



(11) **EP 3 951 281 A1**

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

(43) Date of publication:  
**09.02.2022 Bulletin 2022/06**

(21) Application number: **20783874.9**

(22) Date of filing: **26.03.2020**

(51) International Patent Classification (IPC):  
**F24F 13/20** <sup>(2006.01)</sup> **F24F 1/0007** <sup>(2019.01)</sup>  
**F24F 1/0029** <sup>(2019.01)</sup> **F24F 1/0047** <sup>(2019.01)</sup>

(52) Cooperative Patent Classification (CPC):  
**F24F 1/0007; F24F 1/0029; F24F 1/0047;**  
**F24F 13/20**

(86) International application number:  
**PCT/JP2020/013593**

(87) International publication number:  
**WO 2020/203623 (08.10.2020 Gazette 2020/41)**

(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: **03.04.2019 JP 2019071547**

(71) Applicant: **Toshiba Carrier Corporation**  
**Kawasaki-Shi,**  
**Kanagawa 212-8585 (JP)**

(72) Inventor: **NAGASAWA, Atsushi**  
**Fuji-shi, Shizuoka 416-8521 (JP)**

(74) Representative: **Gramm, Lins & Partner**  
**Patent- und Rechtsanwälte PartGmbB**  
**Theodor-Heuss-Straße 1**  
**38122 Braunschweig (DE)**

(54) **AIR-CONDITIONER INDOOR UNIT AND METHOD FOR INSTALLING AIR-CONDITIONER INDOOR UNIT**

(57) An air-conditioner indoor unit (1) includes: a housing (5) that has inlets (22) on the lateral faces and an outlet (25) on the bottom face, and can be installed to be suspended from a structure in an installation place; a heat exchanger (6) that faces the inlets (22), and is annularly disposed as viewed from the bottom of the housing (5); a propeller fan (9) that has a rotary shaft (7) extending in the vertical direction of the housing (5), and is surrounded by the heat exchanger (6) as viewed from

the bottom of the housing (5); and a fan guard (13) provided at the outlet (25). When the area of a projection region of the moving range of blades (8) is defined as a first projection area, and the area of projection of opening portions of the fan guard (13) is defined as a second projection area, the opening ratio calculated by dividing the second projection area by the first projection area is at least 1/2. The propeller fan (9) has an appearance of low brightness.

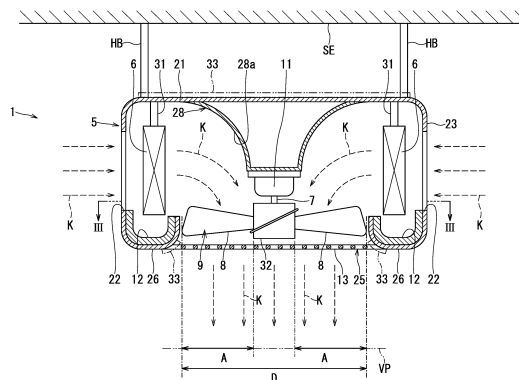


FIG. 2

**Description**

## TECHNICAL FIELD

5 **[0001]** Embodiments of the present invention relates to an indoor unit of an air conditioner and a method for installing the indoor unit of the air conditioner.

## BACKGROUND

10 **[0002]** A known indoor unit of an air conditioner performs air-conditioning in attic space and supplies the conditioned air into the room. Such indoor unit includes a casing, a fan, and a heat exchanger.

**[0003]** The casing has an inlet provided on its side face and an outlet provided on its bottom face. The fan is disposed inside the casing, and generates an air flow from the inlet to the outlet. The heat exchanger is disposed inside the casing and between the fan and the inlet.

15

PRIOR ART Document

## PATENT DOCUMENT

20 **[0004]** [Patent Document 1] JP 2010-164294 A

## SUMMARY

## PROBLEMS TO BE SOLVED BY INVENTION

25

**[0005]** The conventional indoor unit is installed in the attic space. In detail, the conventional indoor unit is embedded in a place sufficiently distant from the floor surface of the installation location in the height direction, i.e., embedded in the ceiling.

30 **[0006]** Further, the conventional indoor unit is provided with an outlet that has a plurality of round cone-shaped blades, i.e., a so-called anemostat type diffuser. This type of outlet blocks the view from directly below. Thus, in the conventional indoor unit, it is difficult to directly see the fan in the casing from below the outlet.

**[0007]** However, the indoor unit installed to be suspended from the ceiling of the installation location is closer to the floor surface than the conventional type of indoor unit embedded in the ceiling is.

35 **[0008]** When a fan guard having a better visibility than the anemostat type diffuser does is provided at the outlet, the fan rotating in the casing can be readily seen through.

**[0009]** When the installation of the indoor unit, which allows a user to readily see through the fan rotating in the casing, is brought closer to the floor surface, the commercial value of indoor unit may be reduced due to unnecessary fear of the rotating fan.

40 **[0010]** Thus, the present invention aims to provide an indoor unit of an air-conditioner, which indoor unit can be installed to be suspended from the ceiling and includes a fan guard allowing the fan rotating in the casing to be readily seen through while providing a sense of security without inciting unnecessary fear of the rotating fan. The present invention also aims to provide a method for installing such indoor unit.

