

INDOOR UNIT OF A VENTILATION SYSTEM,
VENTILATOR AND AIR CONDITIONER

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to an indoor unit configuration of a ventilation system, a ventilator and an air conditioner indoor unit in which reduction of noise is attained.

RELATED ART

A conventional example of this type air conditioner has been described in Unexamined Japanese Utility Model Application No. Sho 58-71613. A conventional example of the ventilator as a constituent member of the air conditioner indoor unit has been described in Unexamined Japanese Utility Model Application No. Hei 1-78292. Fig. 7 is a sectional view showing a conventional air conditioner indoor unit, and Fig. 8 is a perspective view thereof. In the drawings, the reference numeral 1 designates a ceiling panel, 2 a suction grill which forms an inlet port and 3 a ventilator disposed between the suction grill 2 and the ceiling panel 1. The reference numeral 4 designates a heat exchanger which is fixed to the ceiling panel 1 or the like. The reference numeral 5 designates a partition plate which is provided between the ventilator 3 and the heat exchanger 4 to form an air inlet chamber 10 and an air outlet chamber 11. The reference numeral 6 designates a

decorative panel which is fixed to the partition plate 5 or a side wall (not shown). The reference numeral 7 designates a drain pan provided at the lower portion of the heat exchanger 4 and 8 a front panel fixed to the ceiling panel 1 or the like. The reference numeral 9 designates a blowout grill which forms an outlet port. The reference numeral 12 designates a large number of through holes which are of one size and are arranged at regular intervals in a portion of the ceiling panel 1 between the partition plate 5 and the heat exchanger 4 to form an outlet chamber of the ventilator 3 as shown in Fig. 8. The reference numeral 13 designates a noise absorbing material, such as a urethane foam material, stuck to the inside of the ceiling panel 1 to block the through holes at the inside thereof.

Fig. 9 is a vertical sectional view showing a conventional ventilator as described in the Unexamined Japanese Utility Model Application No. Hei 1-78292, and Fig. 10 is a partly sectional view thereof. In the drawings, the reference numeral 14 designates a fan, 15 a blower casing having the fan 14 in its inside, 15a an outlet, 16 a porous structure provided along the inner surface of the blower casing 15 so as to be insulated from the inner surface of the blower casing 15, and 17 an air layer formed between the blower casing 15 and the porous structure 16.

The operation of the ventilator and the operation of the air conditioner will be described hereunder. The operation

of the air conditioner as described in the Unexamined Japanese Utility Model Application No. Sho 58-71613 will be described now with reference to Figs. 7 and 8. Indoor air sucked into the inlet chamber 10 through the suction grill 2 is blown out to the air outlet chamber 11 by the action of the ventilator 3 and passes through the heat exchanger 4, so that air is blown indoors from the blowout grill 9. At this time, ventilation noise generated from the ventilator 3 and air stream noise caused by air turbulence in the indoor unit are radiated from the suction grill 2 and the blowout grill 9. The noise generated in the inside is partially absorbed to the noise absorbing material 13 stuck to the ceiling panel 1. Furthermore, the noise is diffused upwards with respect to the ceiling panel 1 through the large number of through holes 12 just above the noise absorbing material. As a result, a part of noise generated from the air conditioner can be diffused so that noise propagated from the suction grill 2 and the blowout grill 9 can be suppressed to reduce the level of noise in the indoor living area.

The operation of the ventilator as described in the Unexamined Japanese Utility Model Application No. Hei 1-78292 will be described with reference to Figs. 9 and 10. Air flowing in from the axial direction by the rotation of the fan 14 is pressed out centrifugally, so that the air flows along the porous structure 16 provided in the inner surface of the blower casing 15 and is collected. The collected air is blown

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out through the outlet 15a. At this time, noise generated in the fan 14 flows together with the air, so that the noise is diffused radially from the fan 14. A part of the noise passes through the porous structure 16 and propagates in the air layer 17 in the inside thereof to strike the blower casing 15. Then, the noise reflects and propagates in the reverse direction, so that the noise is canceled by the next reflected noise. As a result, noise is suppressed.

