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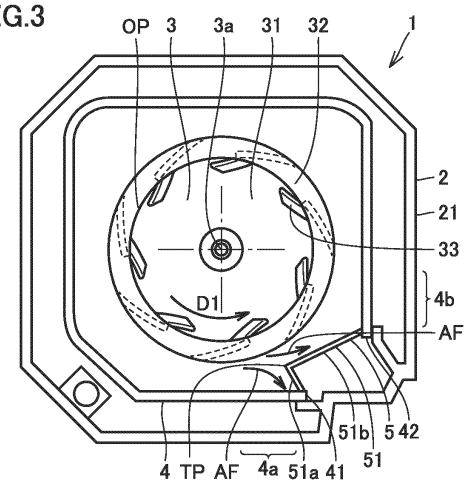
(54) **INDOOR UNIT AND AIR-CONDITIONING DEVICE**

(57) An indoor unit (1) includes a housing (2), a centrifugal fan (3), a heat exchanger (4), and a partition plate (5). The centrifugal fan (3) is contained in the housing (2), has a rotational axis, and is configured to rotate about the rotational axis. The heat exchanger (4) is arranged to surround at least three quarters of an outer circumferential periphery of the centrifugal fan (3), and has a first end (41) located upstream in a rotational direction of the centrifugal fan (3), and a second end (42) located downstream in the rotational direction of the centrifugal fan (3) and spaced from the first end (41). The partition plate (5) has a protruding portion (51) protruding toward the centrifugal fan (3) from the first end (41) and the second end (42) of the heat exchanger (4). An apex (TP) of the protruding portion (51) of the partition plate (5) is located closer to the first end (41) than to the second end (42).

FIG.3

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## Description

TECHNICAL FIELD

**[0001]** The present disclosure relates to an indoor unit and an air conditioner.

BACKGROUND ART

**[0002]** There has been a conventional air conditioner having a four-way cassette type indoor unit. This four-way cassette type indoor unit is configured to be embedded in a ceiling and blow air in four directions in the embedded state. The four-way cassette type indoor unit includes a centrifugal fan, a heat exchanger arranged to surround the centrifugal fan, and a partition plate connecting the opposite ends of the heat exchanger.

**[0003]** For example, Japanese Patent Laying-Open No. H9-49640 (PTL 1) discloses a four-way cassette type indoor unit. In the indoor unit disclosed in this publication, the partition plate is configured to protrude inward of the heat exchanger.

CITATION LIST

PATENT LITERATURE

**[0004]** PTL 1: Japanese Patent Laying-Open No. H9-49640

SUMMARY OF INVENTION

TECHNICAL PROBLEM

**[0005]** In the indoor unit disclosed in the above-referenced publication, the centrifugal fan is rotated to generate airflow. This airflow passes along the partition plate to be concentrated into the heat exchanger on the downstream side in the rotational direction of the centrifugal fan. Therefore, the airflow passing in the heat exchanger on the downstream side in the rotational direction of the centrifugal fan has a large pressure loss. Meanwhile, airflow passing into the heat exchanger on the upstream side in the rotational direction of the centrifugal fan is insufficient.

**[0006]** The present disclosure is given in view of the above problems, and an object of the present disclosure is to provide an indoor unit that can suppress a pressure loss of airflow passing in the heat exchanger on the downstream side in the rotational direction of the centrifugal fan, and can promote passing of airflow into the heat exchanger on the upstream side in the rotational direction of the centrifugal fan, as well as an air conditioner having the indoor unit.

SOLUTION TO PROBLEM

**[0007]** An indoor unit of the present disclosure includes: a housing, a centrifugal fan, a heat exchanger, and a partition plate. The centrifugal fan is contained in the housing, has a rotational axis, and is configured to rotate about the rotational axis. The heat exchanger is arranged to surround at least three quarters of an outer circumferential periphery of the centrifugal fan, and has a first end located upstream in a rotational direction of the centrifugal fan, and a second end located downstream in the rotational direction of the centrifugal fan and spaced from the first end. The partition plate has a protruding portion protruding toward the centrifugal fan from the first end and the second end of the heat exchanger. An apex of the protruding portion of the partition plate is located closer to the first end than to the second end.

ADVANTAGEOUS EFFECTS OF INVENTION

**[0008]** In the indoor unit of the present disclosure, the apex of the protruding portion of the partition plate is located closer to the first end than to the second end. Therefore, the pressure loss of airflow passing in the heat exchanger on the downstream side in the rotational direction of the centrifugal fan can be suppressed. Moreover, passing of airflow into the heat exchanger on the upstream side in the rotational direction of the centrifugal fan can be promoted.

BRIEF DESCRIPTION OF DRAWINGS

**[0009]**

Fig. 1 is a perspective view schematically showing a configuration of an indoor unit according to Embodiment 1.

Fig. 2 is a cross-sectional view along a line II-II in Fig. 1.

Fig. 3 is a bottom view schematically showing the configuration of the indoor unit with its panel removed, according to Embodiment 1.

Fig. 4 is a perspective view schematically showing the configuration of the indoor unit with its panel removed, according to Embodiment 1.

Fig. 5 is a bottom view schematically showing a configuration of a modification of the indoor unit with its panel removed, according to Embodiment 1.

Fig. 6 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 2.

Fig. 7 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 3.

Fig. 8 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 4.

Fig. 9 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 5.

Fig. 10 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 6.

Fig. 11 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 7.

Fig. 12 is a perspective view schematically showing the configuration of the indoor unit with its panel removed, according to Embodiment 7.

Fig. 13 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 8.

Fig. 14 is a perspective view schematically showing the configuration of the indoor unit with its panel removed, according to Embodiment 8.

Fig. 15 is a bottom view schematically showing a configuration of an indoor unit with its panel removed, according to Embodiment 9.

Fig. 16 is a perspective view schematically showing the configuration of the indoor unit with its panel removed, according to Embodiment 9.

Fig. 17 is a refrigerant circuit diagram for an air conditioner according to Embodiment 10.

DESCRIPTION OF EMBODIMENTS

**[0010]** Embodiments are described hereinafter based on the drawings. In the following, the same or corresponding parts are denoted by the same reference characters, and a description thereof is not herein repeated.

Embodiment 1

**[0011]** Referring to Figs. 1 to 4, a configuration of an indoor unit 1 according to Embodiment 1 is described. Indoor unit 1 according to Embodiment 1 is a four-way cassette type indoor unit. Indoor unit 1 according to Embodiment 1 is a ceiling-embedded-type indoor unit. Indoor unit 1 according to Embodiment 1 is an indoor unit for a packaged air conditioner.

**[0012]** Fig. 1 is a perspective view showing, from below, indoor unit 1 according to Embodiment 1. Indoor unit 1 according to Embodiment 1 is embedded in a ceiling in the state shown in Fig. 1. Fig. 2 is a cross-sectional view laterally showing an internal structure of indoor unit 1 according to Embodiment 1. Fig. 3 is a bottom view showing, from below, a configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 1. For ease of visual recognition, Fig. 3 does not show piping connected to heat exchanger 4. In Fig. 3 and subsequent drawings, the configuration in a simplified form is shown for ease of visual recognition. Fig. 4 is a perspective view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 1.

**[0013]** Referring to Figs. 1 and 2, indoor unit 1 according to Embodiment 1 includes a housing 2, a centrifugal fan 3, a heat exchanger 4, a partition plate 5, a motor 6, a bell mouth 7, and a filter 8. In housing 2, centrifugal fan 3, heat exchanger 4, partition plate 5, motor 6, bell mouth 7, and filter 8 are contained.

**[0014]** Housing 2 has a casing 21 and a panel 22. Casing 21 has a top plate 21a and a sidewall 21b. Top plate 21a is placed on the upper end of casing 21. Sidewall 21b is connected to the outer edge of top plate 21a. Sidewall 21b extends from top plate 21a toward panel 22. Sidewall 21b is formed to surround heat exchanger 4.

**[0015]** Panel 22 is attached to the lower end of casing 21. As seen in plan view, panel 22 is formed in a substantially square shape. Panel 22 has a suction inlet 23, a discharge outlet 24, and a louver 25. At least one suction inlet 23 is provided in panel 22. At least one discharge outlet 24 is provided in panel 22. For indoor unit 1 according to Embodiment 1, one suction inlet 23 and four discharge outlets 24 are provided in panel 22. As seen in plan view, suction inlet 23 is formed in a substantially square shape. Suction inlet 23 is arranged centrally of panel 22. A grille is provided in suction inlet 23.

**[0016]** As seen in plan view, four discharge outlets 24 are each formed in a substantially rectangular shape. As seen in plan view, four discharge outlets 24 are each located outward of suction inlet 23. Each of four discharge outlets 24 is located between the outer edge of panel 22 and suction inlet 23. Four discharge outlets 24 are arranged in four ways around suction inlet 23. Each of four discharge outlets 24 is arranged along a corresponding one of four sides of panel 22. Each of four louvers 25 is arranged at a corresponding one of four discharge outlets 24. Louver 25 is configured to adjust passing of airflow from discharge outlet 24 in the top-to-bottom direction and the left-to-right direction.

**[0017]** Centrifugal fan 3 is contained in housing 2. Centrifugal fan 3 has rotational axis 3a. Centrifugal fan 3 is configured to rotate about rotational axis 3a. Plan view herein refers to viewing centrifugal fan 3 along rotational axis 3a. Centrifugal fan 3 is configured to rotate about rotational axis 3a to thereby generate airflow.