## MEANS FOR SOLVING PROBLEM

45

**[0011]** To achieve the above object, an aspect of the present invention provides an indoor unit of an air-conditioner including: a housing that has an inlet on a side face and an outlet on a bottom face, and can be installed to be suspended from a structure of an installation location; a heat exchanger that is provided inside the housing, faces the inlet, and is annularly disposed in a bottom view of the housing; a propeller fan, which has a rotating shaft extending in a vertical direction of the housing and a plurality of blades radially arranged in a circumferential direction of the rotating shaft, and is surrounded by the heat exchanger in the bottom view of the housing, that sucks in air from the inlet, and blows out air after heat-exchange using the heat exchanger from the outlet toward a lower side of the housing; and a fan guard that is provided at the outlet. On a virtual plane orthogonal to an axial direction of the rotating shaft, when a projection region of movement range of the plurality of blades being moved by rotation of the propeller fan is defined a first projection area, and a projection area of an opening portion of the fan guard on the virtual plane and inside the projection region is defined as a second projection area, an opening ratio calculated by dividing the second projection area by the first projection area is 1/2 or more, and is substantially uniform in a rotation direction of the propeller fan. The propeller fan has a low-brightness appearance.

50

55

- [0012] It may be desired that brightness represented by Munsell value of the propeller fan is 5 or less.
- [0013] It may be desired that chroma represented by Munsell value of the propeller fan is 4 or less.
- [0014] It may be desired that a color of a portion of the indoor unit that can be seen through from below is substantially the same as a color of the propeller fan.
- 5 [0015] It may be desired that the heat exchanger has a blackish or bluish appearance.
- [0016] It may be further desired that a heat insulating material is provided on at least one of a top face of the housing and an opening edge of the outlet, and has a blackish or grayish appearance.
- [0017] It may be desired that brightness of appearance of the indoor unit is higher than brightness of the propeller fan.
- 10 [0018] A method for installing an indoor unit of an air-conditioner is to install the indoor unit of the air-conditioner above a lighting device at an installation location.

#### Effects of Invention

- 15 [0019] The present invention can provide an indoor unit of an air-conditioner, which indoor unit can be installed to be suspended from the ceiling and has a fan guard allowing the fan rotating in the casing to be readily seen through while providing a sense of security without inciting unnecessary fear of the rotating fan. The present invention can also provide a method for installing the above-described indoor unit.

#### BRIEF DESCRIPTION OF DRAWINGS

20 [0020]

Fig. 1 is a diagram illustrating an installation location where an indoor unit according to one embodiment of the present invention is installed.

25 Fig. 2 is a schematic longitudinal cross-sectional view of the indoor unit according to the embodiment of the present invention.

Fig. 3 is a schematic cross-sectional view of the indoor unit according to the embodiment of the present invention taken along the line III-III in Fig. 2.

#### 30 DETAILED DESCRIPTION

[0021] Embodiments of an indoor unit of an air conditioner and a method for installing the indoor unit of the air conditioner according to the present invention will now be described by referring to Fig. 1 to Fig. 3. The same reference signs are given to identical or equivalent components in each figure.

35 [0022] Fig. 1 is a diagram illustrating an installation location where the indoor unit according to one embodiment of the present invention is installed.

[0023] As shown in Fig. 1, the air conditioner according to the present embodiment includes an outdoor unit (not shown) installed outdoors, and an indoor unit 1 installed indoors. The outdoor unit and the indoor unit 1 are connected via a refrigerant pipe RP that circulates a refrigerant. The refrigeration cycle of the air conditioner circulates the refrigerant between the outdoor unit and the indoor unit 1.

40 [0024] The indoor unit 1 conditions air in the room, i.e., in the installation location. The installation location is surrounded with a floor FL, a wall WA, and a ceiling SE. The indoor unit 1 is suspended from a structure at the installation location, specifically, from the ceiling SE or from beams (not shown). The ceiling SE of the installation location is provided with a metal rod-shaped hanging members HB extending in the direction toward the floor surface. The indoor unit 1 is suspended from the ceiling SE via the hanging members HB. That is, the indoor unit 1 is provided at a position lower than the ceiling SE.

[0025] As described above, the indoor unit 1 is a bare unit away from the ceiling SE and disposed indoors in an exposed state without its housing 5 being embedded in the ceiling SE.

50 [0026] When a hanging type of lighting device, i.e., a so-called pendant light PL is installed on the ceiling SE of the installation location, it is preferred that the indoor unit 1 is installed above the pendant light PL of the installation location. More precisely, the indoor unit 1 is installed such that the bottom face of the indoor unit 1 (i.e., a face having an outlet 25 of the indoor unit 1 described below) is located above the light source of the pendant light PL. In this case, the indoor unit 1 may be installed above the pendant light PL by moving the fixing portion between the hanging members HB and the indoor unit 1 up or down. Also in this case, the installation height of the indoor unit 1 may be determined in advance, and then the installation height of the pendant light PL (i.e., hanging position) may be adjusted.

55 [0027] As shown in Fig. 2 and Fig. 3 in addition to Fig. 1, the indoor unit 1 according to the present embodiment includes: the housing 5 that is cylindrical or disc-shaped, and has a circular top face and a circular bottom face; a heat exchanger 6 that is provided inside the housing 5, and is annularly disposed in a bottom view of the housing 5; a fan

motor 11 that has a rotating shaft 7 extending in the vertical direction at approximately the center of the housing 5; a propeller fan 9 that has a plurality of blades 8 radially arranged in the circumferential direction of the rotating shaft 7, and is surrounded by the heat exchanger 6 in the bottom view of the housing 5; a drain pan 12 that is provided below the heat exchanger 6, and receives dew condensation water generated on the surface of the heat exchanger 6; and a fan guard 13 that protects the propeller fan 9.

**[0028]** Further, the indoor unit 1 includes an electric expansion valve (not shown) that is an expansion device of the refrigeration cycle.

**[0029]** As shown in Fig. 2, the housing 5 includes a top plate 21 that closes the top face. The top plate 21 is fixed to the hanging members HB that are embedded in and fixed on the ceiling SE.

