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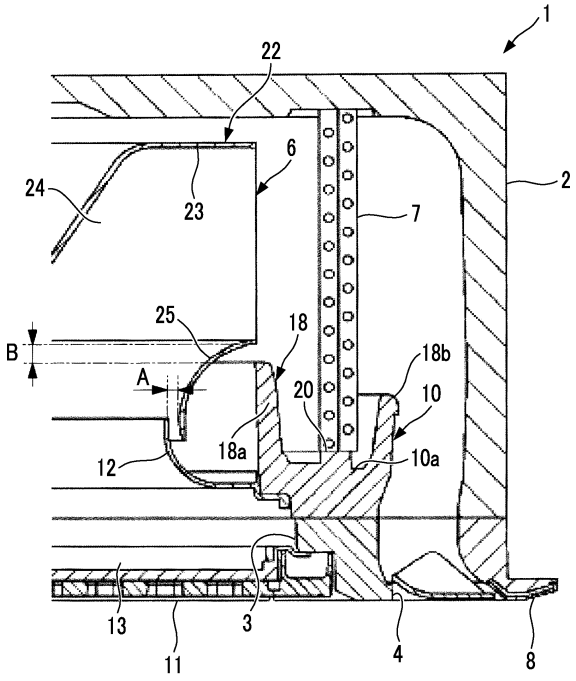
(54) CEILING-EMBEDDED AIR CONDITIONER

(57) In order to reduce noise generated by air sucked in or blown out by a blower, this ceiling-cassette air conditioner comprises: a heat exchanger (7); a blower (6) that is arranged on the inside with respect to the heat exchanger (7), and that has a tubular shroud (25) the diameter of which increases toward the outside; a bell mouth (12) arranged below the shroud (25) and on the suction side of the blower (6); and a drain pan (10), in which is formed a recessed drain groove (18) in which a lower portion of the heat exchanger (7) is accommodated. The ratio of a second gap B between the discharge-side end of the shroud (25) and an inner-peripheral wall part (18a) on the inside of the drain groove 18 relative to the heat exchanger (7) to a first gap A between the upper end of the bell mouth (12) and the suction-side end of the shroud (25) is $B/A \leq 3$ or $10 \leq B/A$.

FIG. 4



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Description

Technical Field

[0001] The present invention relates to a ceiling-cassette air conditioner.

Background Art

[0002] An indoor unit of a ceiling-cassette air conditioner is internally provided with a centrifugal blower, and a lower surface of the indoor unit has a bell mouth having an opening. A diameter of the opening decreases upward and inward from a suction port. In addition, a drain pan for receiving water condensed and dropped on a surface of a heat exchanger during a cooling operation is installed inside the indoor unit.

[0003] The centrifugal blower has an impeller connected to a rotary shaft. The impeller includes a hub (main plate) installed on an upper portion of the impeller and connected to the rotary shaft, a plurality of blades in which one end side is connected to the hub and the other end side is connected to a shroud, and the shroud that connects the other ends of the blades to each other and whose diameter increases upward and outward from the bell mouth side.

[0004] PTL 1 below discloses that the shroud is installed to be relatively rotatable inside a suction-side end portion of the shroud to maintain a predetermined gap (L1) between the shroud and the bell mouth.

Citation List

Patent Literature

[0005] [PTL 1] Japanese Unexamined Patent Application Publication No. 2002-235930

Summary of Invention

Technical Problem

[0006] An upper end portion of a bell mouth is accommodated inside a suction-side end portion of a shroud, and a gap is disposed between the shroud and the bell mouth.

[0007] A drain pan has two side walls (wall portions) to face each of an inside and an outside of a heat exchanger in order to form a drain groove for receiving drain water. A discharge-side end portion of the shroud is located above an inner peripheral wall portion installed inside the heat exchanger in the drain groove, and a gap is disposed between the drain groove and the shroud.

[0008] Accordingly, a suction side of the shroud has a gap from the bell mouth, and a discharge side of the shroud has a gap from the inner peripheral wall portion of the drain groove.

[0009] The inventor has found a fact as follows. If air suctioned by a blower bypasses the blade side without passing through a blade side with respect to the shroud, and passes through the gap between the bell mouth and the shroud, the air causes noise. In addition, the inventor has found another fact as follows. In a case where the air discharged from the blower enters the gap between the shroud and the inner peripheral wall portion of the drain groove, and the air is stagnant or an airflow is separated on a lower side of the shroud, the air also causes the noise.

[0010] The present invention is made in view of the above-described circumstances, and an object thereof is to provide a ceiling-cassette air conditioner capable of reducing noise generated by air suctioned or air discharged by a blower.