**[0018]** Heat exchanger 4 is arranged between sidewall 21b of housing 2 and centrifugal fan 3. Heat exchanger 4 is spaced from sidewall 21b of housing 2. Heat exchanger 4 is spaced from centrifugal fan 3. Heat exchanger 4 is arranged in a fluid path of air that is sucked by centrifugal fan 3 from suction inlet 23 into housing 2 and blown out from four discharge outlets 24 into an indoor space (target space). In heat exchanger 4, heat is exchanged between air flowing outside heat exchanger 4 and refrigerant flowing inside heat exchanger 4.

**[0019]** Heat exchanger 4 has a plurality of fins F and a heat transfer pipe P. The plurality of fins F are spaced from each other. Heat transfer pipe P extends through the plurality of fins F. Heat transfer pipe P is configured to allow refrigerant to flow in heat transfer pipe P.

**[0020]** Partition plate 5 is connected to the opposite ends of heat exchanger 4. Partition plate 5 is spaced from sidewall 21b of housing 2. Partition plate 5 is spaced from centrifugal fan 3. Partition plate 5 is formed in the shape of a plate. Partition plate 5 is configured to separate a space in which centrifugal fan 3 is located, from a space in which piping connected to heat exchanger 4 is located.

**[0021]** Motor 6 is arranged centrally of top plate 21a of casing 21. Motor 6 is attached to the center of top plate 21a of casing 21. Motor 6 has a drive unit 61, a motor shaft 62, and a connection member 63. Drive unit 61 is configured to rotate motor shaft 62. Drive unit 61 is attached to the center of top plate 21a of casing 21. Motor shaft 62 is configured to rotate in the circumferential direction of motor shaft 62. Motor shaft 62 extends from drive unit 61 toward panel 22. Connection member 63 is attached to the outer peripheral surface of motor shaft 62. Connection member 63 is configured to connect motor shaft 62 to centrifugal fan 3. Motor 6 is configured to rotate centrifugal fan 3 in the rotational direction of motor shaft 62.

**[0022]** Bell mouth 7 is arranged between centrifugal fan 3 and suction inlet 23 of panel 22. Bell mouth 7 is configured to guide air sucked from suction inlet 23 of panel 22 to centrifugal fan 3.

**[0023]** Filter 8 is arranged between bell mouth 7 and suction inlet 23 of panel 22. Filter 8 is configured to remove dust from air flowing into housing 2 from suction inlet 23 of panel 22.

**[0024]** Referring to Figs. 2 and 3, the configuration of centrifugal fan 3 is described in further detail.

**[0025]** As seen in plan view, centrifugal fan 3 is formed in a substantially circular shape. Centrifugal fan 3 has a main plate 31, a side plate 32, and a plurality of vanes 33.

**[0026]** Main plate 31 is connected to a connection member 63 of motor 6. Main plate 31 has a central portion 31a, a first flat plate portion 31b, an inclined portion 31c, and a second flat plate portion 31d. As seen in plan view, central portion 31a is located centrally of main plate 31. Central portion 31a is formed substantially in a cylindrical shape. A through hole H is formed in central portion 31a. With connection member 63 inserted in through hole H of central portion 31a, connection member 63 is attached to central portion 31a. Accordingly, main plate 31 is attached to motor shaft 62 of motor 6 through connection member 63. Thus, main plate 31 can be rotated about rotational axis 3a by rotational force of motor 6.

**[0027]** First flat plate portion 31b is connected to central portion 31a. As seen in plan view, first flat plate portion 31b is located outside central portion 31a. Inclined portion 31c is connected to first flat plate portion 31b. As seen in plan view, inclined portion 31c is located outside first flat plate portion 31b. Inclined portion 31c is inclined to expand from first flat plate portion 31b toward second flat plate portion 31d. Second flat plate portion 31d is connected to inclined portion 31c. As seen in plan view, second flat plate portion 31d is located outside inclined portion 31c. Second flat plate portion 31d is located closer to top plate 21a of housing 2 than first flat plate portion 31b.

**[0028]** Side plate 32 is spaced from main plate 31 in the direction in which rotational axis 3a extends. As seen in plan view, side plate 32 is formed in an annular shape. An opening OP is formed centrally of side plate 32. Centrifugal fan 3 is configured to cause air to flow from opening OP into centrifugal fan 3. As seen in plan view, side plate 32 is located along the outer rim of centrifugal fan 3.

**[0029]** The plurality of vanes 33 are arranged between main plate 31 and side plate 32. The plurality of vanes 33 are arranged on second flat plate portion 31d of main plate 31. The upper end of each of the plurality of vanes 33 is attached to second flat plate portion 31d of main plate 31. The lower end of each of the plurality of vanes 33 is attached to side plate 32.

**[0030]** Referring to Figs. 3 and 4, the configuration of heat exchanger 4 and partition plate 5 is described in further detail.

**[0031]** Heat exchanger 4 is arranged to surround centrifugal fan 3, in the circumferential direction of centrifugal fan 3. As seen in plan view, heat exchanger 4 is arranged substantially in the shape of a rectangle. Heat exchanger 4 is arranged to surround at least three quarters of the outer circumferential periphery of centrifugal fan 3. Heat exchanger 4 is arranged in four ways around centrifugal fan 3.

**[0032]** Heat exchanger 4 has a first end 41 and a second end 42. First end 41 is one end of heat exchanger 4 in the circumferential direction. Second end 42 is the other end of heat exchanger 4 in the circumferential direction. First end 41 and second end 42 are spaced from each other. First end 41 and second end 42 are arranged in one corner of a substantially rectangular shape of heat exchanger 4. Namely, first end 41 and second end 42 are arranged in one corner of casing 21. First end 41 is located upstream in the rotational direction of centrifugal fan 3. Namely, first end 41 is located upstream, relative to second end 42, in the rotational direction of centrifugal fan 3. Second end 42 is located downstream in the rotational direction of centrifugal fan 3, and spaced from first end 41. Namely, second end 42 is located downstream, relative to first end 41, in the rotational direction of centrifugal fan 3.

**[0033]** Partition plate 5 is connected to the opposite ends of heat exchanger 4 in the circumferential direction. Namely, partition plate 5 is connected to first end 41 and second end 42. Partition plate 5 has a protruding portion 51. Protruding portion 51 protrudes toward centrifugal fan 3 from first end 41 and second end 42 of heat exchanger 4. Protruding portion 51 protrudes toward centrifugal fan 3 beyond a virtual line connecting first end 41 and second end 42 on the inner circumference side of heat exchanger 4.

**[0034]** An apex TP of protruding portion 51 of partition plate 5 is located closer to first end 41 than to second end 42. Apex TP is located upstream in the rotational direction of centrifugal fan 3, relative to the midpoint of the virtual line connecting first end 41 and second end 42 on the inner circumference side of heat exchanger 4. Namely, apex TP is located away, in the counter-rotational direction of centrifugal fan 3, from the midpoint of the virtual line connecting first end 41 and second end

42 on the inner circumference side of heat exchanger 4.

**[0035]** Protruding portion 51 of partition plate 5 has a first plate portion 51a and a second plate portion 51b. First plate portion 51a is configured to connect apex TP to first end 41. Second plate portion 51b is configured to connect apex TP to second end 42. As seen in plan view, the length of first plate portion 51a is shorter than the length of second plate portion 51b. The joint where first plate portion 51a and second plate portion 51b are connected to each other forms apex TP. Apex TP is formed pointedly.

**[0036]** In the following, referring again to Figs. 1 to 3, operation of indoor unit 1 according to Embodiment 1 is described.

**[0037]** Referring to Figs. 1 and 2, rotation of centrifugal fan 3 causes air in an indoor space (target space) to be sucked into housing 2 from suction inlet 23 of panel 22. From the air sucked into housing 2 from suction inlet 23 of panel 22, dust is removed by filter 8. The air passed through filter 8 is guided by bell mouth 7 to centrifugal fan 3. The air sucked into centrifugal fan 3 through opening OP formed in side plate 32 of centrifugal fan 3 flows between the plurality of vanes 33 to be discharged outward in the radial direction of centrifugal fan 3. The air thus discharged flows toward heat exchanger 4. While air flows outside heat exchanger 4, heat is exchanged between the air outside heat exchanger 4 and refrigerant inside heat exchanger 4. The air with its heat exchanged with refrigerant in heat exchanger 4 flows through the space between heat exchanger 4 and sidewall 21b of housing 2 to be discharged from four discharge outlets 24 into the indoor space (target space).

**[0038]** Referring to Fig. 3, a part of the air discharged from centrifugal fan 3 flows toward partition plate 5. Airflow AF flowing to partition plate 5 then flows along protruding portion 51 of partition plate 5 to a heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3, and to a heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3. Specifically, airflow AF passes along the inner circumferential surface of first plate portion 51a of protruding portion 51 of partition plate 5, to heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3. Airflow AF also passes along the inner circumferential surface of second plate portion 51b of protruding portion 51 of partition plate 5 to heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3.

**[0039]** The angle formed between heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 and second plate portion 51b of protruding portion 51 of partition plate 5 is an obtuse angle. Namely, the angle formed between heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 and second plate portion 51b of protruding portion 51 of partition plate 5 is larger than 90 degrees. Therefore, concentration of airflow AF into heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 is suppressed. In addition, separation of airflow AF from second plate portion 51b of protruding portion 51 of partition plate 5 is suppressed.