**[0030]** Side plates 23 having inlets 22 for sucking air K from the periphery of the indoor unit 1 are provided on the outer peripheral surface of the housing 5, i.e., on the side face of the housing 5. The plurality of inlets 22 are arranged substantially evenly over the entire circumference of the outer peripheral surface of the housing 5. Each inlet 22 is opened in the shape of a curved rectangular window.

**[0031]** A substantially circular bottom plate 26 is provided on the bottom face of the housing 5, and the bottom plate 26 has an outlet 25 for blowing out air K downward. The outlet 25 is formed in the center of the bottom face of the housing 5. The outlet 25 is circular in the bottom view of the housing 5. The outlet 25 is provided with the fan guard 13.

**[0032]** Each of the top plate 21 and the bottom plate 26 of the housing 5 is fixed to the side plates 23 as the frame of the inlets 22 using fastening members, for example, screws (not shown) so as to be integrated.

**[0033]** The boundary portion between the top face and the side face of the housing 5 and the boundary portion between the bottom face and the side face of the housing 5 are arc-shaped with no corners. In other words, the boundary portion between the top face and the side face of the housing 5 and the boundary portion between the bottom face and the side face of the housing 5 have so-called corner radius (rounded corners).

**[0034]** That is, the indoor unit 1 includes the housing 5 in the shape of a cylinder having a corner R or in the shape of a disk having a corner R. Thus, in terms of design, the indoor unit 1 is superior to the conventional ceiling-embedded indoor unit having a rectangular housing. Since there are no sharp corners of the housing 5 of the indoor unit 1, the indoor unit 1 does not give a feeling of oppression to a user under the indoor unit 1 even if the housing 5 is exposed indoors.

**[0035]** The housing 5 may be a polygonal prism shape or a polygonal disc shape. For example, the shape of the top face and the bottom face of the housing 5 may be a polygonal shape of a pentagon or more. From the viewpoint of improving the ventilation efficiency of the propeller fan 9, it is more preferred that the housing 5 is in the shape of a regular polygonal prism or a regular polygonal disc, i.e., it is more preferred that the shape of the top face and the bottom face of the housing 5 is a regular polygon.

**[0036]** The indoor unit 1 sucks in the indoor air K from the inlets 22 on the side face of the housing 5, and blows it out from the outlet 25 on the bottom face of the housing 5. That is, the indoor unit 1 can cause the air K flowing along the ceiling SE to flow toward the floor FL. The air K having reached the floor FL from the indoor unit 1 flows along the wall WA, and returns to the vicinity of the ceiling SE so as to be circulated by the indoor unit 1. Thus, the indoor unit 1 can efficiently circulate the indoor air K. The indoor unit 1 is preferably provided in the central portion of the installation location to be air-conditioned.

**[0037]** Note that the indoor unit 1 may be installed at the installation location in such a manner that the top face of the housing 5, i.e., top plate 21 is positioned close to the ceiling SE. For example, when the ceiling SE is low and the indoor unit 1 suspended from the ceiling SE impairs livability, it is preferred to install the indoor unit 1 close to the ceiling SE.

**[0038]** A mounting base 28 for the fan motor 11 is provided inside the housing 5 and on the bottom face of the top plate 21. The mounting base 28 has, for example, a frustum shape that becomes narrower as the distance from the top plate 21 increases (i.e., narrower toward its bottom). The mounting base 28 has a side face 28a that is recessed and curved toward the central side of the cone in a lateral view. The protruding end face (i.e., bottom face with the smaller diameter) of the mounting base 28 is located approximately in the center of the housing 5. The fan motor 11 is fixed downward to the bottom face of the mounting base 28.

**[0039]** The heat exchanger 6 is fixed to the top plate 21 of the housing 5 via a fixing member 31. The heat exchanger 6 is annularly disposed in the bottom view of the housing 5. The heat exchanger 6 has a rectangular shape that is longer in the vertical direction of the housing 5 in a longitudinal cross-sectional view. The outer peripheral surface of the heat exchanger 6 faces the inlets 22. The inner peripheral surface of the heat exchanger 6 faces the curved side face 28a of the mounting base 28 for the fan motor 11. The shortest distance between the heat exchanger 6 and the circumference drawn by the rotation locus of the blades 8 of the propeller fan 9 is set to be substantially the same over the entire circumference of the propeller fan 9. In other words, the propeller fan 9 is disposed such that ventilation by the propeller fan 9 is made uniform throughout the entire heat exchanger 6. The heat exchanger 6 is a tabular heat exchanger, in which a refrigerant pipe penetrates a large number of aligned aluminum fins, that is bent in an annular shape. As shown in Fig. 3, the gap between both ends of the heat exchanger 6 bent in an annular shape is closed by a closing plate 40 for blocking the air flow before and after the heat exchange.

**[0040]** The propeller fan 9 is rotationally driven by the fan motor 11. The rotating propeller fan 9 sucks in the air K

around the housing 5 from the inlets 22, and blows out the air K after the heat-exchange using the heat exchanger 6 from the outlet 25 toward the lower side of the housing 5.

**[0041]** In the bottom view of the housing 5, the center of the annular heat exchanger 6, the rotation center of the propeller fan 9, and the center of the circular outlet 25 coincide. The diameter D of the propeller fan 9 is slightly smaller than the diameter of the outlet 25.

**[0042]** The propeller fan 9 includes: a hub 32 fixed to the rotating shaft 7; and the plurality of blades 8 integrated into the hub 32. The rotating shaft 7 extends in the vertical direction in a state where the indoor unit 1 is installed as shown in Fig. 1.

**[0043]** Using the rotational drive of the propeller fan 9, the flow of the air K sucked from the inlets 22 toward the center of the housing 5 is smoothly led below the housing 5 toward the outlet 25 along the curved side face 28a of the mounting base 28. The mounting base 28 improves the structural strength for supporting the fan motor 11 while improving the ventilation characteristics of the propeller fan 9.

