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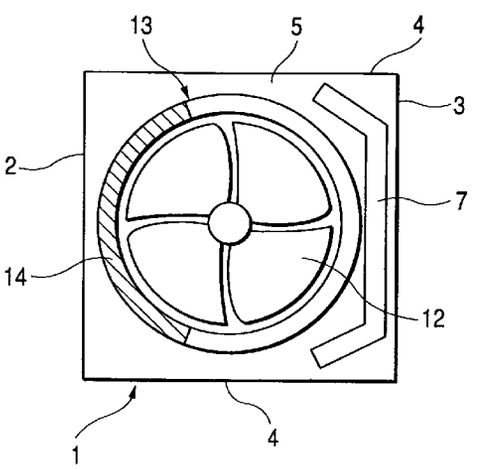
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(54) An outdoor unit of an air-conditioning system

(57) To provide an outdoor unit of an air-conditioning system characterized in that the outdoor unit has a reduced bodily size. The outdoor unit is characterized in that said bell mouth 13 is provided with a damping portion 14 which extends in an upstream direction from part of the circumference of said bell mouth 13 , said part 4 of the circumference located on a side opposite to said heat exchanger 7 where said propeller fan 12 and a side panel 4 are positioned close to each other.

FIG. 2



EP 0 922 911 A2

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an air-conditioning system. More particularly, it is concerned with an outdoor unit of an air-conditioning system that is suited for installation on a rooftop, for example.

[0002] For instance, an outdoor unit proposed in Japanese Unexamined Patent Publication No. 3-255829 is an example of an outdoor unit of an air-conditioning system. This outdoor unit is constructed such that a bell mouth for guiding an air flow produced by a fan is provided at an extreme end of a shroud which forms an air outlet, with a specified clearance provided between the outer periphery of the fan and the bell mouth, and the distance between an extreme end, or the uppermost part, of the bell mouth and the lowermost part of the fan varies along its circumferential direction.

[0003] By employing such construction, it becomes possible to achieve a uniform distribution of air flowing through a heat exchanger and improve the efficiency of heat exchange. The above construction also helps reduce fluid flowing noise produced when the air flows through the heat exchanger.

[0004] When a building is equipped with an air-conditioning system, its outdoor units are installed on rooftop in many cases. Generally speaking, an area available for installing the outdoor units on the rooftop is limited and the number of outdoor units (which determines air-conditioning capacity) is determined by the available rooftop area.

[0005] Thus, to increase the overall air-conditioning capacity, it is necessary to increase the number of outdoor units that can be installed on the rooftop without reducing the capacity of the individual outdoor units, and to install a large number of outdoor units in a limited area, it is essential to reduce the physical size of each outdoor unit.

[0006] One approach to reducing the size of an outdoor unit without sacrificing its capacity is to reduce distances between its various components assembled into the outdoor unit, such as a heat exchanger, propeller fan, compressor and electric element box, without changing their physical sizes and thereby reduce the size of a housing of the outdoor unit.

[0007] When the physical size of the outdoor unit is reduced in this fashion, its inside becomes congested, causing an increased resistance exerted on the air flowing in the interior space of the outdoor unit. This would lead to pressure pulsation due to periodic compression of the air caused by blades of the propeller fan on its inflow side. Furthermore, the distribution of flow velocity of the air flowing through the heat exchanger becomes uneven when the distance between the heat exchanger and the propeller fan is reduced. This would then cause acoustic noise and/or vibration from the outdoor unit when the air-conditioning system is operated.

[0008] Especially when the distance between a side panel on a side where the heat exchanger is not mounted and the propeller fan is small, a high level of acoustic noise would be produced because the aforementioned pressure pulsation causes the side panel to vibrate as well as the whole housing which would vibrate as a resonance box.

[0009] In view of the foregoing situation, it is an object of the invention to provide an outdoor unit of an air-conditioning system characterized in that the outdoor unit has a reduced physical size, and vibration of a housing of the outdoor unit caused by the aforementioned pressure pulsation is reduced.