The conventional air conditioner indoor unit according to the Japanese Utility Model Application No. Sho 58-71631 is constructed as described above to reduce noise by the action of the through holes 12 provided in the ceiling panel 1 and the action of the noise absorbing material 13. It is therefore necessary to use a continuously foamed air-permeable material as the noise absorbing material 13 to achieve a noise absorbing effect. There arises a problem in that air leakage occurs through the noise absorbing material 13 to reduce the quantity of air passing through the heat exchanger to thereby reduce the capacity thereof. A measure to increase the output power of the ventilator 3 to prevent the reduction of the air quantity cannot be used as a radical measure, because ventilation noise in the ventilator 3 is increased by this measure. If the through holes 12 of the ceiling panel 1 are blocked to prevent air leakage, there arises a problem in that the noise absorbing effect by the noise absorbing material 13 is lowered. The ventilator 3 stands a large part of all noise generation

sources in the air conditioner. Accordingly, the area of the noise absorbing material stuck must be widened so that noise generated can be absorbed to the noise absorbing material. In the case of the conventional air conditioner, the area of the noise absorbing material stuck is insufficient. There arises a disadvantage in that the noise absorbing effect cannot be achieved sufficiently.

The conventional ventilator according to Unexamined Japanese Utility Model Application No. Hei 1-78292 is constructed as described above. Accordingly, the blower casing must have the form in which not only a porous member is arranged in the outside of the fan 14 but an air layer is secured in the outside of the porous member. There arises a disadvantage in that the height of the casing becomes so large that a large setting space is required.

SUMMARY OF THE INVENTION

The present invention was made in view of the foregoing problems accompanying the conventional apparatus, and an object of the invention is to provide a

ventilator in which not only lowering of air quantity caused by air leakage or the like can be prevented but noise generated in the ventilator portion as a main noise generation source can be reduced, and to provide a parts arrangement adapted for this system.

The ventilator according to the present invention comprises: a ventilator comprising: a casing; a cross-flow impeller in the casing; an air-permeable porous structure which is fixed to any one of a main plate within and supporting the impeller, a shaft for rotating said impeller through said main plate and or a driving means for driving said impeller; the said porous structure being shaped generally like a cone of which the narrow end projects towards the inlet port end of the impeller and which is hollow; and an air chamber formed by said hollow cone-shaped porous structure and said main plate.

In the ventilator according to the present invention, not only noise from the ventilator is absorbed efficiently but air leakage is prevented, by a combination of a hollow-cone-shaped air-permeable porous structure provided at the inlet port of the ventilator and an air chamber formed at the back surface of the porous structure.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a ventilator according to a first embodiment of the invention;

Fig. 2 is a sectional view of the ventilator shown in Fig. 1;

Fig. 3 is a partly sectional view of the ventilator shown in Fig. 1;

Fig. 4 is a sectional view of a ventilator according to a second embodiment of the invention;

Fig. 5 is a sectional view of a ventilator according to a third embodiment of the invention;

Fig. 6 is a sectional view of a ventilator according to a fourth embodiment of the invention;

Fig. 7 is a sectional view showing a conventional air conditioner indoor unit;

Fig. 8 is a perspective view showing the conventional air conditioner indoor unit;

