



(11)

EP 4 400 777 A1

(12)

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

(43) Date of publication:

17.07.2024 Bulletin 2024/29

(21) Application number: **22872605.5**

(22) Date of filing: **18.08.2022**

(51) International Patent Classification (IPC):

F24F 1/0022 ^(2019.01)

F24F 1/0047 ^(2019.01)

F04D 29/30 ^(2006.01)

(52) Cooperative Patent Classification (CPC):

F04D 29/30; F24F 1/0022; F24F 1/0047

(86) International application number:

PCT/JP2022/031161

(87) International publication number:

WO 2023/047849 (30.03.2023 Gazette 2023/13)

(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 MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

(30) Priority: **21.09.2021 JP 2021152971**

(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES**

THERMAL SYSTEMS, LTD.

Tokyo 100-8332 (JP)

(72) Inventors:

• **SANO, Kumpei**

Tokyo 100-8332 (JP)

• **NAKANIWA, Akihiro**

Tokyo 100-8332 (JP)

(74) Representative: **Cabinet Beau de Loménie**

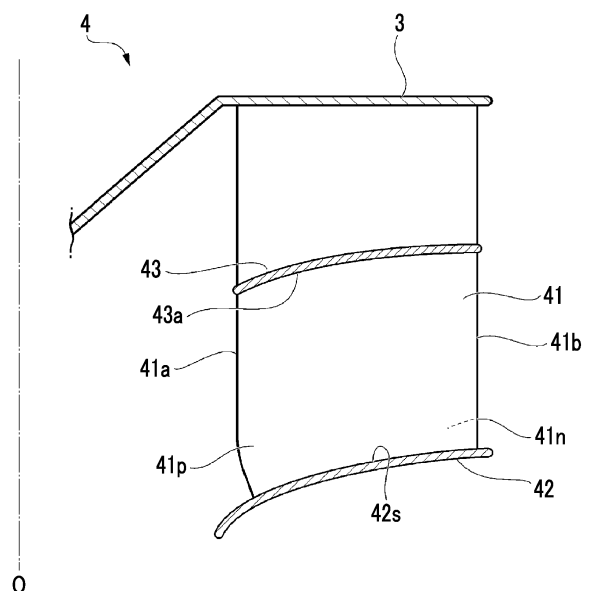
158, rue de l'Université

75340 Paris Cedex 07 (FR)

(54) **CEILING-EMBEDDED AIR CONDITIONER**

(57) This ceiling-embedded air conditioner comprises: a motor having an output shaft rotatable about an axis; a turbo fan attached to the output shaft; and a heat exchanger that surrounds the turbo fan from the outer peripheral side and has a dimension in the axial direction which is larger than the dimension of the outlet flow path of the turbo fan in the axial direction. The turbo fan has: a main plate that is attached to the output shaft and has a disk shape about the axis; a shroud that is axially spaced apart from the main plate; an array of a plurality of circumferentially spaced-apart main blades provided across the shroud and the main plate; and a guide member having a guide surface that faces the shroud side while protruding circumferentially from a pressure surface, which is the surface of the main blade facing the forward side of the output shaft in the rotational direction.

FIG. 2



EP 4 400 777 A1

Description

Technical Field

[0001] The present disclosure relates to a ceiling-embedded air conditioner.

[0002] This application claims priority to Japanese Patent Application No. 2021-152971, filed in Japan on September 21, 2021, the content of which is incorporated herein by reference.

Background Art

[0003] As an example of an air conditioning device, a ceiling-embedded air conditioner as disclosed in PTL 1 below is widely used. The ceiling-embedded air conditioner mainly includes a casing embedded in a ceiling indoors, a motor having an output shaft that rotates around an axis extending in an up-down direction, a turbo fan, a main plate that fixes the turbo fan to the output shaft, a heat exchanger that surrounds the turbo fan, and a bell mouth. The turbo fan has a tubular shroud that surrounds the axis, and a plurality of main blades that are arranged to be spaced apart from each other in a circumferential direction on a surface of the shroud on one side.

[0004] Indoor air is taken into the casing from a central portion of the casing by rotating the turbo fan. The air is pumped to an outer peripheral side by the turbo fan and then passes through the heat exchanger to become cold air or warm air to be supplied indoors.

Citation List

Patent Literature

[0005] [PTL 1] Japanese Patent No. 6130137

Summary of Invention

Technical Problem

[0006] Here, a flow path cross-sectional area of a turbo fan outlet is determined by a head or flow rate required for a product. Meanwhile, a projected area (a product of a height in a direction of the axis and a length in the circumferential direction) of the heat exchanger as viewed in a radial direction is determined by a temperature adjustment ability required for a product. In many cases, the projected area of the heat exchanger is set to be larger than the flow path cross-sectional area of the turbo fan outlet. That is, to increase the height of the heat exchanger in the direction of the axis, the flow path cross-sectional area rapidly increases from the turbo fan toward the heat exchanger. Therefore, a part of a flow of the air flowing out of the turbo fan may form a circulation flow in front of the heat exchanger, and a flow speed distribution may be non-uniform. As a result, there is a concern that

a performance of the heat exchanger cannot be sufficiently utilized in a region where a flow speed is low, and an efficiency of the ceiling-embedded air conditioner is deteriorated.

[0007] The present disclosure has been made to solve the above-described problems, and an object of the present disclosure is to provide a ceiling-embedded air conditioner with a further improvement in the efficiency.

10 Solution to Problem

[0008] To solve the above-described problems, a ceiling-embedded air conditioner according to the present disclosure includes a motor having an output shaft that is rotatable about an axis, a turbo fan attached to the output shaft, and a heat exchanger that surrounds the turbo fan from an outer peripheral side and has a dimension in a direction of the axis larger than a dimension of an outlet flow path of the turbo fan in the direction of the axis, in which the turbo fan includes a main plate that is attached to the output shaft and has a disk shape centered on the axis, a shroud that is disposed to be spaced apart from the main plate in the direction of the axis, a plurality of main blades that are provided across the shroud and the main plate and are arranged to be spaced apart from each other in a circumferential direction, and a guide member that protrudes in the circumferential direction from a pressure surface, which is a surface of the main blade facing a forward side of the output shaft in a rotational direction, and has a guide surface that faces a shroud side.