SUMMARY OF THE INVENTION

[0010] To achieve the aforementioned object, an outdoor unit of an air-conditioning system of the invention is constructed such that a bell mouth is provided with a damping portion which extends in an upstream direction from part of the circumference of the bell mouth, the part of the circumference located on a side opposite to a heat exchanger where a propeller fan and a side panel are positioned close to each other.

[0011] In the aforementioned outdoor unit of the invention, an upstream end of the damping portion is formed such that it is located at the same position with at least an upstream end of the propeller fan.

[0012] Further, it is preferable according to the invention that the damping portion be one-piece formed with the bell mouth in the aforementioned outdoor unit.

[0013] Further, it is preferable according to the invention that the damping portion be one-piece formed with a top panel of the outdoor unit and the bell mouth in the aforementioned outdoor unit.

[0014] Further, it is preferable according to the invention that the damping portion be formed separately from the bell mouth and detachably attached to the bell mouth in the aforementioned outdoor unit.

[0015] Further, it is preferable according to the invention that the damping portion be formed of a synthetic resin in the aforementioned outdoor unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a side view showing the construction of an outdoor unit of an air-conditioning system embodying the present invention;

FIG. 2 is a plan view of the outdoor unit of FIG. 1;

FIG. 3 is an enlarged view of a propeller fan section of FIG. 1;

FIG. 4 is a perspective view of a bell mouth of FIG. 1;

FIG. 5 is an enlarged sectional view of portion B of FIG. 4.

FIG. 6 is a plan view showing an outdoor unit of an

air-conditioning system according to a second embodiment of the invention;

FIG. 7 is a plan view showing an outdoor unit of an air-conditioning system according to a third embodiment of the invention;

FIG. 8 is a plan view showing an outdoor unit of an air-conditioning system according to a fourth embodiment of the invention;

FIG. 9 is a perspective view of a bell mouth according to the second embodiment of the invention;

FIG. 10 is a perspective view of a bell mouth according to the third embodiment of the invention;

FIG. 11 is a perspective view of a bell mouth according to the fourth embodiment of the invention;

FIG. 12 is a perspective view of a bell mouth according to a fifth embodiment of the invention;

FIG. 13 is a perspective view of a bell mouth according to a sixth embodiment of the invention;

FIG. 14 is a perspective view of a bell mouth according to a seventh embodiment of the invention;

FIG. 15 is a perspective view of a bell mouth according to an eighth embodiment of the invention;

FIG. 16 is a perspective view of a bell mouth according to a ninth embodiment of the invention; and

FIG. 17 is a perspective view of a bell mouth according to a tenth embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] Embodiments of the invention are now described with reference to the drawings.

[0018] FIG. 1 is a side view showing the construction of an outdoor unit of an air-conditioning system embodying the present invention; FIG. 2 is a plan view of the outdoor unit of FIG. 1; FIG. 3 is an enlarged view of a propeller fan section of FIG. 1; FIG. 4 is a perspective view of a bell mouth of FIG. 1; and FIG. 5 is an enlarged sectional view of portion B of FIG. 4.

[0019] In these Figures, the numeral 1 indicates a housing of the outdoor unit constructed of a front panel 2, a rear panel 3, left and right side panels 4, a top panel 5 and a bottom plate 6. The numeral 7 indicates a heat exchanger which is located close to the rear panel 3 of the housing 1. The numeral 8 indicates a machine compartment which is located close to the front panel 2, incorporating mechanical devices such as a compressor. The numeral 9 indicates an electric element box which is located above the machine compartment 8, incorporating electric devices such as a controller.