**[0040]** The angle formed between heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 and first plate portion 51a of protruding portion 51 of partition plate 5 is an acute angle. Namely, the angle formed between heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 and first plate portion 51a of protruding portion 51 of partition plate 5 is smaller than 90 degrees. Therefore, passing of airflow AF into heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 is promoted.

**[0041]** In the following, referring to Fig. 5, a modification of indoor unit 1 according to Embodiment 1 is described.

**[0042]** Fig. 5 is a bottom view showing, from below, a configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 1. In the modification of indoor unit 1 according to Embodiment 1, first plate portion 51a and second plate portion 51b are smoothly connected at apex TP to each other. Namely, apex TP is formed by a curved surface.

**[0043]** In the following, functions and effects of indoor unit 1 according to Embodiment 1 are described.

**[0044]** In indoor unit 1 according to Embodiment 1, apex TP of protruding portion 51 of partition plate 5 is located closer to first end 41 than to second end 42. Therefore, concentration of airflow into heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 can be suppressed. Accordingly, a pressure loss of the airflow passing in heat exchanger 4b on the downstream side in the rotational direction of centrifugal fan 3 can be suppressed. In addition, passing of airflow into heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 can be promoted.

**[0045]** Concentration of airflow into heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 can thus be suppressed and passing of airflow into heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 can thus be promoted, and therefore, a uniform wind speed distribution of the airflow passing in heat exchanger 4 can be achieved.

**[0046]** Apex TP of protruding portion 51 of partition plate 5 is thus located closer to first end 41 than to second end 42, and therefore, the angle formed between heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 and second plate portion 51b of protruding portion 51 of partition plate 5 is an obtuse angle. Therefore, the angle formed between heat exchanger 4b on the downstream side in rotational direction D1 of centrifugal fan 3 and second plate portion 51b of protruding portion 51 of partition plate 5 is a gentle curve. Accordingly, separation of airflow from second plate portion 51b of protruding portion 51 of partition plate 5 can be suppressed.

**[0047]** A pressure loss of the airflow passing in heat exchanger 4b on the downstream side in the rotational direction of centrifugal fan 3 can thus be suppressed, and therefore, power consumption of motor 6 rotating centrifugal fan 3 can be reduced. Moreover, since a pressure loss of the airflow passing in heat exchanger 4b on the downstream side in the rotational direction of centrifugal fan 3 can be suppressed, the number of revolutions of centrifugal fan 3 can be reduced. Accordingly, noise caused by rotation of centrifugal fan 3 can be reduced.

**[0048]** In indoor unit 1 according to Embodiment 1, heat exchanger 4 is arranged in four ways around centrifugal fan 3. Therefore, heat can be exchanged, in four ways around centrifugal fan 3, between air flowing outside heat exchanger 4 and refrigerant flowing inside heat exchanger 4. In this way, four-way cassette type indoor unit 1 can be formed.

Embodiment 2

**[0049]** Referring to Fig. 6, a configuration of indoor unit 1 according to Embodiment 2 is described. Fig. 6 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 2.

**[0050]** In indoor unit 1 according to Embodiment 2, when centrifugal fan 3 is seen along rotational axis 3a, a virtual line connecting rotational axis 3a of centrifugal fan 3 and apex TP is defined as a first virtual line A1, a virtual line connecting apex TP and first end 41 is defined as a second virtual line A2, and a virtual line connecting apex TP and second end 42 is defined as a third virtual line A3. Then, a first angle $\theta a$ formed between first virtual line A1 and second virtual line A2 is larger than a second angle $\theta b$ formed between first virtual line A1 and third virtual line A3. Second virtual line A2 is located along the inner surface of first plate portion 51a. Third virtual line A3 is located along the inner surface of second plate portion 51b.

**[0051]** In the following, functions and effects of indoor unit 1 according to Embodiment 2 are described.

**[0052]** In indoor unit 1 according to Embodiment 2, first angle $\theta a$ formed between first virtual line A1 and second virtual line A2 is larger than second angle $\theta b$ formed between first virtual line A1 and third virtual line A3. The angle formed between the direction of airflow and second virtual line A2 is therefore reduced. Accordingly, separation of airflow from second plate portion 51b of protruding portion 51 of partition plate 5 can further be suppressed.

Embodiment 3

**[0053]** Referring to Fig. 7, a configuration of indoor unit 1 according to Embodiment 3 is described. Fig. 7 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 3.

**[0054]** In indoor unit 1 according to Embodiment 3, when centrifugal fan 3 is seen along rotational axis 3a, a virtual line connecting rotational axis 3a of centrifugal fan 3 and first end 41 is defined as a fourth virtual line A4. Then, apex TP is located upstream in rotational direction D1 of centrifugal fan 3, relative to fourth virtual line A4. Apex TP is located upstream, in the rotational direction of centrifugal fan 3, relative to first end 41.

**[0055]** In the following, functions and effects of indoor unit 1 according to Embodiment 3 are described.

**[0056]** In indoor unit 1 according to Embodiment 3, apex TP is located upstream, in rotational direction D1 of centrifugal fan 3, relative to fourth virtual line A4. Thus, passing of airflow into heat exchanger 4a on the upstream side in rotational direction D1 of centrifugal fan 3 can further be promoted. Accordingly, a uniform wind speed distribution of the airflow passing in heat exchanger 4 can be achieved.

Embodiment 4

**[0057]** Referring to Fig. 8, a configuration of indoor unit 1 according to Embodiment 4 is described. Fig. 8 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 4.

**[0058]** In indoor unit 1 according to Embodiment 4, protruding portion 51 of partition plate 5 has first plate portion 51a connecting apex TP to first end 41. First plate portion 51a is configured to protrude toward second end 42. First plate portion 51a is curved toward second end 42. First plate portion 51a is curved toward a space in which piping connected to heat exchanger 4 is located.

**[0059]** In the following, functions and effects of indoor unit 1 according to Embodiment 4 are described.

**[0060]** In indoor unit 1 according to Embodiment 4, first plate portion 51a is configured to protrude toward second end 42. Thus, passing of airflow perpendicularly into heat exchanger 4a located upstream in rotational direction D1 of centrifugal fan 3 is facilitated. Accordingly, passing of airflow into heat exchanger 4a located upstream in rotational direction D1 of centrifugal fan 3 can further be promoted.

Embodiment 5

**[0061]** Referring to Fig. 9, a configuration of indoor unit 1 according to Embodiment 5 is described. Fig. 9 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 5.

**[0062]** In indoor unit 1 according to Embodiment 5, protruding portion 51 of partition plate 5 has second plate portion 51b connecting apex TP to second end 42. Second plate portion 51b is configured to protrude toward centrifugal fan 3. Second plate portion 51b is curved toward centrifugal fan 3. First plate portion 51a is configured to protrude toward second end 42.

**[0063]** In the following, functions and effects of indoor unit 1 according to Embodiment 5 are described.

**[0064]** In indoor unit 1 according to Embodiment 5, second plate portion 51b is configured to protrude toward centrifugal fan 3. Thus, separation of airflow from second plate portion 51b of protruding portion 51 of partition plate 5 can further be suppressed.

**[0065]** First plate portion 51a is configured to protrude toward second end 42. Thus, passing of airflow perpendicularly into heat exchanger 4a located upstream in rotational direction D1 of centrifugal fan 3 is facilitated. Accordingly, passing of airflow into heat exchanger 4a located upstream in rotational direction D1 of centrifugal fan 3 can further be promoted.

Embodiment 6

**[0066]** Referring to Fig. 10, a configuration of indoor unit 1 according to Embodiment 6 is described. Fig. 10 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 6.

**[0067]** In indoor unit 1 according to Embodiment 6, the distance (first distance) n between centrifugal fan 3 and apex TP is shorter than the distance (second distance) m between centrifugal fan 3 and heat exchanger 4. Distance n between centrifugal fan 3 and apex TP is the shortest distance between centrifugal fan 3 and apex TP when centrifugal fan 3 is seen along rotational axis 3a. Distance m between centrifugal fan 3 and heat exchanger 4 is the shortest distance between centrifugal fan 3 and apex TP when centrifugal fan 3 is seen along rotational axis 3a.

**[0068]** In the following, functions and effects of indoor unit 1 according to Embodiment 6 are described.

**[0069]** In indoor unit 1 according to Embodiment 6, distance n between centrifugal fan 3 and apex TP is shorter than distance m between centrifugal fan 3 and heat exchanger 4. Thus, advantageous effects that the pressure loss of airflow passing in heat exchanger 4b located downstream in the rotational direction of centrifugal fan 3 can be suppressed, and that passing of airflow into heat exchanger 4a located upstream in rotational direction D1 of centrifugal fan 3 can be promoted, can sufficiently be ensured.

Embodiment 7

**[0070]** Referring to Figs. 11 and 12, a configuration of indoor unit 1 according to Embodiment 7 is described. Fig. 11 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 7. Fig. 12 is a perspective view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 7.

**[0071]** In indoor unit 1 according to Embodiment 7, centrifugal fan 3 has main plate 31 and side plate 32 connected to main plate 31. Protruding portion 51 of partition plate 5 has second plate portion 51b connecting apex TP to second end 42. Second plate portion 51b has a main plate-side portion 51b1 facing main plate 31, and a side plate-side portion 51b2 facing side plate 32. Side plate-side portion 51b2 is configured to project further toward centrifugal fan 3, relative to main plate-side portion 51b1.