Advantageous Effects of Invention

[0009] According to the present disclosure, even in a ceiling-embedded air conditioner in which the flow path cross-sectional area rapidly increases from the turbo fan to the heat exchanger, it is possible to provide a ceiling-embedded air conditioner with a further improvement in efficiency.

Brief Description of Drawings

[0010]

Fig. 1 is a sectional view showing a configuration of a ceiling-embedded air conditioner according to a first embodiment of the present disclosure.

Fig. 2 is an enlarged view showing a configuration of a turbo fan according to the first embodiment of the present disclosure.

Fig. 3 is an enlarged view showing a modification example of the turbo fan according to the first embodiment of the present disclosure.

Fig. 4 is an enlarged view showing a configuration of a turbo fan according to a second embodiment of the present disclosure.

Fig. 5 is an enlarged view showing a configuration

of a turbo fan according to a third embodiment of the present disclosure.

Description of Embodiments

<First Embodiment>

(Configuration of Ceiling-Embedded Air Conditioner)

[0011] Hereinafter, a ceiling-embedded air conditioner 100 as a centrifugal compressor according to the first embodiment of the present disclosure will be described with reference to Figs. 1 to 4. As shown in Fig. 1, the ceiling-embedded air conditioner 100 includes a casing 1, a motor 2, a main plate 3, a turbo fan 4, a heat exchanger 5, and a bell mouth 6.

[0012] The casing 1 is embedded in a ceiling wall 90 of a building. The casing 1 has a rectangular shape as viewed from below, and is recessed upward to form a space therein. Specifically, the casing 1 includes a panel 1a exposed to a ceiling surface 90a and a box-shaped cabinet 1b provided above the panel 1a. The panel 1a includes a panel body 11 that is a rectangular frame body, and a grill 12 as a suction port 11a provided at a lower center. The panel body 11 forms a blowout port 11b around the suction port 11a.

[0013] The motor 2 is provided at a central portion of a bottom surface 1s facing downward in the cabinet 1b. The motor 2 has a motor body 21 that accommodates a coil, a magnet, and the like, and an output shaft 22 that protrudes vertically downward from the motor body 21. The output shaft 22 is rotationally driven about an axis O extending in the vertical direction (up-down direction).

[0014] The disk-shaped main plate 3 that extends radially outward from the output shaft 22 and that is centered on the axis O is fixed to the output shaft 22. The main plate 3 has a cross-sectional shape that extends from below to above from an inner side to the outer side in the radial direction in a cross-sectional view including the axis O. The turbo fan 4 is attached to a portion of a lower surface of the main plate 3 that includes an outer side end edge in the radial direction.

[0015] The turbo fan 4 has a plurality of main blades 41 arranged to be spaced apart from each other in the circumferential direction, an annular shroud 42 that covers the main blades 41 from below, and a guide member 43 provided on a surface of the main blades 41. A detailed configuration of the turbo fan 4 will be described later. The main plate 3 and the turbo fan 4 rotate with the rotation of the output shaft 22, and air sucked from the suction port 11a is sent radially outward.

[0016] The circular heat exchanger 5 that surrounds the turbo fan 4 is provided radially outside the turbo fan 4. The heat exchanger 5 is a portion of a refrigerant circuit having a refrigerating cycle. In the heat exchanger 5, a dimension in a direction of the axis O is set to be larger than a dimension of an outlet flow path of the turbo fan 4 in the direction of the axis O. Specifically, a lower end

surface of the heat exchanger 5 protrudes downward than the turbo fan 4. That is, a cross-sectional area of the heat exchanger 5 as viewed in the radial direction (a product of a height of the heat exchanger 5 in the direction of the axis O and a length of the heat exchanger 5 in the circumferential direction) is larger than a cross-sectional area of an outlet of the turbo fan 4. Therefore, a flow path cross-sectional area rapidly increases from the outlet of the turbo fan 4 toward the heat exchanger 5.

[0017] The air sent to the heat exchanger 5 by the turbo fan 4 is heat-exchanged with a refrigerant in a case of passing through the heat exchanger 5. Accordingly, the air that has flowed out to an outer peripheral side of the heat exchanger 5 becomes cold air or warm air. The air flows downward along a side surface of the cabinet 1b and is supplied into a room from the blowout port 11b.

[0018] The bell mouth 6 fixed to an upper portion of the panel body 11 is disposed below the turbo fan 4. The bell mouth 6 is provided to guide the air introduced from the suction port 11a and send the air to the turbo fan 4. The bell mouth 6 has a conical shape that gradually contracts from below to above. An end portion of the bell mouth 6 on one side (upper side) in the direction of the axis O is surrounded by the above-described shroud 42 from an outer peripheral side.

(Configuration of Turbo Fan)

[0019] Next, the configuration of the turbo fan 4 will be described in detail. As shown in Fig. 2, the shroud 42 is curved radially outward from the other side to one side in the direction of the axis O. In other words, the shroud 42 is curved radially outward from below to above in the direction of the axis O. Of both surfaces of the shroud 42 in a thickness direction, a surface facing an inner peripheral side is a shroud inner peripheral surface 42s.

[0020] The plurality of main blades 41 arranged to be spaced apart from each other in the circumferential direction with respect to the axis O are provided on the shroud inner peripheral surface 42s. The main blade 41 extends from the lower surface of the main plate 3 to the shroud inner peripheral surface 42s. A cross-sectional shape of the main blade 41 that is orthogonal to the axis O has a two-dimensional blade shape. More specifically, the cross-sectional shape of the main blade 41 has a rectangular shape as an example.

[0021] A leading edge 41a (that is, an inner side end edge in the radial direction) of the main blade 41 extends in the direction of the axis O. A trailing edge 41b (that is, an outer side end edge in the radial direction) of the main blade 41 also extends in the direction of the axis O. Of both surfaces of the main blade 41 in the circumferential direction, a surface facing a forward side of the output shaft 22 in a rotational direction is a pressure surface 41p, and a surface facing a rear side in the rotational direction is a negative pressure surface 41n. The guide member 43 is provided between a pair of main blades 41 adjacent to each other in the circumferential direction.