**[0044]** The drain pan 12 is a heat insulating material having a water receiving portion. The drain pan 12 is mounted on the bottom plate 26 of the housing 5 so as to be integrated with the bottom plate 26. That is, as compared with the case where the drain pan 12 is supported by another member, the number of components of the indoor unit 1 can be reduced and the manufacturing cost can be reduced.

**[0045]** The drain pan 12 is disposed directly below the heat exchanger 6. During cooling operation in which the heat exchanger 6 functions as an evaporator, moisture contained in the air K (i.e., humidity inside the room) after passing through the heat exchanger 6 condenses on the surface of the heat exchanger 6, adheres to the heat exchanger 6 as dew condensation water, and drips from the heat exchanger 6. The drain pan 12 receives the dew condensation water that falls from the heat exchanger 6.

**[0046]** The drain pan 12 is substantially in the form of a U-shape or C-shape in a longitudinal cross-sectional view. The drain pan 12 being ring-shaped in the bottom view of the housing 5 surrounds the periphery of the propeller fan 9. The drain pan 12 extends from directly below the heat exchanger 6 to the edge of the outlet 25. In detail, the drain pan 12 extends to the edge of the outlet 25 that is close to the outer edge of the propeller fan 9. The gap between the outer edge of the propeller fan 9 and the edge of the outlet 25 is narrow, so the drain pan 12 can prevent the dew condensation water from falling or dripping through this gap. The dew condensation water stored in the drain pan 12 is pumped up by a drain pump (not shown) provided in the housing 5, and drained to the outside of the indoor unit 1 through a drain pipe (not shown).

**[0047]** The fan guard 13 is provided in the outlet 25. The fan guard 13 is disposed on the leeward of the propeller fan 9. The fan guard 13 is provided for safety so that users and objects do not contact the propeller fan 9. The fan guard 13 is a grid in which polygons are closely arranged or evenly arranged in the rotation direction (i.e., circumferential direction) of the propeller fan 9. Specifically, the fan guard 13 is a grid in which small openings of regular polygons such as equilateral triangles, squares, and regular pentagons are arranged in an orderly manner and/or a grid in which small fan-shaped openings are arranged in an orderly manner.

**[0048]** When the air conditioner is operated for cooling, the compressor of the outdoor unit discharges a high-temperature and high-pressure gas refrigerant and sends it to the outdoor heat exchanger, i.e., to the condenser. The outdoor heat exchanger exchanges heat between the refrigerant flowing inside it and the outdoor air so as to condense the refrigerant. The condensed liquid refrigerant is sent to the indoor unit 1 through the refrigerant pipe RP. The indoor unit 1 expands the liquid refrigerant flowing in from the refrigerant pipe RP using the electric expansion valve, and sends the low-temperature gas-liquid mixed refrigerant to the heat exchanger 6, i.e., to the evaporator. The heat exchanger 6 exchanges heat between the low-temperature refrigerant flowing inside it and the air in the room so as to gasify the refrigerant. At this time, the room is cooled by the low-temperature air K blown from the indoor unit 1.

**[0049]** When the air conditioner is operated for heating, the compressor of the outdoor unit discharges a high-temperature and high-pressure gas refrigerant and sends it to the heat exchanger 6 of the indoor unit 1, i.e., to the condenser. The heat exchanger 6 exchanges heat between the refrigerant flowing inside it and the air K in the room so as to condense the refrigerant. At this time, the room is heated by the high-temperature air K blew from the indoor unit 1.

**[0050]** Here, a virtual plane VP is set. The virtual plane VP is orthogonal to the extending direction of the rotating shaft 7 (i.e., the axial direction of the rotating shaft 7), that is, the virtual plane VP is orthogonal to the vertical direction in the installed state of the indoor unit 1 (Fig. 2).

**[0051]** On the virtual plane VP, an area of the projection region A that is the movement range of the plurality of blades 8 to be moved by the rotation of the propeller fan 9 is defined as the first projection area S1 (Fig. 3). The projection region A has an annular shape in which the root of each blade 8 (i.e., boundary portion between the hub 32 and the blades 8) is the inner circumference and the tip of each blade 8 is the outer circumference. The projection region A is an annular region in which the locus of movement of each blade 8 is projected onto the virtual plane VP. The first projection area S1 is the area of the annular projection region A. Due to the characteristics of the propeller fan 9, the portion of the hub 32 does not contribute to the ventilation work of the propeller fan 9, so the projection area of the portion of the hub 32 (i.e., the area inside the inner circumference of the projection region A) is excluded from the first projection

area S1. In other words, in the portion inside the inner circumference of the projection region A corresponding to the hub 32, even if the outlet 25 is closed, the ventilation performance of the propeller fan 9 is not affected.

**[0052]** On the virtual plane VP and inside the projection region A, a projection area of the opening portion of the fan guard 13 is defined as the second projection area S2. The grid-shaped fan guard 13 has a large number of small openings. The second projection area S2 corresponds to the total opening area of the large number of small openings in the projection region A when viewed from the axial direction of the rotating shaft 7. In other words, when viewed from the axial direction of the rotating shaft 7, the second projection area S2 is equal to an area calculated by subtracting the projection area of the grid in the projection region A from the area of the projection region A.

**[0053]** The opening ratio AR of the fan guard 13 calculated by dividing the second projection area S2 by the first projection area S1 is 1/2 or more. That is, the relation between the second projection area S2, the first projection area S1, and the opening ratio AR is expressed by the below [Expression 1], which is intended to improve the ventilation performance of the propeller fan 9 as much as possible. The larger the projection area of the grid in the projection region A is, the larger the ventilation resistance of the propeller fan 9 will be, which will reduce the amount of air blown. Thus, it is preferred that the opening ratio AR is as large as possible. Note that the fan guard 13 is required to protect the propeller fan 9.