**[0072]** When centrifugal fan 3 is seen along rotational axis 3a, the angle formed between side plate-side portion 51b2 and a virtual line connecting rotational axis 3a of centrifugal fan 3 and apex TP of protruding portion 51 of partition plate 5 is smaller than the angle formed between main plate-side portion 51b1 and the virtual line.

**[0073]** In the following, functions and effects of indoor unit 1 according to Embodiment 7 are described.

**[0074]** In indoor unit 1 according to Embodiment 7, side plate-side portion 51b2 is configured to project further toward centrifugal fan 3, relative to main plate-side portion 51b1. A turning component, in rotational direction D1 of centrifugal fan 3, of airflow blown out from centrifugal fan 3 is larger on the side plate 32 side than on the main plate 31 side. Since side plate-side portion 51b2 is configured to project further toward centrifugal fan 3 relative to main plate-side portion 51b1, separation of airflow from second plate portion 51b of protruding portion 51 of partition plate 5 can be suppressed.

Embodiment 8

**[0075]** Referring to Figs. 13 and 14, a configuration of indoor unit 1 according to Embodiment 8 is described. Fig. 13 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 8. Fig. 14 is a perspective view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 7.

**[0076]** In indoor unit 1 according to Embodiment 8, centrifugal fan 3 has main plate 31 and side plate 32 connected to main plate 31. Protruding portion 51 of partition plate 5 has second plate portion 51b connecting apex TP to second end 42. Second plate portion 51b has main plate-side portion 51b1 facing main plate 31, and side plate-side portion 51b2 facing side plate 32. The distance between centrifugal fan 3 and apex TP of main plate-side portion 51b1 is longer than the distance between centrifugal fan 3 and apex TP of side plate-side portion 51b2.

**[0077]** When centrifugal fan 3 is seen along rotational axis 3a, the shortest distance between centrifugal fan 3 and apex TP of main plate-side portion 51b1 is longer than the shortest distance between centrifugal fan 3 and apex TP of side plate-side portion 51b2.

**[0078]** In the following, functions and effects of indoor unit 1 according to Embodiment 8 are described.

**[0079]** In indoor unit 1 according to Embodiment 8, the distance between centrifugal fan 3 and apex TP of main plate-side portion 51b1 is longer than the distance between centrifugal fan 3 and side plate-side portion 51b2. The wind speed of airflow blown out from centrifugal fan

3 is larger on the main plate 31 side than on the side plate 32 side. Since the distance between centrifugal fan 3 and apex TP of main plate-side portion 51b1 is longer than the distance between centrifugal fan 3 and apex TP of side plate-side portion 51b2, a pressure variation on the flat surface of second plate portion 51b of protruding portion 51 of partition plate 5 can be suppressed. Accordingly, noise can be reduced.

Embodiment 9

**[0080]** Referring to Figs. 15 and 16, a configuration of indoor unit 1 according to Embodiment 9 is described. Fig. 15 is a bottom view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 9. Fig. 16 is a perspective view showing, from below, the configuration of indoor unit 1 with its panel 22 removed, according to Embodiment 9.

**[0081]** In indoor unit 1 according to Embodiment 9, a slit SL is provided in partition plate 5. Slit SL extends through partition plate 5 in the thickness direction. A plurality of slits SL are provided. Slits SL are provided in each of first plate portion 51a and second plate portion 51b of protruding portion 51 of partition plate 5.

**[0082]** In the following, functions and effects of the indoor unit according to Embodiment 9 are described.

**[0083]** In indoor unit 1 according to Embodiment 9, slits SL are provided in partition plate 5. Thus, excessive increase of the pressure on the inner surface of partition plate 5 can be suppressed. Accordingly, noise can be suppressed.

Embodiment 10

**[0084]** Referring to Fig. 17, a configuration of an air conditioner 100 according to Embodiment 10 is described. Fig. 17 is a refrigerant circuit diagram for the air conditioner according to Embodiment 10.

**[0085]** Air conditioner 100 according to Embodiment 10 includes indoor unit 1 as described above. Air conditioner 100 includes indoor unit 1 and an outdoor unit 200. Outdoor unit 200 is connected to indoor unit 1. Indoor unit 1 and outdoor unit 200 are coupled to each other by refrigerant piping. A refrigerant circuit is thus formed. In the refrigerant circuit, refrigerant is circulated. In the refrigerant piping, a pipe in which refrigerant in gas state (gas refrigerant) flows forms a gas pipe 300, and a pipe in which refrigerant in liquid state (liquid refrigerant or gas-liquid two-phase refrigerant) flows forms a liquid pipe 400.

**[0086]** Outdoor unit 200 includes a compressor 201, a four-way valve 202, an outdoor heat exchanger 203, an outdoor blower 204, and a throttle device (expansion valve) 205.

**[0087]** Compressor 201 is configured to compress sucked refrigerant and discharge the resultant refrigerant. Compressor 201 includes an inverter or the like to change the operating frequency and thereby makes variable the capacity (the amount of refrigerant discharged per unit time) of compressor 201. Four-way valve 202 is configured to be switched, in accordance with an instruction from a controller (not shown), between a state during cooling operation and a state during heating operation to switch flow of refrigerant.

**[0088]** Outdoor heat exchanger 203 is configured to cause exchange of heat between refrigerant inside outdoor heat exchanger 203 and air outside outdoor heat exchanger 203 (outdoor air).

**[0089]** During cooling operation, outdoor heat exchanger 203 serves as a condenser. Regarding outdoor heat exchanger 203, refrigerant compressed by compressor 201 flows through four-way valve 202 into outdoor heat exchanger 203. In outdoor heat exchanger 203, heat is exchanged between refrigerant inside outdoor heat exchanger 203 and air outside outdoor heat exchanger 203. Accordingly, refrigerant is condensed in outdoor heat exchanger 203.

**[0090]** During heating operation, outdoor heat exchanger 203 serves as an evaporator. In outdoor heat exchanger 203, heat is exchanged between low-pressure refrigerant flowing from liquid pipe 400 and air. Accordingly, refrigerant is evaporated in outdoor heat exchanger 203.

**[0091]** In order to make efficient heat exchange between refrigerant in outdoor heat exchanger 203 and air, outdoor blower 204 having a fan and a fan motor for example is provided. Outdoor blower 204 may be configured to change the operating frequency of the fan motor by means of an inverter and thereby make the rotational speed of the fan variable. Throttle device (expansion valve) 205 is configured to reduce the pressure of refrigerant by expanding the refrigerant.

**[0092]** Indoor unit 1 includes centrifugal fan 3 and heat exchanger 4. Centrifugal fan 3 is configured to adjust flow of air with which heat is exchanged in heat exchanger 4. Heat exchanger 4 serves as an evaporator during cooling operation. Heat is exchanged between refrigerant reduced in pressure by throttle device (expansion valve) 205 and flowing into heat exchanger 4 and air outside heat exchanger 4. Accordingly, refrigerant in heat exchanger 4 is evaporated. The evaporated refrigerant flows through gas pipe 300 and flows out of heat exchanger 4. During heating operation, heat exchanger 4 serves as a condenser. Heat is exchanged between refrigerant flowing from gas pipe 300 into heat exchanger 4 and air outside heat exchanger 4. Refrigerant is accordingly condensed in heat exchanger 4. Refrigerant is thus liquefied (or converted into gas-liquid two-phase). The liquefied refrigerant (or refrigerant converted into gas-liquid two-phase) flows into liquid pipe 400.

**[0093]** For air conditioner 100 according to Embodiment 10, indoor unit 1 according to Embodiments 1 to 9 can be used. Thus, air conditioner 100 according to embodiment 10 enables air conditioner 100 producing the effects of indoor unit 1 according to Embodiments 1 to 9 to be achieved.

**[0094]** It should be construed that embodiments disclosed herein are given by way of illustration in all respects, not by way of limitation. It is intended that the scope of the present invention is defined by claims, not by the description above, and encompasses all modifications and variations equivalent in meaning and scope to the claims.

REFERENCE SIGNS LIST

**[0095]** 1 indoor unit; 2 housing; 3 centrifugal fan; 3a rotational axis; 4 heat exchanger; 5 partition plate; 6 motor; 21 casing; 22 panel; 23 suction inlet; 24 discharge outlet; 31 main plate; 32 side plate; 33 vane; 41 first end; 42 second end; 51 protruding portion; 51a first plate portion; 51b second plate portion; 51b1 main plate-side portion; 51b2 side plate-side portion; 100 air conditioner; 200 outdoor unit; 201 compressor; 202 four-way valve; 203 outdoor heat exchanger; 204 outdoor blower; 300 gas pipe; 400 liquid pipe; A1 first virtual line; A2 second virtual line; A3 third virtual line; A4 fourth virtual line; D1 rotational direction; SL slit; TP apex; m distance between centrifugal fan and heat exchanger; n distance between centrifugal fan and apex

## Claims

**1.** An indoor unit comprising:

a housing;
a centrifugal fan contained in the housing, having a rotational axis, and configured to rotate about the rotational axis;
a heat exchanger arranged to surround at least three quarters of an outer circumferential periphery of the centrifugal fan, and having a first end located upstream in a rotational direction of the centrifugal fan, and a second end located downstream in the rotational direction of the centrifugal fan and spaced from the first end; and
a partition plate having a protruding portion protruding toward the centrifugal fan from the first end and the second end of the heat exchanger, an apex of the protruding portion of the partition plate being located closer to the first end than to the second end.

