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- **NAKAYAMA, Satoshi**  
 Fuji-Shi, Shizuoka 4168521 (JP)
- **HAMADA, Yoshinobu**  
 Fuji-Shi, Shizuoka 4168521 (JP)
- **GAJINA, Kenji**  
 Fuji-Shi, Shizuoka 4168521 (JP)
- **MOCHIZUKI, Kiyomi**  
 Fuji-Shi, Shizuoka 4168521 (JP)

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(74) Representative: **Kramer Barske Schmidtchen**  
**Patentanwälte PartG mbB**  
**European Patent Attorneys**  
**Landsberger Strasse 300**  
**80687 München (DE)**

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

(72) Inventors:  
 • **YOSHITAKE, Nobusato**  
**Fuji-Shi, Shizuoka 4168521 (JP)**

(54) **CEILING INSTALLATION TYPE AIR CONDITIONER AND HEAT EXCHANGER**

(57) To provide a ceiling installation type air conditioner that is compact and has a good heat exchange efficiency. This ceiling installation type air conditioner (1) is provided with: a blower chamber (3) having an air inlet (27); a heat exchanger chamber (4) having an air outlet (28); a partitioning plate (26) separating the blower chamber (3) and the heat exchanger chamber (4); a blower (5) accommodated in the blower chamber (3); and a heat exchanger (7) accommodated in the heat exchanger chamber (4). The blower chamber (3) and the heat exchanger chamber (4) are connected via the blowing device (5). The heat exchanger (7) has a first heat exchange section (7A), a second heat exchange section (7B), and a third heat exchange section (7C). The first heat exchange section (7A), the second heat exchange section (7B), and the third heat exchange section (7C) each have a plurality of plate-shaped fins (71) and a plurality of heat transfer tubes (72). The first heat exchange section (7A) to the third heat exchange section (7C) are disposed in a substantially convex shape with respect to the air outlet (28).

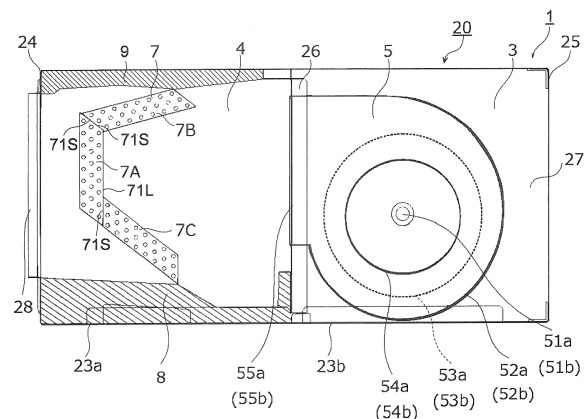


FIG. 3

## Description

### FIELD

**[0001]** Embodiments according to the present invention relate to a ceiling installation type air conditioner and a heat exchanger.

### BACKGROUND

**[0002]** An indoor unit of a ceiling installation type air conditioner (i.e., ceiling-installed air conditioner) is installed in ceiling space such that the indoor unit is suspended from the characteristics of a beam provided on an attic or is buried in the attic. The inside of the indoor unit is partitioned with a partition plate into a heat exchange chamber and a blower chamber. A heat exchanger is disposed in the heat exchange chamber, and a blower for sending air to the heat exchanger is disposed in the blower chamber.

**[0003]** The heat exchanger includes plural heat transfer tubes through which refrigerant flows and plural fins that are thermally connected to the heat transfer tubes. The heat exchanger is in the form of a flat plate as a whole. Further, the heat exchanger is accommodated in the heat exchange chamber in the state of being largely inclined with respect to the blower in order to efficiently receive the air sent from the blower and to minimize the height dimension of the indoor unit.

Prior Art Document

Patent Document

**[0004]** Patent Document 1: Japanese Unexamined Patent Application Publication No. 2006-343043

### SUMMARY

Problems to be solved by Invention

**[0005]** Since the heat exchanger in the form of a flat plate is disposed in the heat exchange chamber so as to be inclined in the conventional air conditioner, much wasted space is inevitably generated inside the heat exchange chamber, which causes increase in depth dimension. The outer dimension of the heat exchange chamber increases in proportion to capacity. Thus, larger space is required inside the heat exchange chamber as capacity of the heat exchanger increases. These factors hinder downsizing of the indoor unit.

**[0006]** Further, since the heat exchanger in the form of a flat plate is disposed in the heat exchange chamber so as to be inclined in the conventional air conditioner, the distance from the blower greatly differs between the front end portion and the rear end portion of the heat exchanger in the conventional air conditioner. Thus, depending on a location of the heat exchanger, the volume

of air passing through the heat exchanger easily varies. Variation in volume of the air passing through the heat exchanger degrades performance of the heat exchanger. Hence, the conventional air conditioner leaves room for improvement in order to fully demonstrate the performance of the heat exchanger.

**[0007]** To achieve the above object, an aspect of the present invention provides a ceiling installation type air conditioner that is compact and has high heat exchange efficiency.

Means for solving Problem

**[0008]** To achieve the above object, an aspect of the present invention provides a ceiling installation type air conditioner including a blower chamber including an air inlet, a heat exchange chamber including an air outlet, a partition plate separating the blower chamber and the heat exchanger from each other, a blower accommodated in the blower chamber, and a heat exchanger accommodated in the heat exchange chamber. The blower chamber is spatially connected with the heat exchange chamber via the blower. The heat exchanger includes a first heat exchange section, a second heat exchange section, and a third heat exchange section. Each of the first heat exchange section, the second heat exchange section, and the third heat exchange section includes a plurality of plate-shaped fins and a plurality of heat transfer tubes. The first heat exchange section, the second heat exchange section, and the third heat exchange section are disposed in a convex shape as a whole toward the air outlet.

**[0009]** It may be desired that the plate-shaped fins has a substantially parallelogram shape.

**[0010]** It may be desired that one of short sides of the plate-shaped fins of the first heat exchange section is in contact with a short side of the plate-shaped fins of the second heat exchange section on a side of the air outlet without any gap, and another short side or a long side on a side of the blower chamber of the plate-shaped fins of the first heat exchange section is in contact with a short side of the plate-shaped fins of the third heat exchange section on a side of the air outlet without any gap.

**[0011]** It may be desired that the first heat exchange section is closest to the air outlet out of the first heat exchange section, the second heat exchange section, and the third heat exchange section, and number of the heat transfer tubes provided for the first heat exchange section is larger than the number of the heat transfer tubes provided for each of the second heat exchange section and the third heat exchange section.

**[0012]** It may be desired that the first heat exchange section is closest to the air outlet out of the first heat exchange section, the second heat exchange section, and the third heat exchange section, the second heat exchange section and the third heat exchange section have a same shape, and the first heat exchange section is line-symmetrical with the second heat exchange sec-

tion and the third heat exchange section.

**[0013]** It may be desired that an interval at which the plate-shaped fins of the first heat exchange sections are arranged is narrower than an interval at which the plate-shaped fins of each of the second heat exchange section and the third heat exchange section are arranged.

**[0014]** It may be desired that slits are provided only in the plate-shaped fins of the first heat exchange section.

**[0015]** It may be desired that a pipe diameter of the heat transfer tubes of the first heat exchange section is larger than a pipe diameter of the heat transfer tubes of the second heat exchange section and the third heat exchange section.

**[0016]** It may be desired that the first heat exchange section, the second heat exchange part, and the third heat exchange section are integrally formed.

**[0017]** It may be desired that the second heat exchange section is disposed at an upper portion of the heat exchange chamber, the third heat exchange section is disposed at a lower portion of the heat exchange chamber, and angle difference is provided in such a manner that an inclination angle of the second heat exchange section is smaller than an inclination angle of the third heat exchange section.

**[0018]** It may be desired that the first heat exchange section is inclined in such a manner that an upper end portion of the first heat exchange section is positioned on a windward side of a lower end portion of the first heat exchange section.

**[0019]** It may be desired that an end portion of a short side of the plate-shaped fins of the third heat exchange section on a side of the air outlet is protruded toward the air outlet more than an end portion of a short side positioned at a lower portion of the plate-shaped fins of the first heat exchange section.

**[0020]** It may be desired that a shortest distance between the air outlet and an end portion on a side of the air outlet of a short side positioned at a lower portion of the plate-shaped fins of the first heat exchange section is longer than a shortest distance between the air outlet and an end portion on a side of the air outlet of a short side positioned at a lower portion of the plate-shaped fins of the third heat exchange section.

#### BRIEF DESCRIPTION OF DRAWINGS

##### **[0021]**

Fig. 1 is a perspective view of a ceiling installation type air conditioner according to a first embodiment.

Fig. 2 is an exploded bottom view illustrating the inside of the ceiling installation type air conditioner according to the first embodiment.

Fig. 3 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to the first embodiment.

Fig. 4 is an enlarged cross-sectional view illustrating a part of fins and heat transfer tubes constituting a

heat exchanger of the ceiling installation type air conditioner according to the first embodiment.

Fig. 5 is a schematic view illustrating a shape of each fin constituting the heat exchanger of the ceiling installation type air conditioner according to the first embodiment.

Fig. 6 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to a second embodiment.

Fig. 7 is a view illustrating shapes of fins constituting the heat exchanger of the ceiling installation type air conditioner according to a third embodiment.

Fig. 8 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to the third embodiment.

Fig. 9 is a view illustrating shapes of fins constituting the heat exchanger of the ceiling installation type air conditioner according to a fifth embodiment.

Fig. 10 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to a sixth embodiment.

Fig. 11 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to a seventh embodiment.

Fig. 12 is a view illustrating shapes of fins constituting the heat exchanger of the ceiling installation type air conditioner according to the seventh embodiment.

Fig. 13 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to an eighth embodiment.

Fig. 14 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to a ninth embodiment.

Fig. 15 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to a tenth embodiment.

Fig. 16 is a schematic diagram illustrating configuration of the heat exchanger of the ceiling installation type air conditioner according to the tenth embodiment.

Fig. 17 is an enlarged schematic view illustrating configuration of the heat exchanger of the ceiling installation type air conditioner according to the tenth embodiment.

#### DETAILED DESCRIPTION

**[0022]** Hereinbelow, embodiments according to the present invention will be described.

(First Embodiment)

**[0023]** The ceiling installation type air conditioner of the first embodiment will be described with by referring to Fig. 1 to Fig. 5.

**[0024]** Fig. 1 illustrates the ceiling installation type air conditioner 1 of the embodiment. An indoor unit 2 of the ceiling installation type air conditioner 1 is installed, e.g.,

on an attic of a building. The attic of the embodiment is defined as ceiling space between a ceiling plate and a beam of the building.

**[0025]** The indoor unit 2 is formed in the shape of a rectangular flat box having a depth dimension D, a width dimension W, and a height dimension H. In addition, the indoor unit 2 includes a metallic housing 20. The housing 20 is an outer periphery of the indoor unit 2. The housing 20 includes a top plate 21, a first side plate 22a, a second side plate 22b, a first bottom plate 23a, a second bottom plate 23b, a front frame 24, a rear frame 25, and a partition plate 26.

**[0026]** As shown in Fig. 2 and Fig. 3, the partition plate 26 of the ceiling installation type air conditioner 1 according to the embodiment partitions the interior of the housing 20 into two chambers that are a blower chamber 3 and a heat exchange chamber 4.

**[0027]** The blower chamber 3 has an air inlet 27 formed in the rear frame 25. A blower 5 is accommodated in the blower chamber 3. As shown in Fig. 2 and Fig. 3, the blower 5 includes a fan motor 51, fan cases 52a and 52b, and multi-blade fans 53a and 53b housed inside the fan cases 52a and 52b. Respective suction ports 54a and 54b are provided on both side surfaces of the fan cases 52a and 52b. The partition plate 26 is provided with blowout ports 55a and 55b.

**[0028]** The fan motor 51 includes two rotating shafts 51a and 51b that are coaxially protruded from both side surfaces thereof. The multi-blade fans 53a and 53b are attached to the respective rotating shafts 51a and 51b.

**[0029]** The heat exchange chamber 4 includes a machine room 6 and an air outlet 28 formed in the front frame 24. The machine room 6 is partitioned from the heat exchange chamber 4 with a machine-room partition plate 61, and accommodates a drain pump and a refrigerant distributor.

**[0030]** The blower chamber 3 and the heat exchange chamber 4 are connected to each other via the blower 5. Specifically, both are spatially connected with each other such that air in the blower chamber 3 can flow into the heat exchange chamber 4 through the blower 5.

**[0031]** In addition, a heat exchanger 7 and a drain pan 8 are disposed in the heat exchange chamber 4 as shown in Fig. 3. In other words, the heat exchanger 7 and the drain pan 8 are housed in the heat exchange chamber 4 of the housing 20. The heat exchanger 7 extends in the width direction of the indoor unit 2 (i.e., in the width direction of the housing 20), and is interposed between the machine-room partition plate 61 and the side plate 22a.

**[0032]** As shown in Fig. 3, the drain pan 8 is disposed below the heat exchanger 7. The drain pan 8 is a heat insulating material such as expanded polystyrene. The drain pan 8 supports the heat exchanger 7 from the lower side, and receives drain water dripping from the heat exchanger 7. The lower surface of the drain pan 8 is covered with the first bottom plate 23a. In addition, the drain pan 8 cooperates with a heat insulating material 9 to surround the heat exchanger 7. The heat insulating material 9 is

disposed above the heat exchanger 7, and is provided on the inner surface of the top plate 21 and in the heat exchange chamber 4.

**[0033]** The heat exchanger 7 of the embodiment includes a first heat exchange section 7A, a second heat exchange section 7B, and a third heat exchanging portion 7C. The first heat exchange section 7A, the second heat exchange section 7B, and the third heat exchange section 7C are disposed so as to protrude toward the air outlet 28 in a convex shape.

**[0034]** The first heat exchange section 7A stands inside the heat exchange chamber 4 so as to face substantially parallel to the partition plate 26 and the blowout ports 55a and 55b of the blower 5. Out of the first heat exchange section 7A, the second heat exchange section 7B, and the third heat exchange section 7C, the first heat exchange section 7A is the closest to the air outlet 28 in the embodiment.

