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(54) INDOOR AIR CONDITIONER

(57) To provide both surging proof stress and energy conservation properties in a wall-mounted air-conditioning indoor machine, a stabilizer (17), a rear guider (18), and a cross-flow fan (30) are arranged so that three expressions, (θa - θ0) > 16°, 17° < (θb - θ0) < 26°, and θb ≥ θa, are satisfied by a reference angle (θ0) formed by a fan-referencing horizontal line (L1) and a scroll-referencing line (L2), a first angle (θa) formed by the fan-referencing horizontal line (L1) and a first straight line (SL1) connecting a fan center point (O) and a front-surface-side closest point (P7) of the stabilizer (17), and a second angle (θb) formed by the fan-referencing horizontal line (L1) and a second straight line (SL2) connecting the fan center point (O) and a back-surface-side closest point (P8) of the rear guider (18).

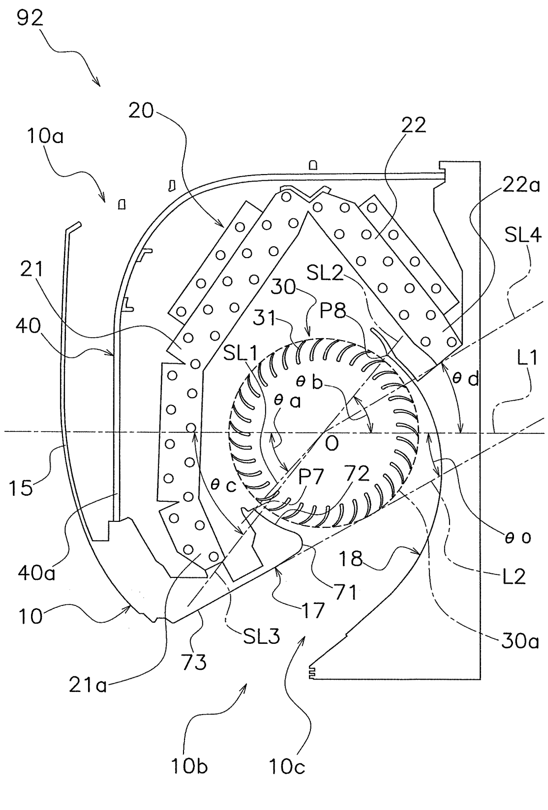

FIG. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to an air-conditioning indoor machine, and particularly relates to a wall-mounted air-conditioning indoor machine.

BACKGROUND ART

[0002] Indoor units (referred to as an air-conditioning indoor machines below) of air conditioners that are installed not in the ceiling but in the side wall of a room, that draw in air from the front surface or top surface, and that blow conditioned air out from a blow-out port in the bottom, have been quite common in the past. The interior of an indoor machine accommodates a heat exchanger for conducting heat exchange between a refrigerant and air, and/or a cross-flow fan.

[0003] For example, an air-conditioning indoor machine has a stabilizer and a rear guider as members configuring an air distribution passage, as is disclosed in Patent Literature 1 (Japanese Laid-open Patent Application No. 2008-8500).

SUMMARY OF THE INVENTION

<Technical Problem>

[0004] In recent air-conditioning indoor machines, higher air volumes are being attained at lower rotational speeds as cross-flow fans are increased in diameter. Surging proof stress, which is reduced by lowering the rotational speed, must be improved even during increased static pressure, and demand for lower power also exists in order to conserve energy.

[0005] An object of the present invention is to provide an air-conditioning indoor machine having both surging proof stress and the property of energy conservation.

<Solution to Problem>

[0006] An air-conditioning indoor machine according to a first aspect of the present invention is a wall-mounted air-conditioning indoor machine, comprising a cross-flow fan, a casing, and a heat exchanger. The cross-flow fan has a plurality of blades aligned along the circumference, and generates an air flow. The casing includes a stabilizer on the front-surface side, and a rear guider on the back-surface side. A blown air channel for air flowing in a scroll-like manner from the cross-flow fan to a blow-out port is formed in the casing by the stabilizer and the rear guider. The stabilizer is divided into a top part and a bottom part with a tongue part in between. The heat exchanger includes a front-surface-side heat exchange section and a back-surface-side heat exchange section, and the heat exchanger is arranged on the airflow-upstream side of the cross-flow fan. In a longitudinal cross-sectional view of this air-conditioning indoor machine, a horizontal line through a fan center point, which is the rotational center of the cross-flow fan, is a fan-referencing horizontal line. In a longitudinal cross-sectional view, a line designated as a scroll-referencing line is a straight line that, of any straight line tangent to a circle connecting the outer ends of the fan blades of the cross-flow fan and adjoining the bottom part of the stabilizer, forms the smallest angle with the fan-referencing horizontal line. In a longitudinal cross-sectional view, the angle formed by the fan-referencing horizontal line and the scroll-referencing line is a reference angle $\theta 0$. In a longitudinal cross-sectional view, an angle designated as a first angle θa is the angle formed by the fan-referencing horizontal line and a first straight line, which is a straight line connecting the fan center point and a front-surface-side closest point which is the point on the top part of the stabilizer that is closest to the cross-flow fan. In a longitudinal cross-sectional view, an angle designated as a second angle θb is the angle formed by the fan-referencing horizontal line and a second straight line, which is a straight line connecting the fan center point and a back-surface-side closest point which is the point on the rear guider that is closest to the cross-flow fan. The stabilizer, the rear guider, and the cross-flow fan are arranged in this air-conditioning indoor machine so that the reference angle $\theta 0$, the first angle θa, and the second angle θb, defined as described above, satisfy the following first angle relational expression, second angle relational expression, and third angle relational expression.

First angle relational expression: $(\theta a - \theta 0) > 16°$
Second angle relational expression: $17° < (\theta b - \theta 0) < 26°$
Third angle relational expression: $\theta b \geq \theta a$

[0007] In the air-conditioning indoor machine according to the present invention, the stabilizer, the rear guider, and the cross-flow fan are arranged not so that any one of the first angle relational expression, the second angle relational expression, and the third angle relational expression described above is satisfied, but so that the first angle relational expression, the second angle relational expression, and the third angle relational expression are all satisfied. The height position of the front-surface-side closest point of the stabilizer is thereby kept low, whereby the air flow from the lower part of the front-surface-side heat exchange section to the cross-flow fan is not so greatly inhibited, and the so-called fan intake angle can be increased within a range of no more than 180°. Therefore, an air flow with little loss is produced, and less of the air flow from the cross-flow fan to the blow-out port flows backward to the intake port. The surging proof stress is improved by this suppression of back flow.