[Expression 1]

(opening ratio AR) =

(second projection area S2)/(first projection area s1)  $\geq$  0.5

**[0054]** The opening ratio AR is substantially equal (i.e., uniform) in the rotation direction of the propeller fan 9. Setting the opening ratio AR substantially equal (i.e., uniform) in the rotation direction of the propeller fan 9 prevents the occurrence of partial bias in the amount of air blown at the outlet 25. That is, when the projection region A is divided into a plurality of regions in the rotation direction of the propeller fan 9, the opening ratio AR in each divided region is substantially 1/2 or more. For example, when the projection region is divided into six divided regions every 60 degrees of the central angle, the opening ratio AR in each divided region is substantially 1/2 or more.

**[0055]** When the opening ratio AR is 1/2 or more, there is a lot of space, thereby the rotation state of each blade 8 of the propeller fan 9 can be readily visually recognized from below, i.e., from the position of the user through the fan guard 13. For example, when the propeller fan 9 is driven at a rotation speed of 10 rotations per second (i.e., 10 revolutions per second or 10 rps) or more in order to obtain sufficient ventilation performance, the plurality of rotating blades 8 may incite unnecessary fear when the users look up at the indoor unit 1 from below.

**[0056]** In order to solve the above-described problem, the propeller fan 9 has a low-brightness appearance. For example, the propeller fan 9 has a black appearance. The brightness represented by Munsell value of the propeller fan 9 is preferably 5 or less. Further, the chroma represented by Munsell value of the propeller fan 9 is preferably 4 or less.

**[0057]** The top face of the housing 5 is closed by the top plate 21. Although the side face of the housing 5 has inlets 22, the light entering from the inlets 22 into the housing 5 is almost blocked by the heat exchanger 6 in the housing 5. Hence, light from a lighting device at the installation location hardly reach the inside of the housing 5, and thus, the inside of the housing 5 is dark. Further, when the inlets 22 are provided with filters for preventing dust from adhering to the heat exchanger 6, the light entering into the housing 5 is further blocked and the inside of the housing 5 is brought into a state of a dark box. Accordingly, by lowering the brightness of the propeller fan 9, the visibility of the propeller fan 9 in the housing 5 is significantly reduced. In this case, the user looking up at the indoor unit 1 from below cannot visually recognize the rotating blades 8 and does not feel unnecessary fear.

**[0058]** In the indoor unit 1, the portions that can be seen through from below desirably have substantially the same color as the propeller fan 9. The portions that can be seen through from below include, for example, the fan guard 13, the external face of the bottom plate 26 (i.e., drain pan 12) of the housing 5, each external face of the side plates 23 of the housing 5, the internal face of the top plate 21 of the housing 5, and the mounting base 28. When the color of each of these portions is substantially the same as the color of the propeller fan 9, for example, black, the difference in brightness between the propeller fan 9 and the other portions becomes extremely small. In this case, the visibility of the propeller fan 9 in the housing 5 is further reduced.

**[0059]** The heat exchanger 6 preferably has a blackish or bluish appearance, and such a configuration can prevent the light entering through the inlets 22 into the housing 5 from being reflected by the heat exchanger 6 and entering further inside than the heat exchanger 6. Such a configuration further reduces the visibility of the propeller fan 9 in the housing 5.

**[0060]** The indoor unit 1 may be provided with a heat insulating material 33 that is provided on at least one of the top face of the housing 5 (i.e., upper face or external face of the top plate 21) and the opening edge of the outlet 25. The

heat insulating material 33 preferably has a blackish or grayish appearance, and such an appearance further reduces the visibility of the propeller fan 9 in the housing 5.

**[0061]** An illusion technique may be applied to reduce the visibility of the propeller fan 9 in the housing 5. In this case, in the indoor unit 1, the brightness of the appearance to be viewed from below, i.e., the brightness of the so-called design surfaces is made higher than the brightness of the propeller fan 9. The difference in brightness therebetween represented by Munsell value between is preferably 4 or more. The design surfaces to be viewed from below include, for example, the bottom face (i.e., external face) of the fan guard 13, the bottom face (i.e., external face) of the bottom plate 26 of the housing 5, and each external face of the side plates 23 of the housing 5. When the brightness of these portions is made higher than the brightness of the propeller fan 9 by adopting, for example, milky white as the color of these portions, the difference in brightness between the appearance of the indoor unit 1 and the propeller fan 9 in the housing 5 increases. In this case, the dark propeller fan 9 in the housing 5 is confused with the bright appearance of the indoor unit 1, i.e., the visibility of the propeller fan 9 is further reduced.

**[0062]** As described above, the indoor unit 1 according to the present embodiment includes: the fan guard 13 that is substantially uniform in the rotation direction of the propeller fan 9, and has an opening ratio AR of 1/2 or more; and the propeller fan 9 with a low-brightness appearance. Consequently, the indoor unit 1 provides the fan guard 13 with better visibility than the anemostat type diffuser at the outlet of the conventional indoor unit, while reducing the visibility of the propeller fan 9 rotating in the housing 5. In other words, the indoor unit 1 can provide a sense of security without inciting unnecessary fear of the rotating propeller fan 9.

**[0063]** In the method for installing the indoor unit 1 according to the present embodiment, the indoor unit 1 is installed above the lighting device of the installation location. That is, the face of the outlet 25 of the indoor unit 1 is disposed above the light source of the illuminating device. Consequently, in the indoor unit 1, the light emitted from the lighting device hardly enters into the housing 5, and the housing 5 itself serves as a shadow, thereby the visibility of the propeller fan 9 rotating in the housing 5 can be reduced. When a user under the indoor unit 1 looks up, a light source with high luminosity comes into the eyes, the user will hardly see the internal face of the outlet 25 of the indoor unit 1 due to the difference in brightness, which further reduces the visibility of the propeller fan 9 rotating in the housing 5.

