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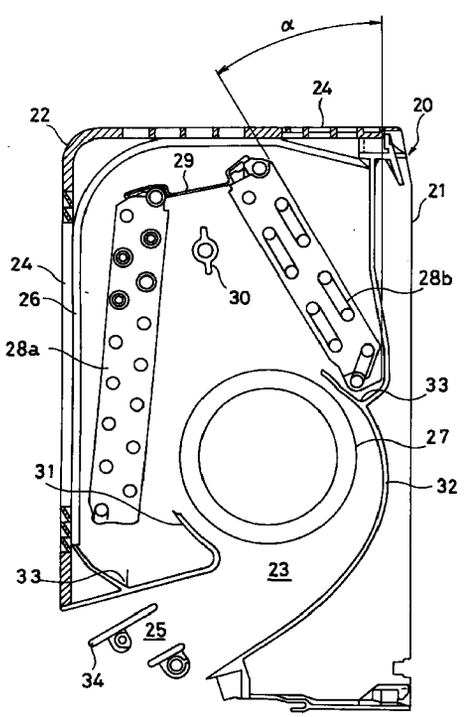
(54) Indoor unit of air conditioner

(57) Heat exchangers(28a)(28b) are disposed upstream of a cross-flow fan(27) within an air flow passage independently from each other on the front and the rear sides in the passage, and are interconnected by a leaf at the upper portions thereof. The rear-side heat exchanger(28b) is inclined toward the cross-flow fan(27) at an angle α with respect to the vertical, the inclination α being in the range of $25° \leqq \alpha \leqq 35°$.

FIG. 1



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Description

TECHNICAL FIELD

The present invention relates to an indoor unit of an air conditioner, and more particularly to a structure of an air flow circuit in a flowthrough-type air conditioner.

BACKGROUND ART

Japanese Unexamined Utility Model Publication No. 4-68921(1992) discloses an indoor unit of a flow-through-type air conditioner. Fig. 7 illustrates the construction of the above indoor unit which has an inlet port 1 at an upper portion, an outlet port 2 at a lower portion thereof, and an air flow passage 3 defined between the inlet port 1 and the outlet port 2. Provided within the air flow passage 3 are a removable air filter 6 inserted along the inner surface of a front cover 4 as extending to a ceiling side of a main body frame 5, a heat exchanger 7 comprised of three portions arranged in a bent relation, and a fan placed in a space enclosed by the heat exchanger 7.

Air enters through the inlet port 1 and pass through the air filter 6, and is subject to a heat exchanging process at the heat exchanger 7 and then discharged into room from the outlet port 2 by means of a fan 8. The direction of an air flow into room is adjusted by means of a vane 9 disposed at the outlet port 2. A drain pan 10 serves to receive condensation dropping from different portions of the heat exchanger 7, and the drain pan 10 also constitutes a portion of a wall defining the air flow passage 3. The air flow passage 3 extending from the fan 8 to the outlet port 2 is provided with a rear guider 11 on the rear side thereof.

The indoor unit of the air conditioner having the aforementioned construction, however, has the following problems. Because of narrow spaces between the fan 8 and the heat exchanger 7 at a front-side and a rear-side portion thereof, streams of sucked air bump against each other and hence, a turbulent flow tends to occur. If the rear-side portion of the heat exchanger 7 is inclined at a small angle with respect to the vertical, a smaller amount of air is sucked into the rear-side portion of the heat exchanger 7 through the inlet port 1 in the top surface. Adversely, if the aforesaid inclination is great, the rear-side portion of the heat exchanger 7 is located closer to the fan 8, resulting in a higher level of noise. The inlet port does not exist at a portion where the main body frame 5 joins the front cover 4 and therefore, air suction into the rear-side portion of the heat exchanger 7 is retarded to cause imbalance in the air flow. The resultant uneven distribution of flow velocity lowers the performance of flow rate. With the heat exchanger 7 comprised of three portions simply arranged in a bent relation, it is difficult to positively assure an increased capability of the heat exchanger within a limited capacity of the air conditioner. Furthermore, there is a very small space allowing for the installation of additional function elements such as a heating element or the like.

DISCLOSURE OF THE INVENTION

For solving the foregoing problems, the indoor unit of the air conditioner of the invention comprises a main body frame, a front cover having an inlet port in a top and a front surface thereof while cooperating with the main body frame to form an air flow passage extending toward an outlet port disposed at the lower end thereof, a cross-flow fan having an impeller formed of a plurality of blades arranged in a column-like form, heat exchangers disposed upstream of the cross-flow fan within the air flow passage independently from each other at the front side and the rear side in the passage, a leaf for interconnecting both the heat exchangers at the upper portions thereof, a stabilizer disposed adjacent to and opposite to the cross-flow fan, and a rear guider defining the air flow passage extending from the cross-flow fan to the outlet port, the rear-side heat exchanger being inclined toward the cross-flow fan at an angle α with respect to the vertical, the angle α being in the range of $25° \leqq \alpha \leqq 35°$.

Such an arrangement assures sufficient suction of air through the rear-side heat exchanger, the air entering through the inlet port in the top portion of the front cover, while preventing an increase in the noise level which results from the position of the rear-side heat exchanger being too close to the cross-flow fan. Furthermore, wider spaces between the cross-flow fan and the heat exchangers at the front and the rear sides provides space allowing for the installation of an additional function element such as a heating element or the like.