[0008] Furthermore, the height position of the back-surface-side closest point of the rear guider is kept to an appropriate range, thereby suppressing the increase in fan power caused by the rear guider being too low, and improving the energy conservation properties. In other words, when the height position of the back-surface-side closest point of the rear guider is too low, the scroll-shaped blown air channel is shorter, less force maintains the circular vortex created on the cross-flow fan side of the back-surface-side closest point, and turbulent flow in the surface of the scroll-shaped blown air channel increases as does fan power, but according to the present invention, this manner of increase in fan power is suppressed.

[0009] An air-conditioning indoor machine according to a second aspect of the present invention is the air-conditioning indoor machine according to the first aspect, wherein, in a longitudinal cross-sectional view, a lower part of the front-surface-side heat exchange section is positioned lower than the fan-referencing horizontal line, and a lower part of the back-surface-side heat exchange section is positioned higher than the fan-referencing horizontal line. In a longitudinal cross-sectional view of the air-conditioning indoor machine: a line designated as a third straight line is a straight line that, of any straight line passing through the fan center point and the lower part of the front-surface-side heat exchange section, forms the largest angle with the fan-referencing horizontal line; the angle formed by the third straight line and the fan-referencing horizontal line is a third angle θc; a line designated as a fourth straight line is a straight line that, of any straight line passing through the fan center point and the lower part of the back-surface-side heat exchange section, forms the smallest angle with the fan-referencing horizontal line; the angle formed by the fourth straight line and the fan-referencing horizontal line is a fourth angle θd; and the stabilizer, the rear guider, the heat exchanger, and the cross-flow fan are arranged so as to satisfy the following fourth angle relational expression and fifth angle relational expression.

Fourth angle relational expression: $\theta c > \theta a$
Fifth angle relational expression: $\theta d < \theta b$

[0010] In the air-conditioning indoor machine according to the second aspect, the lower part of the front-surface-side heat exchange section is arranged in a low position so that the fourth angle relational expression is satisfied, the lower part of the back-surface-side heat exchange section is arranged in a low position so that the fifth angle relational expression is satisfied, and the capacity of the heat exchanger can be increased. Because the first angle relational expression, the second angle relational expression, and the third angle relational expression are satisfied simultaneously, the flow of air from the lower part(s) of the front-surface-side heat exchange section and/or the back-surface-side heat exchange section to the cross-flow fan is not readily inhibited even if either lower part is arranged in a low position, air flows in large quantities to the lower parts of both heat exchange sections, and the property of energy conservation is improved.

<Advantageous Effects of Invention>

[0011] In the air-conditioning indoor machine according to the first aspect of the present invention, surging proof stress and the property of energy conservation are both improved.

[0012] In the air-conditioning indoor machine according to the second aspect of the present invention, the capacity of the heat exchanger is increased, but more air flows to the lower parts of the heat-exchanging parts, and energy conservation is further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is configuration drawing of an air-conditioning apparatus composed of an air-conditioning outdoor machine and an air-conditioning indoor machine.
FIG. 2 is a longitudinal cross-sectional view (a cross-sectional view along line II-II in FIG. 1) of the air-conditioning indoor machine, intended to illustrate the arrangement of the front surface panel, the filter, and the heat exchanger.
FIG. 3 is a longitudinal cross-sectional view of the air-conditioning indoor machine, intended to illustrate the arrangement of the stabilizer and the rear guider.
FIG. 4 is a graph showing the relationship between the arrangement of the stabilizer and the improvement in fan power efficiency.
FIG. 5 is a graph showing the relationship between the arrangement of the rear guider and the improvement in fan power efficiency.

DESCRIPTION OF EMBODIMENTS

[0014] An air-conditioning indoor machine 92 according to an embodiment of the present invention is described below with reference to the drawings. The following embodiment is a specific example of the present invention and is not intended to limit the technical range of the present invention.

(1) Configuration of Air-Conditioning Indoor Machine

[0015] FIG. 1 is a configuration drawing of an air conditioner 90 including the air-conditioning indoor machine 92 according to an embodiment of the present invention. The air-conditioning indoor machine 92 is a wall-mounted indoor unit attached to the surface of a wall indoors. The air-conditioning indoor machine 92 is connected via a refrigerant pipe 93 to an air-conditioning outdoor machine 91 arranged outdoors, configuring the air conditioner 90. The air-conditioning indoor machine 92 performs an indoor air-cooling operation and an air-warming operation in accordance with the manipulations of a remote controller or the like.

[0016] The air-conditioning indoor machine 92 comprises primarily a casing 10, a filter 40, a heat exchanger 20, and a cross-flow fan 30, as shown in FIG. 2.

(1-1) Casing

[0017] The casing 10 is an assemblage of members constituting the outer contours and frame of the air-conditioning indoor machine 92, and the casing supports and houses the filter 40, the heat exchanger 20, the cross-flow fan 30, and other components.

[0018] In the top part of the casing 10, an intake port 10a for taking in indoor air is formed. In the bottom part of the casing 10, a blow-out port 10b for blowing out conditioned air into the room is formed. The intake port 10a is positioned higher than a fan center point O, which is the rotational center of the cross-flow fan 30. More specifically, the intake port 10a, which is formed in the ceiling surface (the top surface) of the casing 10, takes in indoor air from the space above the air-conditioning indoor machine 92. The blow-out port 10b is in a lower position than the fan center point O. More specifically, the blow-out port 10b, which is formed in the front-surface-side portion of the bottom surface of the casing 10, blows out air in front of and below the air-conditioning indoor machine 92.

[0019] The casing 10 includes components such as a front surface panel 15, a stabilizer 17, and a rear guider 18, shown in FIGS. 2 and 3. A blown air channel 10c having a scroll shape through which air flows from the cross-flow fan 30 to the blow-out port 10b is formed in the casing 10 by the stabilizer 17 and the rear guider 18. The stabilizer 17, arranged nearer to the front surface than the rear guider 18, is divided into a top part 72 and a bottom part 73, in between which is a tongue part 71 formed from a curved surface. The stabilizer 17 is closest to the cross-flow fan 30 at a front-surface-side closest point P7 in the top part 72, as shown in the longitudinal cross-sectional view of FIG. 3. The top part of the rear guider 18 is positioned higher than the fan center point O, and the rear guider 18 is closest to the cross-flow fan 30 at a back-surface-side closest point P8. The front surface panel 15 is arranged on the front-surface side of the filter 40.