**[0064]** According to the indoor unit 1 of the present embodiment and the method for installing the indoor unit 1 of the present embodiment as described above, the indoor unit 1 can be installed to be suspended from the ceiling and includes the fan guard 13 allowing the rotating propeller fan 9 in the housing 5 to be readily seen through while providing a sense of security without inciting unnecessary fear of the rotating propeller fan 9.

**[0065]** While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

#### REFERENCE SIGNS LIST

##### **[0066]**

|     |                |
|-----|----------------|
| 1   | indoor unit    |
| 5   | housing        |
| 6   | heat exchanger |
| 7   | rotating shaft |
| 8   | blade          |
| 9   | propeller fan  |
| 11  | fan motor      |
| 12  | drain pan      |
| 13  | fan guard      |
| 21  | top plate      |
| 22  | inlet          |
| 23  | side plate     |
| 25  | outlet         |
| 26  | bottom plate   |
| 28  | mounting base  |
| 28a | side face      |
| 31  | fixing member  |
| 32  | hub            |

33 heat insulating material

## Claims

5 1. An indoor unit of an air-conditioner comprising:

a housing that has an inlet on a side face and an outlet on a bottom face, and can be installed to be suspended from a structure of an installation location;

10 a heat exchanger that is provided inside the housing, faces the inlet, and is annularly disposed in a bottom view of the housing;

a propeller fan that has a rotating shaft extending in a vertical direction of the housing and a plurality of blades radially arranged in a circumferential direction of the rotating shaft, is surrounded by the heat exchanger in the bottom view of the housing, sucks in air from the inlet, and blows out air after heat-exchange using the heat exchanger from the outlet toward a lower side of the housing; and

15 a fan guard that is provided at the outlet,

wherein, when an area of a projection region of movement range of the plurality of blades moved by rotation of the propeller fan on a virtual plane orthogonal to an axial direction of the rotating shaft is defined as a first projection area, and a projection area of an opening portion of the fan guard on the virtual plane and inside the projection region is defined as a second projection area, an opening ratio calculated by dividing the second projection area by the first projection area is 1/2 or more and is substantially uniform in a rotation direction of the propeller fan, and

20 wherein the propeller fan has a low-brightness appearance.

25 2. The indoor unit of an air-conditioner according to claim 1, wherein brightness represented by Munsell value of the propeller fan is 5 or less.

30 3. The indoor unit of an air-conditioner according to claim 2, wherein chroma represented by Munsell value of the propeller fan is 4 or less.

4. The indoor unit of an air-conditioner according to any one of claim 1 to claim 3, wherein a color of a portion of the indoor unit that can be seen through from below is substantially the same as a color of the propeller fan.

35 5. The indoor unit of an air-conditioner according to any one of claim 1 to claim 4, wherein the heat exchanger has a blackish or bluish appearance.

40 6. The indoor unit of an air-conditioner according to any one of claim 1 to claim 5, further comprising a heat insulating material that is provided on at least one of a top face of the housing and an opening edge of the outlet, and has a blackish or grayish appearance.

7. The indoor unit of an air-conditioner according to any one of claim 1 to claim 3, wherein brightness of appearance of the indoor unit is higher than brightness of the propeller fan.

45 8. A method for installing an indoor unit of an air-conditioner according to any one of claim 1 to claim 7 comprising a step of installing the indoor unit of an air-conditioner above a lighting device at an installation location.