[0020] The numeral 10 indicates a motor support which is fixed to a specific position inside the housing 1. The numeral 11 indicates a motor fixed to the motor support 10. The numeral 12 indicates a propeller fan which is fixed to a rotary shaft 11a of the motor 11. Indicated by the numeral 13 is the bell mouth which includes a guide portion 13a for guiding air blown out from the propeller fan 12 and a damping portion 14 projecting upstream from the guide portion along its axial direction, in which the guide portion 13a and the damping portion 14 are formed into a single piece as shown in FIG. 4. The bell mouth 13 is fixed to an air outlet of the top panel 5 in such a way that the guide portion 13a surrounds an outflow side of the propeller fan 12 with a specified clearance provided between the guide portion 13a and the propeller fan 12, and the damping portion 14 is located between the front panel 2 and the propeller fan 12. An end surface 14a of the damping portion 14 at its upstream side is chamfered into an arc shape in cross section as shown in FIG. 5.

[0021] In this construction, the propeller fan 12 rotates when the motor 11 is run, and air in the housing 1 is blown out through the bell mouth 13. Then, a negative pressure is developed inside the housing 1 and, as a consequence, outside air flows into the housing 1 through the heat exchanger 7.

[0022] When the rotating propeller fan 12 forces out the inside air of the housing 1 in the direction of arrows C shown in FIG. 3, there exist air streams in the proximity of the propeller fan 12 that flow into the propeller fan 12 from its radial directions. If the clearance between the front panel 2 and the propeller fan 12 is small, however, there exist no air streams flowing into the propeller fan 12 from the radial directions.

[0023] In this case, the propeller fan 12 draws in the air just from its axial direction and, therefore, pressure variations (pressure pulsation) that cause the front panel 2 to vibrate in the direction of arrow A shown in FIG. 3 occur on an inflow side of the propeller fan 12. However, it is possible to reduce vibration of the front panel 2 in this embodiment, because the damping portion 14 exists between the front panel 2 and the propeller fan 12 and the influence of pressure pulsation is exerted on the damping portion 14.

[0024] The bell mouth 13 and the damping portion 14 may be one-piece formed using a metallic or synthetic resin material. Alternatively, the bell mouth 13 and the damping portion 14 may be formed of metallic and synthetic resin materials, respectively. When using a synthetic resin material only, it is desirable to shape each connecting corner area 14b between the bell mouth 13 and the damping portion 14 into the form of an arc as shown in FIG. 4.

[0025] FIG. 6 is a plan view showing an outdoor unit of an air-conditioning system according to a second embodiment of the invention. In this Figure, elements identical to those shown in FIG. 2 are designated by the same reference numerals. When a heat exchanger 7 is mounted along a rear panel 3 and one side panel 4 as illustrated, the clearance between the outer periphery of a propeller fan 12 and a front panel 2 and the other side panel 4 decreases. Thus, a bell mouth 13 is installed such that a damping portion 14 is positioned in the

clearance between them to thereby reduce vibration of the outdoor unit caused by pressure pulsation.

[0026] FIG. 7 is a plan view showing an outdoor unit of an air-conditioning system according to a third embodiment of the invention.

[0027] In this Figure, elements identical to those shown in FIG. 2 are designated by the same reference numerals. When a heat exchanger 7 is mounted only along a rear panel 3 as illustrated, the clearance between the outer periphery of a propeller fan 12 and a front panel 2 and left and right side panels 4 decreases. Thus, a bell mouth 13 is installed such that a damping portion 14 is positioned in the clearance between them to thereby reduce vibration of the outdoor unit caused by pressure pulsation.

[0028] FIG. 8 is a plan view showing an outdoor unit of an air-conditioning system according to a fourth embodiment of the invention.

[0029] In this Figure, elements identical to those shown in FIG. 2 are designated by the same reference numerals. When a heat exchanger 7 is mounted along a rear panel 3 and both left and right side panels 4 as illustrated, the clearance between the outer periphery of a propeller fan 12 and a front panel 2 decreases. Thus, a bell mouth 13 is installed such that a damping portion 14 is positioned in the clearance between them to thereby reduce vibration of the outdoor unit caused by pressure pulsation.