[0022] The guide member 43 divides a surface of the main blade 41 into a plurality of (two) regions. The guide member 43 is positioned at a central portion of the main blade 41 in the direction of the axis O. The guide member 43 extends from the pressure surface 41p of one main blade 41 to the negative pressure surface 41n of the other main blade 41. That is, the guide member 43 continuously extends in the circumferential direction. The guide member 43 may be provided on at least the pressure surface 41p and may not be connected to a negative pressure surface 41n side. That is, it is possible to adopt a configuration in which the guide member 43 protrudes from only the pressure surface 41p in the circumferential direction.

[0023] An inner side end edge of the guide member 43 in the radial direction is positioned on the leading edge 41a of the main blade 41. In addition, an outer side end edge of the guide member 43 in the radial direction is positioned on the trailing edge 41b of the main blade 41. A shape of the guide member 43 is not limited to the above, and the inner side end edge of the guide member 43 in the radial direction may not be positioned on the leading edge 41a. In addition, the outer side end edge of the guide member 43 in the radial direction may not be positioned on the trailing edge 41b.

[0024] The guide member 43 is curved along a direction in which the shroud 42 extends. That is, the guide member 43 is curved radially outward from the other side to one side in the direction of the axis O. The guide member 43 may not be completely curved along the direction in which the shroud 42 extends, and may extend in substantially the same direction as the shroud 42. Of both surfaces of the guide member 43 facing the direction of the axis O, a surface facing a shroud 42 side is a guide surface 43a. A separation distance between the guide surface 43a and the shroud inner peripheral surface 42s is constant from the inner side to the outer side in the radial direction. Note that being "constant" here referred to means being substantially constant, and for example, design tolerances and manufacturing errors are allowed. That is, the separation distance between the guide surface 43a and the shroud inner peripheral surface 42s may not be completely constant.

[0025] The separation distance between the shroud 42 and the guide surface 43a can also be set as follows. That is, a configuration can be adopted in which the guide surface 43a extends to be close to the shroud 42 side as the guide surface 43a is directed radially outward in a range not falling below a reduction ratio of the flow path cross-sectional area from the inner side to the outer side in the radial direction in a flow path between the main plate 3 and the shroud 42.

(Effects of Action)

[0026] Next, an operation of the ceiling-embedded air conditioner 100 will be described. In a case of operating the ceiling-embedded air conditioner 100, the motor 2 is

first driven. The output shaft 22, the main plate 3, and the turbo fan 4 rotate around the axis O by driving the motor 2. As the turbo fan 4 is rotated, the air in the room is taken into from the suction port 11a. The air is sent to the turbo fan 4 via the bell mouth 6 and then is pumped radially outward to form a main flow. The main flow flows along the lower surface of the main plate 3. That is, the main flow flows from the inner side to the outer side in the radial direction from below to above. Most of the main flow is heat-exchanged with the refrigerant by passing through the heat exchanger 5, and becomes cold air or warm air to be supplied into the room from the blowout port 11b.

[0027] Here, a flow path cross-sectional area of the outlet of the turbo fan 4 is determined by a head or flow rate required for a product. Meanwhile, the cross-sectional area of the heat exchanger 5 as viewed in the radial direction is determined by a temperature adjustment ability required for a product. In many cases, a cross-sectional area of the heat exchanger 5 is set to be larger than the flow path cross-sectional area of the outlet of the turbo fan 4 as in the present embodiment. That is, the flow path cross-sectional area rapidly increases from the turbo fan 4 toward the heat exchanger 5. For this reason, a part of the flow of the air flowing out of the turbo fan 4 may form a circulation flow in front of a flow path between the heat exchanger 5 and the turbo fan 4, and a flow speed distribution may be non-uniform. As a result, there is a concern that a performance of the heat exchanger 5 cannot be sufficiently utilized, and an efficiency of the ceiling-embedded air conditioner 100 is deteriorated.

[0028] Therefore, in the present embodiment, the guide member 43 is provided in the main blade 41. According to this configuration, the flow of the air radially outward along the main blade 41 of the turbo fan 4 is divided into a plurality of flows in the direction of the axis O by the guide member 43. Thereby, the flow speed distribution in the direction of the axis O can be further made uniform at the outlet of the turbo fan 4. As a result, for example, the formation of the circulation flow in front of the heat exchanger 5 is suppressed. Therefore, the flow of the air is supplied to an entire cross-sectional area of the heat exchanger 5, and the performance as the heat exchanger 5 can be sufficiently utilized. Therefore, it is possible to improve the efficiency of the ceiling-embedded air conditioner 100.

[0029] Further, according to the above-described configuration, since the guide member 43 continuously extends from the pressure surface 41p to the negative pressure surface 41n in the circumferential direction, the flow speed distribution can be stably made uniform over an entire region in the circumferential direction. As a result, it is possible to further suppress the formation of the above-described circulation flow.

[0030] In addition, according to the above-described configuration, since the guide member 43 extends from the leading edge 41a to the trailing edge 41b, the flow of

the air can be more stably guided over an entire region in the radial direction.

[0031] In addition, according to the above-described configuration, since the separation distance between the guide member 43 (guide surface 43a) and the shroud 42 is constant from the inner side to the outer side in the radial direction, it is possible to minimize an occurrence of pressure loss because of a disposition of the guide member 43. In this way, the efficiency of the ceiling-embedded air conditioner 100 can be further improved.

[0032] The first embodiment of the present disclosure has been described above. Various changes or improvements can be made to the configuration without departing from the concept of the present disclosure.

[0033] In the first embodiment, the example has been described in which only one guide member 43 is provided in the direction of the axis O. However, the number of the guide members 43 is not limited to the above, and as shown in Fig. 3 as a modification example, a plurality of (two or more) guide members 43 can be arranged to be spaced apart from each other in the direction of the axis O. With this configuration, the flow of the air radially outward is further finely divided, and thus it is possible to further make the flow speed distribution in the direction of the axis O uniform.