(1-2) Heat Exchanger and Filter

[0020] The heat exchanger 20 is a fin-and-tube type heat exchanger in the shape of an upside-down letter V as seen in a longitudinal cross section, in which heat exchange takes place between air flowing from the intake port 10a toward the cross-flow fan 30, and refrigerant flowing through tubes. The heat exchanger 20 is configured from numerous aluminum heat transfer fins, and numerous tubes passing through numerous holes opened in the heat transfer fins. The tubes, which are heat transfer tubes made of copper, have an outside diameter of 5 mm or 4 mm.

[0021] The heat exchanger 20 includes a front-surface-side heat exchange section 21 positioned nearer to the front surface than a peak part 20a, and a back-surface-side heat exchange section 22 positioned nearer to the back surface than the peak part 20a. A lower part 21a of the front-surface-side heat exchange section 21 is positioned lower than a fan-referencing horizontal line L1, described hereinafter, and a lower part 22a of the back-surface-side heat exchange section 22 is positioned higher than the fan-referencing horizontal line L1.

[0022] The heat exchanger 20, which is positioned on the airflow-upstream side of the cross-flow fan 30, i.e., above and in front of the cross-flow fan 30, is covered by the filter 40. The filter 40, which is arranged on the airflow-upstream side of the heat exchanger 20, is positioned above and in front of the heat exchanger 20, and the filter 40 collects dust contained in the air flowing from the intake port 10a to the heat exchanger 20.

(1-3) Cross-Flow Fan

[0023] The cross-flow fan 30 comprises a cylindrical fan rotor extending horizontally lengthwise, and a motor for rotating the fan rotor. The fan rotor has numerous fan blades 31 aligned along the circumferential direction, and by rotating, the fan rotor generates an air flow from the side near heat exchanger 20 to the side near the blow-out port 10b.

[0024] When the cross-flow fan 30 rotates, air flows from inside the room to the heat exchanger 20 via the intake port 10a and the filter 40, and air that has passed through the heat exchanger 20 flows to the blown air channel 10c to be blown out into the room from the blow-out port 10b.

[0025] The rotational speed of the motor of the cross-flow fan 30 is varied by a control device (not shown). The control device built into the air-conditioning indoor machine 92 changes the rotational speed of the motor on the basis of user manipulation input through a remote controller or the like.

(2) Details of Arrangement of Front Surface Panel, Filter, and Heat Exchanger

[0026] The air-conditioning indoor machine 92 according to the present invention employs a new arrangement of components not seen in past air-conditioning indoor machines. The arrangement of the front surface panel, the filter, and the heat exchanger is described in detail below.

[0027] In a longitudinal cross-sectional view of the air-conditioning indoor machine 92, the lower part 21a of the front-surface-side heat exchange section 21 and the lower part 40a of the filter 40 are positioned lower than the fan center point O, as shown in FIG. 2. In other words, the front-surface-side heat exchange section 21 includes the lower part 21 a positioned lower than the fan center point O, and the filter 40 includes the lower part 40a positioned lower than the fan center point O.

[0028] Here, the lines L1, SL3, and SL5, angles θc and θe, and gap distances D1, D2, and D3 are defined as follows.

[0029] The fan-referencing horizontal line L1 is a horizontal line passing through the fan center point O.

[0030] The third straight line SL3 is a straight line that, of any straight line passing through the lower part 21 a of the front-surface-side heat exchange section 21 and the fan center point O, forms the largest angle with the fan-referencing horizontal line L1.

[0031] The heat exchanger bottom part angle θc is an angle formed by the third straight line SL3 and the fan-referencing horizontal line L1.

[0032] The fifth straight line SL5 is a straight line that, of any straight line passing through the lower part 40a of the filter 40 and the fan center point O, forms the largest angle with the fan-referencing horizontal line L1.

[0033] The filter bottom part angle θe is an angle formed by the fifth straight line SL5 and the fan-referencing horizontal line L1.

[0034] The first distance D1 is the distance of the gap between the cross-flow fan 30 and the front-surface-side heat exchange section 21 at the same height as the fan center point O.

[0035] The second distance D2 is the distance of the gap between the front-surface-side heat exchange section 21 and the filter 40 at the same height as the fan center point O.

[0036] The third distance D3 is the distance of the gap between the filter 40 and the front surface panel 15 at the same height as the fan center point O.

[0037] The cross-flow fan 30, the heat exchanger 20, the filter 40, and the front surface panel 15 are arranged in the air-conditioning indoor machine 92 so that the lines L1, SL3, and SL5, the angles θc and θe, and the gap distances D1, D2, and D3, defined as described above, satisfy the first expression, second expression, and third expression below.

First expression: $\theta e > (\theta c \times 0.4)$
Second expression: $D3 > D2 > D1$
Third expression: $D1 > (0.3 \times R)$

[0038] The fan radius R, which is the radius of the fan rotor of the cross-flow fan 30, is the distance from the fan center point O to an imaginary circle (refer to the circle 30a shown in a dashed line in FIG. 2) connecting the outer ends of the numerous fan blades 31, as seen in a longitudinal cross section.

[0039] Due to these expressions being satisfied, sufficient air reaches the lower part 21a of the front-surface-side heat exchange section 21 while the depth dimension of the air-conditioning indoor machine 92 is kept small, but in the air-conditioning indoor machine 92, the following numerical values are employed to satisfy these expressions.

Heat exchanger bottom part angle $\theta c = 52°$
Filter bottom part angle $\theta e = 23° > (\theta c \times 0.4)$
Fan radius R = 52 mm
First distance D1 = 16 mm > $(0.3 \times R)$
Second distance D2 = 22 mm > D1
Third distance D3 = 27 mm > D2

[0040] In the air-conditioning indoor machine 92, a fourth distance D4, which is the distance between the fan center point O and the front surface panel 15 at the same height as the fan center point O as seen in a longitudinal cross section, is kept shorter than thrice the fan radius R. In other words, the fourth distance D4 and the fan radius R satisfy the following fourth expression.

Fourth expression: $D4 < (3 \times R)$

[0041] Specifically, the front surface panel 15 is arranged relative to the cross-flow fan 30 so that the fourth distance D4 is 143 mm. The fourth distance D4 is kept small to ensure that the depth dimension of the air-conditioning indoor machine 92 is not too large, but due to the cross-flow fan 30, the heat exchanger 20, the filter 40, and the front surface panel 15 being arranged so as to satisfy the first through third expressions described above, air taken in from the intake port 10a formed in the ceiling surface is sent in a sufficient quantity to the lower part 21 a of the front-surface-side heat exchange section 21.

(3) Details of Arrangement of Stabilizer and Rear Guider

[0042] Next, a detailed description is given of the new arrangement of the stabilizer 17 and the rear guider 18, which has not been seen in past air-conditioning indoor machines.