Solution to Problem

[0011] According to an aspect of the present invention, there is provided a ceiling-cassette air conditioner including a heat exchanger, a blower having a tubular shroud having a diameter which increases upward and outward, and installed inside the heat exchanger, a bell mouth installed below the shroud and on a suction side of the blower, and a drain pan having a concave drain groove which accommodates a lower portion of the heat exchanger. A ratio of a second gap B between a discharge-side end portion of the shroud and a side wall of the drain groove inside the heat exchanger with respect to a first gap A between an upper end portion of the bell mouth and a suction-side end portion of the shroud is $B/A \leq 3$ or $10 \leq B/A$.

[0012] According to this configuration, noise is reduced, compared to a case where a ratio of the second gap B between the discharge-side end portion of the shroud and an upper end portion of the side wall of the drain groove inside the heat exchanger with respect to the first gap A between the upper end portion of the bell mouth and the suction-side end portion of the shroud is $3 < B/A < 10$.

[0013] In the above-described aspect, a height of the side wall of the drain groove inside the heat exchanger may be higher than a side wall of the drain groove outside the heat exchanger.

[0014] According to this configuration, it is possible to shorten a distance between the discharge-side end portion of the shroud and the upper end portion of the side wall inside the drain groove.

Advantageous Effects of Invention

[0015] According to the present invention, it is possible to reduce noise generated by air suctioned or air discharged by a blower.

Brief Description of Drawings

[0016]

Fig. 1 is a bottom view illustrating an indoor unit of a ceiling-cassette air conditioner according to an embodiment of the present invention.

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

Fig. 3 is a plan view illustrating a drain pan according to the embodiment of the present invention.

Fig. 4 is a partially enlarged longitudinal sectional view illustrating the indoor unit of the ceiling-cassette air conditioner according to the embodiment of the present invention.

Fig. 5 is a graph illustrating a relationship between a sound pressure level (dB) and a ratio (B/A) of a second gap B between a discharge-side end portion of a shroud and an inner peripheral wall portion of a drain groove with respect to a first gap A between an upper end portion of a bell mouth and a suction-side end portion of the shroud.

Description of Embodiments

[0017] Hereinafter, a ceiling-cassette air conditioner according to an embodiment of the present invention will be described with reference to the drawings.

[0018] The ceiling-cassette air conditioner (hereinafter, referred to as an "air conditioner") includes an indoor unit 1, an outdoor unit (not illustrated), and a refrigerant pipe (not illustrated) that connects the indoor unit 1 and the outdoor unit to each other.

[0019] The indoor unit 1 is installed so that a case body 2 is cassette in a ceiling. As illustrated in Fig. 2, the case body 2 is internally equipped with a heat exchanger 7, a drain pan 10, a motor 5, a blower 6, and a bell mouth 12. A ceiling panel 8 exposed on a ceiling surface is mounted on a lower portion of the case body 2. Fig. 1 is a bottom view when the indoor unit 1 is viewed from an indoor side, that is, when the indoor unit 1 is viewed from a lower surface of the indoor unit 1. Fig. 2 is a longitudinal sectional view taken along line II-II in Fig. 1.

[0020] The blower 6 is a centrifugal blower, and has an impeller 22 connected to a rotary shaft 21. The impeller 22 includes a hub (main plate) 23 installed in an upper portion of the impeller 22 and connected to the rotary shaft 21, a plurality of blades 24 in which one end side is connected to the hub 23 and the other end side is connected to a shroud 25, and the shroud 25 that connects the other ends of the blades 24 to each other and whose diameter increases upward and outward from the bell mouth 12 side.

[0021] The shroud 25 has a tubular shape. In the shroud 25, a radius of a lower portion is larger than a radius of an upper portion, and the radius gradually increases from the lower portion to the upper portion. A suction-side end portion of the shroud 25, that is, a lower end portion is located on an outer peripheral side of the bell mouth 12, and has a gap from the bell mouth 12. In addition, a discharge-side end portion of the shroud 25, that is, an upper end portion is located above an inner peripheral wall portion 18a of a drain groove 18, and has a gap from the inner peripheral wall portion 18a.

[0022] The bell mouth 12 is a tubular member, and is installed below the shroud 25 and on a suction side of the blower 6. In the bell mouth 12, a radius of a lower portion is smaller than a radius of an upper portion, and the radius gradually decreases from the lower portion to the upper portion. An upper end portion of the bell mouth 12 is accommodated inside the suction-side end portion of the shroud 25.

[0023] The drain pan 10 is disposed in a lower portion of the heat exchanger 7, and receives drain water dropped from the heat exchanger 7. The bell mouth 12 is disposed in a lower portion of the drain pan 10. A suction port 3 is formed in a central portion on a lower surface of the indoor unit 1, and a discharge port 4 is formed adjacent to the suction port 3 and along an outer peripheral portion on the lower surface of the indoor unit 1. A suction grill 11 and a filter 13 disposed above the suction grill 11 are installed in the suction port 3.