**[0035]** The second heat exchange section 7B is located at the upper portion of the heat exchange chamber 4, and extends in the depth direction of the indoor unit 2 so as to be separated away from the blower 5 in a cross-sectional view. In addition, the second heat exchange section 7B is inclined slightly downward as separating from the blower 5. In other words, the second heat exchange section 7B is inclined slightly downward as it approaches the air outlet 28. The front end (i.e., the side of the air outlet 28) of the second heat exchange section 7B is spatially continuous with the upper end of the first heat exchange section 7A.

**[0036]** The third heat exchange section 7C is positioned at the lower portion of the heat exchange chamber 4, and extends in the depth direction of the indoor unit 2 so as to be separated away from the blower 5 in a cross-sectional view. In addition, the third heat exchange section 7C is inclined slightly upward as separating from the blower 5. In other words, the third heat exchange section 7C is inclined slightly upward as it approaches the air outlet 28. The front end (i.e., the side of the air outlet 28) of the third heat exchange section 7C is spatially continuous with the lower end of the first heat exchange section 7A.

**[0037]** In other words, the heat exchanger 7 includes: the first heat exchange section 7A that stands so as to face the blowout ports 55a and 55b and the partition plate 26; the second heat exchange section 7B that extends obliquely upward from the upper end of the first heat exchange section 7A toward the blower 5; and the third heat exchange section 7C that extends obliquely downward from the lower end of the first heat exchange section 7A toward the blower 5.

**[0038]** Thus, when the indoor unit 2 is viewed from the side, the first to third heat exchange sections 7A, 7B, and 7C of the first embodiment are combined so as to be substantially in the form of an angled bracket or a gate. That is, the heat exchanger 7 is disposed so as to have a convex shape protruding toward the leeward side with respect to wind sent from the blower chamber 3, and is

disposed so as to have a substantially concave shape recessed toward the windward side.

**[0039]** In addition, it can be said that the first to third heat exchange sections 7A, 7B, and 7C are disposed in a substantially trapezoidal shape including a smaller base (a top) and a pair of leg portions when the indoor unit 2 is viewed from the side. The first heat exchange section 7A is disposed at the portion (side) corresponding to the smaller base and the second and third heat exchange sections 7B and 7C are disposed at the respective portions (sides) corresponding to the pair of leg portions in such a manner that the substantially trapezoidal shape is formed as a whole with its longer portion opened.

**[0040]** As shown in Fig. 4, the heat exchanger 7 of the ceiling installation type air conditioner 1 according to the embodiment is a fin-tube type heat exchanger that is a combination of plate-like fins and heat transfer tubes. Each of the first to third heat exchange sections 7A, 7B, and 7C of the embodiment includes plural elongated fins 71 and plural heat transfer tubes 72 through which a refrigerant flows.

**[0041]** As shown in Fig. 5, the fins 71 of the ceiling installation type air conditioner 1 according to the embodiment are, e.g., a quadrilateral plate made of aluminum and has a pair of long sides 71L and a pair of short sides 71S. The long sides 71L are parallel to each other. The short sides 71S are parallel to each other, and extend obliquely so as to intersect the long sides 71L. In other words, the fins 71 have a parallelogram shape in which two pairs of opposite sides are parallel to each other.

**[0042]** Further, the fins 71 are provided with plural engagement holes 73. The engagement holes 73 have a cylindrical flange portion that is pierced by, e.g., applying a burring process to the fins 71 and rises from the fins 71. For instance, the engagement holes 73 are arranged in eight rows in the direction along the long sides 71L of the fins 71 and in three columns in the direction along the short sides 71S of the fins 71.

**[0043]** As shown in Fig. 4, the fins 71 are arranged in one row at intervals in the width direction W of the indoor unit 2. In other words, the fins 71 are arranged at intervals in the width direction of the housing 20. The respective tips of the flange portions rising from each fin 71 butts against the adjacent fin 71 so as to coaxially match the engagement holes 73 of the adjacent fin 71. Thus, ventilation passages 74 through which air flows are provided between the adjacent fins 71.

**[0044]** The heat transfer tubes 72 are, e.g., copper tubes that are excellent in thermal conductivity. Each of the heat transfer tubes 72 includes a straight pipe portion extending straight in the width direction of the indoor unit 2 and a bent pipe portion bent substantially in a U shape. The respective straight pipe portions of the heat transfer tubes 72 continuously penetrate the engagement holes 73 of the fins 71. As a result, the heat transfer tubes 72 are thermally connected to the fins 71. The heat transfer tubes 72 are integrated with the fins 71 by continuously penetrating the adjacent fins 71.

**[0045]** In addition, as shown in Fig. 3, one of the short sides 71S of each fin 71 of the first heat exchange section 7A and the short side 71S of each fin 71 of the second heat exchange section 7B on the side of the air outlet 28 are disposed so as to be in contact with each other without any gap in the first embodiment.

**[0046]** Further, the long side 71L of the fins 71 of the first heat exchange section 7A on the side of the blower chamber 3 and the short side 71S of the third heat exchange section 7C on the side of the air outlet 28 are arranged so as to be in contact with each other without any gap in the embodiment. Alternatively, the other short side 71S of the fin 71 of the first heat exchange section 7A and the long side 71L of the third heat exchange section 7C on the side of the blower chamber 3 are arranged so as to be in contact with each other without any gap.

**[0047]** When the fan motor 51 rotates the multi-blade fans 53a and 53b of the embodiment, the multi-blade fans 53a and 53b suck air in the blower chamber 3 from the suction ports 54a and 54b of the fan cases 52a and 52b and discharge the sucked air from the blowout ports 55a and 55b of the fan cases 52a and 52b.

**[0048]** Thus, the air in the building room is sucked into the blower chamber 3 from the air inlet 27 of the housing 20 via a non-illustrated duct or a suction grill of the ceiling board. The air sucked into the blower chamber 3 is blown out from the blowout ports 55a and 55b toward the heat exchanger 7 via the fans 52a and 52b.

**[0049]** Since the first heat exchange section 7A of the heat exchanger 7 stands so as to face the blowout ports 55a and 55b inside the heat exchange chamber 4, a major portion of the air blown out from the blowout ports 55a and 55b toward the heat exchange chamber 4 flows through the interval between the fins 71 of the first heat exchange section 7A (i.e., through the ventilation passages 74).

**[0050]** The rest of the air blown out toward the heat exchange chamber 4 flows through the interval between the fins 71 of the second heat exchange section 7B extending obliquely upward from the upper end of the first heat exchange section 7A towards the blower 5 (i.e., through the ventilation passages 74), and further flows through the interval between the fins 71 of the third heat exchange section 7C extending obliquely downward from the lower end of the first heat exchange section 7A toward the blower 5 (i.e., through the ventilation passages 74).

**[0051]** As a result, the heat exchanger 7 converts the inhaled air into cold or warm air by heat exchange between the air blown out from the blowout ports 55a and 55b and the refrigerant flowing through the heat transfer tubes 72. The air subjected to the heat exchange is delivered from the air outlet 28 to the inside of the room through a blow duct.

**[0052]** The heat exchanger 7 of the embodiment combines the first to third heat exchange sections 7A, 7B, and 7C in a substantially trapezoidal shape and is three-dimensionally bent into a steric shape. Thus, the dimen-

sion of the heat exchanger 7 along the depth direction of the heat exchange chamber 4 can be shortened as compared with the case where the conventional straight heat exchanger is disposed so as to be inclined in the heat exchange chamber.

**[0053]** Additionally, the first heat exchange section 7A stands inside the heat exchange chamber 4 in the embodiment. Thus, the dimension of the heat exchanger 7 along the depth direction of the heat exchange chamber 4 in the embodiment can be shortened by the difference between the distance from the open ends of the blowout ports 55a and 55b to the front end of the first heat exchange section 7A and the distance from the open ends of the blowout ports 55a and 55b to the rear end of the second heat exchange section 7B, as compared with the case where the conventional straight heat exchanger is disposed so as to be inclined in the heat exchange chamber. As a result, the depth dimension of the heat exchange chamber 4 can be kept small, and the housing 20 of the indoor unit 2 can be made compact.

**[0054]** Further, the heat capacity of the heat exchanger 7 can be sufficiently improved by bending the heat exchanger 7 in the embodiment. Thus, in the embodiment, the heat exchanger 7 having a large capacity can be disposed in the compact heat exchange chamber 4, and the indoor unit 2 having excellent heat exchange performance can be provided.

**[0055]** Moreover, as the housing 20 is made more compact, the housing 20 can be reduced in weight in the embodiment. Thus, the workability at the time of installing the indoor unit 2 in ceiling space is improved. Furthermore, since the housing 20 becomes smaller, it is possible to obtain an inexpensive indoor unit 2 by reducing manufacturing cost of the housing 20.

**[0056]** In addition, since the first heat exchange section 7A stands inside the heat exchange chamber 4 in the embodiment, the difference between the distance from the open ends of the blowout ports 54 to the front end of the first heat exchange section 7A and the distance from the open ends of the blowout ports 54 to the rear end of the second heat exchange section 7B is smaller than in the case where the conventional straight heat exchanger is disposed so as to be inclined inside the heat exchange chamber. Accordingly, it is possible to blow air substantially uniformly to the heat exchanger 7, and thus satisfactory heat exchange performance can be obtained.

**[0057]** The second heat exchange section 7B of the embodiment is inclined upward from the upper end of the first heat exchange section 7A toward the blower chamber side, and the third heat exchange section 7C is inclined downward from the lower end of the first heat exchange section 7A toward the blower chamber side. Hence, the second heat exchange section 7B and the third heat exchange section 7C become susceptible to air, and thus air volume of the air passing through the upper portion and the lower portion of the heat exchanger 7 can be improved. Accordingly, the heat exchanger 7 having excellent heat exchange performance can be ob-

tained.

**[0058]** Further, in the embodiment, a gap causing air leakage is excluded from the joint of (i.e., boundary between) the first and second heat exchange sections 7A and 7B and the joint of (i.e., boundary between) the first and third heat exchange sections 7A and 7C. Thus, it is possible to reduce the amount of air leaking without being subjected to heat exchange from the boundaries of the first to third heat exchange sections 7A, 7B, and 7C, which is advantageous in enhancing the heat exchange performance of the heat exchanger 7.

**[0059]** Moreover, it is possible to reduce the number of members that prevent air from leaking without being subjected to heat exchange from the joints in the embodiment.

**[0060]** Thus, according to the embodiment, it is possible to provide a ceiling installation type air conditioner that is compact and has high heat exchange efficiency.

(Second Embodiment)

**[0061]** The ceiling installation type air conditioner of the second embodiment will be described with reference to Fig. 6. The same reference signs are assigned to the components of the second embodiment that are the same as the components shown in Fig. 1 to Fig. 5.

**[0062]** Fig. 6 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the second embodiment. As shown in Fig. 6, the heat transfer tubes 72 are disposed such that the number of the heat transfer tubes 72 of the first heat exchange section 7A is larger than the number of the heat transfer tubes 72 of each of the heat exchange sections 7B and 7C.

**[0063]** The first heat exchange section 7A of the embodiment stands inside the heat exchange chamber 4 so as to face the partition plate 26 and the blowout ports 55a and 55b of the blower 5, and thus receives much wind sent out from the blower 5.

**[0064]** A total of 24 engagement holes 73 are provided in a fins 711 of the first heat exchange section 7A, and are arranged in eight rows along the long side direction of the fins 711 and in three columns along the short side direction of the fins 711. A total of 20 engagement holes 73 are provided in a fins 712 of the second and third heat exchange sections 7B and 7C, and are arranged in ten rows along the long side direction of the fins 712 and in two columns along the short side direction of the fins 712. In other words, the number of the heat transfer tubes in the first heat exchange section 7A is larger than that in each of the second and third heat exchange sections 7B and 7C, and it is possible to increase heat exchange capacity of the portion which receives more wind sent from the blower 5.

**[0065]** In the embodiment as described above, the major portion of the total air sent to heat exchanger 7 is distributed to the first heat exchange section 7A, and this first heat exchange section 7A performs heat exchange

more than the other heat exchange sections. Thus, it is possible to perform heat exchange in a well-balanced manner and to improve heat exchange performance.

**[0066]** According to the second embodiment, it is possible to provide a ceiling installation type air conditioner with high heat exchange efficiency.

(Third Embodiment)

**[0067]** The ceiling installation type air conditioner of the third embodiment will be described with reference to Fig. 7 and Fig. 8. The same reference signs are assigned to the components of the third embodiment that are the same as the components shown in Fig. 1 to Fig. 6.

**[0068]** Fig. 7 is a schematic view illustrating the shape of the fins 71 of the heat exchanger of the ceiling installation type air conditioner according to the third embodiment. Fig. 8 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the third embodiment.

**[0069]** In the ceiling installation type air conditioner 1 of the embodiment as shown in Fig. 7 and Fig. 8, the fins 711 of the first heat exchange section 7A are line-symmetrical with the fins 712 of the second and third heat exchange sections 7B and 7C.

**[0070]** Since the fins 711 and the fins 712 are line-symmetrical in the ceiling installation type air conditioner 1 of the embodiment, the fins can be made common between respective sections of the heat exchanger 7. Thus, the ceiling installation type air conditioner 1 of the embodiment can improve manufacturability and reduce cost.

**[0071]** According to the embodiment, it is possible to provide a compact ceiling installation type air conditioner with improved manufacturability and high heat exchange efficiency.

(Fourth Embodiment)

**[0072]** The ceiling installation type air conditioner of the embodiment will be described. The same reference signs are assigned to the components of the fourth embodiment that are the same as the components shown in Fig. 1 to Fig. 8.

**[0073]** Hereinafter, a fin pitch of the embodiment is defined as an interval by which the fins 711 of the first heat exchange section 7A or the fins 712 of the second and third heat exchange sections 7B and 7C are arranged in the width direction W of the housing 20. The fin pitch of the fins 711 is narrower than the fin pitch of the fins 712.