<Second Embodiment>

[0034] Next, a second embodiment of the present disclosure will be described with reference to Fig. 4. The same configurations as those of the first embodiment will be assigned with the same reference numerals, and detailed description thereof will be omitted. As shown in Fig. 4, in the present embodiment, a plurality of guide members 43 are arranged to be spaced apart from each other in the direction of the axis O. Further, the plurality of guide members 43 are disposed to be biased toward the shroud 42 side with respect to a main plate 3 side in the direction of the axis O. That is, the separation distance between the guide member 43 and the shroud 42 is set to be smaller than a separation distance between the guide member 43 and the main plate 3.

[0035] Here, a curvature of a shape on the shroud 42 side is larger than that on the main plate 3 side. Therefore, as is apparent from arrows in Fig. 1, a direction of the flow changes rapidly from the direction of the axis O to the radial outer side on the shroud 42 side. Accordingly, a loss tends to increase on the shroud 42 side. However, with the above-described configuration, since the guide member 43 is disposed to be biased toward the shroud 42 side, a rectifying effect on the shroud 42 side can be further enhanced. As a result, it is possible to reduce the loss. As a result, it is possible to further improve the efficiency of the ceiling-embedded air conditioner 100.

[0036] The second embodiment of the present disclosure has been described above. Various changes or improvements can be made to the configuration without departing from the concept of the present disclosure. In

the second embodiment, the example has been described in which the plurality of guide members 43 are provided. However, it is also possible to adopt a configuration in which only one guide member 43 is provided and the guide member 43 is provided at a position biased toward the shroud 42 side.

<Third Embodiment>

[0037] Next, a third embodiment of the present disclosure will be described with reference to Fig. 5. The same configurations as in each of the embodiments described above are denoted by the same reference numerals, and detailed description thereof is omitted. As shown in Fig. 5, in the present embodiment, a shape of the trailing edge 41b of the main blade 41 is different from that of each of the above-described embodiments.

[0038] Specifically, an end portion of the main blade 41 on the shroud 42 side is positioned radially outside an end portion of the main plate 3 side. In addition, the trailing edge 41b of the main blade 41 extends radially outward from the main plate 3 side toward the shroud 42 side. That is, the trailing edge 41b is inclined with respect to the axis O.

[0039] Here, on the shroud 42 side, a curvature of the flow of the air is larger than that on the main plate 3 side. Therefore, the loss tends to increase on the shroud 42 side. However, with the above-described configuration, the trailing edge 41b of the main blade 41 extends radially outward from the main plate 3 side toward the shroud 42 side. That is, the main blade 41 protrudes radially outward on the shroud 42 side. Accordingly, a work of the main blade 41 on the shroud 42 side with respect to the flow of the air is increased, and a head can be increased. As a result, it is possible to reduce the loss on the shroud 42 side. As a result, it is possible to further improve the efficiency of the ceiling-embedded air conditioner 100.

[0040] The third embodiment of the present disclosure has been described above. Various changes or improvements can be made to the configuration without departing from the concept of the present disclosure. In addition, the configurations described in the respective embodiments can also be combined with each other.

<Additional Notes>

[0041] The ceiling-embedded air conditioner 100 in each embodiment is grasped as follows, for example.

[0042]

(1) A ceiling-embedded air conditioner 100 according to a first aspect includes a motor 2 having an output shaft 22 that is rotatable about an axis O, a turbo fan 4 attached to the output shaft 22, and a heat exchanger 5 that surrounds the turbo fan 4 from an outer peripheral side and has a dimension in a direction of the axis O larger than a dimension of an outlet flow path of the turbo fan 4 in the direction of

the axis O, in which the turbo fan 4 includes a main plate 3 that is attached to the output shaft 22 and has a disk shape centered on the axis O, a shroud 42 that is disposed to be spaced apart from the main plate 3 in the direction of the axis O, a plurality of main blades 41 that are provided across the shroud 42 and the main plate 3 and are arranged to be spaced apart from each other in a circumferential direction, and a guide member 43 that protrudes in the circumferential direction from a pressure surface 41p, which is a surface of the main blade 41 facing a forward side of the output shaft 22 in a rotational direction, and has a guide surface 43a that faces a shroud 42 side.

According to the above-described configuration, the flow of the air radially outward along the main blade 41 of the turbo fan 4 is divided into a plurality of flows in the direction of the axis O by colliding with the guide surface 43a of the guide member 43. Thereby, the flow speed distribution in the direction of the axis O can be made uniform at the outlet of the turbo fan 4. As a result, for example, the formation of the circulation flow in front of the heat exchanger 5 is suppressed.

(2) In the ceiling-embedded air conditioner 100 according to a second aspect, the guide member 43 may continuously extend in the circumferential direction from the pressure surface 41p to a negative pressure surface 41n, which is a surface of the other main blade 41 adjacent to the pressure surface 41p facing a rear side in the rotational direction.

According to the above-described configuration, since the guide member 43 continuously extends in the circumferential direction, the flow speed distribution can be stably made uniform over the entire region in the circumferential direction.

(3) In the ceiling-embedded air conditioner 100 according to a third aspect, the guide member 43 may extend from a leading edge 41a that is an inner side end edge of the main blade 41 in a radial direction to a trailing edge 41b that is an outer side end edge of the main blade 41 in the radial direction.

According to the above-described configuration, since the guide member 43 extends from the leading edge 41a to the trailing edge 41b, the flow of the air can be stably guided over the entire region in the radial direction.

(4) In the ceiling-embedded air conditioner 100 according to a fourth aspect, a separation distance between the guide member 43 and the shroud 42 may be constant from an inner side to an outer side in a radial direction.

According to the above-described configuration, since the separation distance between the guide member 43 and the shroud 42 is constant from the inner side to the outer side in the radial direction, it is possible to minimize an occurrence of pressure loss because of the disposition of the guide member

43.

(5) In the ceiling-embedded air conditioner 100 according to a fifth aspect, a plurality of the guide members 43 may be arranged to be spaced apart from each other in the direction of the axis O.