[0043] Lines L2, SL1, SL2, and SL4 and angles $\theta 0$, θa, θb, θc, and θd are defined in the following manner as seen in a longitudinal cross section of the air-conditioning indoor machine 92, as shown in FIG. 3. The fan-referencing horizontal line L1 and the third straight line SL3 are as described above.

[0044] The scroll-referencing line L2 is a straight line that, of any straight line tangent to the circle 30a connecting the outer ends of the numerous fan blades 31 of the cross-flow fan 30 and adjoining the bottom part 73 of the stabilizer 17, forms the smallest angle with the fan-referencing horizontal line L1. In this embodiment, the bottom part 73 of the stabilizer 17, which serves as the top wall of the blown air channel 10c in proximity to the blow-out port 10b, is a flat surface, and a straight line extending from this flat surface to the back-surface side adjoins the circle 30a as seen in a longitudinal cross section. This straight line is therefore the scroll-referencing line L2.

[0045] The reference angle $\theta 0$ is the angle formed by the fan-referencing horizontal line L1 and the scroll-referencing line L2.

[0046] The first straight line SL1 is a straight line connecting the fan center point O and the front-surface-side closest point P7, which is the point on the top part 72 of the stabilizer 17 that is closest to the cross-flow fan 30.

[0047] The first angle θa is the angle formed by the first straight line SL1 and the fan-referencing horizontal line L1.

[0048] The second straight line SL2 is a straight line connecting the fan center point O and the back-surface-side closest point P8, which is the point on the rear guider 18 that is closest to the cross-flow fan 30.

[0049] The second angle θb is the angle formed by the second straight line SL2 and the fan-referencing horizontal line L1.

[0050] The third angle θc, which is the heat exchanger bottom part angle θc described above, is the angle formed by the third straight line SL3 and the fan-referencing horizontal line L1.

[0051] The fourth straight line SL4 is a straight line that, of any straight line passing through the fan center point O and the lower part 22a of the back-surface-side heat exchange section 22, forms the smallest angle with the fan-referencing horizontal line L1.

[0052] The fourth angle θd is the angle formed by the fourth straight line SL4 and the fan-referencing horizontal line L1.

[0053] The stabilizer 17, the rear guider 18, the heat exchanger 20, and the cross-flow fan 30 are arranged in the air-conditioning indoor machine 92 so that the lines L2, SL1, SL2, and SL4 and the angles θ0, θa, θb, θc, and θd, defined as described above, satisfy all the following relational expressions, from the first angle relational expression to the fifth angle relational expression.

First angle relational expression: (θa - θ0) > 16°
Second angle relational expression: 17° < (θb - θ0) < 26°
Third angle relational expression: θb ≥ θa
Fourth angle relational expression: θc > θa
Fifth angle relational expression: θd < θb

[0054] Due to these expressions being satisfied, the surging proof stress is improved as described later and the increase in fan power is suppressed, but the air-conditioning indoor machine 92 employs the following numerical values to satisfy these expressions.

Reference angle θ0 = 28°
First angle θa = 48°
Second angle θb = 51°
Third angle θc = 52°
Fourth angle θd = 31 °

(4) Characteristics

[0055]

(4-1) In the air-conditioning indoor machine 92 according to the present embodiment, the stabilizer 17, the rear guider 18, and the cross-flow fan 30 are arranged not so that any one of the first angle relational expression, the second angle relational expression, and the third angle relational expression described above is satisfied, but so that the first angle relational expression, the second angle relational expression, and the third angle relational expression are all satisfied.
Because this arrangement is used, the height position of the front-surface-side closest point P7 of the stabilizer 17 is kept low, and the air flow from the lower part 21 a of the front-surface-side heat exchange section 21 to the cross-flow fan 30 is less inhibited. In other words, a flow of air with little loss is created from the lower part 21a of the front-surface-side heat exchange section 21 to the cross-flow fan 30. FIG. 4 shows data to be a base of the first angle relational expression. In the graph of FIG. 4, the horizontal axis represents the angle difference (θa - θ0), and the vertical axis represents an efficiency improvement amount, which is the ratio of fan power, i.e., the load imposed on the motor of the cross-flow fan 30, to a certain predetermined reference value. As a result of testing, the efficiency improvement amount is small when the angle difference (θa - θ0) is less than 16°, and the efficiency improvement amount is large when the angle difference exceeds 16°. When the angle difference (θa - θ0) is either 17°, 20°, 24°, or 28°, the efficiency improvement amount is large and the increase in fan power is suppressed.
Due to the arrangement used in this air-conditioning indoor machine 92, the "fan intake angle" (the angle on the intake port 10a side formed by the first straight line SL1 and the second straight line SL2) can be increased within a range of no more than 180°. The fan intake angle in this embodiment is as follows.

$$180° - \theta\mathrm{b} + \theta\mathrm{a} = 177°$$

The flow of air from the cross-flow fan 30 toward the blow-out port 10b is hindered from flowing back to the intake port 10a. In other words, surging proof stress is improved in the air-conditioning indoor machine 92. Past air-conditioning indoor machines often have a fan intake angle of about 170°.
Furthermore, in the air-conditioning indoor machine 92, the height position of the back-surface-side closest point P8 of the rear guider 18 is kept to an appropriate range, thereby suppressing the increase in fan power caused by the rear guider 18 being too low, and improving the property of energy conservation. In other words, when the height position of the back-surface-side closest point P8 of the rear guider

18 is too low, the scroll-shaped blown air channel 10c is shorter, less force maintains the circular vortex created on the cross-flow fan 30 side of the back-surface-side closest point P8, and turbulent flow in the surface of the scroll-shaped blown air channel 10c increases as does fan power, but with the arrangement of the rear guider 18 and the cross-flow fan 30 described above, this manner of increase in fan power is suppressed. FIG. 5 shows data to be a base of the second angle relational expression. In the graph in FIG. 5, the horizontal axis represents the angle difference (θb - $\theta 0$), and the vertical axis represents the same efficiency improvement amount as FIG. 4. As a result of testing, the efficiency improvement amount is small when the angle difference (θb - $\theta 0$) is less than 17° or greater than 26°, and the efficiency improvement amount is large when the angle difference is within a range of 17° to 26°. When the angle difference (θb - $\theta 0$) is either 18°, 22°, or 25°, the efficiency improvement amount is large and the increase in fan power is suppressed.

As described above, in the air-conditioning indoor machine 92 according to the present embodiment, surging proof stress is improved and the increase in fan power is suppressed by arranging the stabilizer 17, the rear guider 18, and the cross-flow fan 30 so as to satisfy the first angle relational expression, the second angle relational expression, the and third angle relational expression all together.