**[0074]** In other words, the fin pitch is each ventilation passage 74. The narrower the fin pitch of the fins 711 and 712 becomes, the larger the ventilation resistance becomes, which reduces air volume.

**[0075]** The first heat exchange section 7A is arranged to receive more wind sent from the blower 5 so that the major portion of the total air sent to the heat exchanger 7 is distributed to the first heat exchange section 7A. The

fin pitch of the fins 711 of the first heat exchange section 7A is narrower than the fin pitch of the fins 712 of each of the second and third heat exchange sections 7B and 7C. This arrangement makes it possible to send more wind to the second and third heat exchange sections 7B and 7C, which are less susceptible to wind than the first heat exchange section 7A, and thus it is possible to adjust air volume.

**[0076]** Thus, in the embodiment, it is possible to improve heat exchange performance by adjusting air volume distributed to the first heat exchange section 7A, the second heat exchange section 7B, and the third heat exchange section 7C.

**[0077]** According to the embodiment, it is possible to provide a ceiling installation type air conditioner with high heat exchange efficiency.

(Fifth Embodiment)

**[0078]** The ceiling installation type air conditioner of the fifth embodiment will be described with reference to Fig. 9. In Fig. 9 of the embodiment, the same reference signs are assigned to the same components as the components shown in Fig. 1 to Fig. 8.

**[0079]** In the embodiment as shown in Fig. 9, slits 81 are provided in the fins 711 of the first heat exchange section 7A. Generally, by forming the slits 81 that become cuts or narrow gaps in aluminum fins, heat transfer performance is enhanced and air resistance is also increased.

**[0080]** The slits 81 are provided in the fins 711 of the first heat exchange section 7A and the slits 81 are not provided in the fins 712 of the second and third heat exchange sections 7B and 7C. This configuration makes it possible to enhance the heat transfer performance of the fins 711 of the first heat exchange section 7A to which the major portion of air volume is distributed.

**[0081]** At the same time, it is possible to send more wind to the second and third heat exchange sections 7B and 7C that receive relatively small volume of wind, and thus air volume can be adjusted, because of the increased air resistance of the fins 711 of the first heat exchange section 7A.

**[0082]** According to the embodiment, it is possible to provide a ceiling installation type air conditioner with high heat exchange efficiency.

(Sixth Embodiment)

**[0083]** The ceiling installation type air conditioner of the sixth embodiment will be described with reference to Fig. 10. The same reference signs are assigned to the components of the embodiment that are the same as the components shown in Fig. 1 to Fig. 9.

**[0084]** Fig. 10 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the sixth embodiment.

**[0085]** As shown in Fig. 10, the tube diameter of each

heat transfer tube 731 of the first heat exchange section 7A of the embodiment is larger than the tube diameter of each heat transfer tube 732 of the second and third heat exchange sections 7B and 7C. The larger the tube diameter becomes, the larger the flow rate of the refrigerant becomes, which enhances heat transfer performance.

**[0086]** In the embodiment, it is possible to perform heat exchange in a well-balanced manner and enhance heat exchange performance by improving the heat transfer performance of the first heat exchange section 7A to which the major portion of air volume is distributed.

**[0087]** According to the embodiment, it is possible to provide a ceiling installation type air conditioner with high heat exchange efficiency.

(Seventh Embodiment)

**[0088]** The ceiling installation type air conditioner of the seventh embodiment will be described with reference to Fig. 11 and Fig. 12. The same reference signs are assigned to the components of the seventh embodiment that are the same as the components shown in Fig. 1 to Fig. 10.

**[0089]** Fig. 11 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the seventh embodiment.

**[0090]** As shown in Fig. 11, the heat exchanger 7 of the embodiment is an integrally molded product, and the first to third heat exchange sections 7A, 7B, and 7C are integrally formed. Instead of being formed by combining separate heat exchange sections, the heat exchanger 7 of the embodiment has a substantially trapezoidal shape as one piece.

**[0091]** Since the heat exchanger 7 is integrally formed as one piece instead of combining the first to third heat exchange sections 7A, 7B, and 7C with separate components, components for fixing respective heat exchange sections can be omitted and thus the heat exchanger can reduce the number of components, and thus the heat exchanger can improve in manufacturability.

**[0092]** Further, as shown in FIG. 12, the fins 71 before a bending process of the heat exchanger 7 of the embodiment is linear, and the first to third heat exchange sections 7A, 7B, and 7C may be formed by bending two points thereof.

**[0093]** For instance, as a manufacturing process, the fins 71 of the heat exchanger 7 are first formed into such a shape that a total length of the fin 71 is the combined length of the first to third heat exchange sections 7A, 7B, and 7C. Next, in order to perform the bending process, the boundary between the first and second heat exchange sections 7A and 7B (i.e., the joint of the first and second heat exchange sections) is cut out according to the bending margin. Similarly, the boundary between the first and third heat exchange sections 7A and 7C (i.e., the joint of the first and third heat exchange sections) is cut out according to the bending margin. In this case, the

respective portions corresponding to the first and third heat exchanging portions 7A and 7C have a trapezoidal shape, and the portion corresponding to the second the heat exchanger portion 7B has a parallelogram shape. When a series of these fins 71 is bent, the heat exchanger 7 is formed in a substantially trapezoidal shape.

**[0094]** By forming the heat exchanger 7 in this manner, its manufacturability can be improved. Specifically, it is possible to make favorable the yield of the fins material and to share pipe expanding equipment of a linear heat exchanger. Thus, it is possible to suppress capital investment and reduce cost by reducing materials.

**[0095]** According to the embodiment, it is possible to provide a ceiling installation type air conditioner with improved manufacturability.

(Eighth Embodiment)

**[0096]** The ceiling installation type air conditioner of the eighth embodiment will be described with reference to Fig. 13. The same reference signs are assigned to the components of the eighth embodiment that are the same as the components shown in Fig. 1 to Fig. 12.

**[0097]** Fig. 13 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the eighth embodiment.

**[0098]** As shown in Fig. 13, the inclination angle  $\theta_1$  of the second heat exchange section 7B disposed at the upper portion of the heat exchange chamber 4 of the embodiment is smaller than the inclination angle  $\theta_2$  of the third heat exchange section 7C disposed at the lower part of the heat exchange chamber 4. That is, angle difference is provided between the inclination angle  $\theta_1$  and the inclination angle  $\theta_2$ .

**[0099]** The second heat exchange section 7B is inclined slightly downward as being separated from the blower 5, and the third heat exchange section 7C is inclined slightly upward as being separated from the blower 5. It is possible to reduce the ventilation resistance of the third heat exchange section 7C positioned at the lower side where wind is relatively hard to reach, and thereby air volume can be improved by providing the angle difference between the inclination angles  $\theta_1$  and  $\theta_2$ , it.

**[0100]** According to the embodiment, it is possible to provide a ceiling installation type air conditioner with high heat exchange efficiency.

(Ninth Embodiment)

**[0101]** The ceiling installation type air conditioner of the ninth embodiment will be described with reference to Fig. 14. The same reference signs are assigned to the components of the ninth embodiment that are the same as the components shown in Fig. 1 to Fig. 13.

**[0102]** Fig. 14 is a side cross-sectional view illustrating the heat exchanger of the ceiling installation type air conditioner according to the ninth embodiment.

**[0103]** As shown in Fig. 14, the first heat exchange

section 7A is positioned at the center of the heat exchange chamber 4 of the embodiment and is inclined such that its upper end portion is positioned on the windward side of its lower end portion.

**[0104]** The second heat exchange section 7B is positioned at the upper portion of the heat exchange chamber 4. The second heat exchange section 7B is disposed such that the front end portion of the second heat exchange section 7B and the upper end portion of the first heat exchange section 7A are continuous.

**[0105]** The third heat exchange section 7C is positioned at the lower portion of the heat exchange chamber 4. The third heat exchange section 7C is disposed such that the front end portion of the third heat exchange section 7C and the lower end portion of the first heat exchange section 7A are continuous.

**[0106]** For instance, the first and second heat exchange sections 7A and 7B are disposed such that the long sides 71L of the fins 71 of the first heat exchange section 7A on the side of the blower chamber 3 are in contact with the short sides 71S of the fins 71 of the second heat exchange section 7B on the side of the air outlet 28 without any gap.

**[0107]** In addition, the first and third heat exchange sections 7A and 7C are disposed such that the short sides 71S on the lower side of the fins 71 of the first heat exchange section 7A are in contact with the short sides 71S of the fins 71 of the third heat exchange section 7C on the side of on the air outlet 28 without any gap.

**[0108]** In the embodiment, the shape of the fins 71 of the first heat exchange section 7A is line-symmetrical with the shape of the fins 71 of the third heat exchange section 7C. In the second heat exchange section 7B, the length dimension of the long side 71L of each of the fins 71 is shorter than that of the other heat exchange sections.

**[0109]** The second heat exchange section 7B that is harder to wind than the first heat exchange section 7A has fewer heat transfer tubes than the other heat exchange sections. For instance, when the number of stages (rows) of the heat transfer tubes of each of the first and third heat exchange sections 7A and 7C is ten, the number of stages (rows) of the second heat exchange section 7B is eight.

**[0110]** According to the embodiment, the first heat exchange section 7A positioned at the center portion is inclined with respect to the blowout ports 55a and 55b and the partition plate 26 so as to be susceptible to wind. The heat exchanger 7 is more likely to receive air, and air volume and wind speed of the air passing through the heat exchanger 7 can be improved by tilting the first heat exchange section 7A. In addition, the wind speed distribution improves and the blowing performance is enhanced by improving the air volume and the wind speed.

**[0111]** Accordingly, it is possible to smooth the flow of air and efficiently divide the flow into the respective heat exchange sections in the embodiment, and thus it is possible to provide a ceiling installation type air conditioner

with better performance.

**[0112]** As shown in FIG. 1, the housing 20 accommodating the blower 5 and the heat exchanger 7 is hung from the beam of the building via four hanger bolts HB in each of the above embodiments, for instance. Specifically, four metallic hangers 29 are fixed to the top plate 21 of the housing 20. The respective metallic hangers 29 horizontally protrude from the four corner portions of the top plate 21 toward the four sides of the housing 20, and the respective lower end portions of the hanger bolts HB are connected to the metallic hangers 29.

**[0113]** Although the first heat exchange section 7A is disposed so as to stand inside the heat exchange chamber 4 in each of the above-described embodiments, the first heat exchange section 7A may be inclined and disposed as a convex shape protruding toward the air outlet 28, for instance. In this case, out of the first to third heat exchange sections 7A, 7B, and 7C, the short sides 71S on the lower side of the fins 71 of the first heat exchange section 7A and the short sides 71S of the fins 71 of the third heat exchange section 7C on the side of the air outlet 28 are closest to the air outlet 28.

(Tenth Embodiment)

**[0114]** The ceiling installation type air conditioner of the tenth embodiment will be described with reference to Fig. 15 to Fig. 17. The same reference signs are assigned to the components of the tenth embodiment that are the same as the components shown in Fig. 1 to Fig. 14.

**[0115]** Fig. 15 is a schematic side cross-sectional view of the ceiling installation type air conditioner according to the tenth embodiment.

**[0116]** As shown in Fig. 15, the heat exchanger 7 and the drain pan 8 of the embodiment are housed in the heat exchange chamber 4 of the housing 20.

**[0117]** The heat exchanger 7 extends in the width direction of the housing 20. The drain pan 8 is a heat insulating material such as expanded polystyrene. The drain pan 8 supports the heat exchanger 7 from below so as to receive the drain water dripping from the heat exchanger 7, and cooperates with the heat insulating material 9 to surround the heat exchanger 7. Further, the lower surface of the drain pan 8 is covered with the first bottom plate 23a.

**[0118]** The heat exchanger 7 of the embodiment includes the first heat exchange section 7A, the second heat exchange section 7B, and the third heat exchange section 7C. These first to third heat exchange sections 7A, 7B, and 7C are independent components and are three-dimensionally combined into a predetermined stereic shape.

**[0119]** Each of the first to third heat exchange sections 7A, 7B, and 7C includes plural elongated plate-shaped fins 71 and plural heat transfer tubes 72 through which the refrigerant flows. The fins 71 are arranged at intervals in the width direction of the housing 20. The heat transfer

tubes 72 are integrated with the fins 71 by continuously penetrating the adjacent fins 71.

**[0120]** The second heat exchange section 7B is positioned at the upper portion of the heat exchange chamber 4. The second heat exchange section 7B extends in the depth direction of the housing 20 from the partition plate 26 toward the air outlet 28 of the housing 20. In addition, the second heat exchange section 7B is inclined slightly downward as it approaches the air outlet 28.

**[0121]** The third heat exchange section 7C is positioned at the bottom of the heat exchange chamber 4, and is separated from the second heat exchange section 7B in the height direction of the housing 20. The third heat exchange section 7C extends in the depth direction of the housing 20 from the partition plate 26 toward the air outlet 28 of the housing 20. In addition, the third heat exchange section 7C is inclined slightly upward as it approaches the air outlet 28. Therefore, each of the second heat exchange section 7B and the third heat exchange section 7C has one end that is positioned closer to the air outlet 28 than the partition plate 26.

**[0122]** The first heat exchange section 7A is interposed between one end of the second heat exchange section 7B and one end of the third heat exchange section 7C. The first heat exchange section 7A stands so as to face the partition plate 26, and is inclined such that the portion thereof closer to one end of the second heat exchange section 7B is closer to the partition plate 26. In other words, the first heat exchange section 7A is inclined such that one end portion on the side of the third heat exchange section 7C is the closest to the air outlet 28 and another end portion on the side of the second heat exchange section 7B is the farthest from the air outlet 28.

**[0123]** Thus, in the embodiment, the first to third heat exchange sections 7A, 7B, and 7C are combined in a shape that is more opened towards the partition plate 26 when viewing the housing 20 from the side. In other words, out of the first to third heat exchange sections 7A, 7B, and 7C, the short side 71S of the fins 71 of the third heat exchange section 7C on the side of the air outlet 28 is the closest to the air outlet 28.