According to the above-described configuration, the flow of the air radially outward is divided by the plurality of guide members 43. Thereby, the flow speed distribution in the direction of the axis O can be further made uniform.

(6) In the ceiling-embedded air conditioner 100 according to a sixth aspect, the guide member 43 may be disposed to be biased toward the shroud 42 side with respect to a main plate 3 side in the direction of the axis O.

Here, on the shroud 42 side, a curvature of the flow of the air is larger than that on the main plate 3 side. Therefore, the loss tends to increase on the shroud 42 side. However, with the above-described configuration, since the guide member 43 is disposed to be biased toward the shroud 42 side, a rectifying effect on the shroud 42 side can be further enhanced. As a result, it is possible to reduce the loss.

(7) In the ceiling-embedded air conditioner 100 according to a seventh aspect, an end portion of the main blade 41 on the shroud 42 side may be positioned radially outside an end portion of a main plate 3 side, and a trailing edge 41b that is an outer side end edge of the main blade 41 in the radial direction may extend radially outward from the main plate 3 side toward the shroud 42 side.

[0043] Here, on the shroud 42 side, a curvature of the flow of the air is larger than that on the main plate 3 side.

Therefore, the loss tends to increase on the shroud 42 side. However, with the above-described configuration, the trailing edge 41b of the main blade 41 extends radially outward from the main plate 3 side toward the shroud 42 side. That is, the main blade 41 protrudes radially outward on the shroud 42 side. Accordingly, the work of the main blade 41 on the shroud 42 side is increased, and the head can be increased. As a result, it is possible to reduce the loss on the shroud 42 side.

Industrial Applicability

[0044] According to the present disclosure, even in a ceiling-embedded air conditioner in which the flow path cross-sectional area rapidly increases from the turbo fan to the heat exchanger, it is possible to provide a ceiling-embedded air conditioner with a further improvement in efficiency.

Reference Signs List

[0045]

100: ceiling-embedded air conditioner

1: casing
 1a: panel
 1b: cabinet
 1s: bottom surface
 2: motor
 3: main plate
 4: turbo fan
 5: heat exchanger
 6: bell mouth
 6s: outer peripheral surface
 11: panel body
 11a: suction port
 11b: blowout port
 12: grill
 21: motor body
 22: output shaft
 41: main blade
 41a: leading edge
 41b: trailing edge
 42: shroud
 42s: shroud inner peripheral surface
 43: guide member
 43a: guide surface
 O: axis

Claims

1. A ceiling-embedded air conditioner comprising:

a motor having an output shaft that is rotatable about an axis;
 a turbo fan attached to the output shaft; and
 a heat exchanger that surrounds the turbo fan from an outer peripheral side and has a dimension in a direction of the axis larger than a dimension of an outlet flow path of the turbo fan in the direction of the axis,
 wherein the turbo fan includes

a main plate that is attached to the output shaft and has a disk shape centered on the axis,
 a shroud that is disposed to be spaced apart from the main plate in the direction of the axis,
 a plurality of main blades that are provided across the shroud and the main plate and are arranged to be spaced apart from each other in a circumferential direction, and
 a guide member that protrudes in the circumferential direction from a pressure surface, which is a surface of the main blade facing a forward side of the output shaft in a rotational direction, and has a guide surface that faces a shroud side.

2. The ceiling-embedded air conditioner according to

Claim 1, wherein the guide member continuously extends in the circumferential direction from the pressure surface to a negative pressure surface, which is a surface of the other main blade adjacent to the pressure surface facing a rear side in the rotational direction.

3. The ceiling-embedded air conditioner according to Claim 1 or 2, wherein the guide member extends from a leading edge that is an inner side end edge of the main blade in a radial direction to a trailing edge that is an outer side end edge of the main blade in the radial direction.

4. The ceiling-embedded air conditioner according to Claim 1 or 2, wherein a separation distance between the guide member and the shroud is constant from an inner side to an outer side in a radial direction.

5. The ceiling-embedded air conditioner according to Claim 1 or 2, wherein a plurality of the guide members are arranged to be spaced apart from each other in the direction of the axis.

6. The ceiling-embedded air conditioner according to Claim 1 or 2, wherein the guide member is disposed to be biased toward the shroud side with respect to a main plate side in the direction of the axis.

7. The ceiling-embedded air conditioner according to Claim 1 or 2, wherein an end portion of the main blade on the shroud side is positioned radially outside an end portion of a main plate side, and a trailing edge that is an outer side end edge of the main blade in the radial direction extends radially outward from the main plate side toward the shroud side.