[0030] FIG. 9 is a perspective view of the bell mouth according to the second embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from the propeller fan and the damping portion 14 projecting upstream from the guide portion 13a along its axial direction, in which the guide portion 13a and the damping portion 14 are formed into a single piece and a far end of the damping portion 14 at its upstream side is cut into an arc shape.

[0031] FIG. 10 is a perspective view of the bell mouth according to the third embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from the propeller fan and the damping portion 14 projecting in a semicircular shape upstream from the guide portion 13a along its axial direction, in which the guide portion 13a and the damping portion 14 are formed into a single piece.

[0032] FIG. 11 is a perspective view of the bell mouth according to the fourth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from the propeller fan and the damping portion 14 projecting upstream from the guide portion 13a along its axial direction, the width of the damping portion 14 decreasing toward the upstream side, in which the guide portion 13a and the damping portion 14 are formed into a single piece.

[0033] FIG. 12 is a perspective view of a bell mouth according to a fifth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from a propeller fan and a damping portion 14 projecting upstream from the guide portion 13a along its axial direction, in which the damping portion 14 is cut into an arc shape in such a way that the width of the damping portion 14 decreases toward the upstream side, and the guide portion 13a and the damping portion 14 are formed into a single piece.

[0034] The constructions shown in FIGS. 9, 10, 11 and 12 make it possible to reduce the cost of materials without impairing the damping effect when the position where pressure pulsation occurs exists close to the guide portion 13a due to the relationship between the positions of the propeller fan and the bell mouth 13 along the axial direction.

[0035] FIG. 13 is a perspective view of a bell mouth according to a sixth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from a propeller fan and a damping portion 14 projecting upstream from the guide portion 13a along its axial direction, in which the damping portion 14 is cut at its connecting areas adjoining the guide portion 13a in such a way that the width of the damping portion 14 increases toward the upstream side, and the guide portion 13a and the damping portion 14 are formed into a single piece.

[0036] FIG. 14 is a perspective view of a bell mouth according to a seventh embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from a propeller fan and a damping portion 14 projecting upstream from the guide portion 13a along its axial direction, in which the damping portion 14 is cut into an arc shape at its connecting areas adjoining the guide portion 13a in such a way that the width of the damping portion 14 increases toward the upstream side, and the guide portion 13a and the damping portion 14 are formed into a single piece.

[0037] The constructions shown in FIGS. 13 and 14 make it possible to reduce the cost of materials without impairing the damping effect when the position where pressure pulsation occurs exists upstream side of the damping portion 14 due to the relationship between the positions of the propeller fan and the bell mouth 13 along the axial direction.

[0038] FIG. 15 is a perspective view of a bell mouth according to an eighth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth which includes a guide portion 13a for guiding air blown out from a propeller fan and a damping portion 14 which is formed separately from the guide portion 13a and is detachably joined to the guide portion 13a by fixing parts 15 like screws.

[0039] In this construction, it is possible to produce the guide portion 13a and the damping portion 14 with dis-

similar materials and to increase the degree of freedom in the shape of the damping portion 14.

[0040] FIG. 16 is a perspective view of a bell mouth according to a ninth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth of which guide portion 13a and damping portion 14 are formed as single piece together with a top panel 5.

[0041] FIG. 17 is a perspective view of a bell mouth according to a tenth embodiment of the invention. In this Figure, the numeral 13 indicates the bell mouth of which guide portion 13a and a top panel 5 is formed as single piece while a damping portion 14 is formed as a separate element and detachably joined to the guide portion 13a by fixing parts 15.

[0042] In the constructions shown in FIGS. 16 and 17, it is possible to reduce man-hours required for assembling an outdoor unit and thereby improve labor efficiency. In the constructions of FIG. 17, it is also possible to produce the guide portion 13a and the damping portion 14 with dissimilar materials and to increase the degree of freedom in the shape of the damping portion 14.

[0043] As thus far described, the present invention makes it possible to decrease vibration of an outdoor unit of an air-conditioning system due to pressure pulsation which is produced by a propeller fan when the physical size of the outdoor unit is reduced.