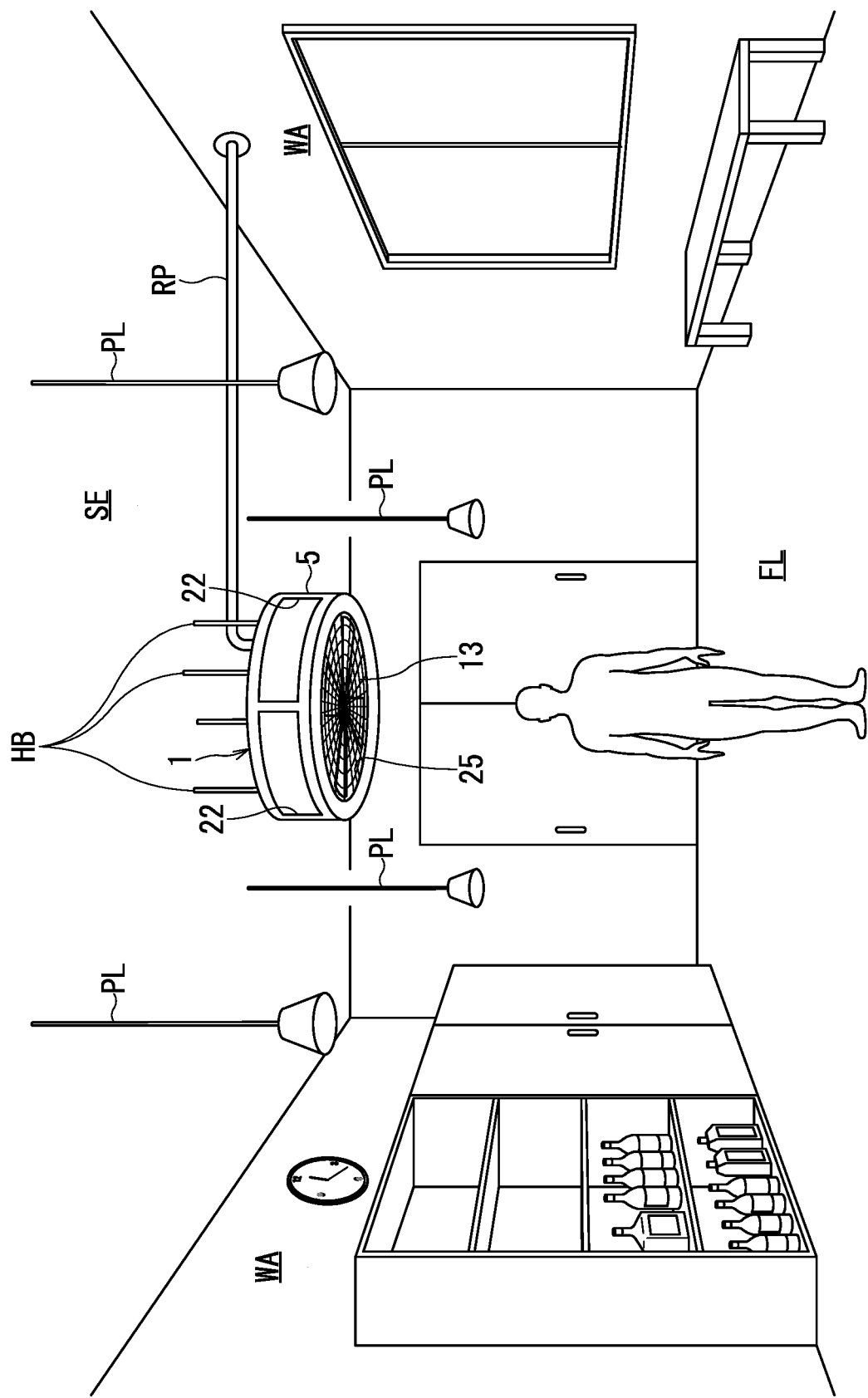
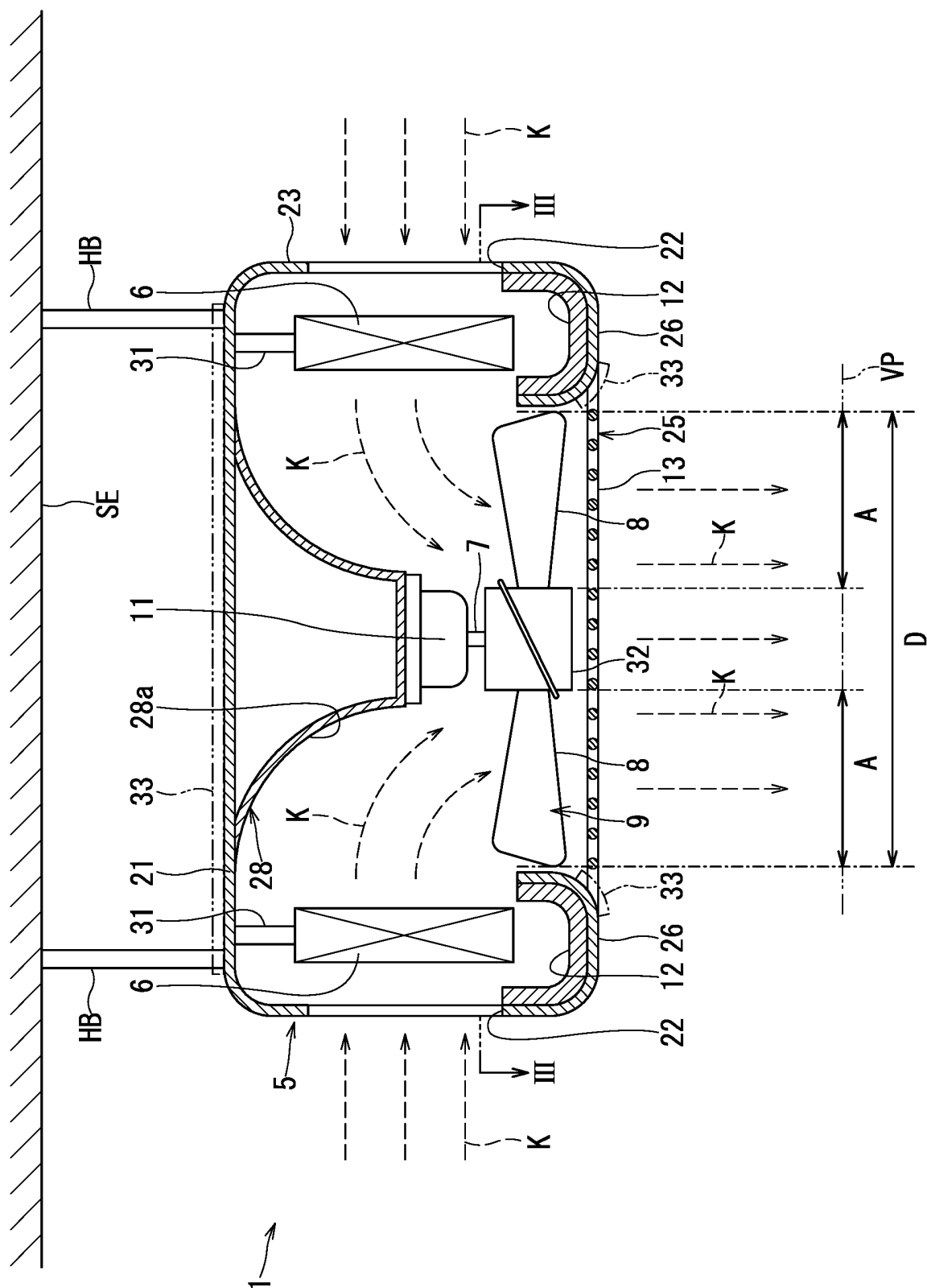