**2.** The indoor unit according to claim 1, wherein the heat exchanger is arranged in four ways around the centrifugal fan.

**3.** The indoor unit according to claim 1 or 2, wherein when the centrifugal fan is seen along the rotational axis, a first angle formed between a first virtual line and a second virtual line is larger than a second angle formed between the first virtual line and a third virtual line, where the first virtual line is a virtual line connecting the rotational axis of the centrifugal fan and the apex, the second virtual line is a virtual line connecting the apex and the first end, and the third virtual line is a virtual line connecting the apex and the second end.

**4.** The indoor unit according to claim 1 or 2, wherein when the centrifugal fan is seen along the rotational axis, the apex is located upstream in the rotational direction of the centrifugal fan, relative to a fourth virtual line, where the fourth virtual line is a virtual line connecting the rotational axis of the centrifugal fan and the first end.

**5.** The indoor unit according to any one of claims 1 to 4, wherein

the protruding portion of the partition plate has a first plate portion connecting the apex to the first end, and
the first plate portion protrudes toward the second end.

**6.** The indoor unit according to any one of claims 1 to 5, wherein

the protruding portion of the partition plate has a second plate portion connecting the apex to the second end, and
the second plate portion protrudes toward the centrifugal fan.

**7.** The indoor unit according to any one of claims 1 to 5, wherein

the centrifugal fan has a main plate and a side plate connected to the main plate,
the protruding portion of the partition plate has a second plate portion connecting the apex to the second end,
the second plate portion has a main plate-side portion facing the main plate, and a side plate-side portion facing the side plate, and
the side plate-side portion projects further toward the centrifugal fan, relative to the main plate-side portion.

**8.** The indoor unit according to any one of claims 1 to 5, wherein

the centrifugal fan has a main plate and a side plate connected to the main plate,
the protruding portion of the partition plate has a second plate portion connecting the apex to the second end,
the second plate portion has a main plate-side portion facing the main plate, and a side plate-side portion facing the side plate, and

a distance between the centrifugal fan and the apex of the main plate-side portion is longer than a distance between the centrifugal fan and the apex of the side plate-side portion.

**9.** The indoor unit according to any one of claims 1 to 8, wherein the distance between the centrifugal fan and the apex is shorter than the distance between the centrifugal fan and the heat exchanger.

**10.** The indoor unit according to any one of claims 1 to 9, wherein a slit is provided in the partition plate.

**11.** An air conditioner comprising:

the indoor unit according to any one of claims 1 to 10; and
an outdoor unit connected to the indoor unit.

FIG.1

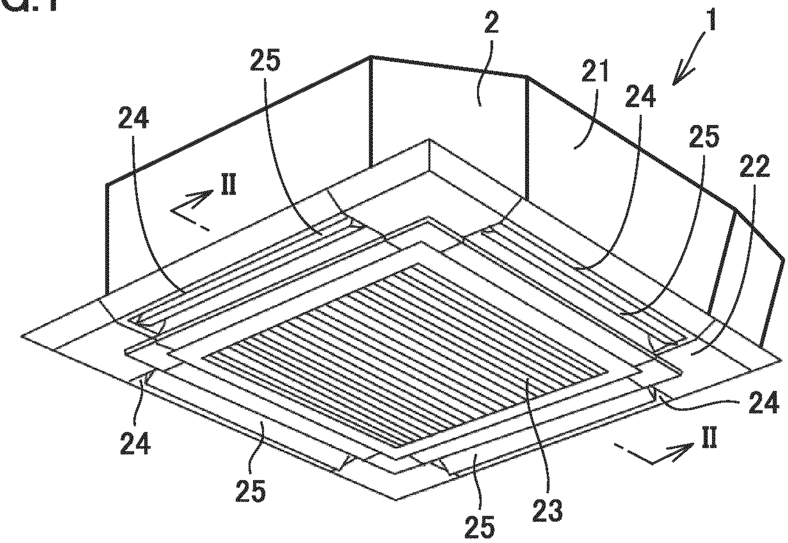

FIG.2

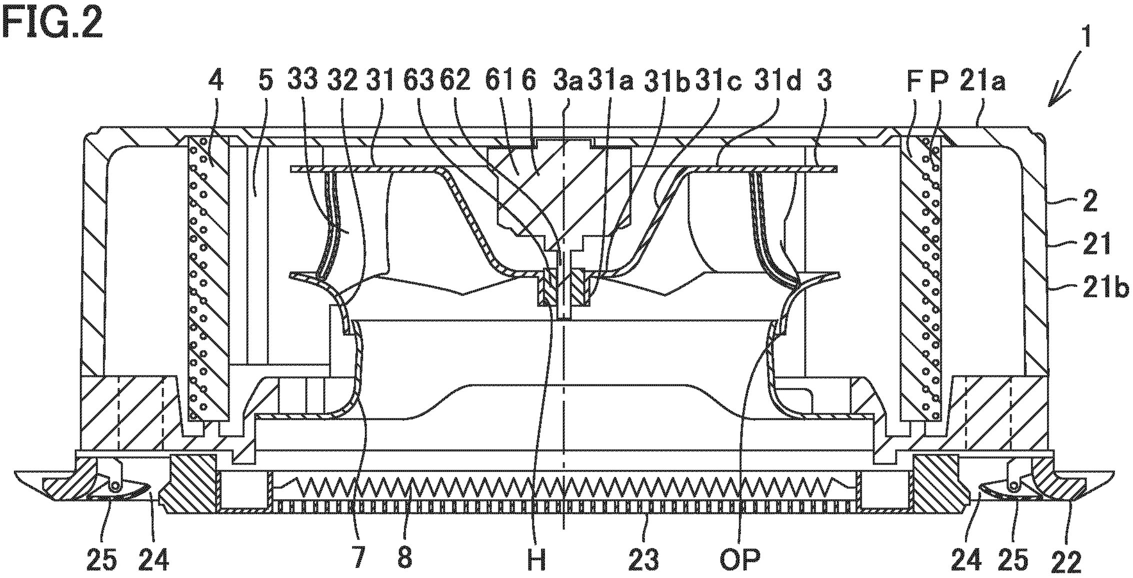
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FIG.3

