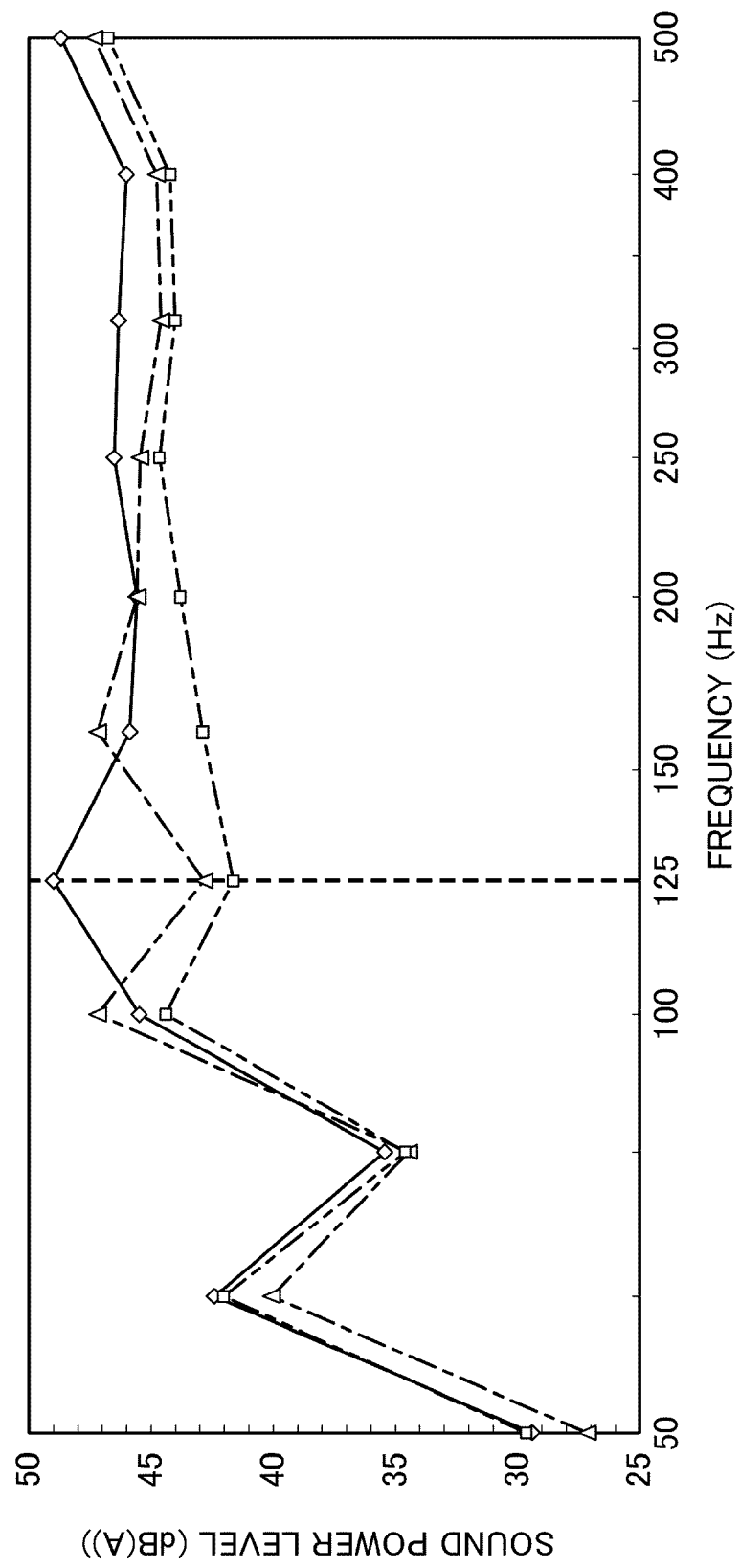


FIG.5

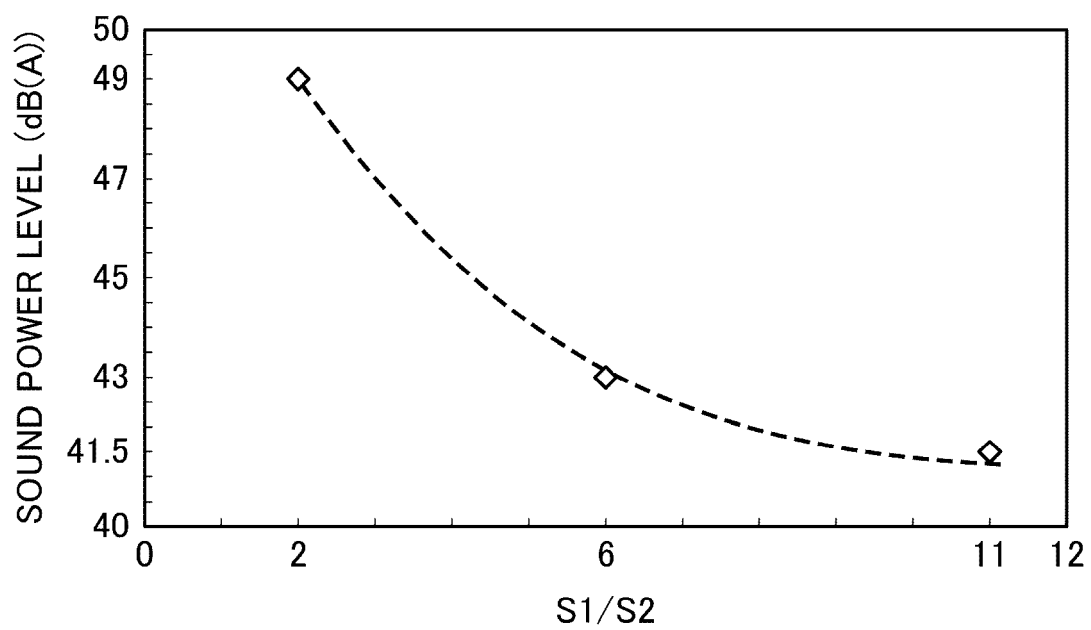
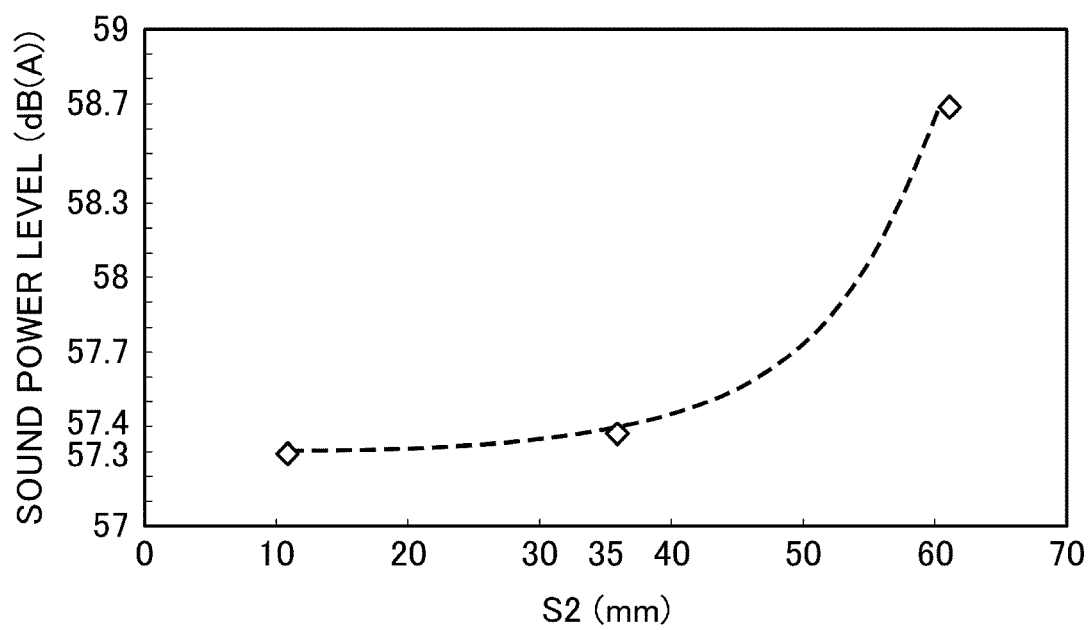


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/030412

A. CLASSIFICATION OF SUBJECT MATTER

F24F 1/38 (2011.01) i; F24F 1/48 (2011.01) i

FI: F24F1/48; F24F1/38

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)

F24F1/38; F24F1/48

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 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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.
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Y	JP 2013-221439 A (MITSUBISHI ELECTRIC CORP.) 28.10.2013 (2013-10-28) paragraph [0024], fig. 5	1-2
A	JP 2000-205001 A (HITACHI, LTD.) 28.07.2000 (2000-07-28) entire text, all drawings	1-2
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
29 September 2020 (29.09.2020)Date of mailing of the international search report
13 October 2020 (13.10.2020)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/030412

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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REFERENCES CITED IN THE DESCRIPTION

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