A more preferred mode of the invention in which the front-side heat exchanger comprises two portions arranged in a bent form improves the suction performance of the front-side heat exchanger. In addition, it is possible to obtain a wider space accommodating additional function elements such as a heater or the like.

In another preferred mode in which a joint section of the main frame body and the front cover is disposed above the leaf interconnecting both the heat exchangers at the upper portions thereof, a portion where the main body frame joins the front cover and no opening exists is superposed relative to the leaf presenting no suction capability, thereby reducing an area retarding air suction to increase the performance of flow rate.

In yet another preferred mode in which a ratio of the front-side heat exchanger to the rear-side heat exchanger by the length along the height thereof is at about 9:6, an optimum area distribution of the front-side and the rear-side heat exchangers can be achieved within a limited capacity of the air conditioner, and thus enabling to enhance the performance of the heat exchangers.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a transverse sectional view of a first embodiment of the present invention;

Fig.2 is a graph illustrating the relationship between an inclination α of a rear-side heat exchanger 28b with respect to the vertical and air flow ratio at an identical noise level,

Fig.3 is a transverse sectional view of a second embodiment of the present invention,

Fig.4 is a transverse sectional view of a third embodiment of the present invention,

Fig.5 is a transverse sectional view of a fourth embodiment of the present invention,

Fig.6 is a graph illustrating the relationship between a ratio of a front-side heat exchanger 28a to the rear-side heat exchanger 28b by the number of heat exchanger area and air flow ratio at an identical noise level, and

Fig.7 is a transverse sectional view of the prior art.

EMBODIMENTS

Fig.1 is a transverse sectional view of a first embodiment of the present invention. In Fig. 1, an indoor unit 20 includes an air flow passage 23 defined between a main body frame 21 and a front cover 22, the air flow passage 23 communicating with a room space via an inlet port 24 and an outlet port 25. The inlet port 24 exists in the front and the top surfaces of the front cover 22 as well as in the top surface of the main body frame 21. The outlet port 25 exists at the lower end of the front cover 22.

Removably disposed along the inner surface of the front cover 22 is an air filter 26, which covers the inlet port 24. A cross-flow fan 27 is located halfway of the air flow passage 23. The cross-flow fan 27 is formed of a plurality of unitized bodies of impellers arranged along the direction of a rotary axis, the unitized body of the impeller being formed of a plurality of blades arranged in a column-like form.

The heat exchangers 28a and 28b are disposed upstream of the cross-flow fan 27 in the air flow passage 23 independently from each other on the front and the rear sides therein. Both the heat exchangers 28a and 28b are interconnected at the upper portions thereof by means of a leaf 29. The heat exchanger 28b on the rear side is inclined toward the cross-flow fan 27 at an angle α with respective to the vertical. A suitable inclination angle α is in the range of $25° \leqq \alpha \leqq 35°$, and such an inclination is set at 30° in this embodiment. An additional function element such as a heater 30 is interposed between the heat exchangers 28a and 28b. However, it is not essential that the additional function element be provided.

On the downstream side of the cross-flow fan 27 in the air flow passage, there are disposed a stabilizer 31 adjacent to and opposite to the cross-flow fan 27, and a rear guider 32 defining the air flow passage 23 extending from the cross-flow fan 27 to the outlet port 25. A part of the rear guider 32 and the stabilizer 31 each defines a drain pan 33 for receiving condensation dropping from the heat exchangers 28a and 28b. A vane 34 to adjust a direction of air flow into room is rotatably provided at the outlet port 25.

In this construction, air in a room flows through the inlet port 24 in the front cover 22 and the main body frame 21 and through the air filter 26 into the air flow passage 23, and the air penetrates the heat exchangers 28a and 28b to be sucked by the cross-flow fan 27. The cross-flow fan 27 discharges the sucked air into space in the room from the outlet port 25 by way of the air flow passage 23 defined by the rear guider 32 and the stabilizer 31.

Fig.2 illustrates the relationship between an inclination α of the rear-side heat exchanger 28b with respect to the vertical and air flow ratio at an identical noise level. As apparent from Fig.2, if $\alpha<25°$, a smaller amount of air is sucked into the rear-side heat exchanger 28b through the top portion of the front cover 22 and of the main body frame 21, resulting in poor air flow ratio. Whereas if $\alpha>35°$, the rear-side heat exchanger 28b is located too close to the cross-flow fan 27 and therefore, a noise level increases. As a result, air flow ratio as compared at an identical noise level is lowered. Accordingly, it is confirmed that an optimum value of the inclination α of the rear-side heat exchanger 28b with respect to the vertical is in the range of $25° \leqq \alpha \leqq 35°$. Additionally, by widening the area surrounded by the front-side and rear-side heat exchangers 28a, 28b and the cross-flow fan 27, there is a room for disposing additional function elements such as a heater 30 and the like.

Fig.3 is a transverse sectional view of the second embodiment of the present invention. Components having the same function as do those shown in Fig.1 are represented by the same reference numerals and therein descriptions are omitted. In Fig.3, of two independent heat exchangers 28a and 28b, the front-side heat exchanger 28a comprises two portions U and D arranged in a bent form.