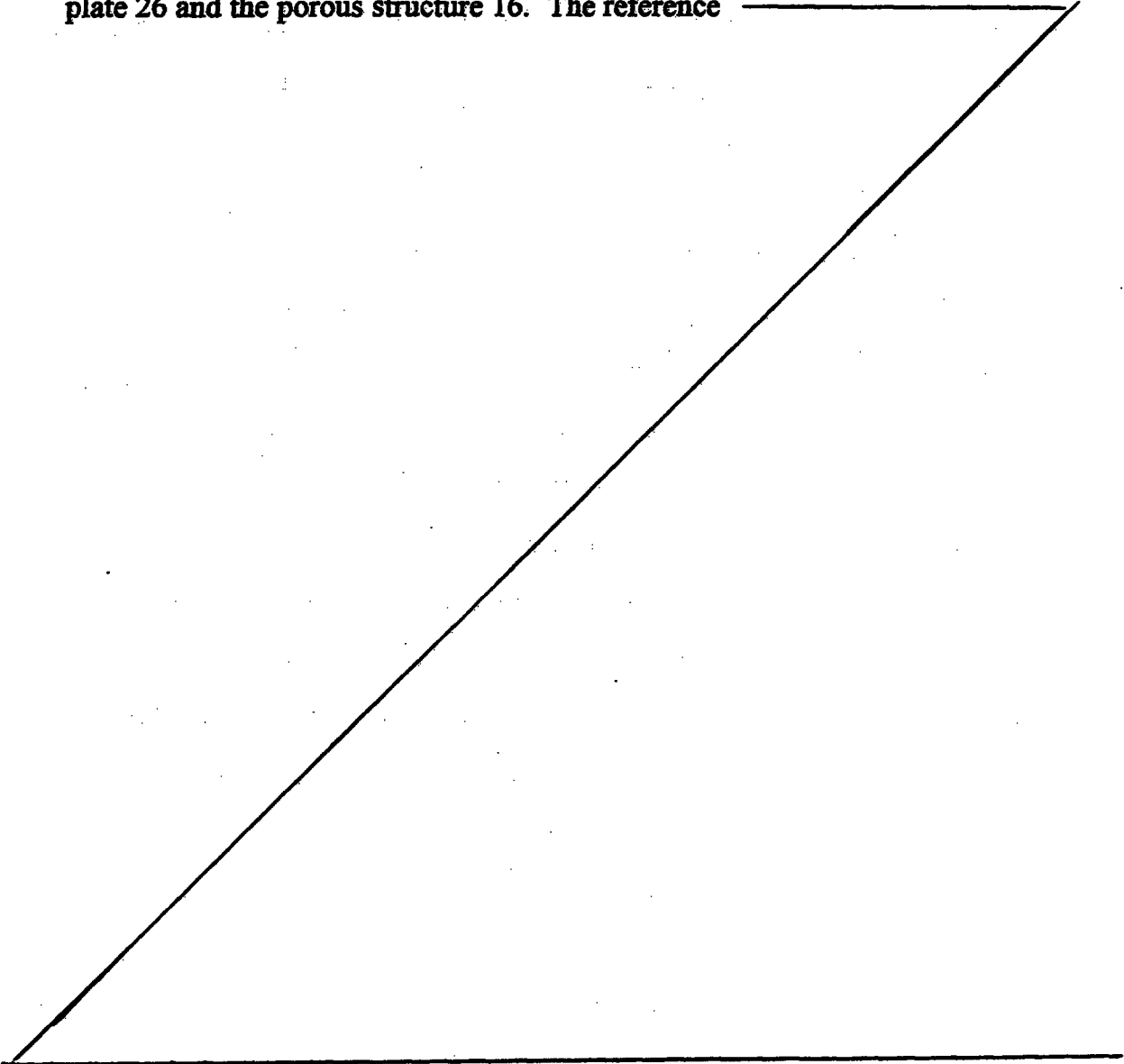
Fig. 9 is a sectional view showing a conventional ventilator; and

Fig. 10 is a partly sectional view showing the conventional ventilator.

Preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

Fig. 1 is a sectional view of a centrifugal ventilator formed by using a double suction type multiblade impeller in a ventilator which is a constituent member of the air conditioner indoor unit, Fig. 2 is a sectional view taken along the line VIII-VIII of Fig. 1, and Fig. 3 is a partly sectional view thereof. In each of the drawings like numerals refer to like parts. In the drawings, the reference numeral 22 designates a double suction type multiblade impeller, 15 a blower casing having the impeller 22 mounted to the inside thereof, 15a an outlet of

the blower casing and 15b an inlet thereof. The reference numeral 23 designates a rotation shaft for driving the ventilator, 25 a boss portion for fixing the multiblade impeller 22 to the rotation shaft 23, 26 a main plate for supporting the boss portion, 16 an air-permeable porous structure closely fixed to the main plate 26 by an adhesive agent or by screwing to form a hollow cone, 24 a through hole provided at the horn base portion of the porous structure to pierce the shaft therein, and 21 an air chamber formed by the main plate 26 and the porous structure 16. The reference



symbol D1 designates the inner diameter of the multiblade impeller.

The operation of the embodiment will be described hereunder. The double suction type multiblade impeller 22 makes a rotating motion by driving the rotation shaft 23, so that air is sucked along the shaft from the casing inlet 15b to the inside of the multiblade impeller 22. The air is radiated along the smooth conical surface of the air-permeable porous structure 16 attached to the inside of the multiblade impeller 22 and passes through blades of the multiblade impeller so that the air flows centrifugally. The air is collected along the spiral form of the blower casing 15 and then blown out through the blower casing outlet 15a. The porous structure 16 is shaped like a conical horn so that a through hole 24 being smallest to pierce the rotation shaft 23 is provided in the convex portion of the porous structure. The diameter of the porous structure opened in opposite directions is adjusted to the inner diameter D1 of the impeller. Furthermore, the end surface of the porous structure is cut perpendicularly to the center axis of the conical form to prevent the end surface from touching the blades. Accordingly, the blades can be used effectively as a whole, so that there arises no irregular flow.