FIG. 1



# FIG. 2

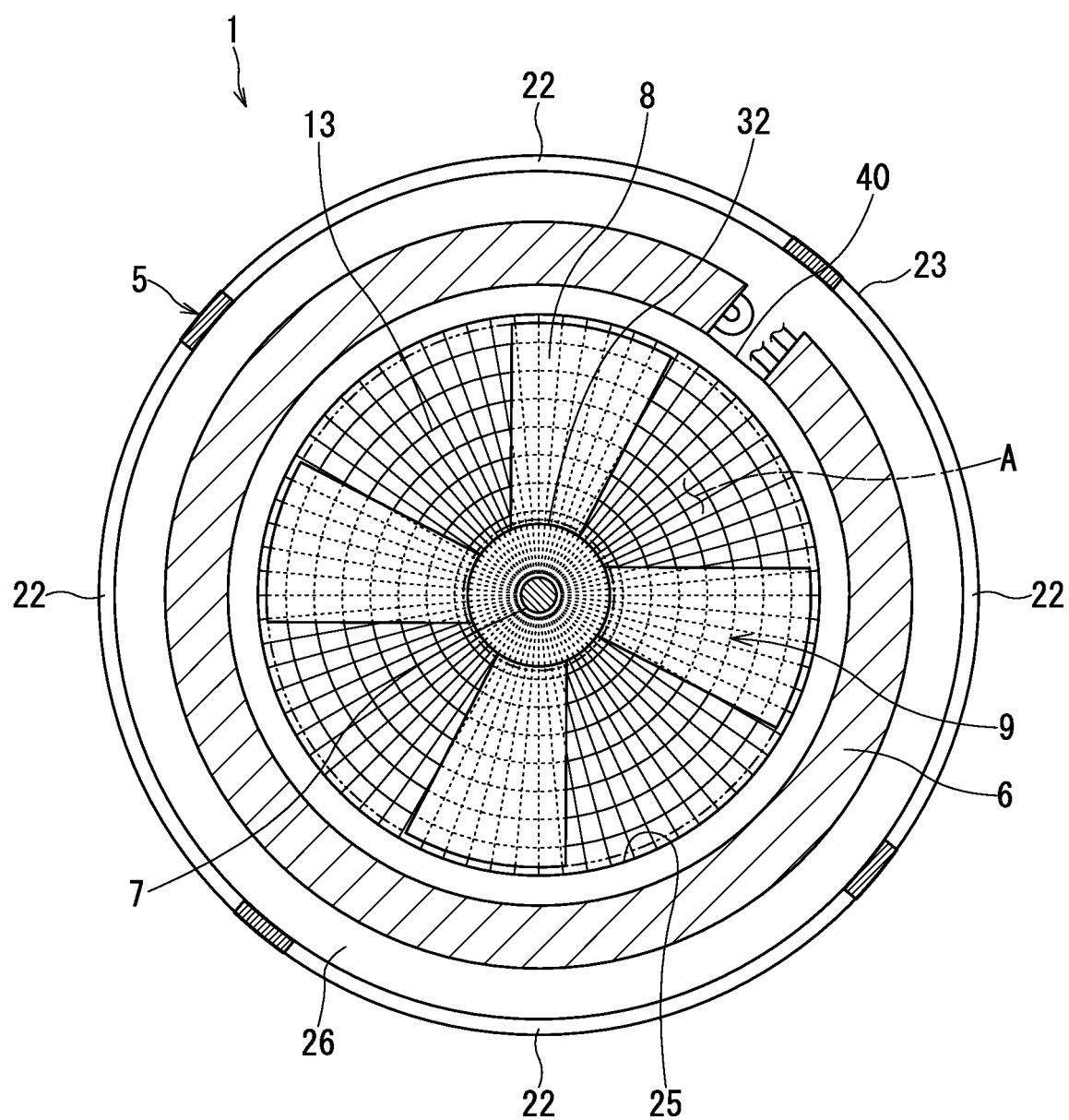


FIG. 3

5

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/013593

10

## A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F24F13/20 (2006.01) i, F24F1/0007 (2019.01) i, F24F1/0029 (2019.01) i, F24F1/0047 (2019.01) i

FI: F24F1/0029, F24F1/0007321, F24F1/0047, F24F13/20205

According to International Patent Classification (IPC) or to both national classification and IPC

15

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F24F13/20, F24F1/0007, F24F1/0029, F24F1/0047

20

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

25

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                               | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | JP 2009-168323 A (DAIKIN INDUSTRIES, LTD.) 30.07.2009 (2009-07-30)                                                                                                                                               | 1-8                   |
| A         | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 163706/1985 (Laid-open No. 072510/1987) (MITSUBISHI ELECTRIC CORPORATION) 09.05.1987 (1987-05-09)   | 1-8                   |
| A         | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 038511/1990 (Laid-open No. 129832/1991) (MITSUBISHI HEAVY INDUSTRIES, LTD.) 26.12.1991 (1991-12-26) | 1-8                   |
| A         | JP 2014-215025 A (DAIKIN INDUSTRIES, LTD.) 17.11.2014 (2014-11-17)                                                                                                                                               | 1-8                   |

40

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

45

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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

"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

"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

"&amp;" document member of the same patent family

50

Date of the actual completion of the international search  
15.06.2020Date of mailing of the international search report  
23.06.2020

55

Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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

5

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/JP2020/013593

10

JP 2009-168323 A 30.07.2009 (Family: none)

JP 62-072510 U1 09.05.1987 (Family: none)

JP 03-129832 U1 26.12.1991 (Family: none)

15

JP 2014-215025 A 17.11.2014 US 2016/0076789 A1  
WO 2014/178166 A1  
EP 2985542 A1  
CN 105247292 A

20

25

30

35

40

45

50

55

**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 2010164294 A [0004]