(4-2) In the air-conditioning indoor machine 92, the lower part 21 a of the front-surface-side heat exchange section 21 is arranged in a low position so that the fourth angle relational expression is satisfied, and the lower part 22a of the back-surface-side heat exchange section 22 is arranged in a low position so that the fifth angle relational expression is satisfied; therefore, the capacity of the heat exchanger 20 increases. Particularly, a greater capacity of the heat exchanger 20 than those in the past is ensured because the third angle θc is at least 45° and the air-conditioning indoor machine 92 employs a structure in which the lower part 21a of the front-surface-side heat exchange section 21 is extended downward. When the air-conditioning indoor machine is equipped with this large heat exchanger 20, the distribution of the air flow through the heat exchanger is partially imbalanced, the air flow is inhibited, and fan power tends to be high, but because the air-conditioning indoor machine 92 employs a component arrangement that satisfies the first angle relational expression, the second angle relational expression, and the third angle relational expression all together as described above, the air flow from the lower parts 21a, 22a of the heat exchanger 20 to the cross-flow fan 30 is not readily inhibited, and air flows in large quantities to the lower parts 21a, 22a of the heat exchange sections 21, 22 as well. In other words, the property of energy conservation of the air-conditioning indoor machine 92 is improved.

(4-3) The air-conditioning indoor machine 92 employs a structure in which indoor air is drawn in through the intake port 10a formed in the ceiling of the casing 10, which is in a higher position than the fan center point O, and also employs a structure in which the lower part 21 a of the front-surface-side heat exchange section 21 and the lower part 40a of the filter 40 are both positioned lower than the fan center point O. Therefore, when past design methods are followed, less air passes through the lower part 21 a of the front-surface-side heat exchange section 21, and the entire heat exchanger 20 can no longer be effectively utilized.

In view of this, in the air-conditioning indoor machine 92, the lower part 40a of the filter 40 is first extended downward to a lower position than in the past so as to satisfy the first expression described above, and a channel is ensured for air to flow through the lower part 40a of the filter 40 toward the lower part 21a of the front-surface-side heat exchange section 21.

Furthermore, in the air-conditioning indoor machine 92, the cross-flow fan 30, the heat exchanger 20, the filter 40, and the front surface panel 15 are arranged so that the three gap distances D1, D2, and D3 satisfy the second expression described above, and while the depth dimension of the air-conditioning indoor machine 92 is kept small, there is little pressure loss in the channel for air flowing through the gap between the filter 40 and the front surface panel 15 (of which the gap distance is the third distance D3), from the intake port 10a to the lower part 40a of the filter 40 and the lower part 21a of the front-surface-side heat exchange section 21. A sufficient quantity of air passing through the lower part 21 a of the front-surface-side heat exchange section 21 is thereby ensured, and a structure is achieved in which the entire heat exchanger 20 is effectively utilized.

Employing an arrangement such as that described above makes it possible in the air-conditioning indoor machine 92 to extend the width of the air channel leading to the lower part 21a of the front-surface-side heat exchange section 21 and to keep friction resistance (pressure loss) low, without making the gap distance (the first distance D1) between the heat exchanger 20 and the cross-flow fan 30 too small. The second distance D2 is greater than the first distance D1, the third distance D3 is greater than the second distance D2, and the width is ensured to increase as the channel gets further away from the cross-flow fan 30; therefore, there is no longer a space where the width becomes small in the path from the intake port 10a to the lower part 21a of the front-surface-side heat exchange section 21 as shown in FIG. 2, and fluid friction resistance is greatly reduced in comparison with past structures.

(4-4) The air-conditioning indoor machine 92 employs a component arrangement that satisfies the second expression in order to keep the depth dimension (the dimension in the left-right direction in FIG. 2) small, but when the first distance D1 is too small, the front-surface-side heat exchange section 21 and the cross-flow fan 30 are too close together, and there may be sounds when air passes through the front-surface-side heat exchange section 21. Particularly, in the air-conditioning indoor machine 92 which employs a fin-and-tube type heat exchanger 20 of which the tube outside diameter is small (5 mm or 4 mm), there are fluctuations with strong turbulence at higher frequencies among periodic flow rate fluctuations typified by Karman vortexes, and there is a high risk of discrete frequency sounds at high frequencies due to interaction with the periodic pressure fluctuation of the fan blades 31.

To keep these sounds to a minimum, the air-conditioning indoor machine 92 employs a component arrangement that satisfies the third expression described above. In other words, the first distance D1, which is the gap distance between the cross-flow fan 30 and the front-surface-side heat exchange section 21 at the same height position as the fan center point O, is made to be greater than 30% of the fan radius R, whereby the sounds are kept to an allowable range. If this size is ensured for the first distance D1 of the air-conditioning indoor machine 92, the air flow that has passed through the heat exchanger 20 can be changed to a non-periodic wide-range turbulent flow structure and then made to collide with the fan blades 31, and the periodic sounds caused by the interaction with the fan blades 31 can be reduced.

(4-5) In the air-conditioning indoor machine 92, the front surface panel 15 is arranged so as to satisfy the fourth expression described above, and the distance from the fan center point O to the front surface panel 15 (the fourth distance D4) is comparatively small. A thin air-conditioning indoor machine 92 with a minimized depth dimension is thereby achieved, but because a structure is employed which simultaneously satisfies the first through third expressions, the entire heat exchanger 20 can be effectively utilized even if the machine has a thin profile.

REFERENCE SIGNS LIST

[0056]

10	Casing
10b	Blow-out port
10c	Blown air channel
17	Stabilizer
18	Rear guider
20	Heat exchanger
21	Front-surface-side heat exchange section
21a	Lower part of front-surface-side heat exchange section
22	Back-surface-side heat exchange section
22a	Lower part of back-surface-side heat exchange section
30	Cross-flow fan
30a	Circle connecting outer ends of blades
31	Fan blades (blades)
71	Tongue part of stabilizer
72	Top part of stabilizer
73	Bottom part of stabilizer
92	Air-conditioning indoor machine
L1	Fan-referencing horizontal line
L2	Scroll-referencing line
O	Fan center point
P7	Front-surface-side closest point of stabilizer
P8	Back-surface-side closest point of rear guider
$\theta 0$	Reference angle
θa	First angle
θb	Second angle
θc	Third angle
θd	Fourth angle
SL1	First straight line
SL2	Second straight line
SL3	Third straight line
SL4	Fourth straight line