FIG. 1

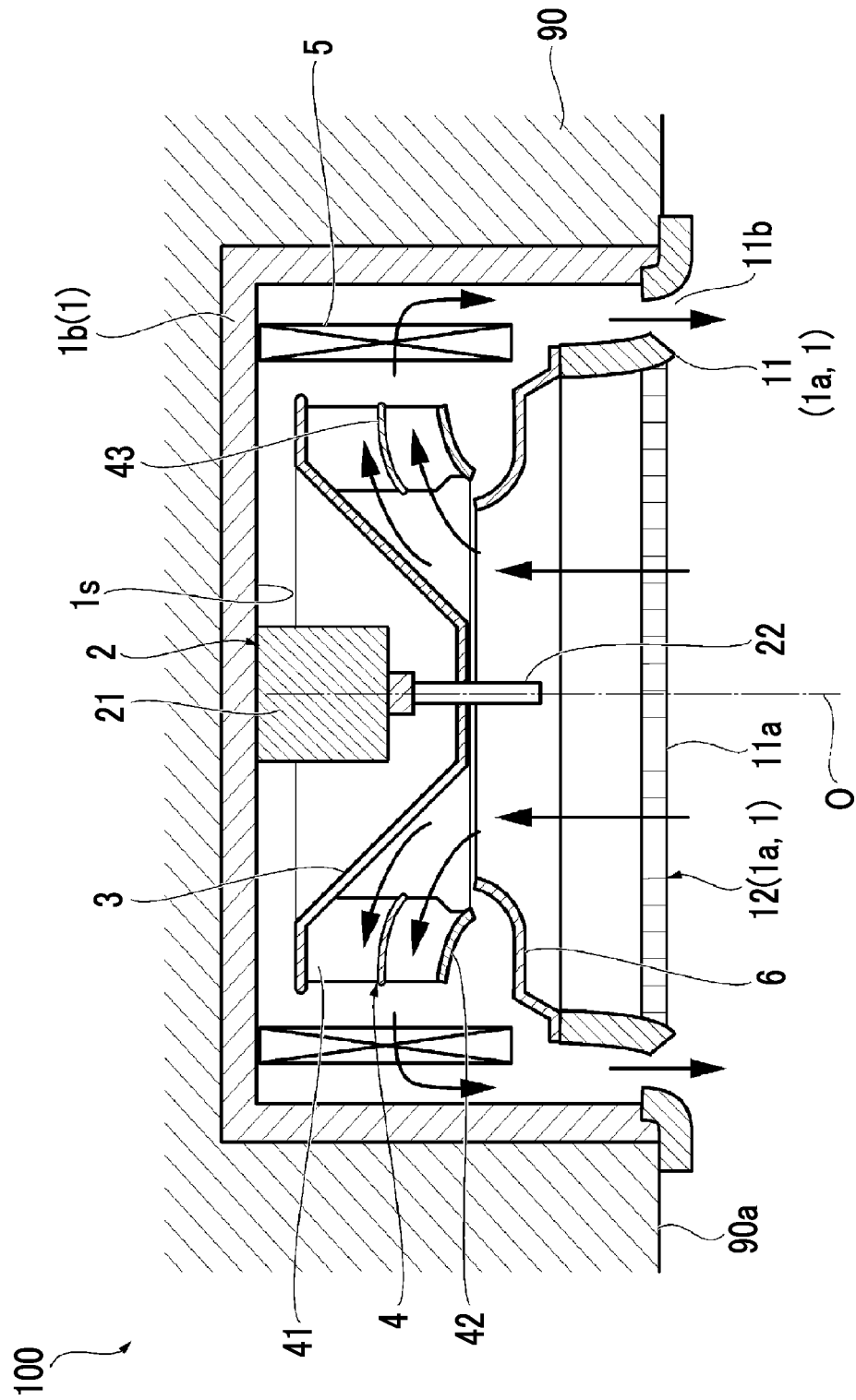


FIG. 2

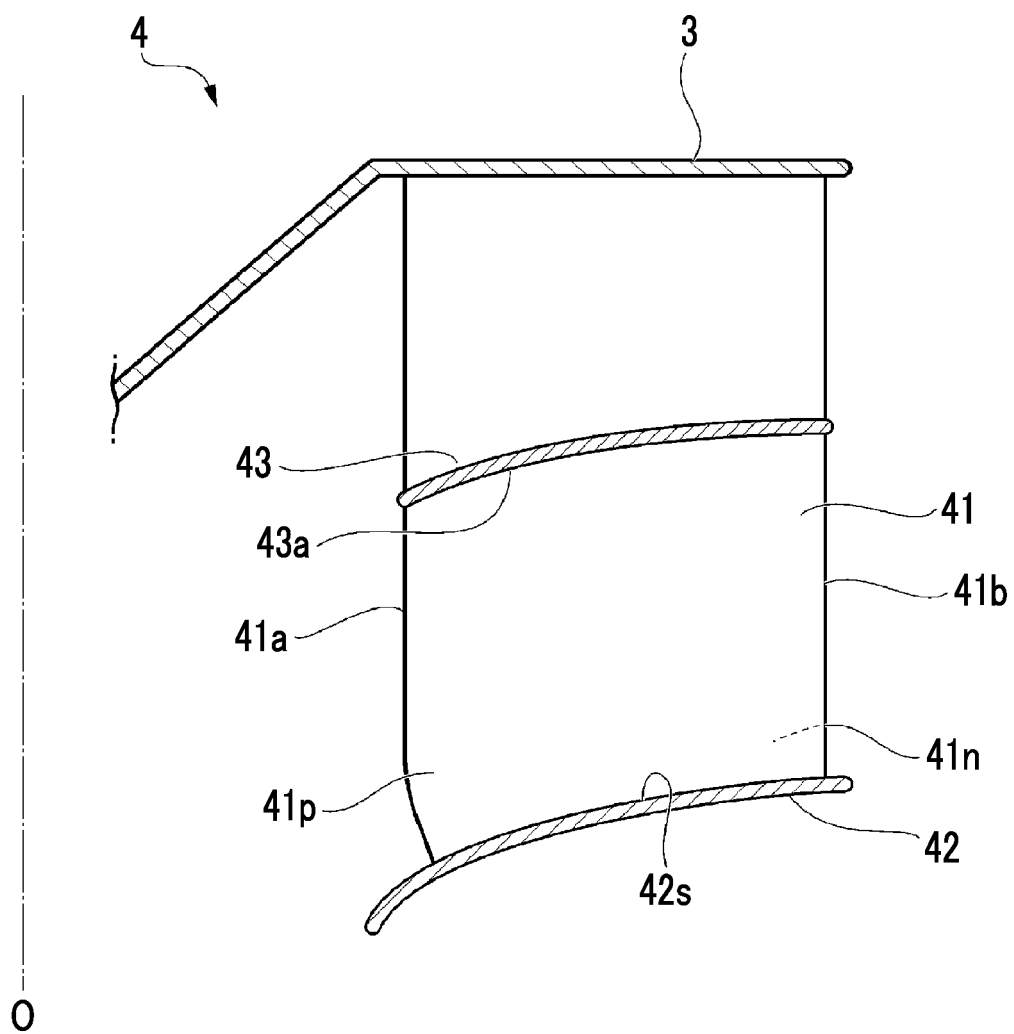


FIG. 3

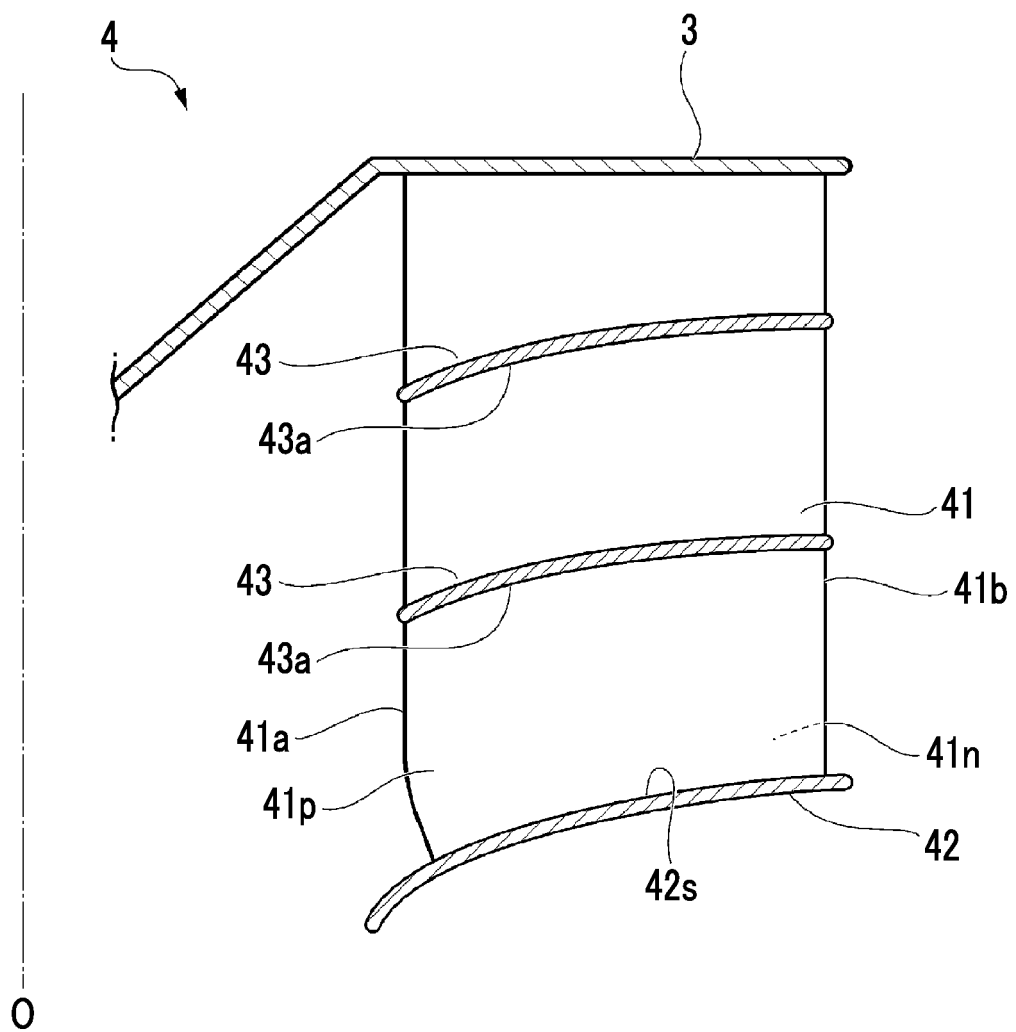


FIG. 4

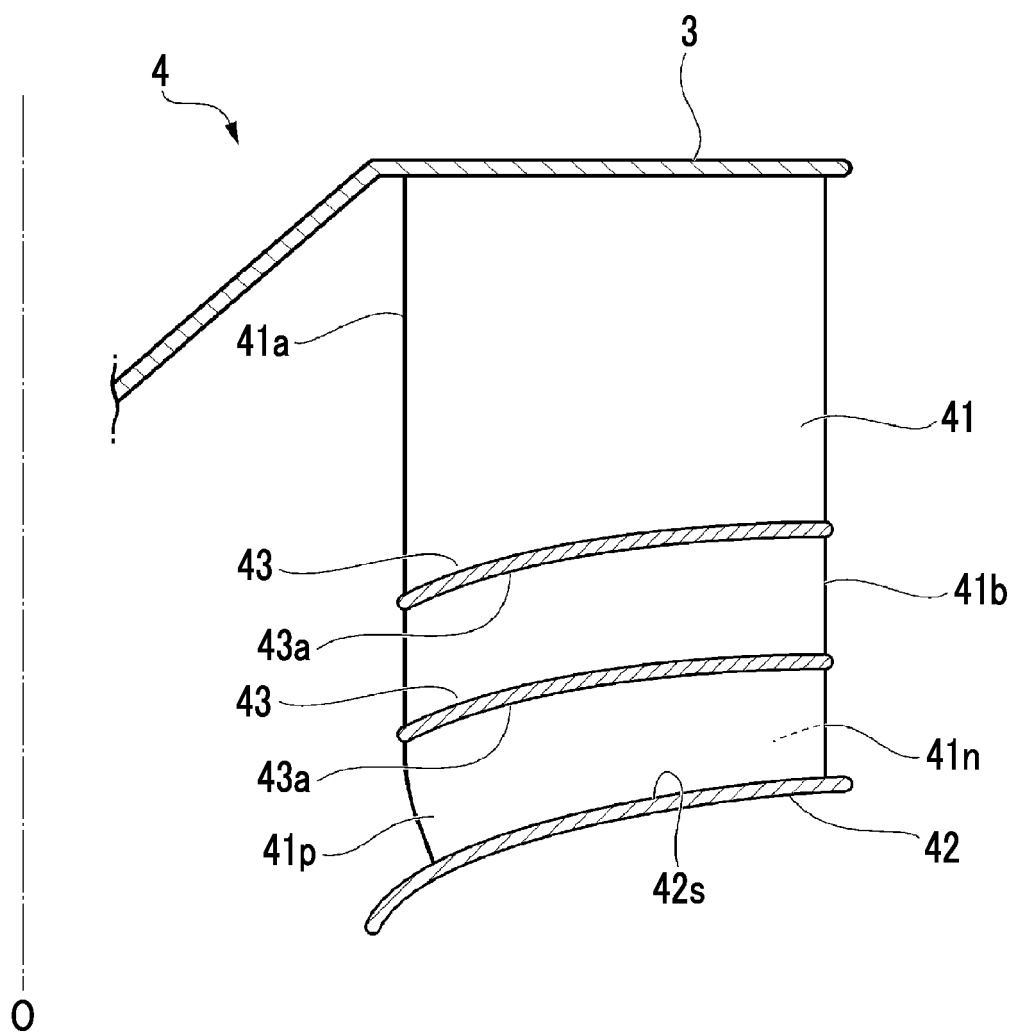
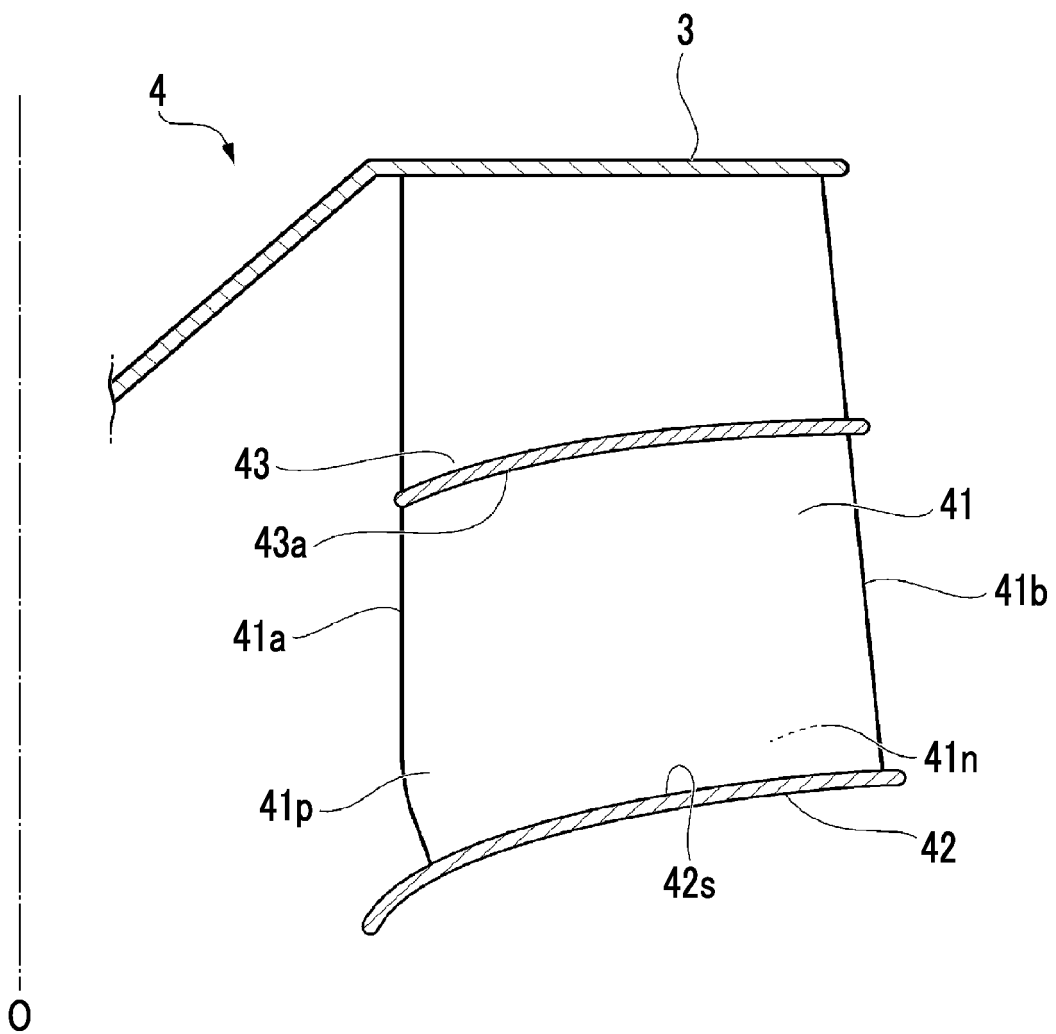


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/031161

A. CLASSIFICATION OF SUBJECT MATTER

F24F 1/0022(2019.01)i; **F24F 1/0047**(2019.01)i; **F04D 29/30**(2006.01)i
FI: F04D29/30 C; F24F1/0022; F24F1/0047

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)

F24F1/0022; F24F1/0047; F04D29/30

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