[0024] When the air conditioner is operated, refrigerant from an outdoor unit (not illustrated) circulates through the heat exchanger 7, and the blower 6 is driven by the motor 5. Since the blower 6 is driven, indoor air is guided to the bell mouth 12 from the suction port 3 through the suction grill 11 and the filter 13, and is suctioned into the blower 6. Then, the suctioned air passes through the heat exchanger 7. In this manner, the suctioned air is cooled or heated, and thereafter is discharged indoor through the discharge port 4.

[0025] For example, the drain pan 10 is made of styrene foam, and a surface for storing the drain water is coated with a waterproof paint. As illustrated in Fig. 3, a shape of the drain pan 10 in a plan view is a substantially quadrangular shape. Openings 16 and 17 are formed in the drain pan 10 to correspond to the suction port 3 and the discharge port 4. A bottom portion 10a of the drain pan 10 is disposed over an entire region having the heat exchanger 7 installed therein, along a lower portion of the heat exchanger 7 disposed to surround the blower 6. Fig. 3 is a plan view illustrating the drain pan 10.

[0026] As illustrated in Fig. 2, a concave drain groove 18 is formed in the drain pan 10, and the drain water is accumulated inside the drain groove 18. As illustrated in Figs. 2 and 3, the drain groove 18 has an inner peripheral wall portion 18a formed inside the heat exchanger 7, that is, on an inlet side of the heat exchanger 7, and an outer peripheral wall portion 18b formed outside the heat exchanger 7, that is, on an outlet side of the heat exchanger 7. As illustrated in Fig. 3, the inner peripheral wall portion 18a is disposed along the opening 16 formed corresponding to the suction port 3. The outer peripheral wall portion 18b is disposed along the opening 17 formed corresponding to the discharge port 4.

[0027] As illustrated in Fig. 2, the lower portion of the heat exchanger 7 is accommodated in the drain groove 18, and a height position of a lower end of the heat exchanger 7 is lower than an upper end of the drain groove

18. In this manner, the outer peripheral wall portion 18b of the drain groove 18 prevents the drain water adhering to the lower portion of the heat exchanger 7 from being scattered outward.

[0028] As illustrated in Figs. 2 and 3, a convex portion 19 protruding upward is formed in the bottom portion 10a of the drain pan 10. The heat exchanger 7 is placed on an upper surface of the convex portion 19. The convex portion 19 is formed corresponding to a shape of a bottom surface of the heat exchanger 7 along the bottom surface of the heat exchanger 7 so that a gap from the heat exchanger 7 is not formed as far as possible.

[0029] In the bottom portion 10a of the above-described drain pan 10, as illustrated in Fig. 2, it is desirable that the bottom portion 10a outside the heat exchanger 7 is formed at a lower position than the bottom portion 10a inside the heat exchanger 7. In this manner, the water accumulated in the drain pan 10 is easily guided outward from the inside of the heat exchanger 7. In addition, in the indoor unit 1, the blower 6 is disposed inside the heat exchanger 7. A wind flow from the blower 6 is oriented outward from the inside of the heat exchanger 7. Accordingly, the drain water accumulated in the drain pan 10 is easily discharged outward from the inside of the heat exchanger 7 by using a wind force.

[0030] As illustrated in Fig. 2, an insulation 20 is installed between a lower portion of the heat exchanger 7 and an upper surface of the convex portion 19. In this manner, a space between the heat exchanger 7 and the convex portion 19 is closed by the insulation 20. Accordingly, it is possible to reduce the air flowing outward from the inside of the heat exchanger 7 after passing through a gap without passing through the heat exchanger 7. In addition, since the insulation 20 is installed between the lower portion of the heat exchanger 7 and the upper surface of the convex portion 19, the insulation 20 is accommodated in the drain groove 18. Therefore, even the drain water dropped from the heat exchanger 7 and adhering to the insulation 20 is prevented from being scattered outward.

[0031] Next, referring to Figs. 4 and 5, a relationship between a first gap A between the upper end portion of the bell mouth 12 and the suction-side end portion of the shroud 25 and a second gap B between the discharge-side end portion of the shroud 25 and the inner peripheral wall portion 18a of the drain groove 18 will be described.

[0032] In the present embodiment, a ratio of the second gap B between the discharge-side end portion of the shroud 25 and the inner peripheral wall portion 18a of the drain groove 18 with respect to the first gap A between the upper end portion of the bell mouth 12 and the suction-side end portion of the shroud 25 is $B/A \leq 3$ or $10 \leq B/A$.

[0033] Fig. 5 is a graph illustrating a relationship between a sound pressure level (dB) of the sound generated by the air flow and B/A. The inventor obtains the following result. In a case of $B/A \leq 3$ or $10 \leq B/A$, as illustrated in Fig. 5, the sound pressure level is reduced, compared to a case of $3 < B/A < 10$. In addition, it is confirmed that the sound having a frequency of approximately 1 kHz is particularly reduced.