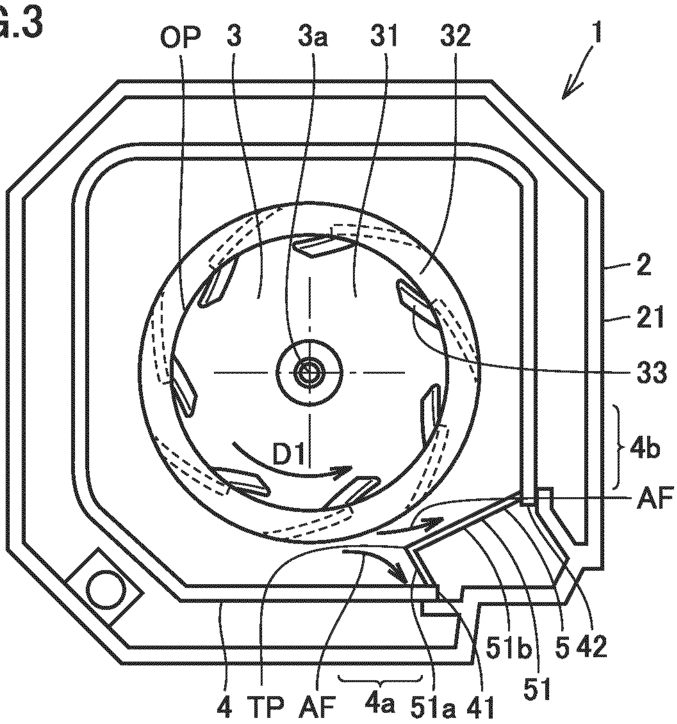


FIG.4

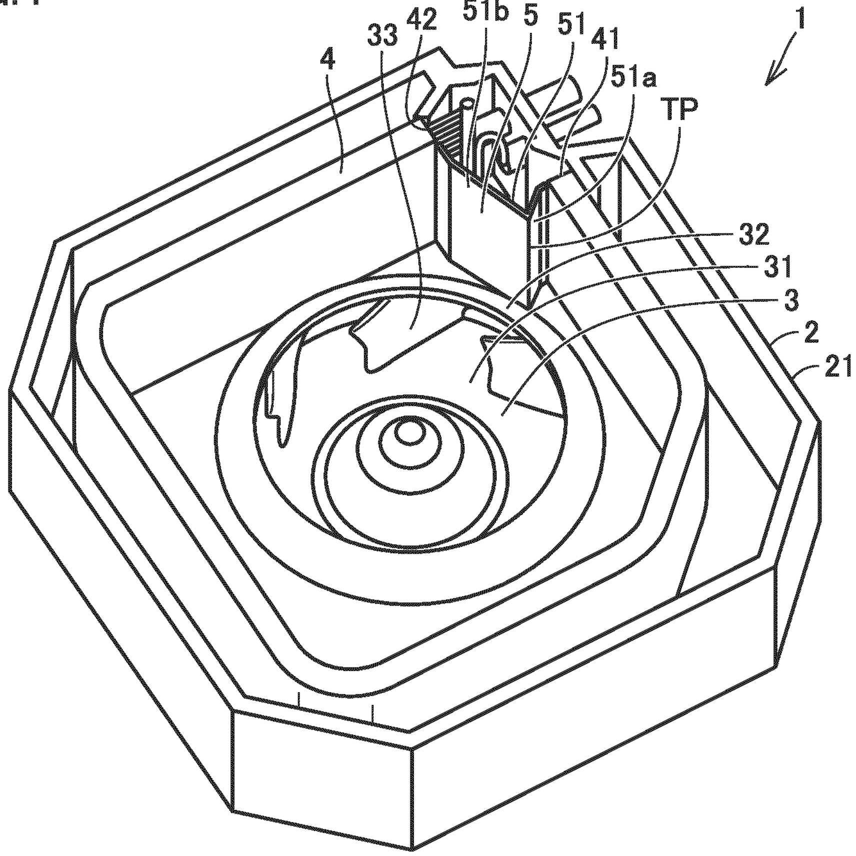


FIG.5

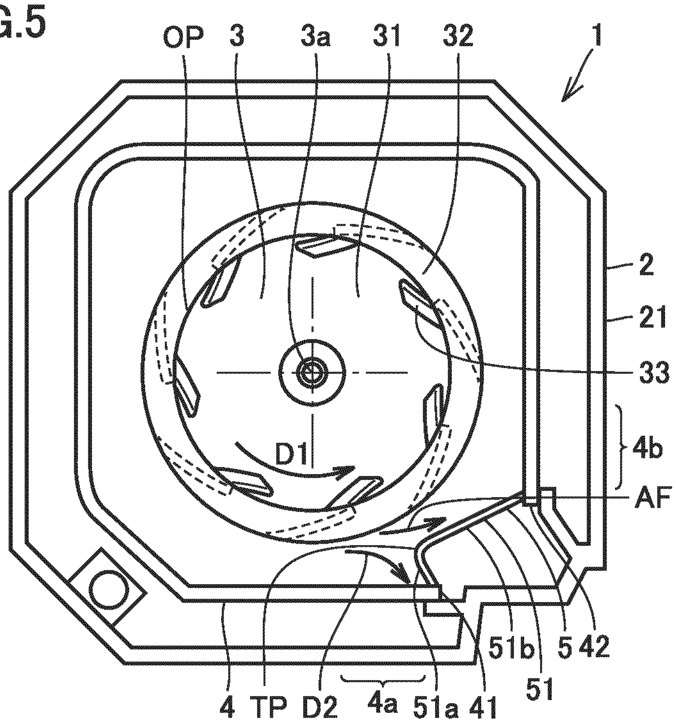


FIG.6

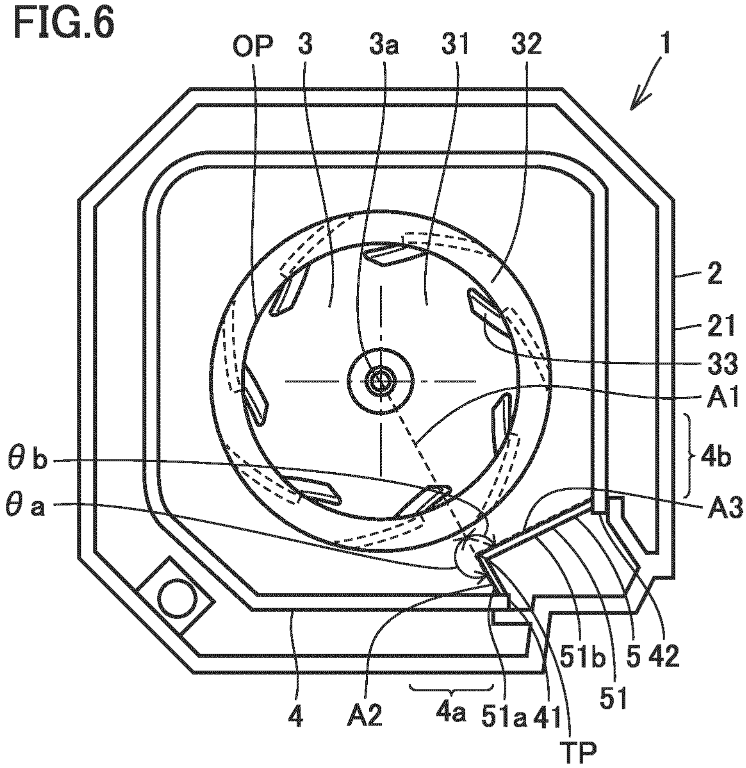


FIG.7

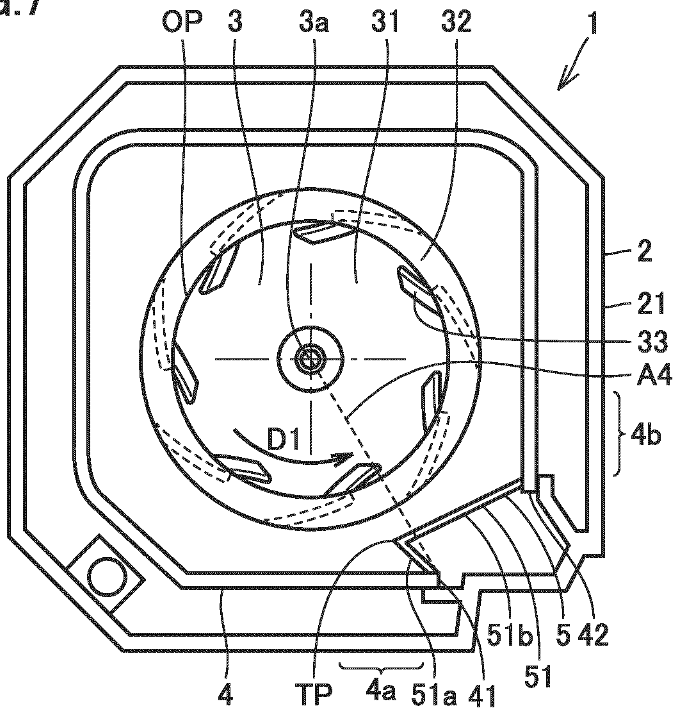


FIG.8

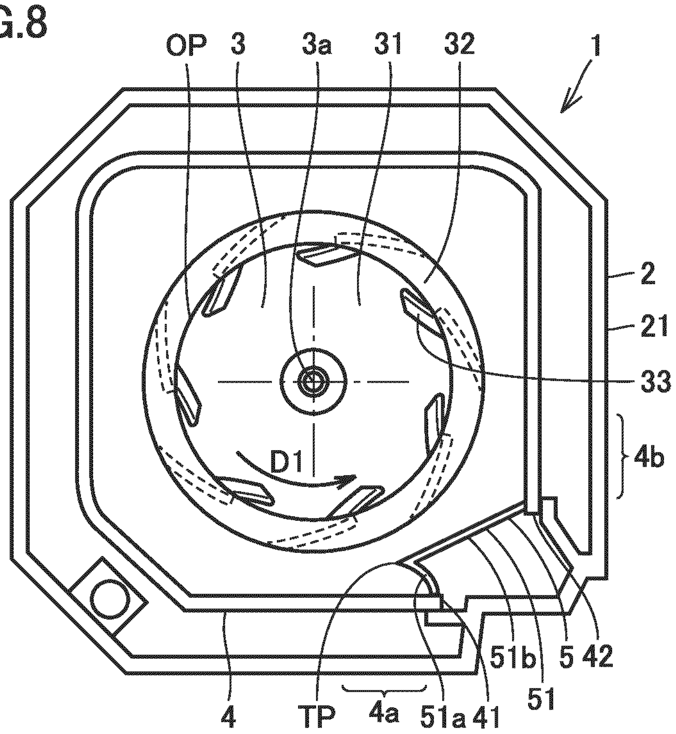


FIG.9

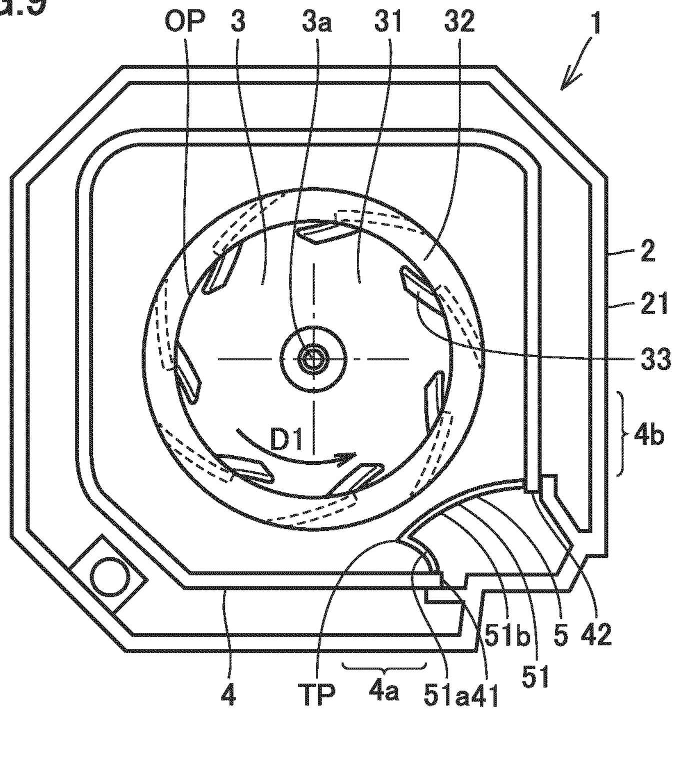


FIG.10

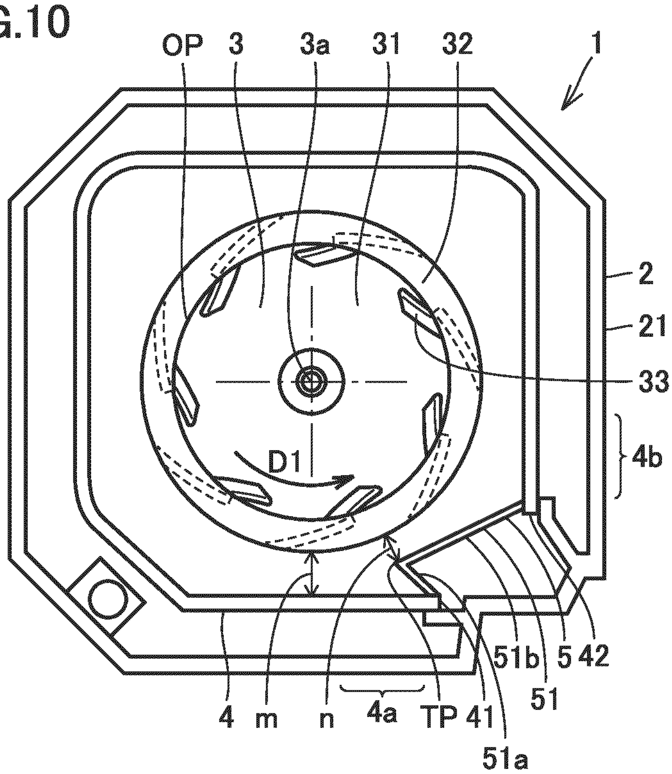


FIG.11

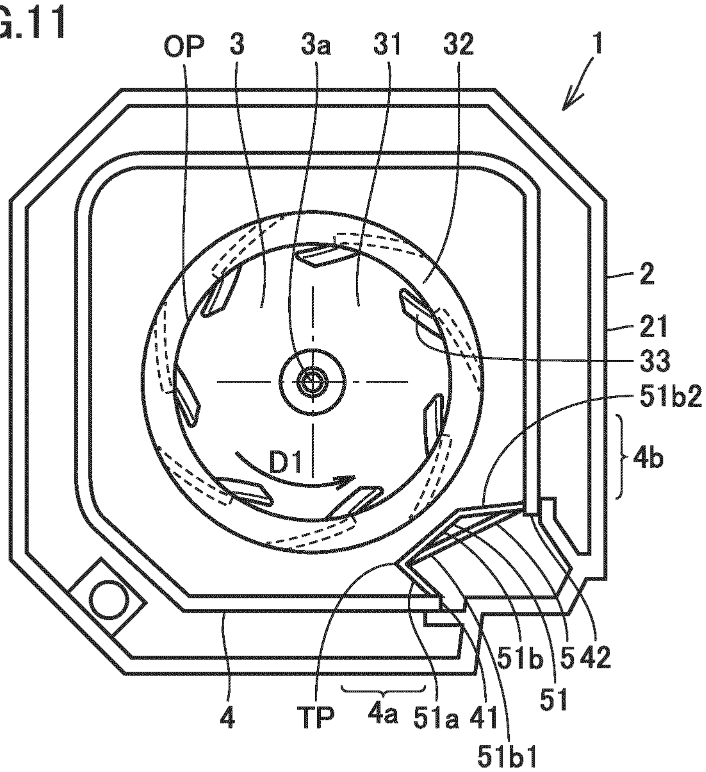


FIG.12

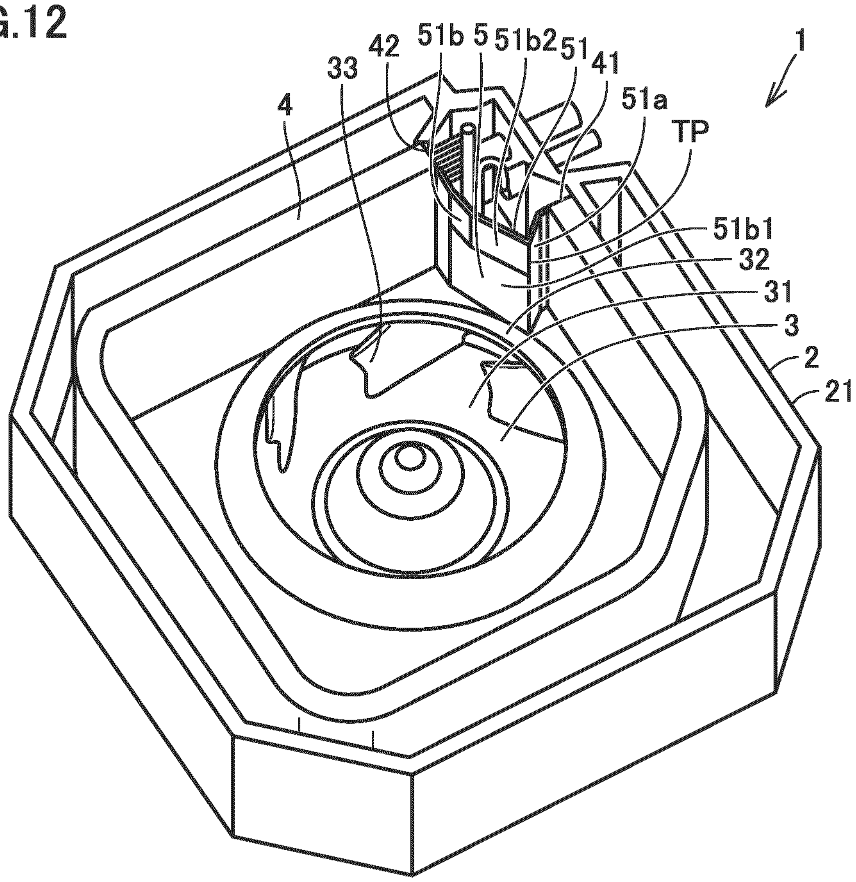


FIG.13

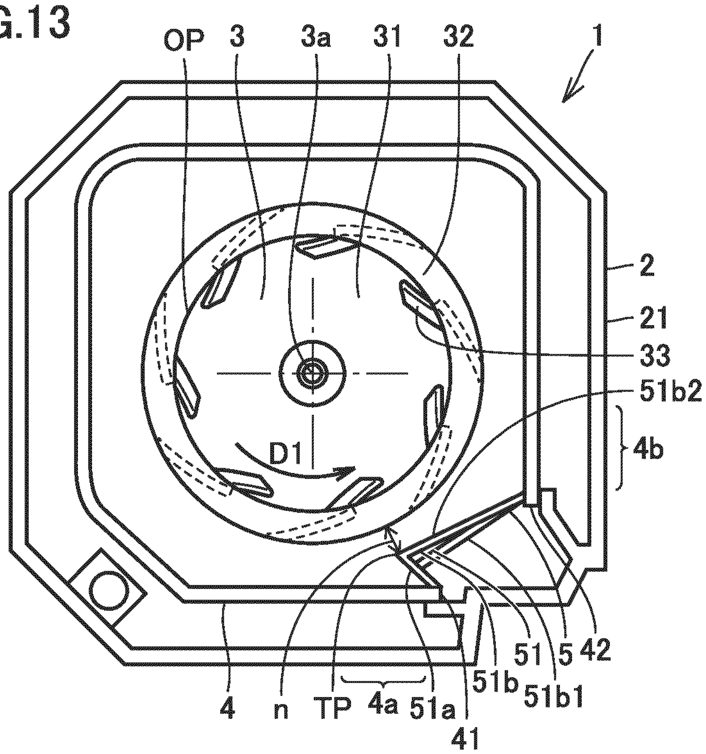


FIG.14

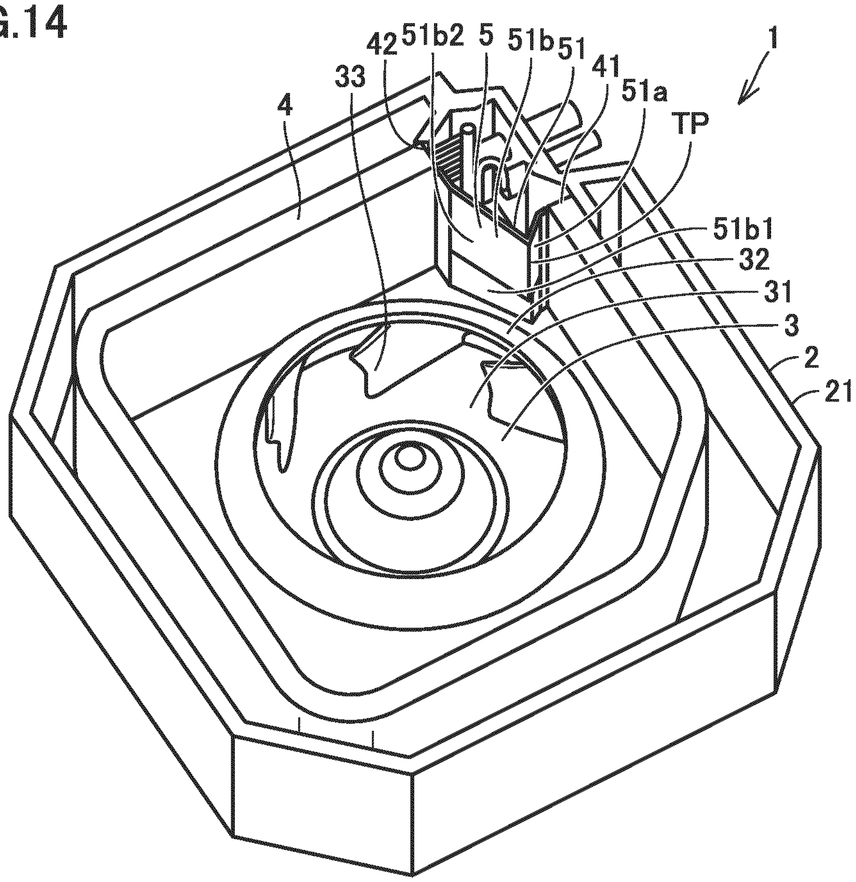


FIG.15

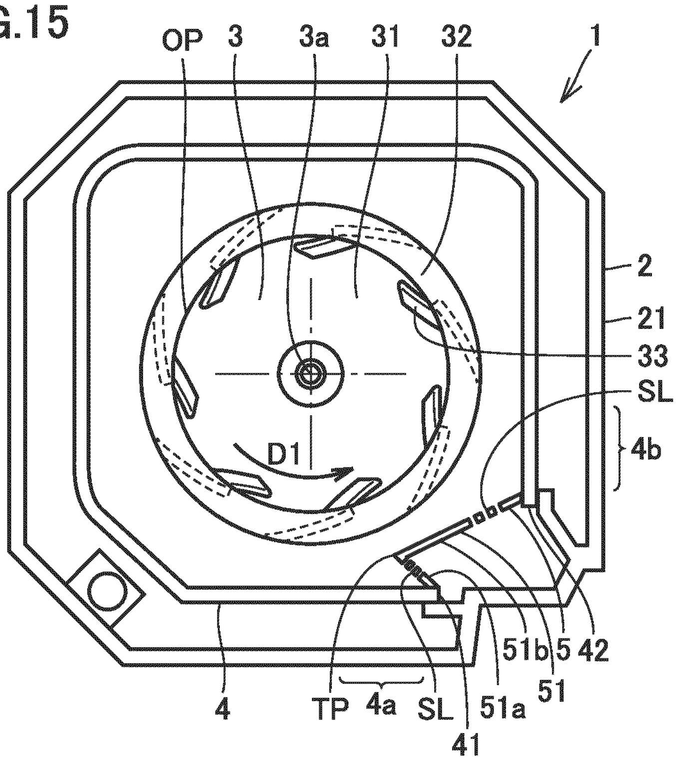


FIG.16

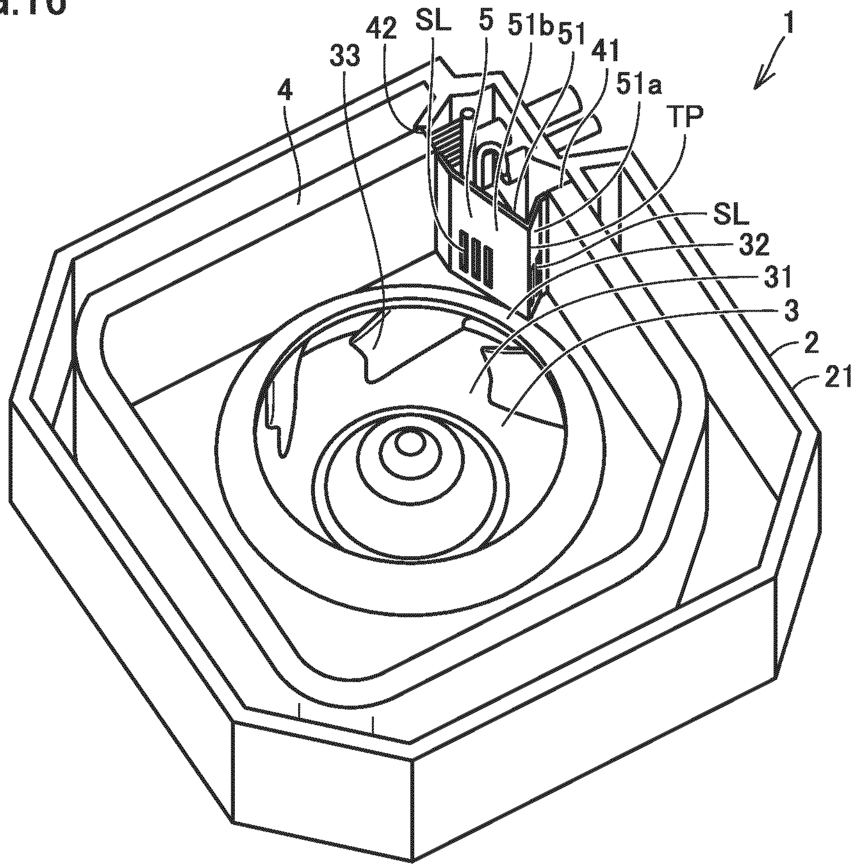
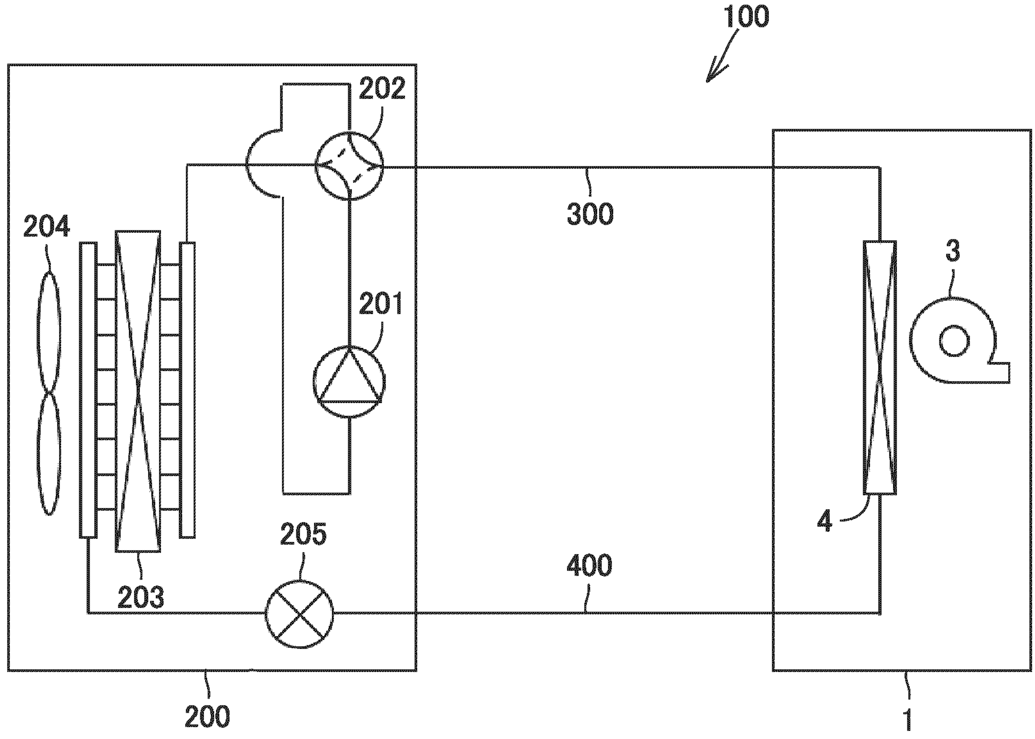


FIG.17



**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2020/011236

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F24F13/24(2006.01)i, F24F1/0007(2019.01)i, F24F13/20(2006.01)i, F24F1/0022(2019.01)i