In this construction, an air flow toward a cross-flow fan 27 from the upper portion U of the bent form of the frontside heat exchanger 28a suffers less flow loss due to deflection, thereby increasing air flow ratio. Additionally, the bent form of the front-side heat exchanger 28a can widen room surrounded by the heat exchangers 28a, 28b and the cross-flow fan 27, where additional function elements such as a heater 30 is readily installed. It is noted that although the front-side heat exchanger 28a comprises two portions arranged in the bent form, an equivalent effect may be attained by a structure in which three or more portions are arranged in a bent form.

Fig.4 is a transverse sectional view of the third embodiment of the present invention. Components having the same function as do those shown in Fig.1 are represented by the same reference numerals and

therein descriptions are omitted. In Fig.4, a joint section 35 of a front cover 22 and a main body frame 21 is positioned above a leaf 29 interconnecting a front-side heat exchanger 28a and a rear-side heat exchanger 28b at the upper portions thereof.

With this construction, the joint section 35 of the main body frame 21 and the front cover 22 where no opening exists is superposed relative to the leaf 29 presenting no suction capability, so that parts interfering with air suction is reduced, resulting in increase of air flow ratio.

Fig.5 is a transverse sectional view of the fourth embodiment of the present invention. Components having the same function as those shown in Fig.1 are represented by the same reference numerals and therein descriptions are omitted. In Fig.5, a ratio of the two independent heat exchangers 28a,28b by the number of heat exchanger area therein (area flow ratio) is 9:6. The number of heat exchanger area is counted on the basis of a piping pitch and is proportional to the area of the heat exchanger. In Fig.5, "P" corresponds to one section of the heat exchanger area.

Fig.6 illustrates the relationship between a ratio of the front-side heat exchanger 28a to the rear-side heat exchanger 28b by the number of the heat exchanger sections and air flow ratio at the same noise level, in the case where the capacity of space disposing the heat exchangers 28a, 28b is fixed and the sum of heat exchanger sections of the front-side and rear-side heat exchangers 28a and 28b is fixed (the sum of the heat exchanger sections is 15 in this embodiment). In Fig.6, a ratio of the two heat exchangers 28a and 28b by the number of the heat exchanger sections is indicated by way of, for simplicity, the number of the heat exchanger sections of the front-side heat exchanger 28a. In this case, the number of the heat exchanger sections of the rear-side heat exchanger 28b is found by subtracting the number of the heat exchanger sections of the front-side heat exchanger 28a from 15.

As apparent from Fig.6, when the number of the heat exchanger area of the front-side heat exchanger 28a is 10 (i.e., the aforesaid ratio is 10:5) or when the number of the heat exchanger sections of the front-side heat exchanger 28a is 11(i.e., the aforesaid ratio is 11:4), the front-side heat exchanger 28a is inclined at a greater angle α with respect to the vertical, so that is approaches a cross-flow fan 27 to increase level, resulting in poor air flow ratio. If the front-side heat exchanger 28a accounts for 12 or more in the aforesaid ratio, there is a possibility that condensation drops from the front-side heat exchanger 28a. If the aforesaid ratio is 8:7 or 7:8, air flow ratio of the rear-side heat exchanger 28b will decrease for the same reason as the above case of the front-side heat exchanger 28a. Thus, it is most suitable to set at about 9:6 in the ratio of the front-side heat exchanger 28a to the rear-side heat exchanger 28b by the number of sections thereof, or the ratio of the front-side heat exchanger 28a to the rear-side heat exchanger 28b by the length along the height thereof.

Claims

1. An indoor unit of an air conditioner comprising:

   a main body frame,
   a front cover having an inlet port in a top and a front surfaces thereof while cooperating with the main body frame to form an air flow passage extending toward an outlet port disposed at the lower end thereof,
   a cross-flow fan having an impeller formed of a plurality of blades arranged in a column-like form,
   heat exchangers disposed upstream of the cross-flow fan within the air flow passage independently from each other on a front side and a rear side in the passage,
   a leaf for interconnecting both the heat exchangers at the upper portions thereof,
   a stabilizer disposed adjacent to and opposite to the cross-flow fan, and
   a rear guider defining the air flow passage extending from the cross-flow fan to the outlet port,
   the rear-side heat exchanger being inclined toward the cross-flow fan at an angle α with respect to a vertical, and the angle α being in a range of $25° \leqq \alpha \leqq 35°$.

2. An indoor unit of an air conditioner as set forth in Claim 1, wherein the front-side heat exchanger is comprised of two portions arranged in a bent form.

3. An indoor unit of an air conditioner as set forth in Claim 1 or 2, wherein a joint section of the main body frame and the front cover is superposed relative to the leaf for interconnecting the two heat exchangers at the upper portions thereof.

4. An indoor unit of an air conditioner as set forth in any one of Claims 1 through 3, wherein a ratio of the front-side heat exchanger to the rear-side heat exchanger by the length along the height thereof is about 9:6.