[0034] Since $B/A \leq 3$ is set, the first gap A between the upper end portion of the bell mouth 12 and the suction-side end portion of the shroud 25 is relatively narrowed. As a result, the air suctioned in by the blower 6 is less likely to pass through the gap between the bell mouth 12 and the shroud 25, and the more air passes through the blade 24 side with respect to the shroud 25. Therefore, compared to a case where $3 < B/A$, the air that bypasses the blade 24 side without passing through the blade 24 side with respect to the shroud 25 and passes through the gap between the bell mouth 12 and the shroud 25 is reduced. Therefore, noise is reduced.

[0035] In a case of $B/A \leq 3$, as in an example illustrated in Fig. 2, the height of the inner peripheral wall portion 18a is higher than the height of the outer peripheral wall portion 18b. In this manner, it is possible to shorten a distance between the discharge-side end portion of the shroud 25 and the upper end portion of the inner peripheral wall portion 18a. As illustrated in Fig. 5, it is desirable that $1 \leq B/A$ is satisfied, in view of the following facts. In a case of $B/A < 1$, compared to a case of $1 \leq B/A \leq 3$, the sound pressure level becomes higher, and the contact caused by the vibration of the bell mouth 12 and the shroud 25 is avoided.

[0036] In addition, since $10 \leq B/A$ is set, the second gap B between the discharge-side end portion of the shroud 25 and the inner peripheral wall portion 18a of the drain groove 18 is relatively widened. As a result, even if the air discharged from the blower 6 enters the gap between the shroud 25 and the inner peripheral wall portion 18a of the drain groove 18, the air is less likely to stagnate on the lower side of the shroud 25, and the airflow is less likely to be separated. Therefore, compared to a case of $3 < B/A < 10$, the air flows on the lower side of the shroud 25, and the airflow is less likely to be separated. Accordingly, the noise is reduced. As illustrated in Fig. 5, it is found that the sound pressure level is reduced in a range of $10 \leq B/A \leq 20$.

[0037] As described above, according to the present embodiment, the ratio of the second gap B between the discharge-side end portion of the shroud 25 and the inner peripheral wall portion 18a of the drain groove 18 with respect to the first gap A between the upper end portion of the bell mouth 12 and the suction-side end portion of the shroud 25 is $B/A \leq 3$ or $10 \leq B/A$. The noise is reduced, compared to a case of $3 < B/A < 10$.

Reference Signs List

[0038]

1:	indoor unit
2:	case body
3:	suction port
4:	discharge port
5:	motor

6:	blower
7:	heat exchanger
8:	ceiling panel
10:	drain pan
10a:	bottom portion
11:	suction grill
12:	bell mouth
13:	filter
16, 17:	opening
18:	drain groove
18a:	inner peripheral wall portion
18b:	outer peripheral wall portion
19:	convex portion
20:	insulation
21:	rotary shaft
22:	impeller
23:	hub
24:	blade
25:	shroud
A:	first gap
B:	second gap

Claims

1. A ceiling-cassette air conditioner comprising:
a heat exchanger;
a blower having a tubular shroud having a diameter which increases upward and outward, and installed inside the heat exchanger;
a bell mouth installed below the shroud and on a suction side of the blower; and
a drain pan having a concave drain groove which accommodates a lower portion of the heat exchanger,
wherein a ratio of a second gap B between a discharge-side end portion of the shroud and a side wall of the drain groove inside the heat exchanger with respect to a first gap A between an upper end portion of the bell mouth and a suction-side end portion of the shroud is $B/A \leq 3$ or $10 \leq B/A$.

2. The ceiling-cassette air conditioner according to claim 1, wherein a height of the side wall of the drain groove inside the heat exchanger is higher than a side wall of the drain groove outside the heat exchanger.