FI: F24F1/0007 401Z, F24F1/0007 321, F24F1/0022, F24F13/24
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)
Int. Cl. F24F13/24, F24F1/0007, F24F13/20, F24F1/0022

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

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|---|---|
| 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. |
|---|---|---|
| X<br>Y<br>A | JP 9-133374 A (MITSUBISHI ELECTRIC CORP.) 20 May 1997, paragraphs [0008]-[0024], fig. 1, 2 | 1-3<br>5, 9-11<br>4, 6-8 |
| Y | JP 2015-81692 A (HITACHI APPLIANCES, INC.) 27 April 2015, paragraphs [0025]-[0032], [0049], fig. 1, 2 | 5, 9-11 |
| Y | JP 2012-220163 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 12 November 2012, paragraphs [0022]-[0038], fig. 1-4 | 10-11 |
| A | JP 2005-241069 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 08 September 2005, entire text, all drawings | 1-11 |

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 28.05.2020 | 09.06.2020 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| Japan Patent Office<br>3-4-3, Kasumigaseki, Chiyoda-ku,<br>Tokyo 100-8915, Japan | Telephone No. |

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

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

International application No.
PCT/JP2020/011236

| Patent Documents referred to in the Report | Publication Date | Patent Family | Publication Date |
|---|---|---|---|
| JP 9-133374 A | 20.05.1997 | (Family: none) | |
| JP 2015-81692 A | 27.04.2015 | (Family: none) | |
| JP 2012-220163 A | 12.11.2012 | (Family: none) | |
| JP 2005-241069 A | 08.09.2005 | (Family: none) | |

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

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