Claims

1. An outdoor unit of an air-conditioning system, said outdoor unit comprising:

   a top panel in which an air outlet is formed;
   a propeller fan provided inside said air outlet;
   a bell mouth provided at said air outlet with a specified clearance between the outer periphery of said propeller fan and said bell mouth; and
   a heat exchanger provided between said top panel and a bottom plate;
   wherein said outdoor unit is so constructed as to draw in air for cooling said heat exchanger through part of a side panel, and wherein said outdoor unit is characterized in that said bell mouth is provided with a damping portion which extends in an upstream direction from part of the circumference of said bell mouth, said part of the circumference located on a side opposite to said heat exchanger where said propeller fan and a side panel are positioned close to each other.

2. An outdoor unit of an air-conditioning system as defined in claim 1, said outdoor unit being characterized in that an upstream end of said damping portion is formed such that it is located at the same position with at least an upstream end of said propeller fan.

3. An outdoor unit of an air-conditioning system as defined in claim 1 or 2, said outdoor unit being characterized in that said damping portion is one-piece formed with said bell mouth.

4. An outdoor unit of an air-conditioning system as defined in claim 1 or 2, said outdoor unit being characterized in that said damping portion is one-piece formed with the top panel of said outdoor unit and said bell mouth.

5. An outdoor unit of an air-conditioning system as defined in claim 1 or 2, said outdoor unit being characterized in that said damping portion is formed separately from said bell mouth and detachably attached to said bell mouth.

6. An outdoor unit of an air-conditioning system as defined in claim 4, said outdoor unit being characterized in that said damping portion is formed of a synthetic resin.