FIG. 1

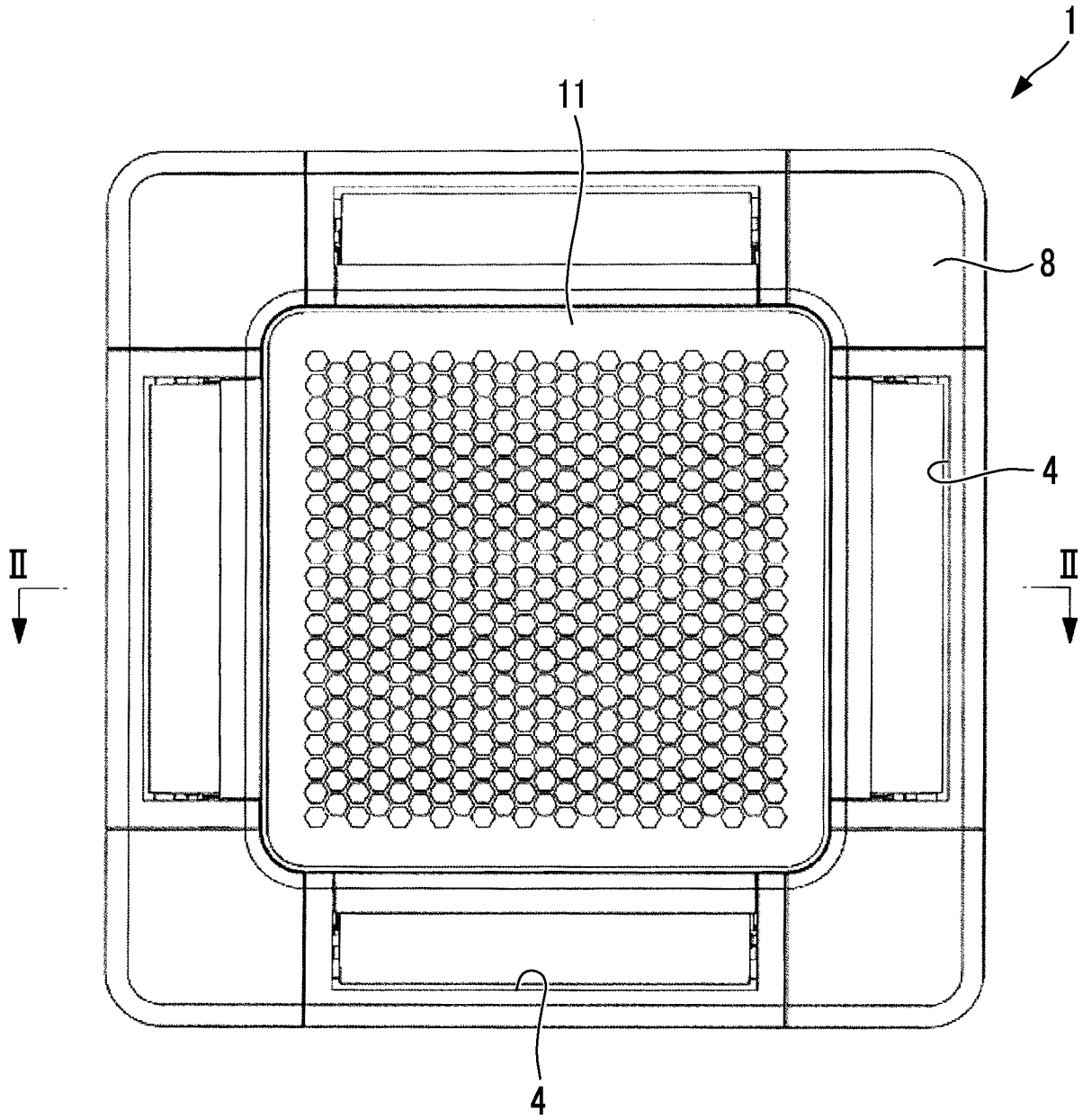


FIG. 2

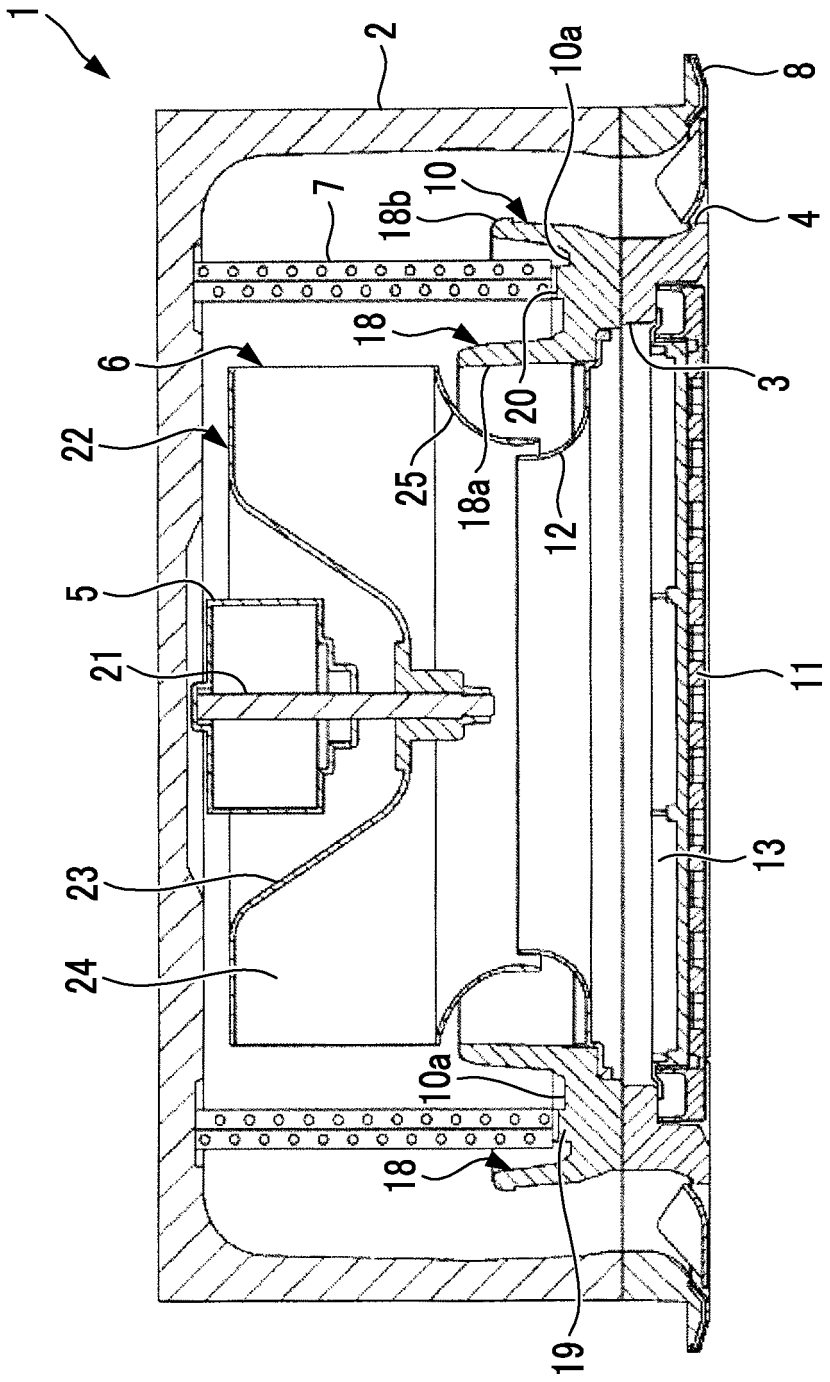