FIG. 1

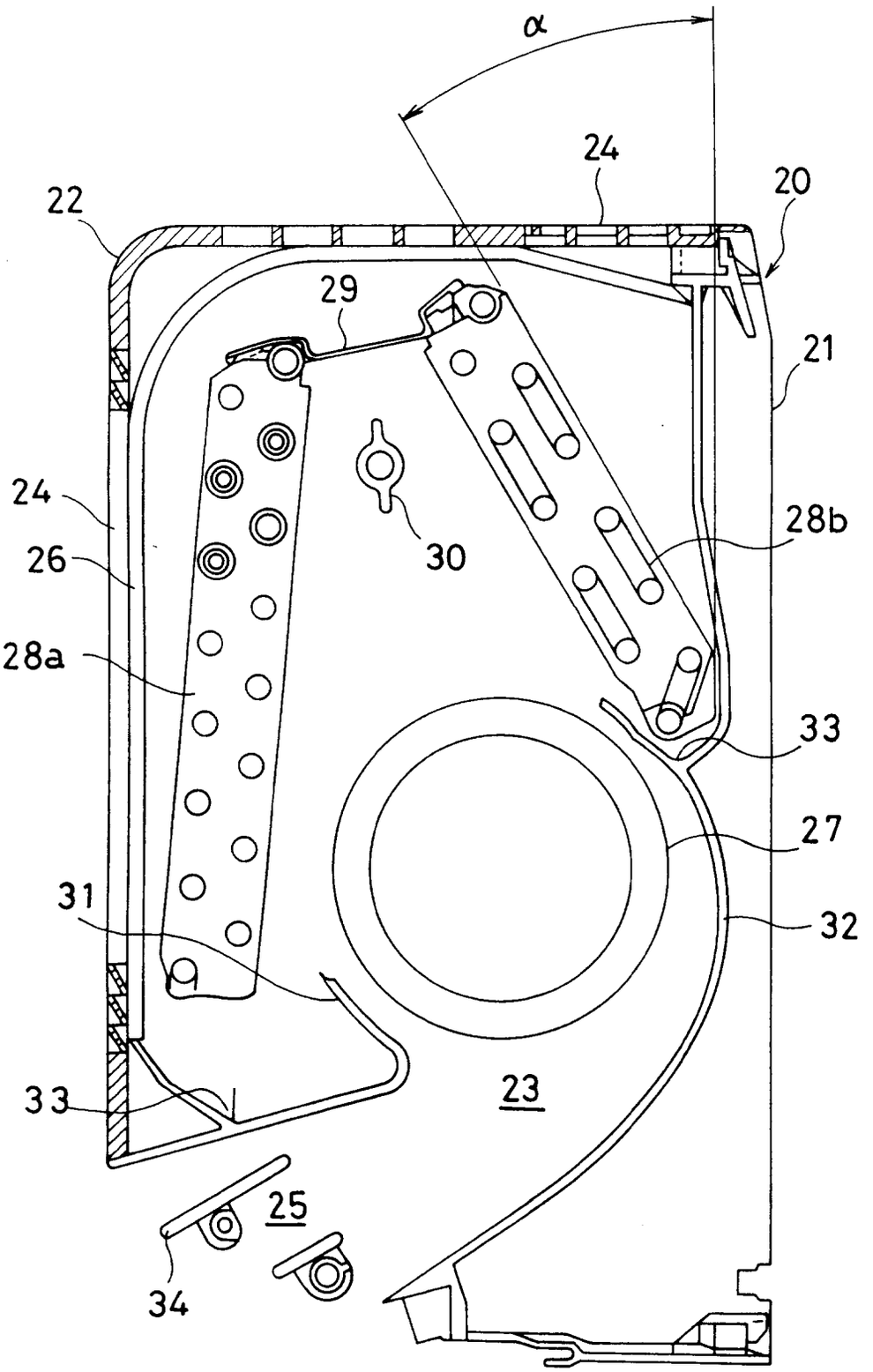


FIG. 2

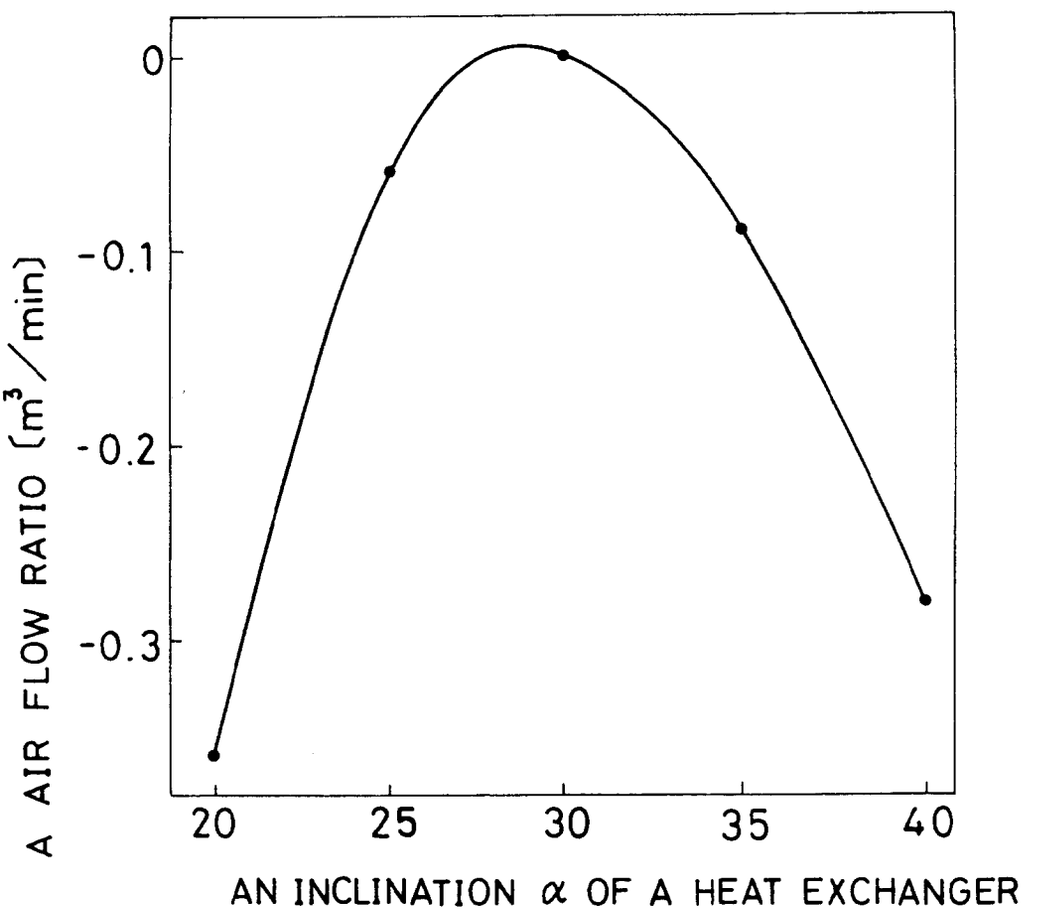

0
-0.1
-0.2
-0.3
A AIR FLOW RATIO (m³/min)
20
25
30
35
40
AN INCLINATION α OF A HEAT EXCHANGER

FIG. 3

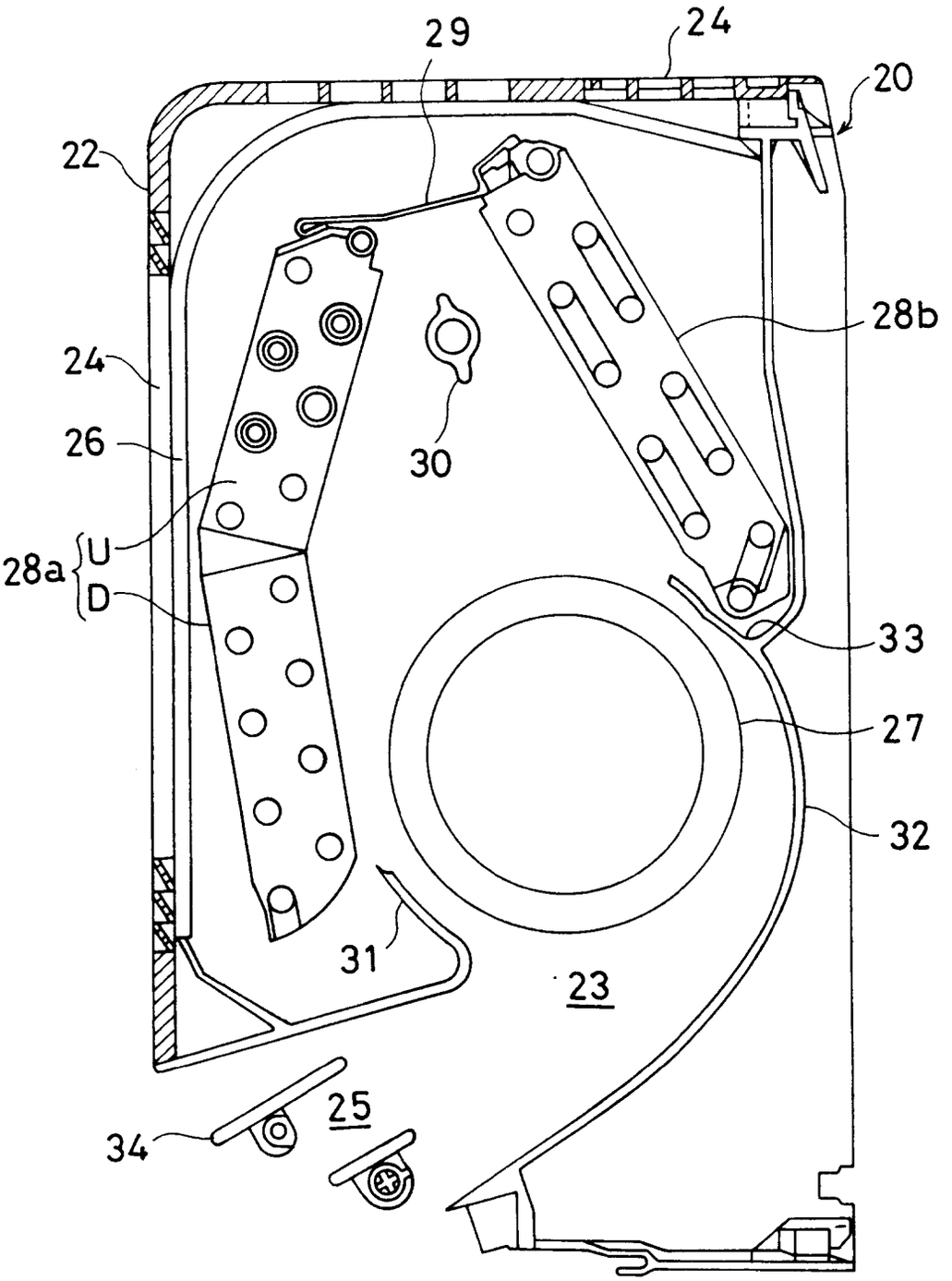


FIG.4