**[0124]** The end portion PC of the third heat exchange section 7C is the corner portion of the short side 71S and the long side 71L on the side of the air outlet 28. The third heat exchange section 7C is arranged such that the end portion PC more protrudes towards the air outlet 28 than the end PA that is the corner of the short side 71S and the long side 71L of the first heat exchange section 7A on the air outlet 28 side (i.e., the tip of the end portion PC does not match the tip of the end portion PA).

**[0125]** In other words, on the short side 71S of the third heat exchange section 7C on the side of the air outlet 28, there is a protruding portion (step)  $\alpha$  that protrudes toward the air outlet 28 by a predetermined length  $l$  from the tip of the long side 71L of the first heat exchange section 7A on the side of the air outlet 28.

**[0126]** Specifically, when the shortest distance between the first heat exchange section 7A and the air outlet

28 is defined as distance LA and the shortest distance between the third heat exchange section 7C and the air outlet 28 is defined as distance LC as shown in Fig. 17, the first and third heat exchange sections 7A and 7C are arranged such that the distance LA is longer than the distance LC.

**[0127]** The shortest distance LA in the first heat exchange section 7A is the distance between the end portion PA and the air outlet 28, since the end portion PA that is the corner of the short side 71S and the long side 71L on the side of the air outlet 28 is the point closest to the air outlet 28. Similarly, the shortest distance LC in the third heat exchange section 7C is the distance between the end portion PC and the air outlet 28, since the end portion PC which is the corner of the short side 71S and the long side 71L on the side of the air outlet 28 is the point closest to the air outlet 28.

**[0128]** In the heat exchanger 7 of the embodiment, condensed water Y is generated when wind X sent from the blower 5 passes between the fins 71 of the heat exchanger 7 (i.e., passes through the ventilation passages 74) during cooling operation. This condensed water Y is generated in each of the first to third heat exchange sections 7A, 7B, and 7C. In Particular, the condensed water Y generated in the first heat exchange section 7A flows down toward the third heat exchange section 7C positioned at the lower part along the fins 71.

**[0129]** In a contact surface  $\beta$  of the first heat exchange section 7A and the third heat exchange section 7C, the ends of the fins 71 of the respective heat exchanging sections are closely packed, and thus the condensed water Y tends to stay. When the contact surface  $\beta$  receives the wind X from the blower 5, the accumulated condensed water Y may be pushed out in the ventilation direction and sometimes be flied out of the air conditioner from the air outlet 28.

**[0130]** For this reason, in the embodiment, the end portion of the third heat exchange section 7C is arranged so as to protrude toward the air outlet 28 more than the end portion PA of the first heat exchange section 7A, and the protruding portion  $\alpha$  is provided because the end portion PC is not aligned with the end portion PA. As a result, the condensed water Y staying on the contact surface  $\beta$  of the first heat exchange section 7A and the third heat exchange section 7C once stays in the protruding portion  $\alpha$  in the course of being sent to the side of the air outlet 28 by the wind X, and flows down to the third the heat exchange section 7C. Thus, the condensed water Y is guided to the drain pan 8 without being scattered by the wind X.

**[0131]** When the end portion PA of the first heat exchange section 7A and the end portion PC of the third heat exchange section 7C are butted without providing the protruding portion  $\alpha$  (such that the tip of the end portion PA matches the tip of the end portion PC), the condensed water Y is likely to splash by the wind X from the end portions PA and PC that are the most protruding tip portions on the side of the air outlet 28 in the heat ex-

changer 7. However, the most protruding tip portion of the heat exchanger 7 is not the end portion PA in the embodiment by providing the protruding portion  $\alpha$  which is a stepped portion. Accordingly, the condensed water Y flowing down from the first heat exchange section 7A does not directly flow to the end portion PC of the third heat exchange section 7C but once stays in the protrusion portion  $\alpha$  by the surface tension before reaching the end portion PC of the third heat exchange section 7C. Hence, the condensed water Y easily flows down to the third heat exchange section 7C, and becomes unlikely to scatter.

**[0132]** According to the embodiment, the condensed water Y that has stagnated in the contact surface  $\beta$  of the first and third heat exchange sections 7A and 7C can be recovered in the third heat exchange section 7C, and thus scattering of the condensed water Y by the wind X can be suppressed.

**[0133]** In addition, a gap may be generated on the contact surface  $\beta$  of the first and third heat exchange sections 7A and 7C due to causes such as manufacturing error and aging deformation. When the gap is generated on the contact surface  $\beta$  of the first and third heat exchange sections 7A and 7C, it is conceivable that a lot of condensed water Y stays in this gap due to the surface tension. However, in the embodiment, scattering of such condensed water Y can be suppressed.

**[0134]** According to the ceiling installation type air conditioner of at least one of the embodiments as described above, it is possible to provide a ceiling installation type air conditioner that is compact and has high heat exchange efficiency.

**[0135]** 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 invention. Indeed, the novel apparatuses and units described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the apparatuses and units described herein may be made without departing from the spirit of the invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

Reference Signs

**[0136]**

- 1 ceiling installation type air conditioner
- 2 indoor unit
- 3 blower chamber
- 4 heat exchange chamber
- 5 blower
- 6 machine room
- 7 heat exchanger
- 7A first heat exchange section
- 7B second heat exchange section

- 7C third heat exchange section
- 8 drain pan
- 9 heat insulating material
- 20 housing
- 5 21 top plate
- 22 side plate
- 23a, 23b bottom plate
- 24 front frame
- 25 rear frame
- 10 26 partition plate
- 27 air inlet
- 28 air outlet
- 51 fan motor
- 51a, 51b rotating shaft
- 15 52a, 52b fan
- 52a, 52b fan case
- 53a, 53b multi-blade fan
- 54a, 54b suction port
- 55a, 55b blowout port
- 20 61 machine-room partition plate
- 71 fin
- 72 heat transfer tube
- 73 engagement hole
- 74 ventilation passage
- 25 81 slit

**Claims**

- 30 1. A ceiling installation type air conditioner comprising:
  - a blower chamber including an air inlet;
  - a heat exchange chamber including an air outlet;
  - a partition plate separating the blower chamber and the heat exchanger from each other;
  - 35 a blower accommodated in the blower chamber; and
  - a heat exchanger accommodated in the heat exchange chamber,
  - 40 wherein the blower chamber is spatially connected with the heat exchange chamber via the blower;
  - wherein the heat exchanger includes a first heat exchange section, a second heat exchange section, and a third heat exchange section;
  - 45 wherein each of the first heat exchange section, the second heat exchange section, and the third heat exchange section includes a plurality of plate-shaped fins and a plurality of heat transfer tubes; and
  - wherein the first heat exchange section, the second heat exchange section, and the third heat exchange section are disposed in a convex shape as a whole toward the air outlet.
- 50
- 55 2. The ceiling installation type air conditioner according to claim 1, wherein the plate-shaped fins have a substantially

parallelogram shape.

- 3. The ceiling installation type air conditioner according to claim 1 or claim 2, wherein one of short sides of the plate-shaped fins of the first heat exchange section is in contact with a short side of the plate-shaped fins of the second heat exchange section on a side of the air outlet without any gap; and another short side or a long side on a side of the blower chamber of the plate-shaped fins of the first heat exchange section is in contact with a short side of the plate-shaped fins of the third heat exchange section on a side of the air outlet without any gap. 5
- 4. The ceiling installation type air conditioner according to any one of claim 1 to claim 3, wherein the first heat exchange section is closest to the air outlet out of the first heat exchange section, the second heat exchange section, and the third heat exchange section; and the number of the heat transfer tubes provided for the first heat exchange section is larger than the number of the heat transfer tubes provided for each of the second heat exchange section and the third heat exchange section. 10 15 20 25
- 5. The ceiling installation type air conditioner according to any one of claim 1 to claim 3, wherein the first heat exchange section is closest to the air outlet out of the first heat exchange section, the second heat exchange section, and the third heat exchange section; the second heat exchange section and the third heat exchange section have a same shape; and the first heat exchange section is line-symmetrical with the second heat exchange section and the third heat exchange section. 30 35
- 6. The ceiling installation type air conditioner according to any one of claim 1 to claim 5, wherein an interval at which the plate-shaped fins of the first heat exchange section are arranged is narrower than an interval at which the plate-shaped fins of each of the second heat exchange section and the third heat exchange section are arranged. 40 45
- 7. The ceiling installation type air conditioner according to any one of claims 1, 2, 3, 4, and 6, wherein slits are provided only in the plate-shaped fins of the first heat exchange section. 50
- 8. The ceiling installation type air conditioner according to any one of claims 1, 2, 3, 4, 6, and 7, wherein a pipe diameter of the heat transfer tubes of the first heat exchange section is larger than a pipe diameter of the heat transfer tubes of the second heat exchange section and the third heat exchange 55

section.

- 9. The ceiling installation type air conditioner according to any one of claim 1 to claim 8, wherein the first heat exchange section, the second heat exchange part, and the third heat exchange section are integrally formed. 5
- 10. The ceiling installation type air conditioner according to any one of claim 1 to claim 9, wherein the second heat exchange section is disposed at an upper portion of the heat exchange chamber; wherein the third heat exchange section is disposed at a lower portion of the heat exchange chamber; and wherein an angle difference is provided in such a manner that an inclination angle of the second heat exchange section is smaller than an inclination angle of the third heat exchange section. 10 15 20
- 11. The ceiling installation type air conditioner according to any one of claim 1 to claim 10, wherein the first heat exchange section is inclined in such a manner that an upper end portion of the first heat exchange section is positioned on a windward side of a lower end portion of the first heat exchange section. 25
- 12. The ceiling installation type air conditioner according to any one of claim 1 to claim 11, wherein an end portion of a short side of the plate-shaped fins of the third heat exchange section on a side of the air outlet is protruded toward the air outlet more than an end portion of a short side positioned at a lower portion of the plate-shaped fins of the first heat exchange section. 30 35 40
- 13. The ceiling installation type air conditioner according to any one of claim 1 to claim 12, wherein a shortest distance between the air outlet and an end portion on a side of the air outlet of a short side positioned at a lower portion of the plate-shaped fins of the first heat exchange section is longer than a shortest distance between the air outlet and an end portion on a side of the air outlet of a short side positioned at a lower portion of the plate-shaped fins of the third heat exchange section. 45 50 55