FIG. 3

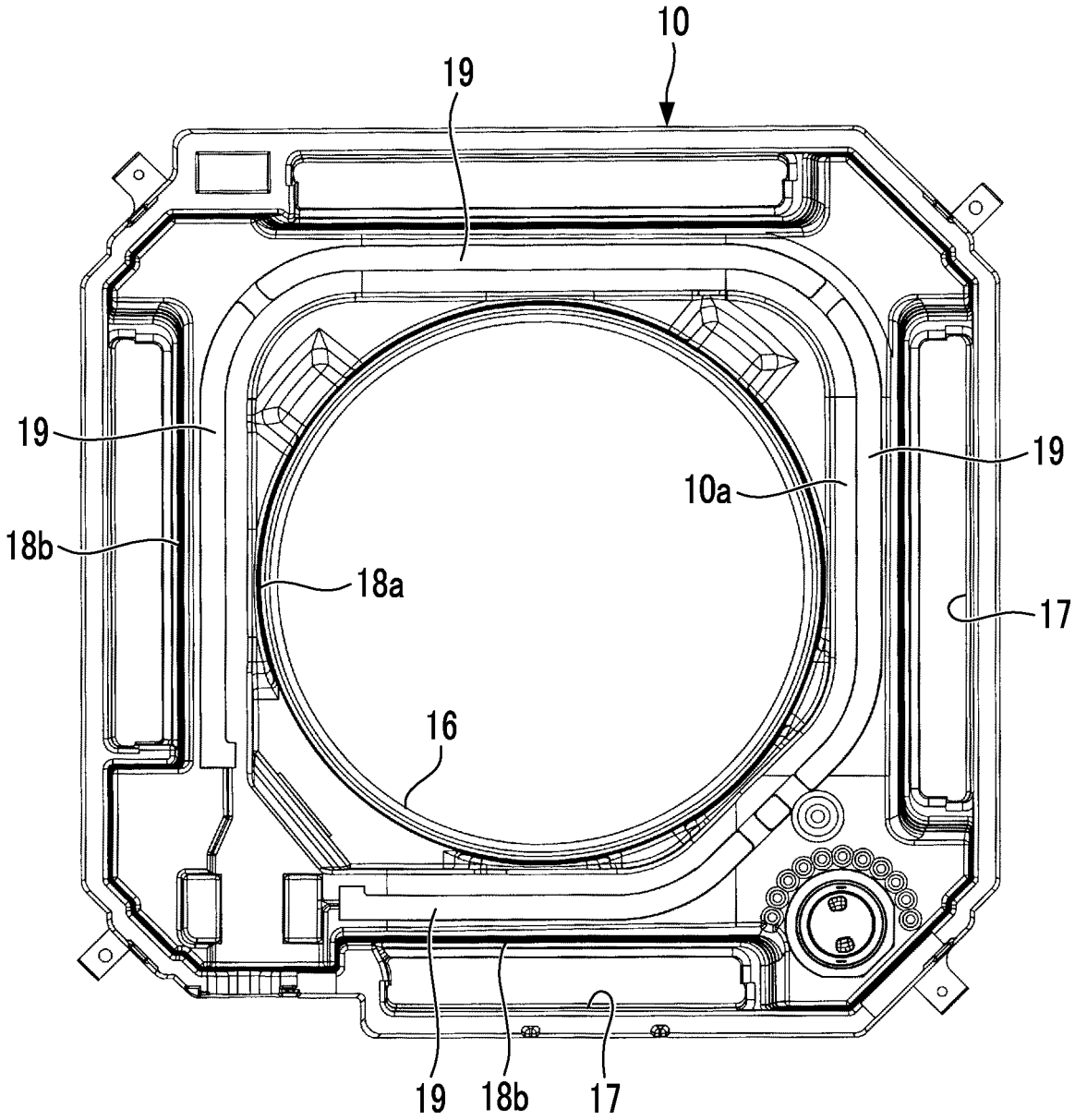


FIG. 4