Among ventilation noises generated when air passes through the impeller, noise propagating to the suction side of the impeller propagates as compressional wave. When the compressional wave passes through small pores of the porous

structure 16, the porous structure serves as resistance to absorb acoustic energy. Then, the compressional wave propagates to the air chamber 21 and reflects at the main plate 26 which serves as a partition plate for partitioning the sucked air. As a result, the compressional wave propagates in the direction reverse to the direction of incidence, so that the wave is canceled by the next incident wave and then passes through the porous structure 16 again to thereby promote the noise absorbing effect. Accordingly, noise generated in the ventilator can be reduced greatly.

Although the embodiment has shown the case of a centrifugal ventilator using a double suction type multiblade impeller, a second embodiment shows the case of a centrifugal ventilator using a single suction type multiblade impeller as will be described with reference to Fig. 4. In the drawings, parts the same as or equivalent to those in Figs. 1, 2 and 3 are referenced correspondingly. In the drawing, the reference numeral 29 designates a single suction type multiblade impeller, 15 a blower casing having the impeller 22 mounted to the inside thereof, and 15b an inlet of the blower casing. The reference numeral 23 designates a rotation shaft for driving the ventilator, 26 a main plate of the single suction type multiblade impeller, 16 an air-permeable porous structure closely fixed to the main plate 26 by an adhesive agent or by screwing to form a hollow cone, and 21 an air chamber formed by the porous structure 16 and the main plate 26.

The operation of the embodiment will be described hereunder. The single suction type multiblade impeller 29 makes a rotating motion by driving the rotation shaft 23, so that air is sucked along the shaft from the casing inlet 15b to the inside of the multiblade impeller 29. The air is radiated along the smooth conical surface of the air-permeable porous structure 16 attached to the inside of the multiblade impeller 29 and passes through blades of the multiblade impeller so that the air flows centrifugally. The air is collected along the spiral form of the blower casing 15 and then blown out through the blower casing outlet 15a. The porous structure 16 is shaped like a conical horn. The diameter of the porous structure opened in opposite directions is adjusted to the inner diameter of the impeller. Furthermore, the end surface of the porous structure is cut perpendicularly to the center axis of the conical form to prevent the end surface from touching the blades. Accordingly, the blades can be used effectively as a whole, so that there arises no irregular flow.

Among ventilation noises generated when air passes through the impeller, noise propagating to the suction side of the impeller propagates as compressional wave. When the compressional wave passes through small pores of the porous structure 16, the porous structure serves as resistance to absorb acoustic energy. Then, the compressional wave propagates to the air chamber 21 and reflects at the main plate 26. As a result, the compressional wave propagates in the

direction reverse to the direction of incidence, so that the wave is canceled by the next incident wave and then passes through the porous structure 16 again to thereby promote the noise absorbing effect. Accordingly, noise generated in the ventilator can be reduced greatly.

Although the second embodiment has shown the case where a single side bearing (not shown) is applied to the driving rotation shaft in the centrifugal ventilator using a single suction type multiblade impeller, a third embodiment shows the case where rotation shaft bearings are provided on both sides as will be described with reference to Fig. 5. In the drawings, the parts the same as or equivalent to those in Figs. 1 and 2 are referenced correspondingly. In the drawing, the reference numeral 29 designates a single suction type multiblade impeller, 15 a blower casing having the impeller 22 mounted to the inside thereof, and 15b an inlet of the blower casing. The reference numeral 23 designates a rotation shaft for driving the centrifugal ventilator, 26 a main plate of the single suction type multiblade impeller, and 28 a pair of shaft bearings. The porous structure 16 is a conical air-permeable structure in which both ends are opened. One end of the opening is closely fixed to the main plate of the impeller, and the other end is closely fixed to the rotation shaft 23 by an adhesive agent or by screwing. The reference numeral 21 designates an air chamber formed by the porous structure 16 and the main plate 26.