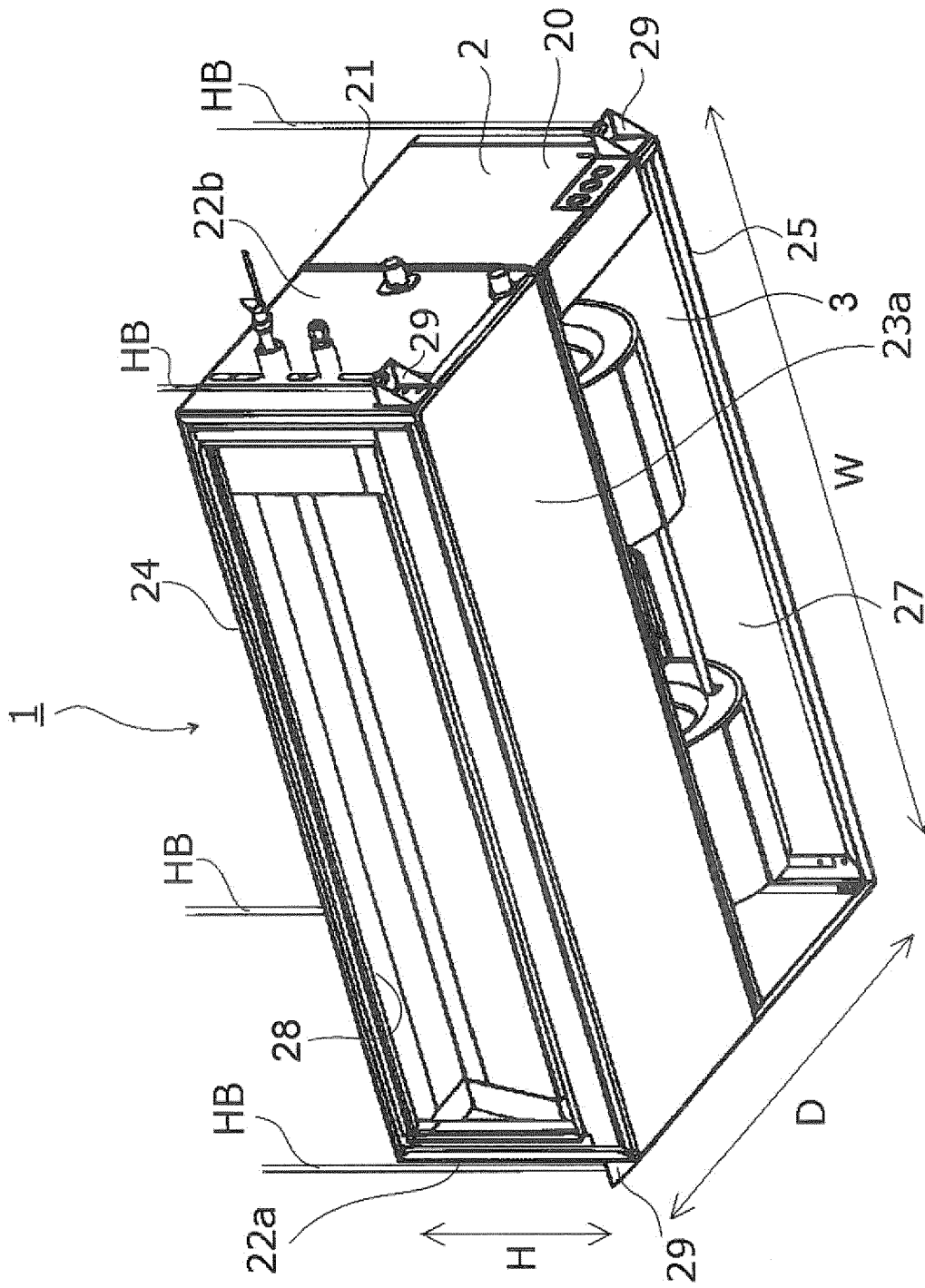


FIG. 1

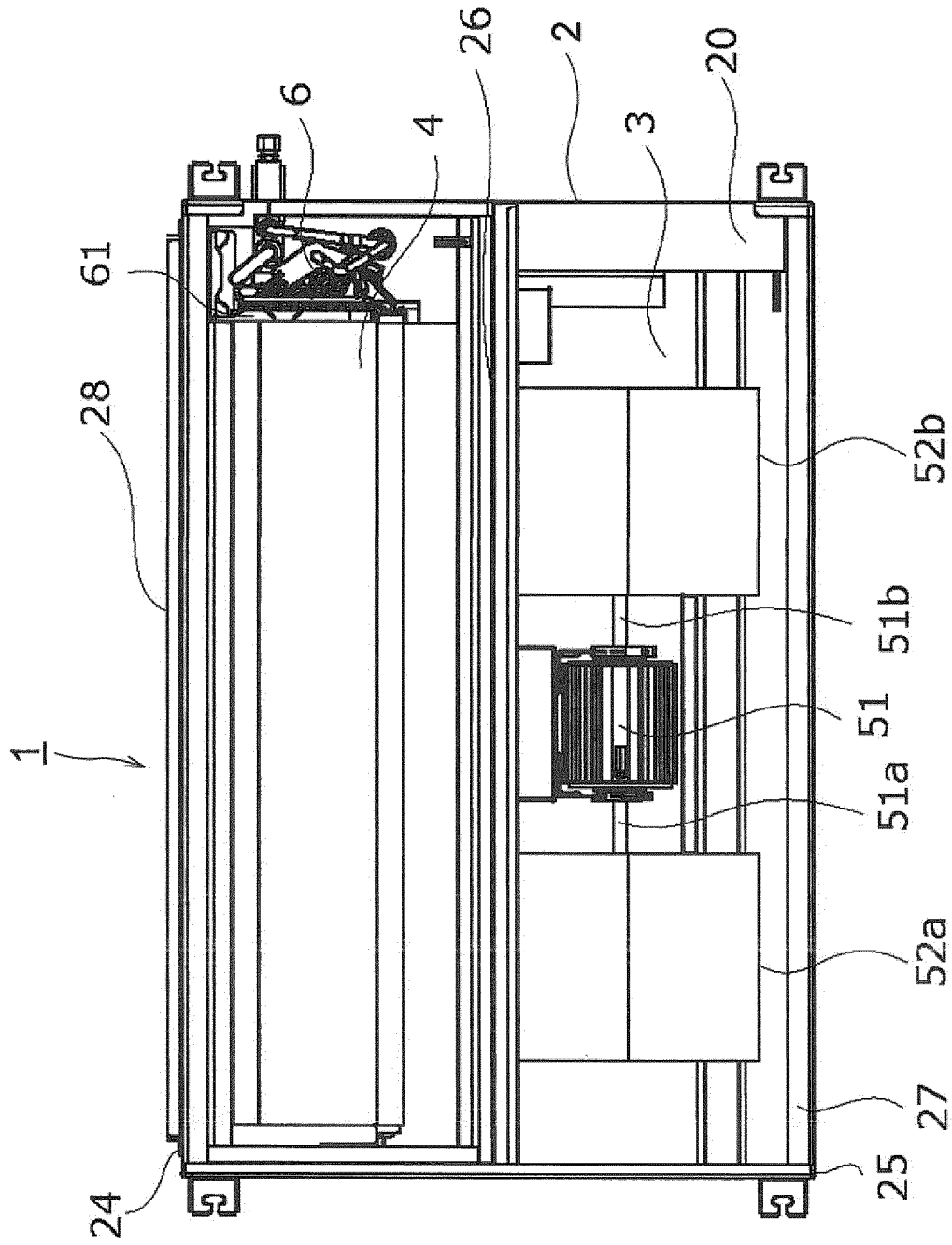


FIG. 2

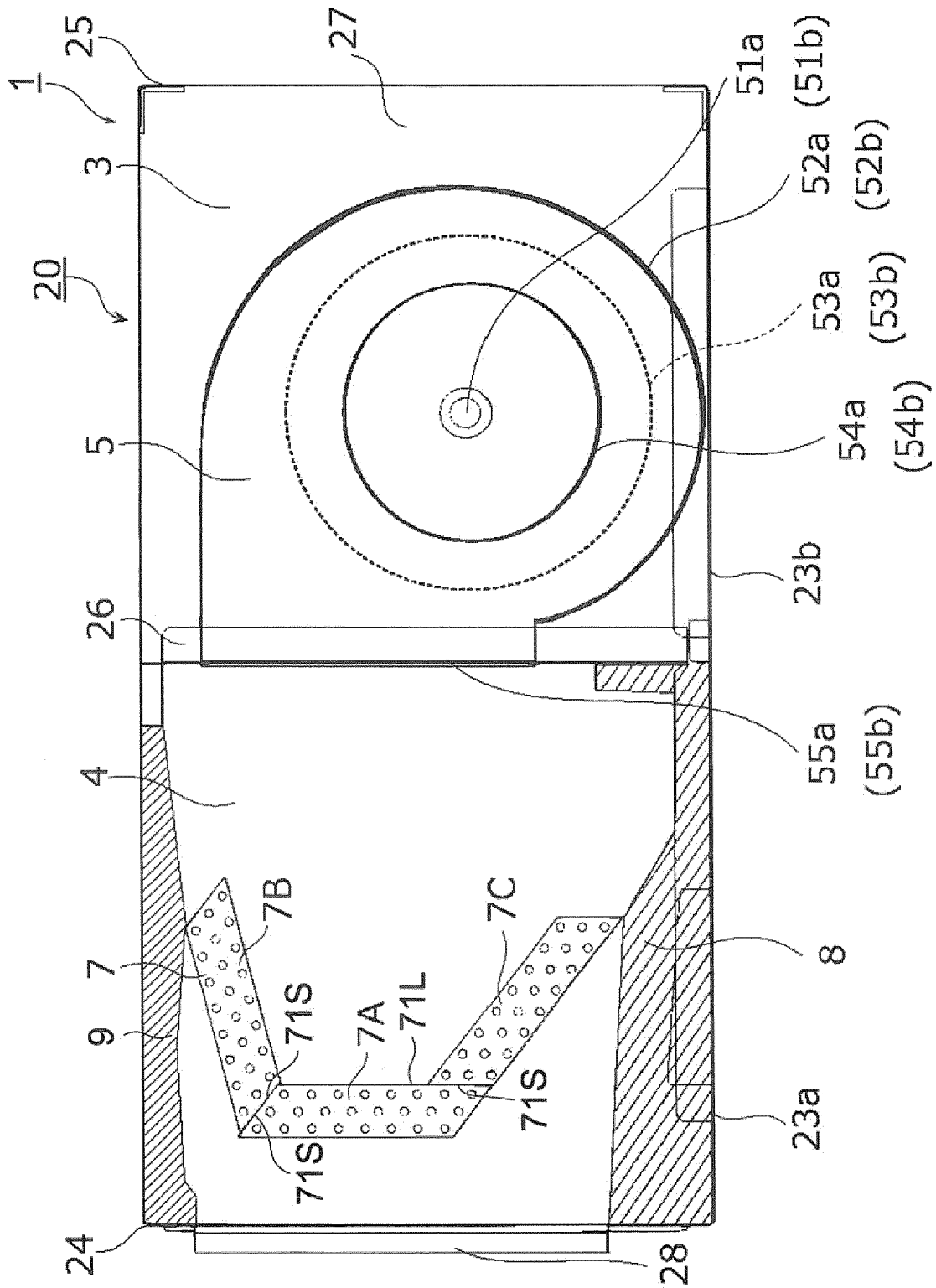


FIG. 3

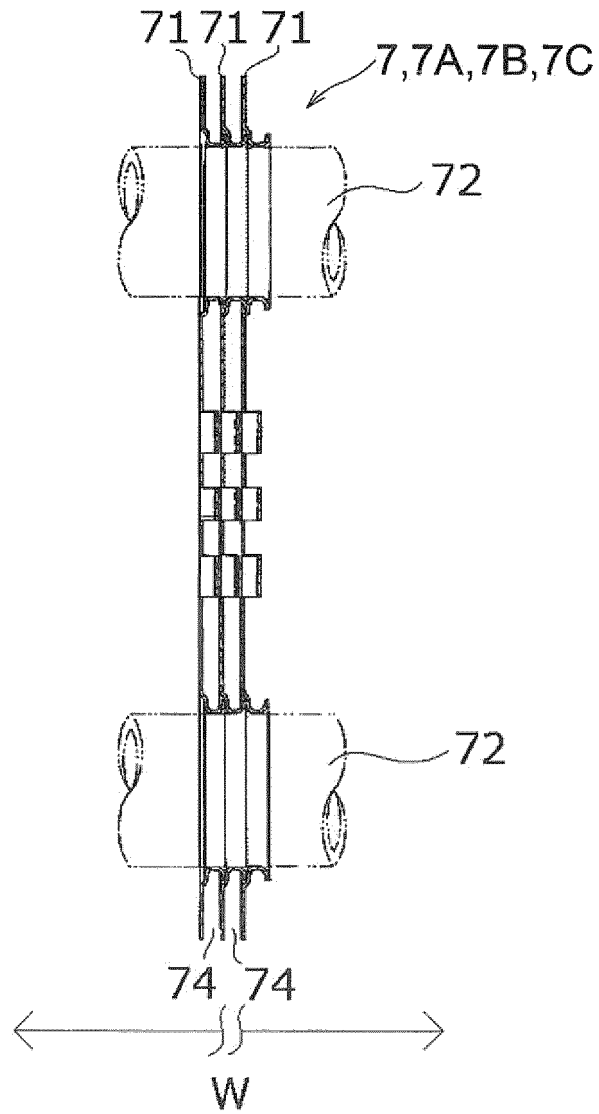


FIG. 4

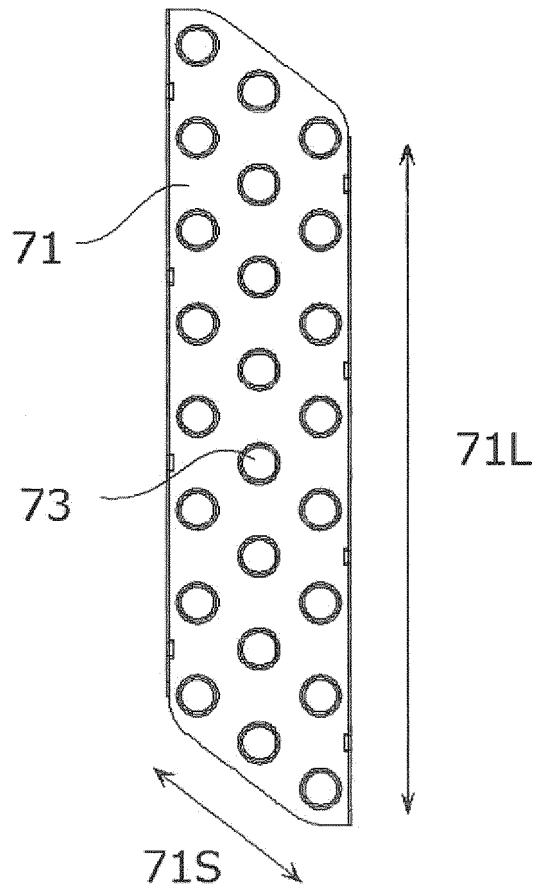