CITATION LIST

PATENT LITERATURE

[0057] [Patent Literature 1] Japanese Laid-open Patent Application No. 2008-8500

Claims

1. A wall-mounted air-conditioning indoor machine (92), comprising:

    a cross-flow fan (30), for generating an air flow, the cross-flow fan having a plurality of blades (31) aligned along a circumference;
    a casing (10) including a stabilizer (17) on the front-surface side and a rear guider (18) on the back-surface side, the stabilizer (17) being divided into a top part (72) and a bottom part (73) with a tongue part (71) in between, a blown air channel (10c) having a scroll shape through which air flows from the cross-flow fan to a blow-out port (10b) being formed in the casing (10) by the stabilizer and the rear guider; and
    a heat exchanger (20) including a front-surface-side heat exchange section (21) and a back-surface-side heat exchange section (22), the heat exchanger (20) arranged on the airflow-upstream side of the cross-flow fan;

    in a longitudinal cross-sectional view:

    a horizontal line through a fan center point (O),

which is the rotational center of the cross-flow fan, being a fan-referencing horizontal line (L1);
a line designated as a scroll-referencing line (L2) being a straight line that, of any straight line tangent to a circle (30a) connecting the outer ends of the plurality of fan blades of the cross-flow fan and adjoining the bottom part of the stabilizer, forms the smallest angle with the fan-referencing horizontal line;
the angle formed by the fan-referencing horizontal line and the scroll-referencing line being a reference angle $\theta 0$;
an angle designated as a first angle θa being the angle formed by the fan-referencing horizontal line (L1) and a first straight line (SL1), which is a straight line connecting the fan center point and a front-surface-side closest point (P7) which is the point on the top part of the stabilizer that is closest to the cross-flow fan;
an angle designated as a second angle θb being the angle formed by the fan-referencing horizontal line (L1) and a second straight line (SL2), which is a straight line connecting the fan center point and a back-surface-side closest point (P8) which is the point on the rear guider that is closest to the cross-flow fan; and

the stabilizer, the rear guider, and the cross-flow fan being arranged so as to satisfy

a first angle relational expression: $(\theta a - \theta 0) > 16°$,
a second angle relational expression: $17° < (\theta b - \theta 0) < 26°$, and
a third angle relational expression: $\theta b \geq \theta a$.

2. The air-conditioning indoor machine according to claim 1, wherein,
in a longitudinal cross-sectional view:

a lower part (21a) of the front-surface-side heat exchange section is positioned lower than the fan-referencing horizontal line (L1);
a lower part (22a) of the back-surface-side heat exchange section is positioned higher than the fan-referencing horizontal line (L1);
a line designated as a third straight line (SL3) is a straight line that, of any straight line passing through the fan center point and the lower part of the front-surface-side heat exchange section, forms the largest angle with the fan-referencing horizontal line (L1);
the angle formed by the third straight line and the fan-referencing horizontal line is a third angle θc;
a line designated as a fourth straight line (SL4) is a straight line that, of any straight line passing through the fan center point and the lower part of the back-surface-side heat exchange section, forms the smallest angle with the fan-referencing horizontal line;
the angle formed by the fourth straight line and the fan-referencing horizontal line is a fourth angle θd; and
the stabilizer, the rear guider, the heat exchanger, and the cross-flow fan are arranged so as to satisfy
a fourth angle relational expression: $\theta c > \theta a$, and
a fifth angle relational expression: $\theta d < \theta b$.