Y	JP 2001-82384 A (SANYO ELECTRIC CO LTD) 27 March 2001 (2001-03-27) claims 1-4, paragraphs [0001]-[0023], fig. 1-2, 10	1-5, 7
Y	JP 2007-162465 A (FUJITSU GENERAL LTD) 28 June 2007 (2007-06-28) claims 1-4, paragraphs [0001]-[0023], [0041]-[0043], fig. 1, 5-7	1-3, 6-7
Y	JP 2011-163690 A (HITACHI APPLIANCES INC) 25 August 2011 (2011-08-25) paragraphs [0013], [0025], fig. 1-2	1-7
Y	JP 2007-154702 A (FUJITSU GENERAL LTD) 21 June 2007 (2007-06-21) paragraphs [0010]-[0013], fig. 1-2	1-7
Y	JP 2007-154685 A (FUJITSU GENERAL LTD) 21 June 2007 (2007-06-21) paragraphs [0013]-[0014], [0025]-[0026], fig. 1-2	1-7
Y	JP 2010-133254 A (DAIKIN IND LTD) 17 June 2010 (2010-06-17) paragraphs [0002], [0005], [0007], [0027], [0030], fig. 2, 16	7

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 24 October 2022	Date of mailing of the international search report 08 November 2022
Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2022/031161

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2001-82384 A	27 March 2001	(Family: none)	
JP 2007-162465 A	28 June 2007	(Family: none)	
JP 2011-163690 A	25 August 2011	(Family: none)	
JP 2007-154702 A	21 June 2007	(Family: none)	
JP 2007-154685 A	21 June 2007	(Family: none)	
JP 2010-133254 A	17 June 2010	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2021152971 A [0002]
- JP 6130137 B [0005]