FIG. 5

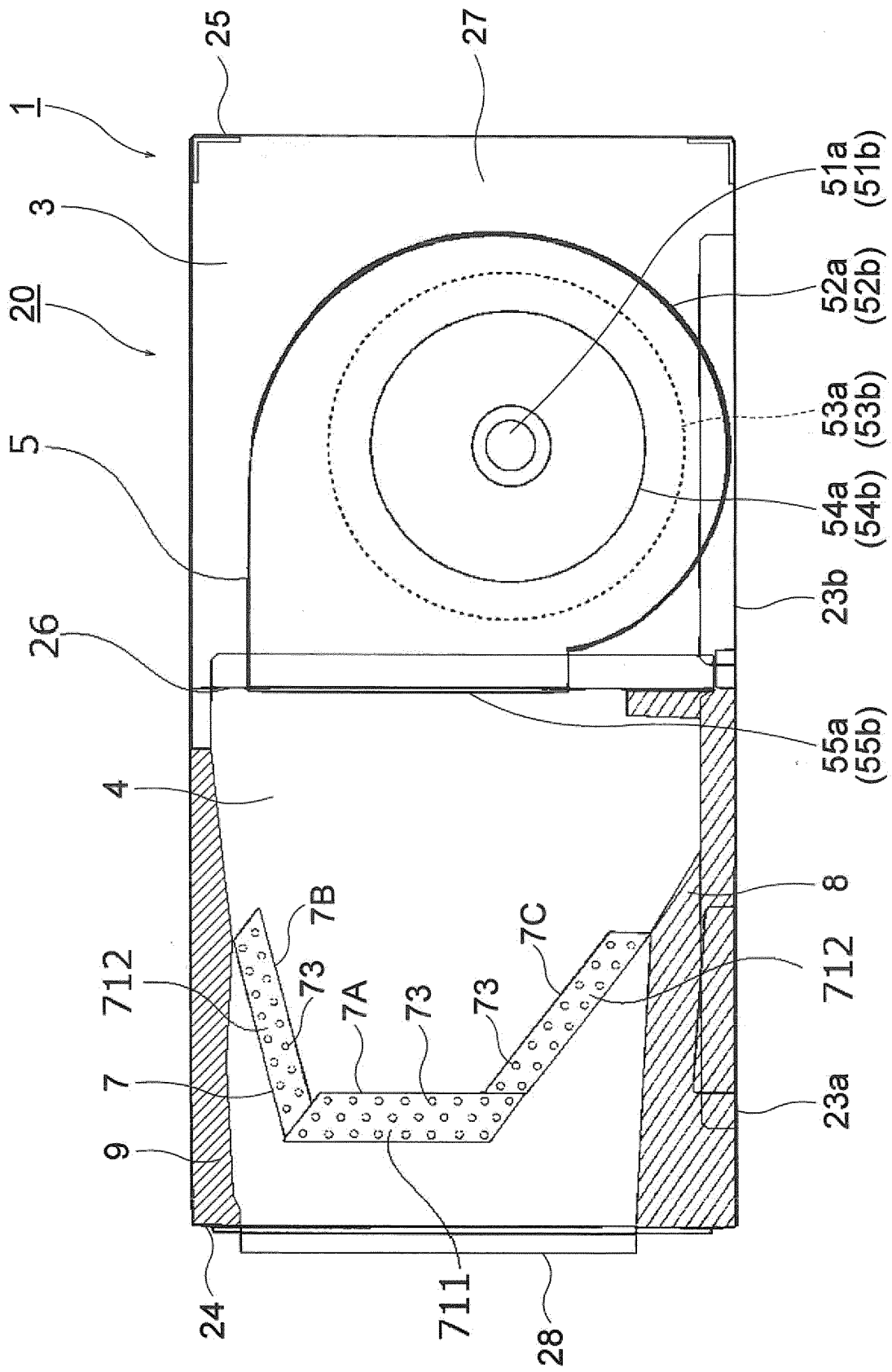


FIG. 6

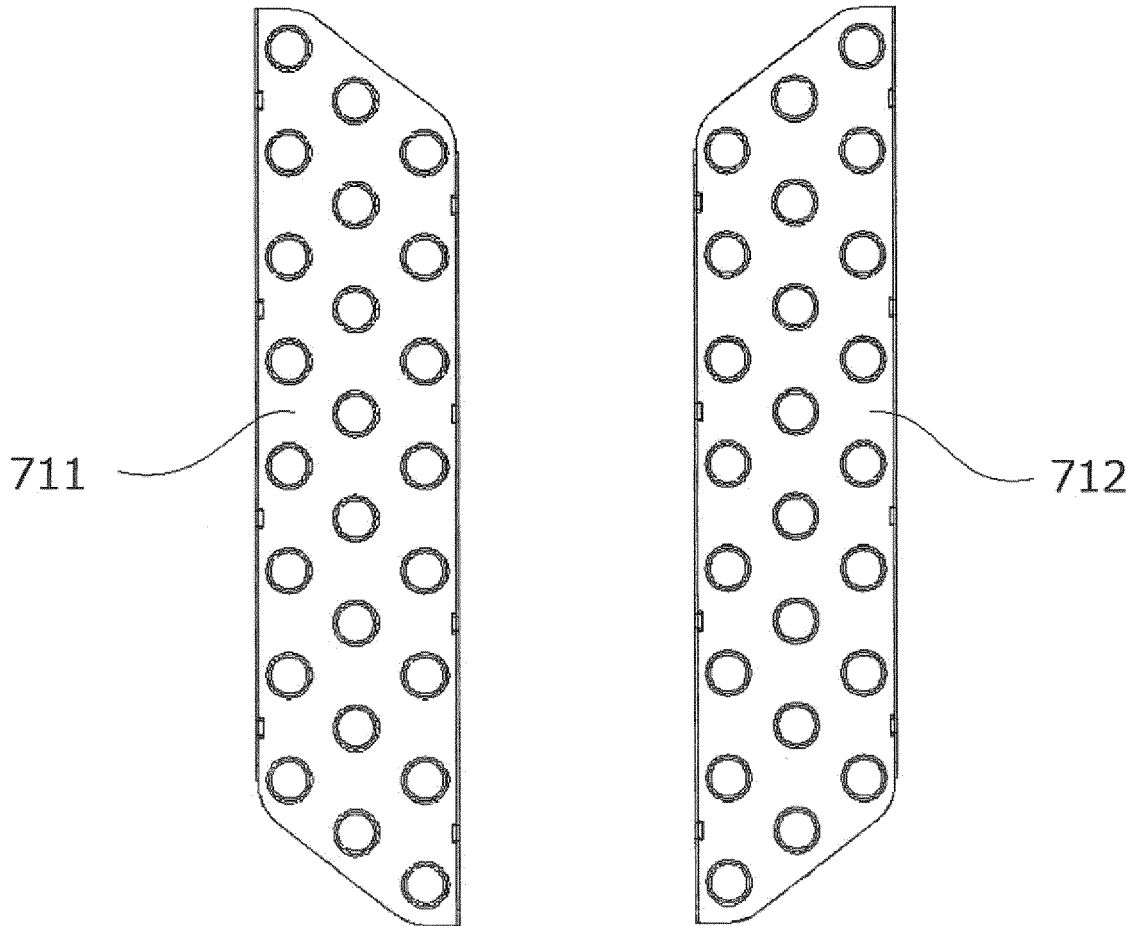


FIG. 7

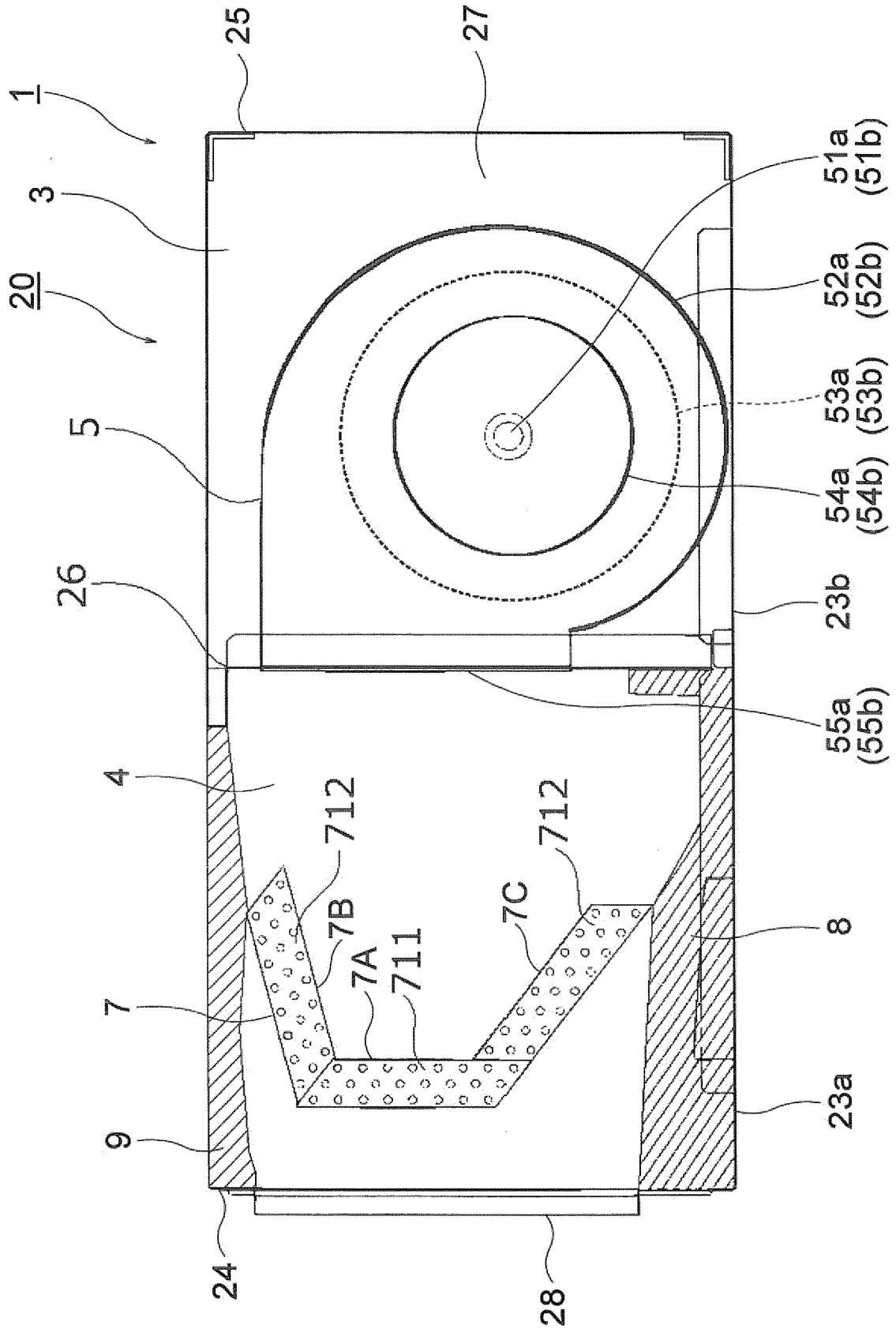


FIG. 8

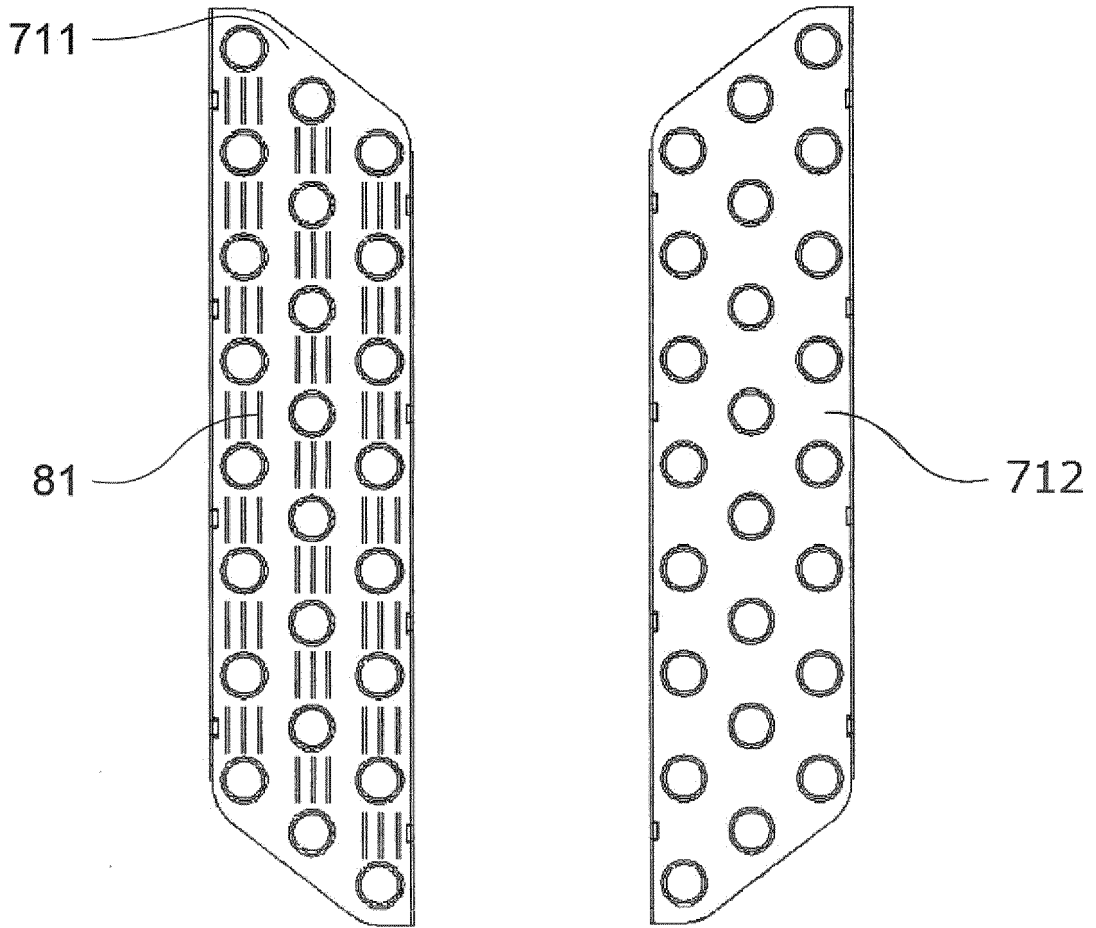


FIG. 9