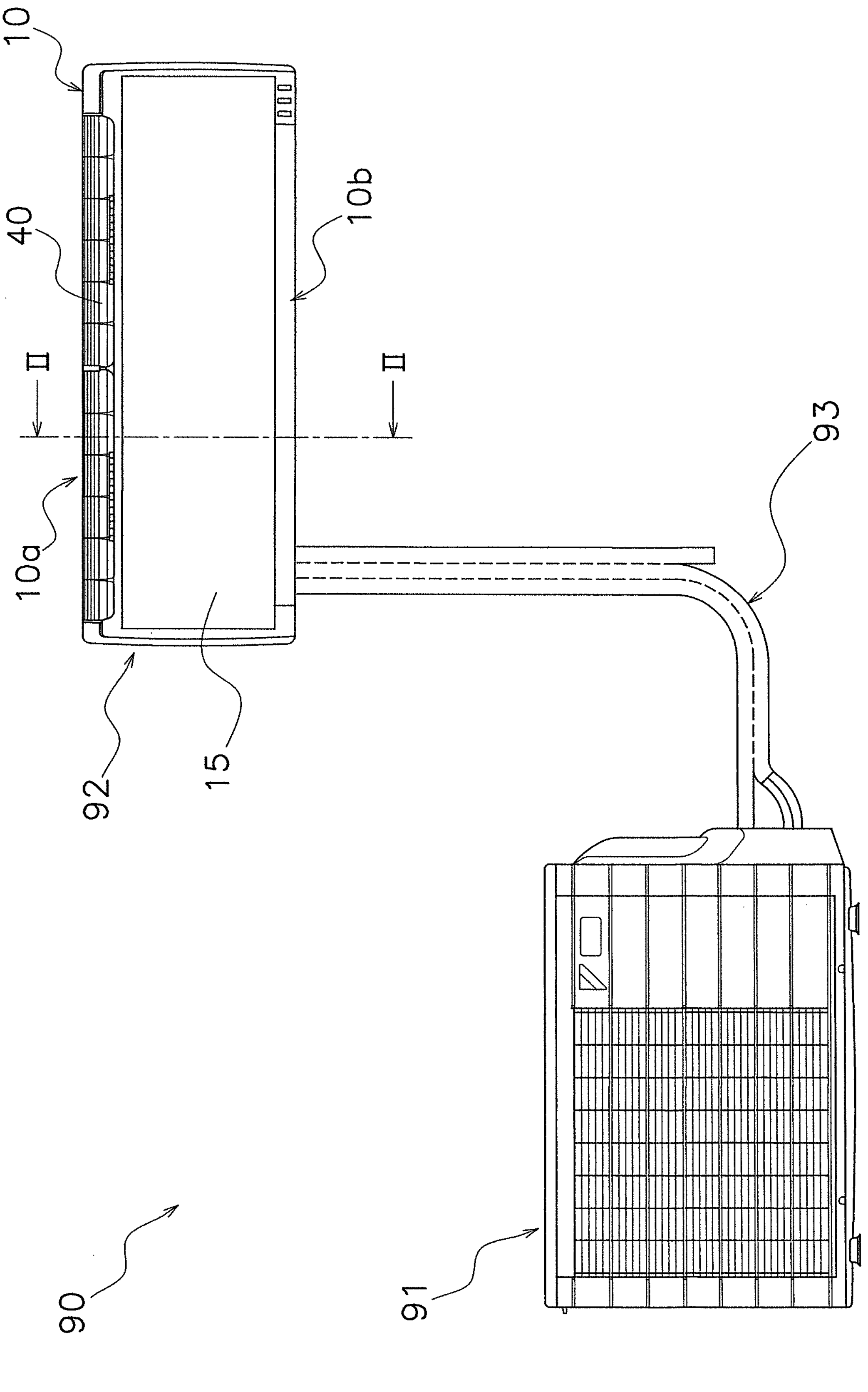


FIG. 1

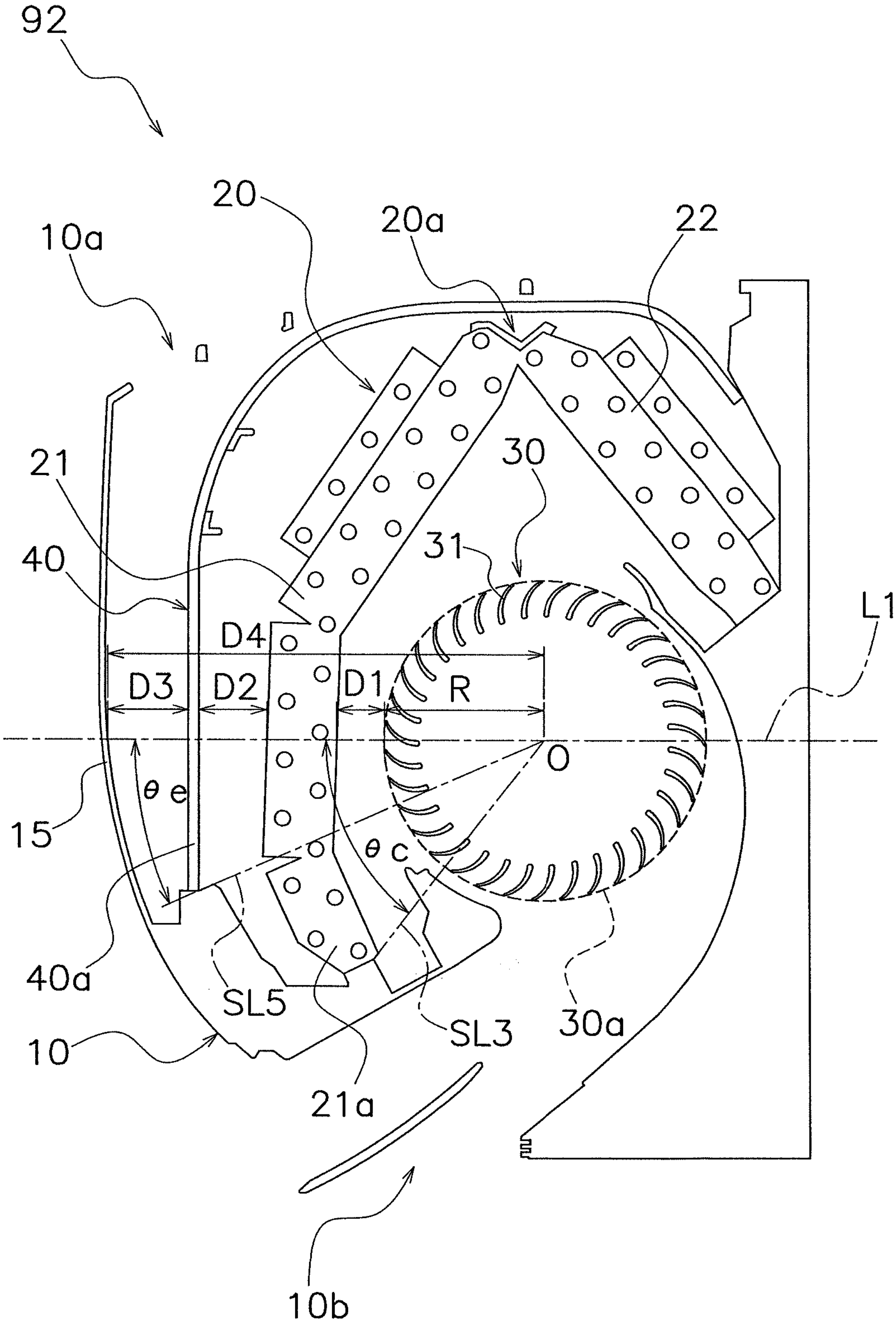

92
20
20a
22
10a
21
30
31
40
D4
L1
D3
D2
D1
R
O
θe
θc
15
40a
SL5
SL3
30a
10
21a
10b