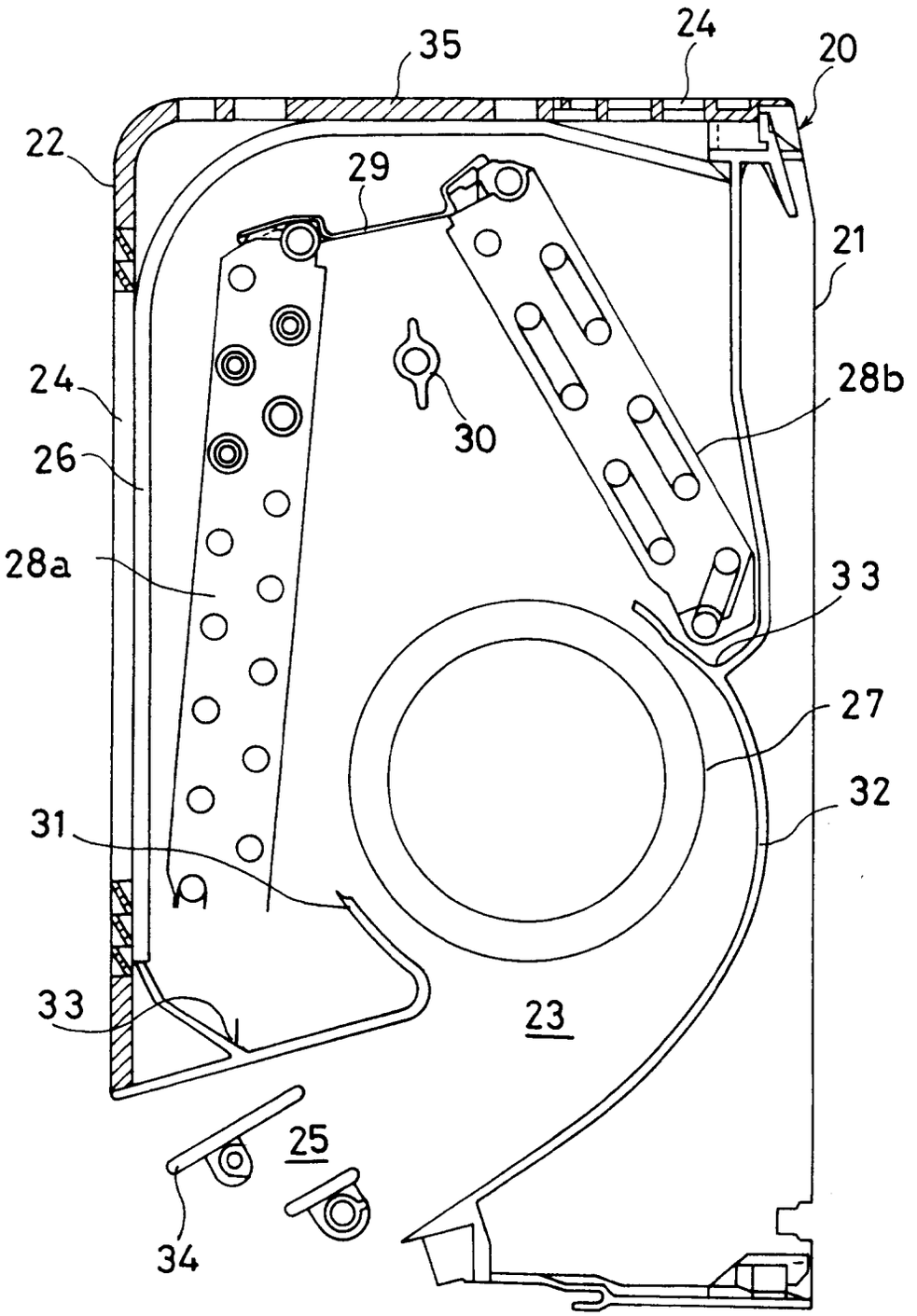


FIG.5

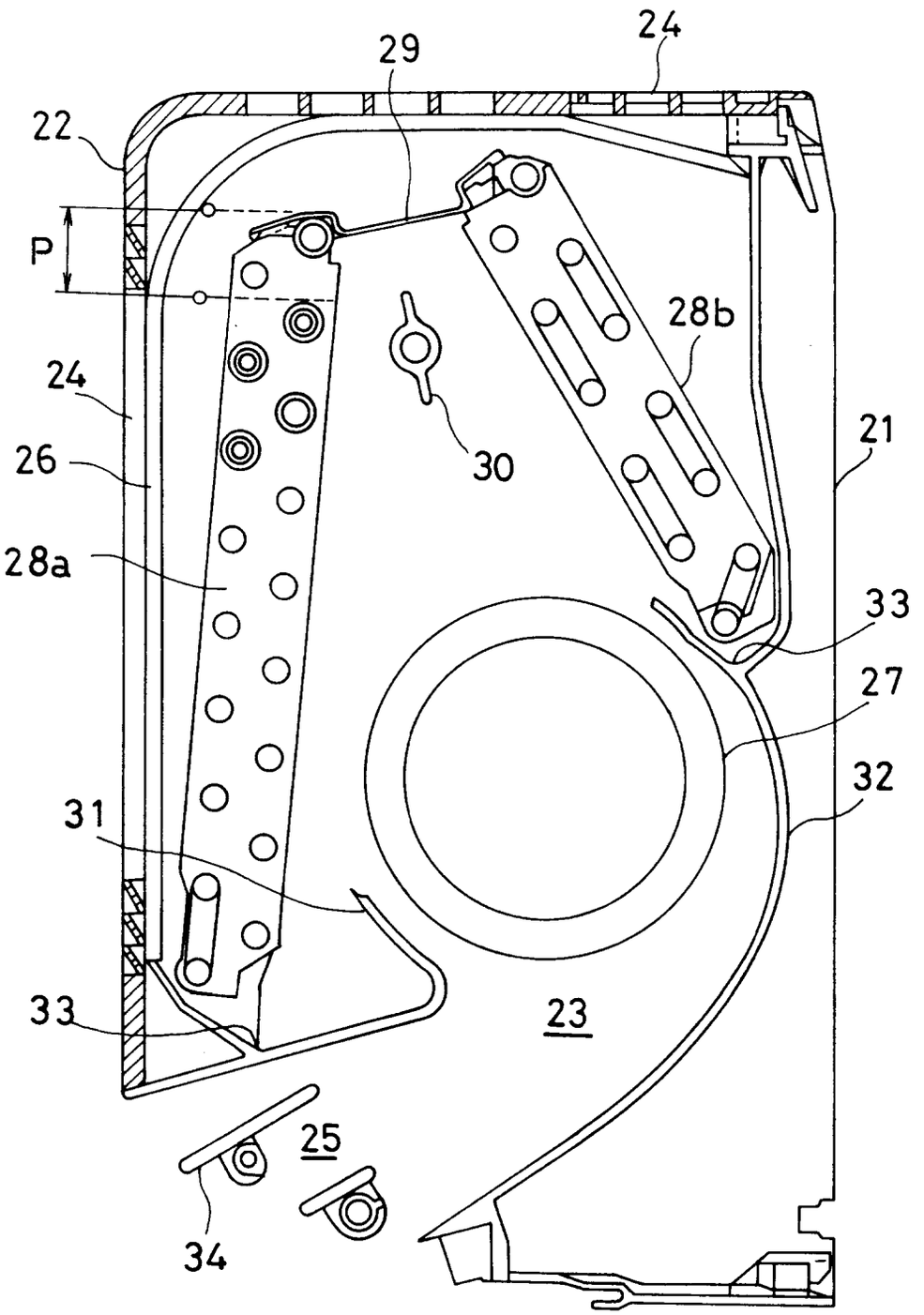


FIG. 6

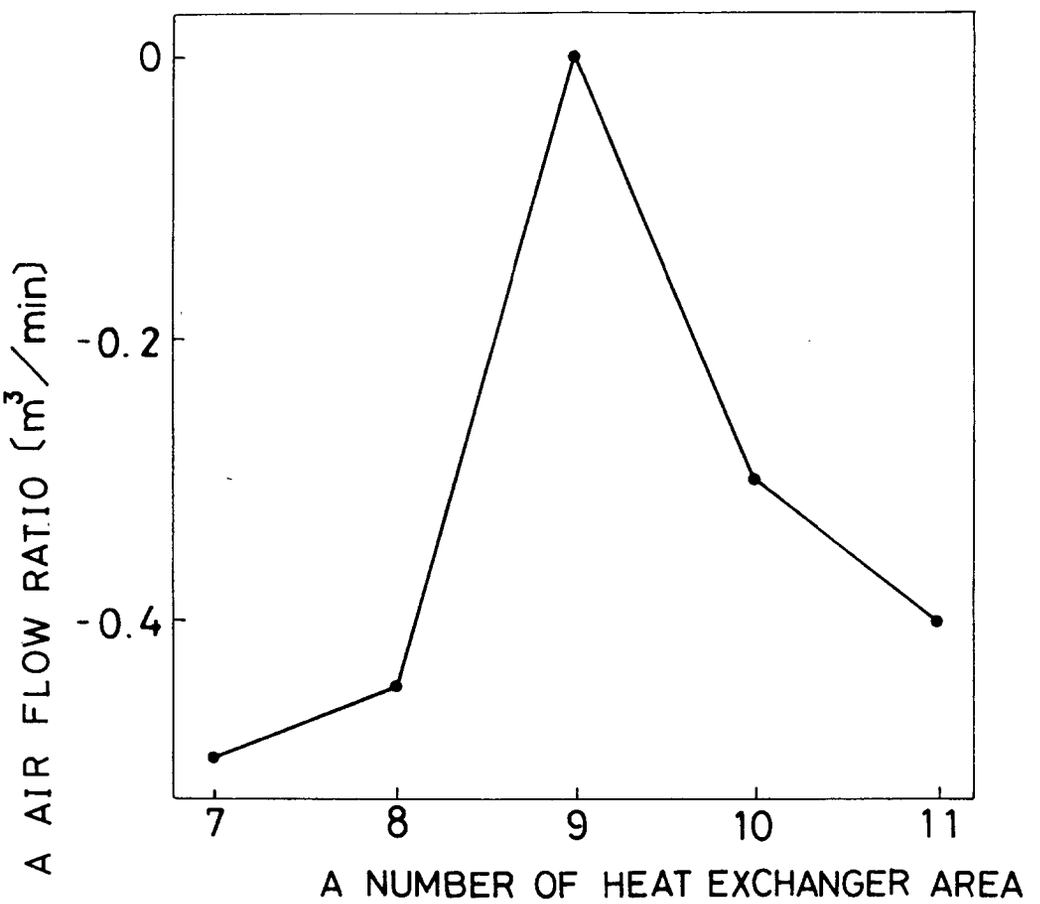
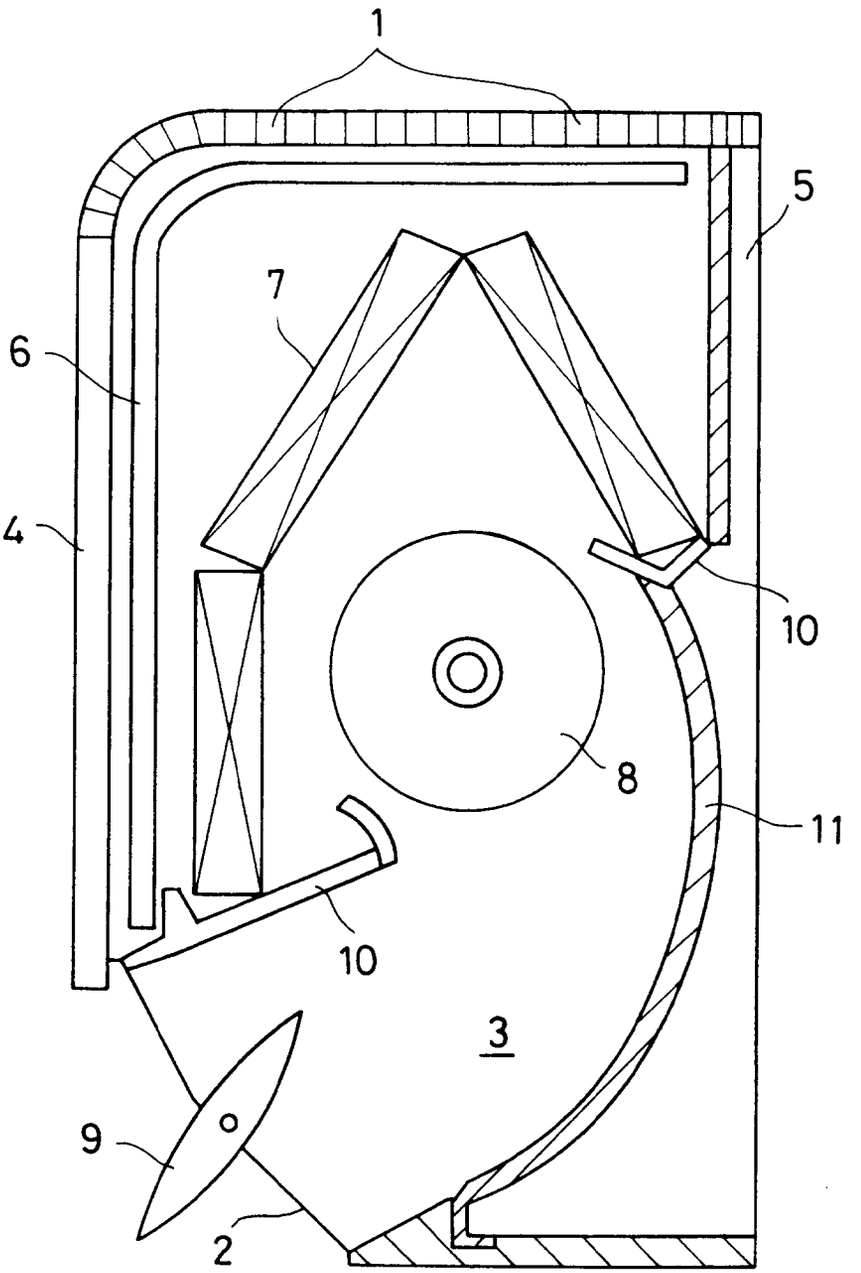

0
-0.2
-0.4
A AIR FLOW RATIO (m³/min)
7
8
9
10
11
A NUMBER OF HEAT EXCHANGER AREA

FIG. 7
PRIOR ART



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 11 4659

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 95, no. 007 & JP-A-07 190474 (MATSUSHITA ELECTRIC IND CO LTD), 28 July 1995, * abstract * ---	1-4	F24F1/00 F24F13/24
A	PATENT ABSTRACTS OF JAPAN vol. 95, no. 007 & JP-A-07 190476 (MATSUSHITA ELECTRIC IND CO LTD), 28 July 1995, * abstract * ---	1-4	
A	EP-A-0 466 431 (MITSUBISHI ELECTRIC CORP) 15 January 1992 * abstract; figures * ---	1	
A	EP-A-0 560 037 (TOKYO SHIBAURA ELECTRIC CO) 15 September 1993 * abstract; figures * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) F24F F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 January 1997	Gonzalez-Granda, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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