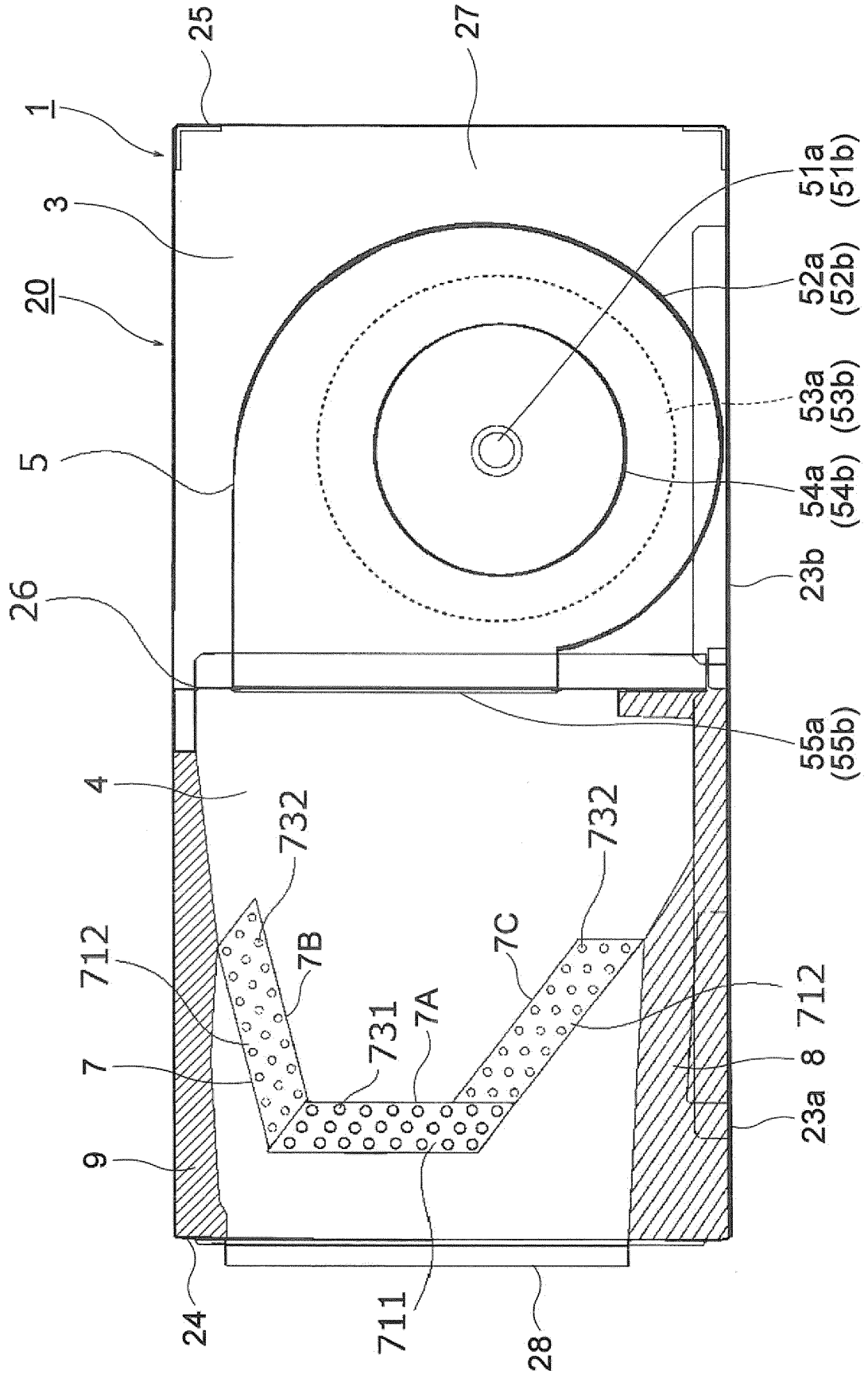


FIG. 10

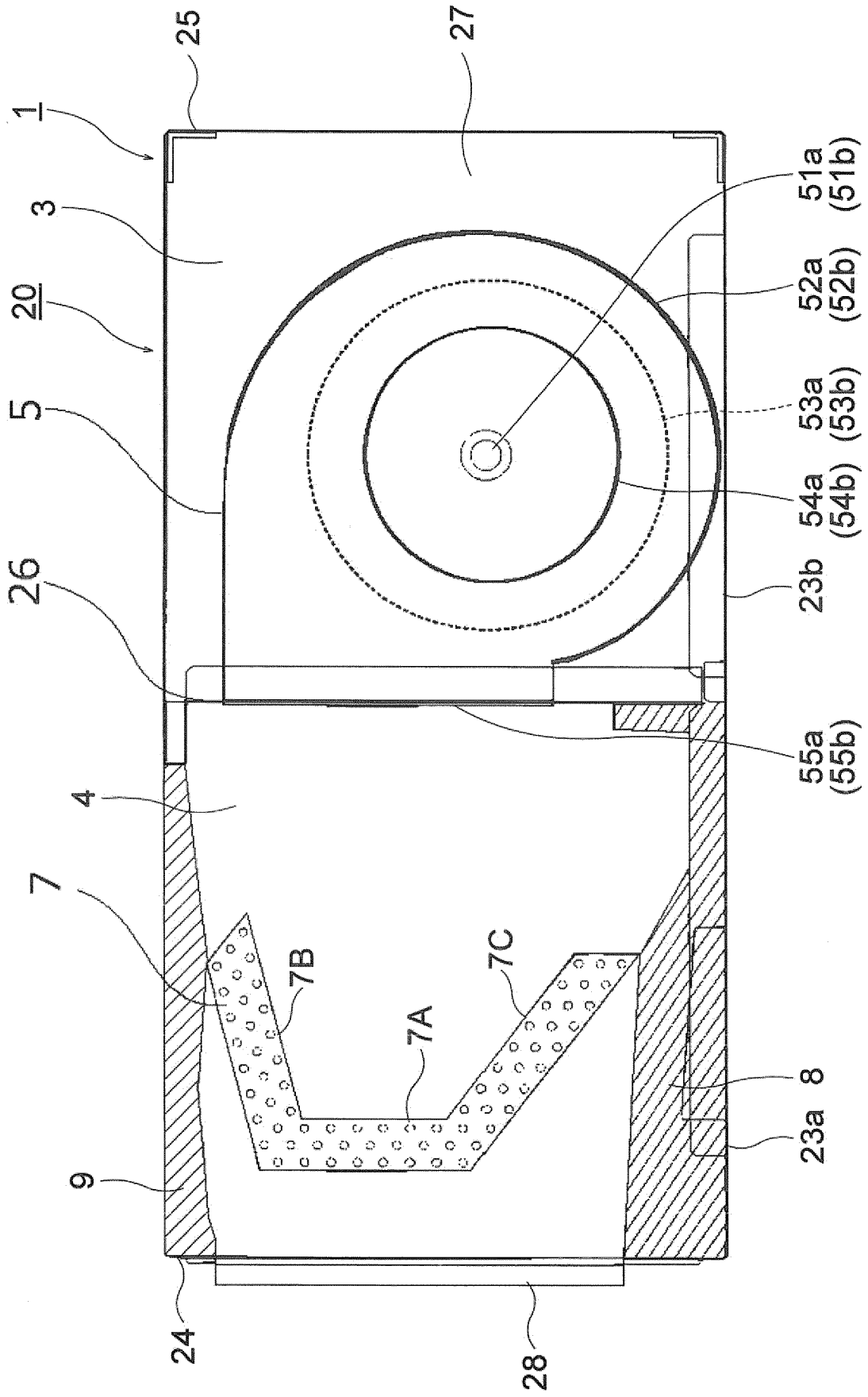


FIG. 11

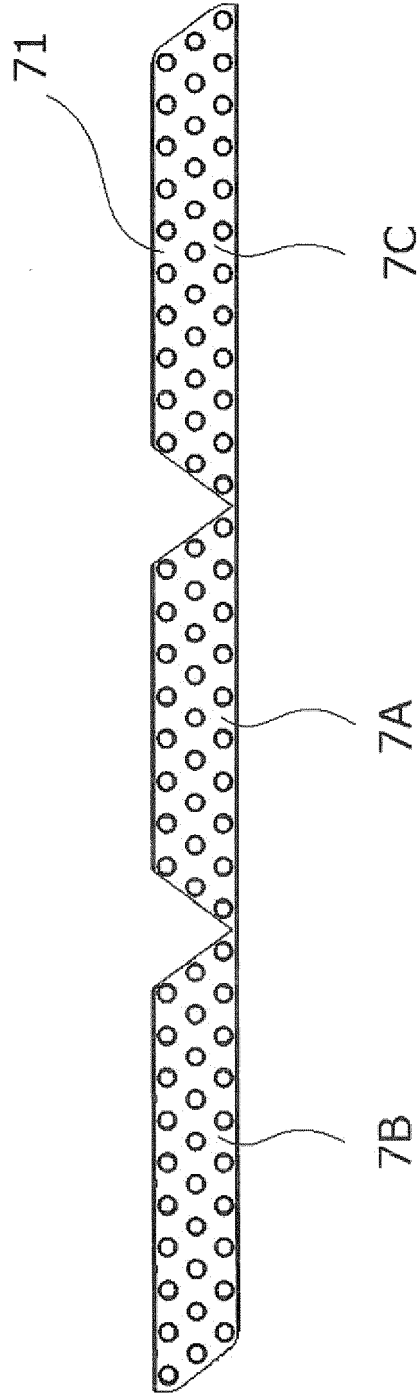


FIG. 12

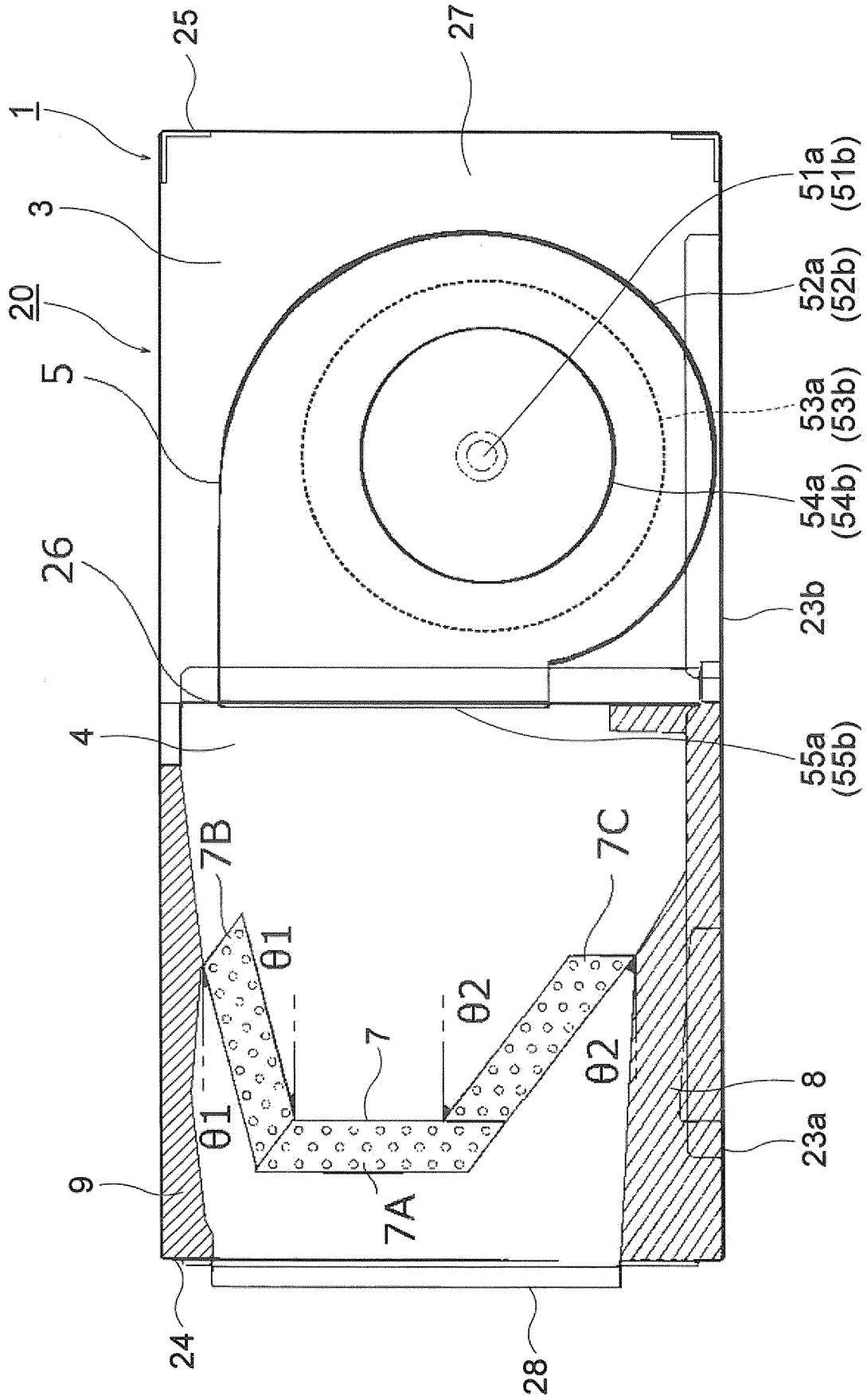
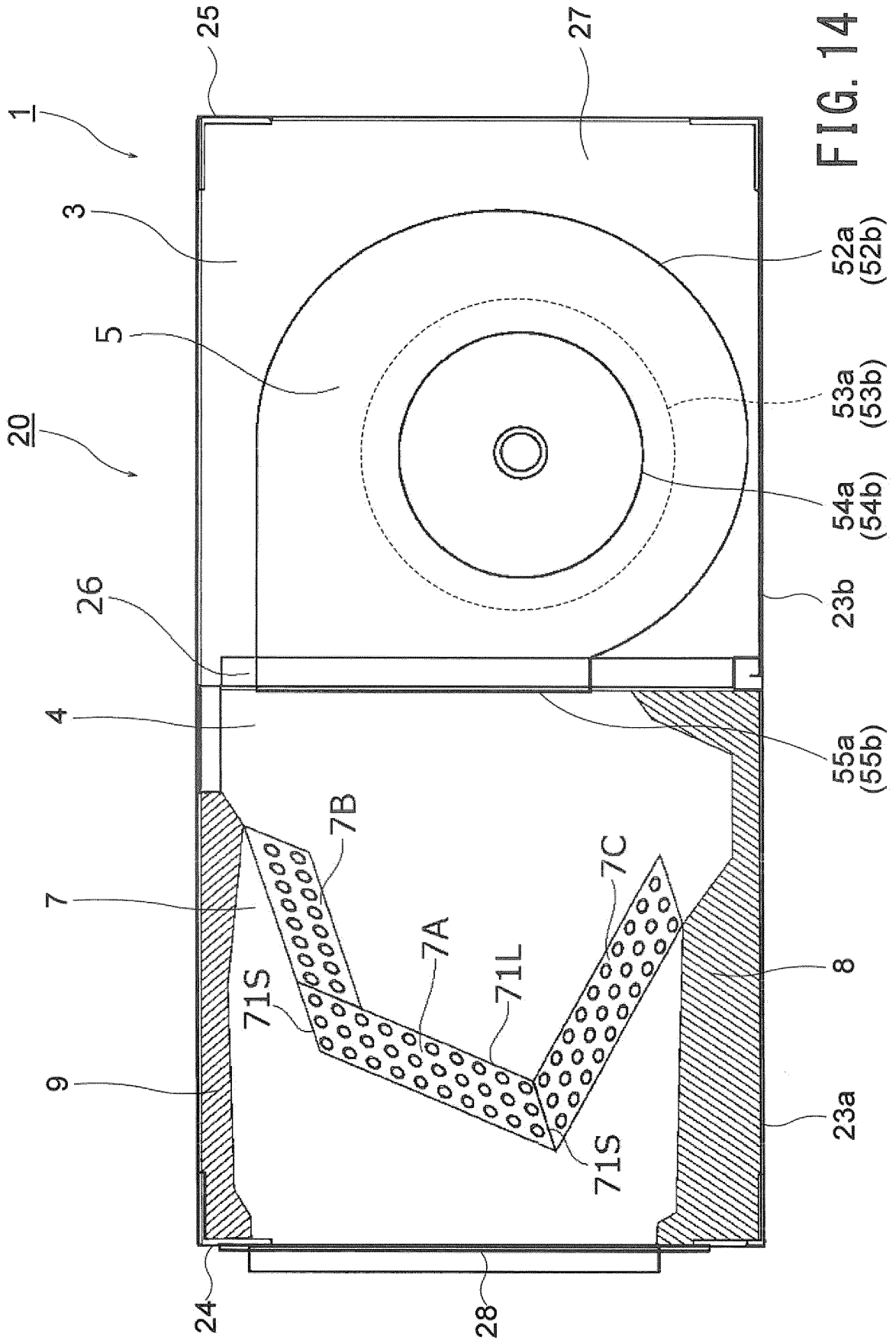