The operation of the embodiment will be described hereunder. The single suction type multiblade impeller 29 makes a rotating motion by driving the rotation shaft 23, so that air is sucked along the shaft from the casing inlet 15b to the inside of the multiblade impeller 29. The air is radiated along the smooth conical surface of the air-permeable porous structure 16 attached to the inside of the multiblade impeller 29 and passes through blades of the multiblade impeller so that the air flows centrifugally. The air is collected along the spiral form of the blower casing 15 and then blown out through the blower casing outlet 15a. The porous structure 16 is shaped like a cone. The diameter of the porous structure opened in opposite directions is adjusted to the inner diameter of the impeller. Furthermore, the end surface of the porous structure is cut perpendicularly to the center axis of the cone to prevent the end surface from touching the blades. Accordingly, the blades can be used effectively as a whole, so that there arises no irregular flow.

Among ventilation noises generated when air passes through the impeller, noise propagating to the suction side of the impeller propagates as compressional wave. When the compressional wave passes through small pores of the porous structure 16, the porous structure serves as resistance to absorb acoustic energy. Then, the compressional wave propagates to the air chamber 21 and reflects at the main plate 26. As a result, the compressional wave propagates in the

direction reverse to the direction of incidence, so that the wave is canceled by the next incident wave and then passes through the porous structure 16 again to thereby promote the noise absorbing effect. Accordingly, noise generated in the ventilator can be reduced greatly.

Although the second embodiment has shown the case where the driving motor (not shown) is provided in the outside of the blower casing, a fourth embodiment shows the case where the motor is provided in the inside of the blower casing as will be described with reference to Fig. 6. In the drawings, the parts the same as or equivalent to those in Figs. 1 and 2 are referenced correspondingly. In the drawing, the reference numeral 29 designates a single suction type multiblade impeller, 15 a blower casing having the impeller 22 mounted to the inside thereof, and 15b an inlet of the blower casing. The reference numeral 23 designates a rotation shaft for driving the centrifugal ventilator, 26 a main plate of the single suction type multiblade impeller, 20 a motor for driving the centrifugal ventilator, and 30 a leg for mounting the motor. The porous structure 16 is a conical air-permeable structure in which both ends are opened. One end of the opening is closely fixed to the outer circumferential surface of the motor, and the other end is closely fixed to the main plate of the impeller. The reference numeral 21 designates an air chamber formed by the porous structure 16 and the main plate 26.

The operation of the embodiment will be described hereunder. The single suction type multiblade impeller 29 makes a rotating motion by driving the rotation shaft 23, so that air is sucked along the shaft from the casing inlet 15b to the inside of the multiblade impeller 29. The air is radiated along the smooth conical surface of the air-permeable porous structure 16 attached to the inside of the multiblade impeller 29 and passes through blades of the multiblade impeller so that the air flows centrifugally. The air is collected along the spiral form of the blower casing 15 and then blown out through the blower casing outlet 15a.

Among ventilation noises generated when air passes through the impeller, noise propagating to the suction side of the impeller propagates as compressional wave. When the compressional wave passes through small pores of the porous structure 16, the porous structure serves as resistance to absorb acoustic energy. Then, the compressional wave propagates to the air chamber 21 and reflects at the main plate 26. As a result, the compressional wave propagates in the direction reverse to the direction of incidence, so that the wave is canceled by the next incident wave and then passes through the porous structure 16 again to thereby promote the noise absorbing effect. Accordingly, noise generated in the ventilator can be reduced greatly.

The porous structure 16 is shaped like a cone and fixed to the motor. The open side of the porous structure is not

closely fixed to the main plate of the impeller, so that the noise reducing effect is lowered compared with the Embodiments 3, 4 and 5. The motor is provided in the inside of the casing, so that the size of the ventilator can be reduced.

The present invention has the following effects.

The ventilator has an air-permeable porous structure which is fixed to a main plate for supporting an impeller of the ventilator and is shaped like a cone in which the inside projecting to the inlet port side is hollow, and an air chamber formed by the porous structure and the main plate. Accordingly, not only noise from the ventilator can be absorbed efficiently but deterioration of the aerodynamic characteristic of the ventilator caused by air leakage can be prevented, so that a low-noise ventilator can be provided.

**CLAIMS**

1. **A ventilator comprising:**
 a casing; a cross-flow impeller in the casing;
 an air-permeable porous structure which is fixed to any one of a main
plate within and supporting the impeller, a shaft for rotating said impeller
through said main plate and or a driving means for driving said impeller; the
said porous structure being shaped generally like a cone of which the narrow
end projects towards the inlet port end of the impeller and which is hollow; and
 an air chamber formed by said hollow cone-shaped porous structure and
said main plate.

2. **An air conditioner indoor unit substantially as described with reference**
to figures 1 to 3, figure 4, 5 or 6 of the accompanying drawings.