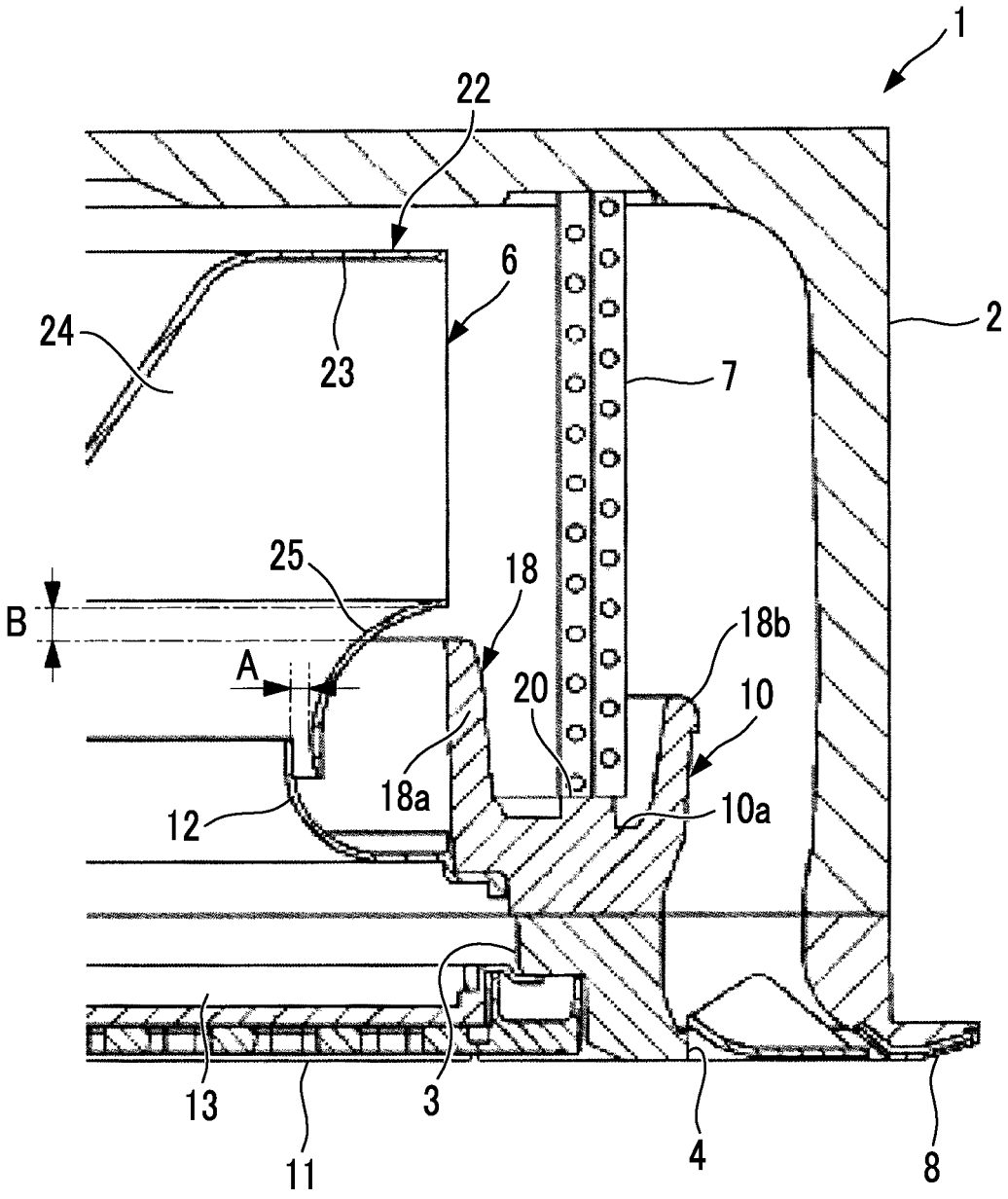
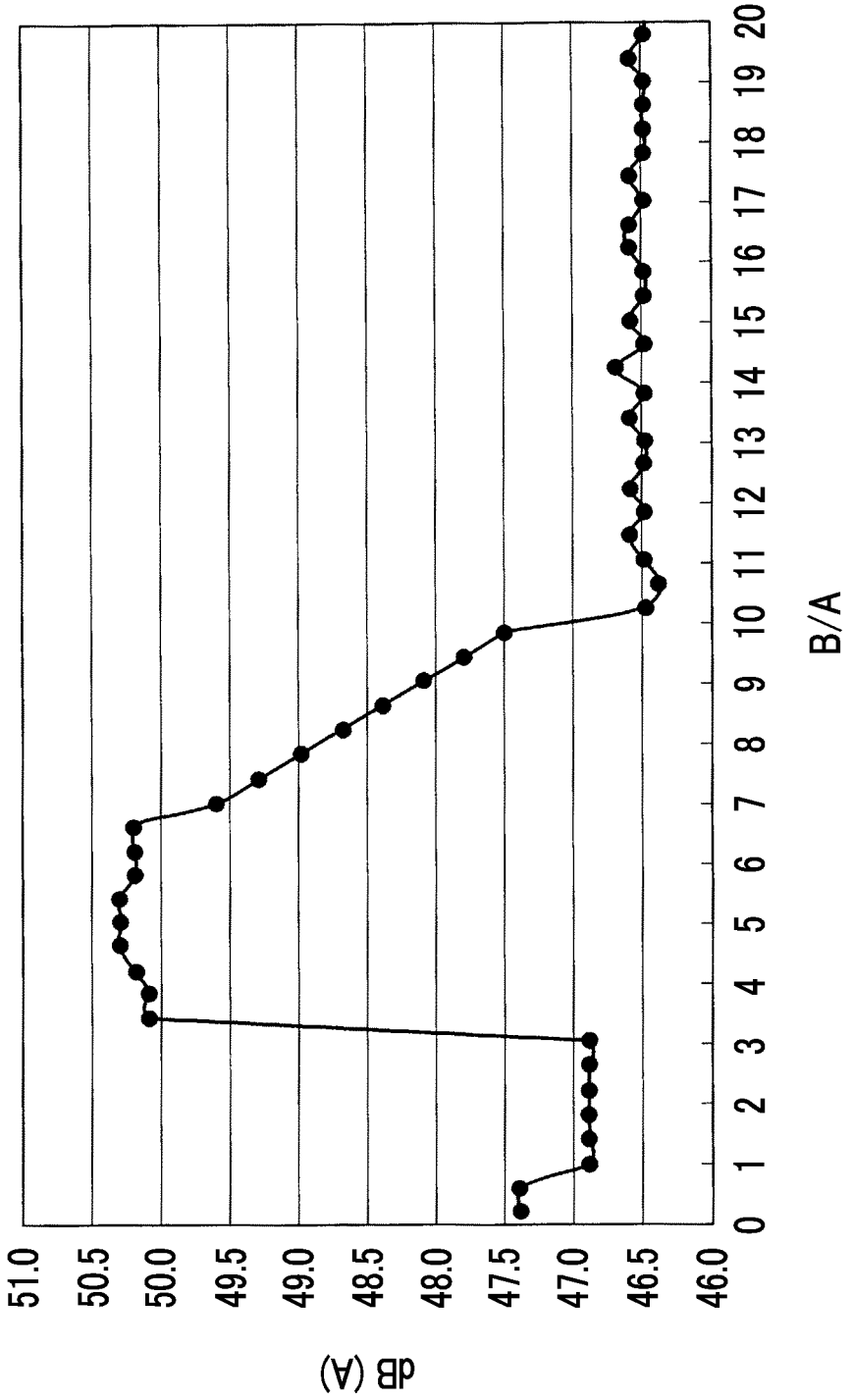