FIG. 2

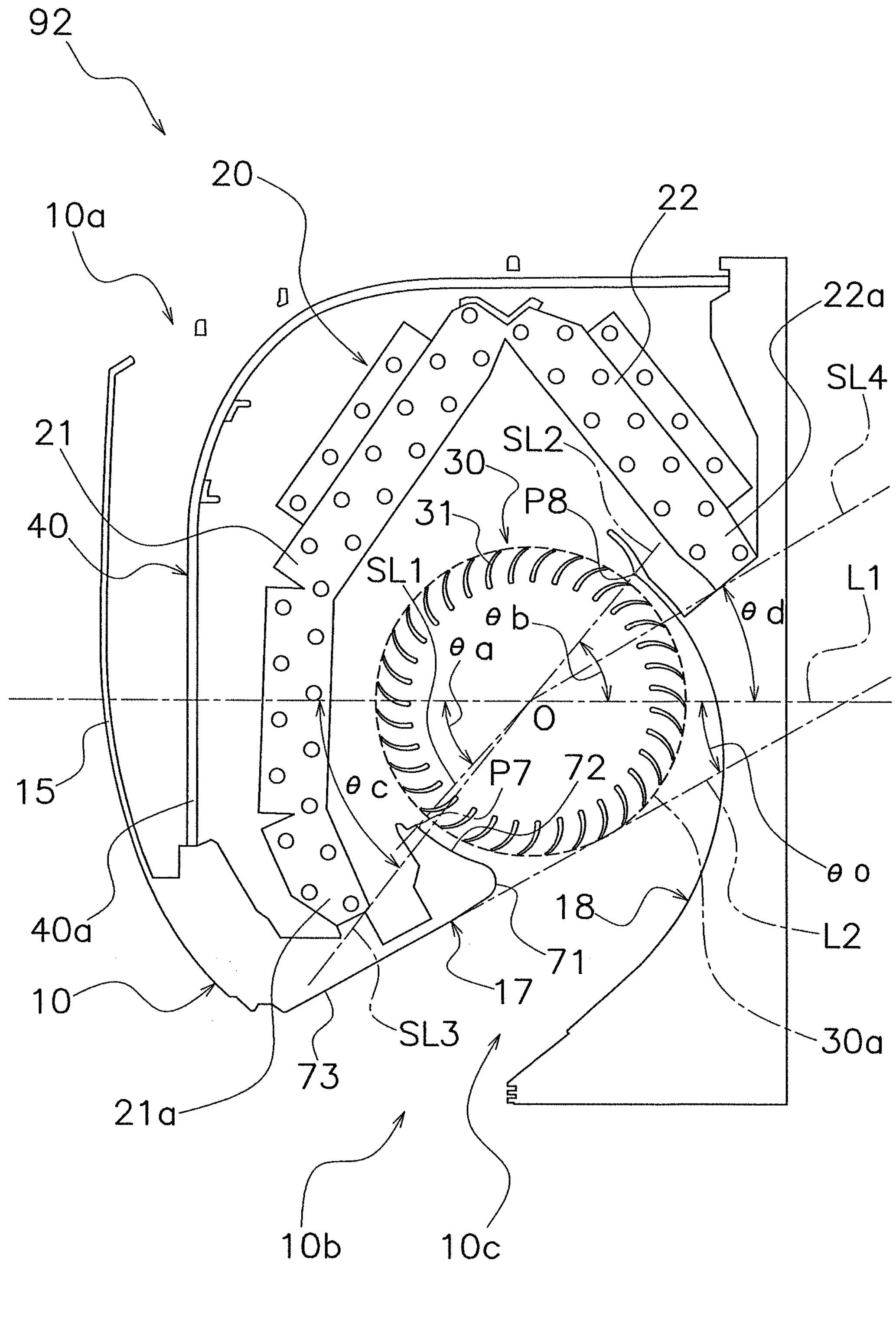
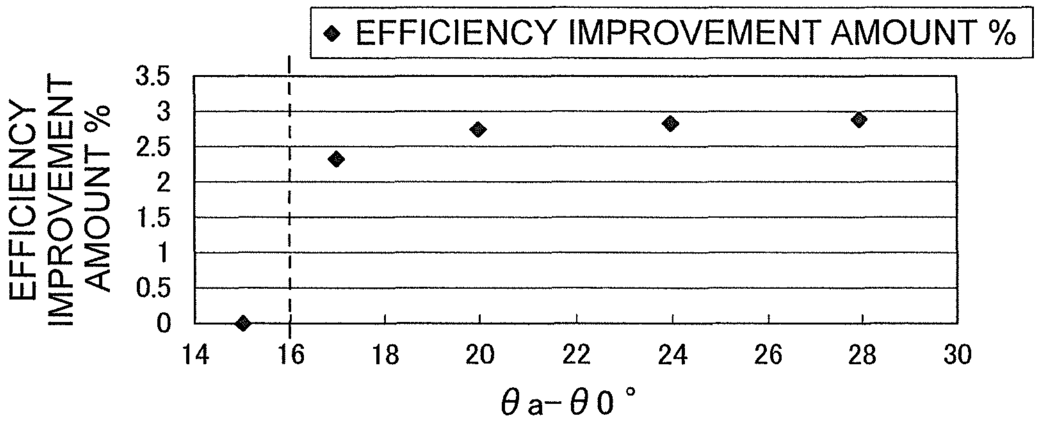

92
20
22
10a
22a
SL4
21
SL2
30
40
P8
31
L1
SL1
θ d
θ b
θ a
O
15
P7
72
θ c
θ o
40a
18
L2
71
10
17
SL3
30a
73
21a
10b
10c

FIG. 3

FIG. 4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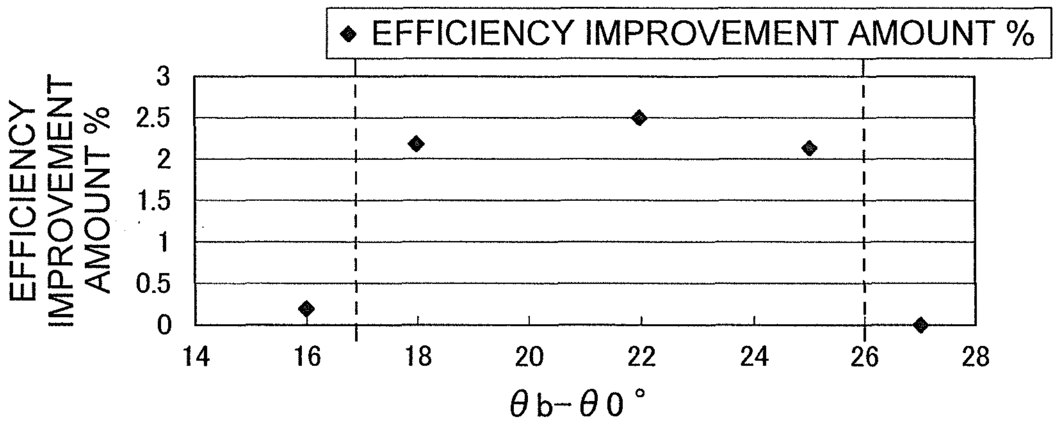
14
16
18
20
22
24
26
28
30
θa−θ0°

FIG. 5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20
22
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θb−θ0°

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/083440

A. CLASSIFICATION OF SUBJECT MATTER
F24F1/00(2011.01)i, *F24F13/20*(2006.01)i, *F24F13/30*(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, F24F13/20, F24F13/30

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	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

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	JP 2002-276585 A (Mitsubishi Heavy Industries, Ltd.), 25 September 2002 (25.09.2002), claim 2; paragraphs [0020] to [0021], [0039] to [0040]; fig. 1 to 2 & EP 1243864 A2 & CN 1376878 A	1-2
Y	JP 2006-177641 A (Mitsubishi Electric Corp.), 06 July 2006 (06.07.2006), claim 4; paragraphs [0029], [0038] to [0042]; fig. 1, 8 (Family: none)	1-2

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

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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
24 March 2015 (24.03.15)	31 March 2015 (31.03.15)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/083440

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2002/29331 A1 (Mitsubishi Electric Corp.), 11 April 2002 (11.04.2002), claims 10, 12; page 23, line 1 to page 24, line 26; page 26, line 14 to page 28, line 3; fig. 28, 37 & US 2002/0172588 A1 & EP 1321721 A1 & CN 1392940 A	1-2

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008008500 A **[0003] [0057]**