FIG. 13



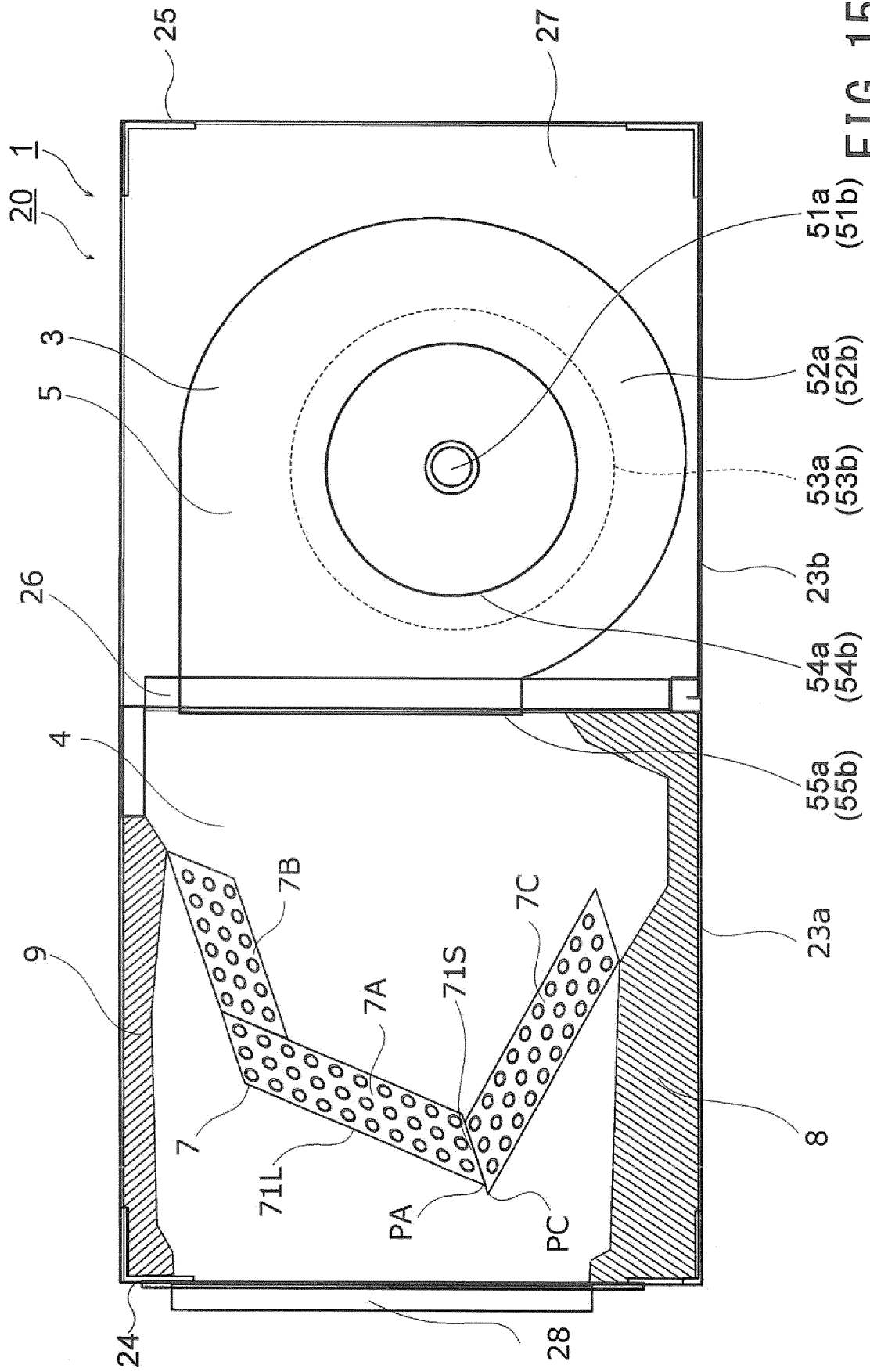


FIG. 15

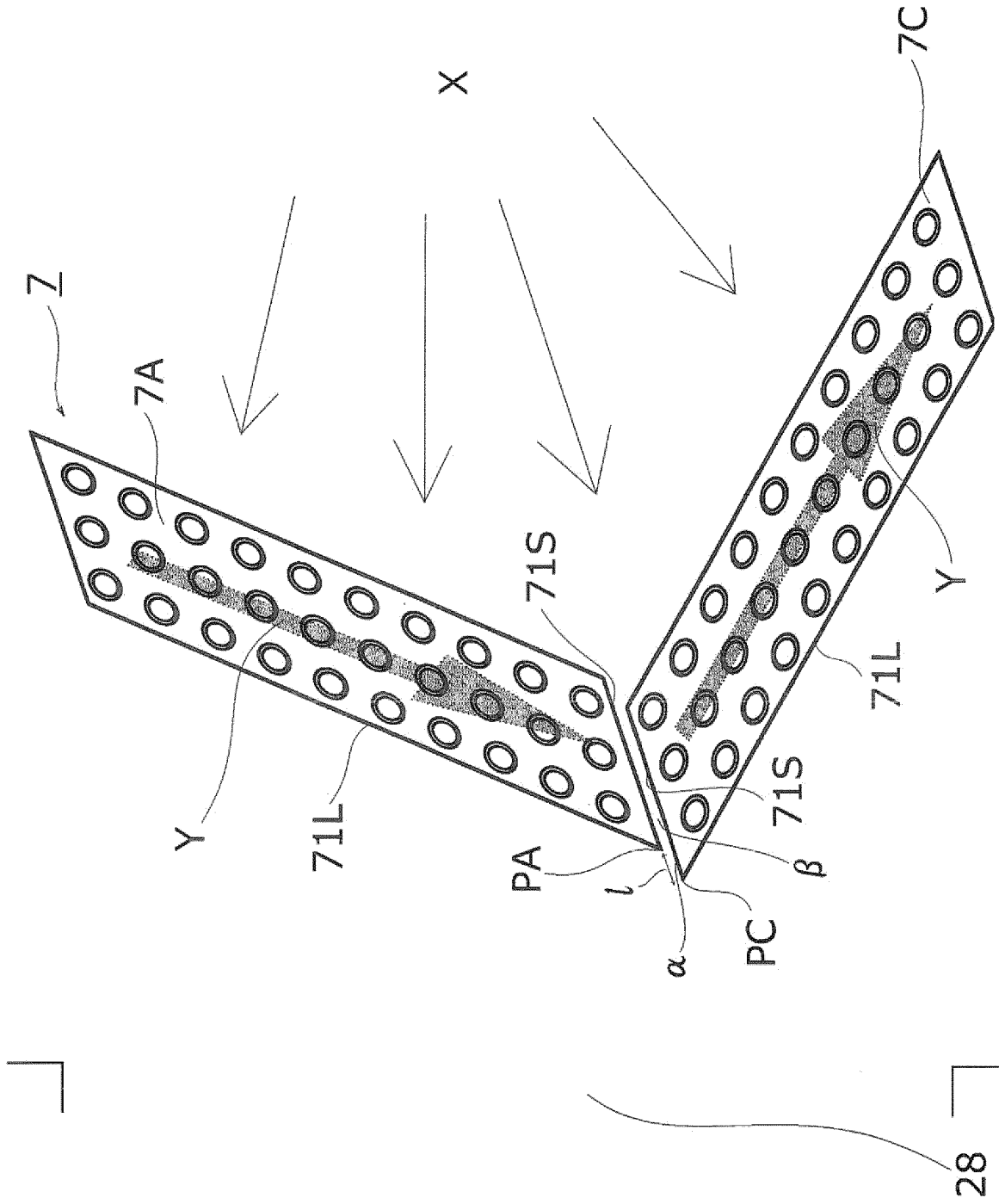


FIG. 16

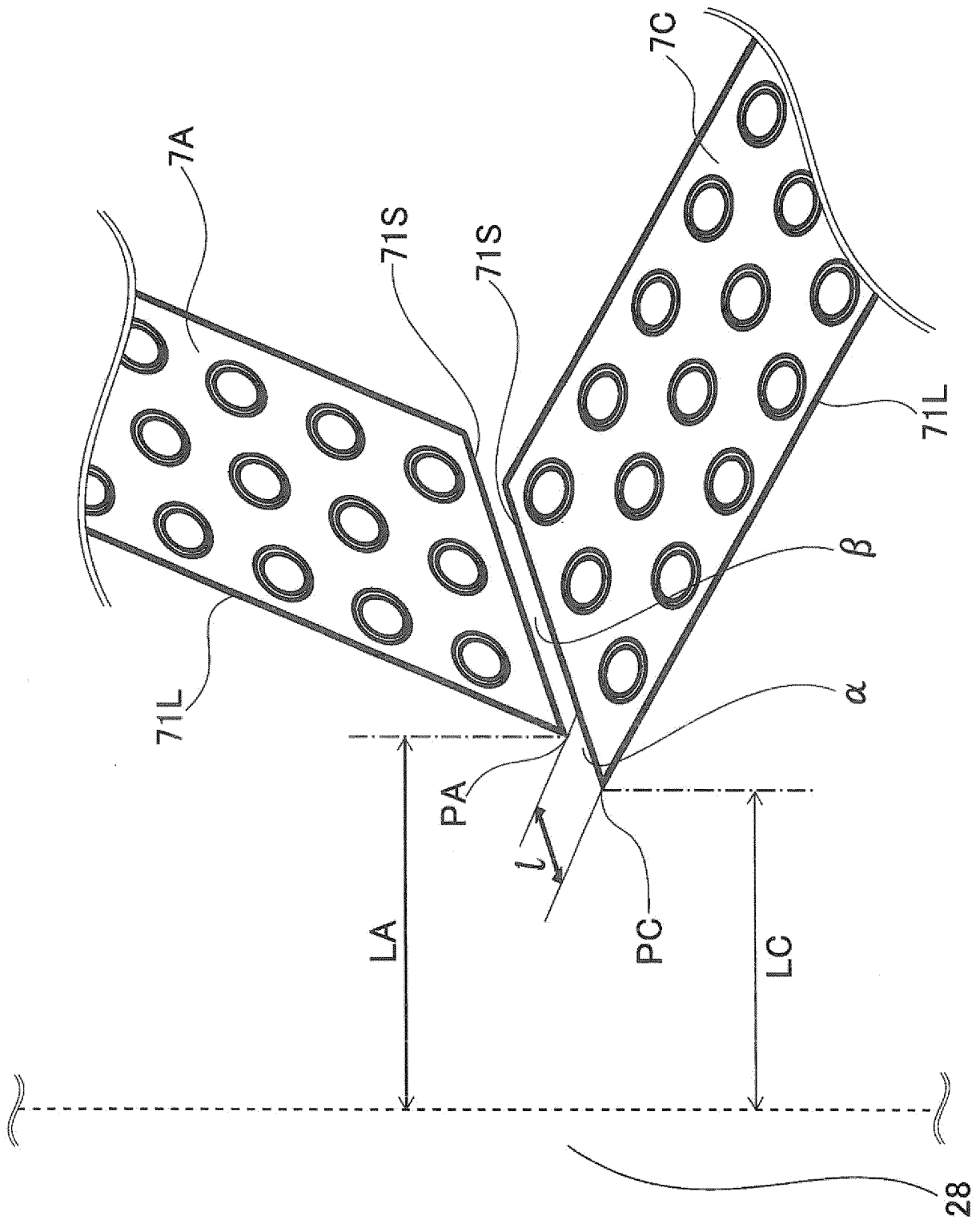


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP2016/068358

A. CLASSIFICATION OF SUBJECT MATTER F24F1/00(2011.01)i, F24F13/30(2006.01)i, F24F13/32(2006.01)i, F28D1/047(2006.01)i, F28F1/32(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) F24F1/00, F24F13/30, F24F13/32, F28D1/047, F28F1/32		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016 Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016		
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 A	JP 2012-13295 A (Sanyo Electric Co., Ltd.), 19 January 2012 (19.01.2012), paragraphs [0025] to [0038]; fig. 1 to 6 & EP 2402669 A2 paragraphs [0039] to [0060]; fig. 1 to 6 & CN 102313318 A & KR 10-2012-0002407 A	1-3, 6-13 4-5
Y A	WO 2012/176805 A1 (Sanyo Electric Co., Ltd.), 27 December 2012 (27.12.2012), paragraphs [0034] to [0040]; fig. 1 to 6 & EP 2722609 A1 paragraphs [0040] to [0046]; fig. 1 to 6 & CN 103608629 A	1-3, 6-13 4-5
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* 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 "&" document member of the same patent family		
Date of the actual completion of the international search 15 September 2016 (15.09.16)		Date of mailing of the international search report 27 September 2016 (27.09.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan		Authorized officer  Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP2016/068358

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2012-37085 A (Mitsubishi Electric Corp.), 23 February 2012 (23.02.2012), paragraphs [0032] to [0039]; fig. 1 & US 2012/0031139 A1 paragraphs [0048] to [0055]; fig. 1 & EP 2416075 A2 & CN 102374588 A	1-3, 6-13 4-5
A	WO 2007/060922 A1 (Daikin Industries, Ltd.), 31 May 2007 (31.05.2007), paragraph [0051]; fig. 24 & JP 2007-147144 A	1-13
P, A	WO 2015/097821 A1 (Toshiba Carrier Corp.), 02 July 2015 (02.07.2015), entire text; all drawings (Family: none)	1-13

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2006343043 A [0004]