FIG. 5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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
B/A

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F24F1/00(2011.01)i, F24F13/22(2006.01)i

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. F24F1/00, F24F13/22

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	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2017/006467 A1 (JOHNSON CONTROLS HITACHI AIR CONDITIONING TECHNOLOGY (HONGKONG) LTD.) 12 January 2017, paragraphs [0012]-[0041], fig. 1-6 & US 2018/0202684 A1, paragraphs [0017]-[0046], fig. 1-6 & EP 3321597 A1 & CN 107850318 A	1-2
Y	JP 2000-9327 A (FUJITSU GENERAL LTD.) 14 January 2000, paragraphs [0002]-[0044], fig. 1-12 (Family: none)	1-2

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 December 2018 (10.12.2018)	18 December 2018 (18.12.2018)

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/041452

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2016/084216 A1 (HITACHI APPLIANCES, INC.) 02 June 2016, entire text, all drawings & US 2017/0299201 A1 & EP 3225934 A1 & CN 107076455 A	1-2
A	JP 2015-114089 A (SAMSUNG ELECTRONICS CO., LTD.) 22 June 2015, entire text, all drawings (Family: none)	1-2
A	JP 2016-11827 A (SAMSUNG ELECTRONICS CO., LTD.) 21 January 2016, entire text, all drawings & US 2017/0159946 A1, entire text, all drawings & EP 3153785 A1 & WO 2015/186992 A1 & KR 10-2015-0140240 A & CN 106415138 A	1-2
A	JP 2010-138700 A (DAIKIN INDUSTRIES, LTD.) 24 June 2010, entire text, all drawing (Family: none)	1-2

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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