FIG. 1

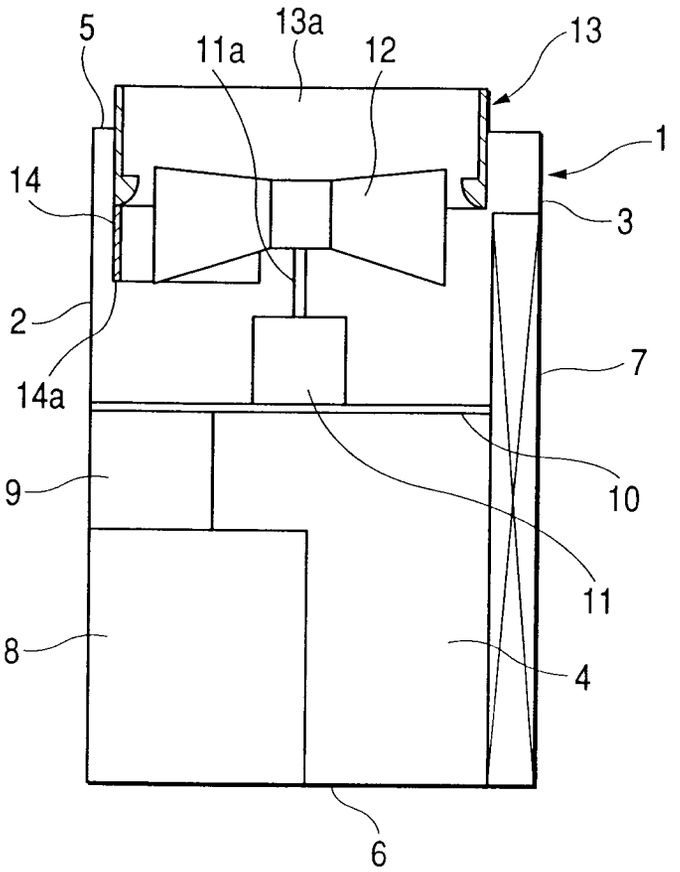


FIG. 2

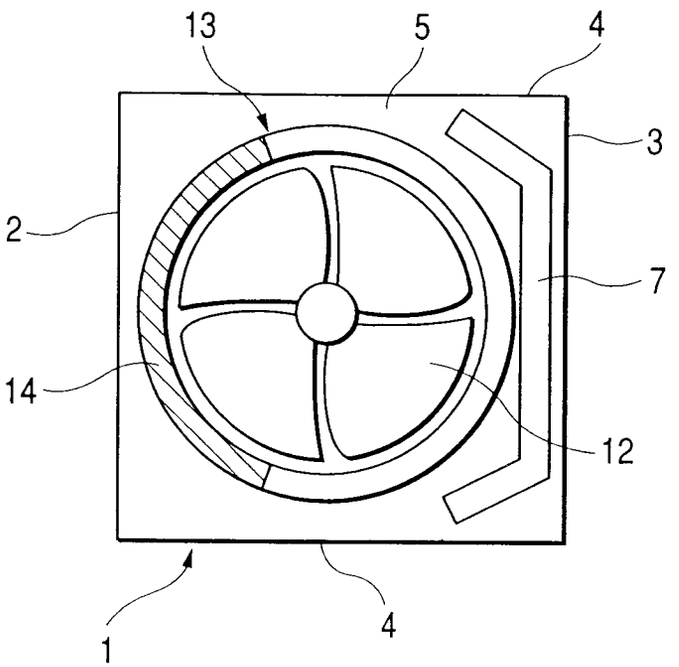


FIG. 3

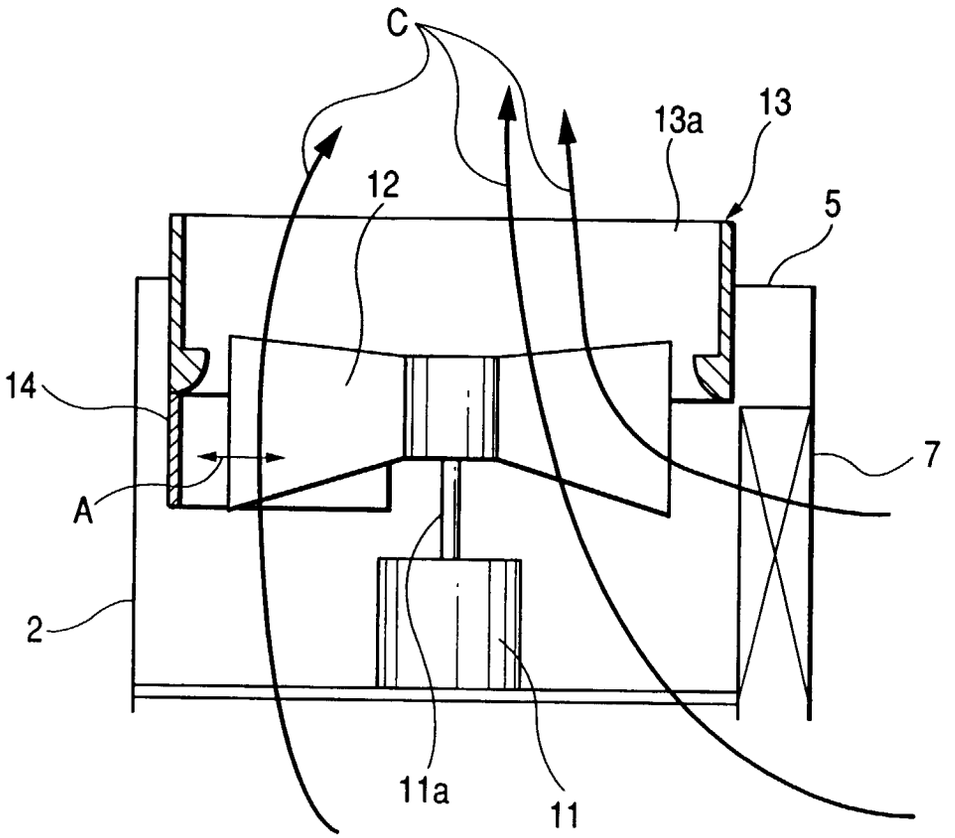


FIG. 4

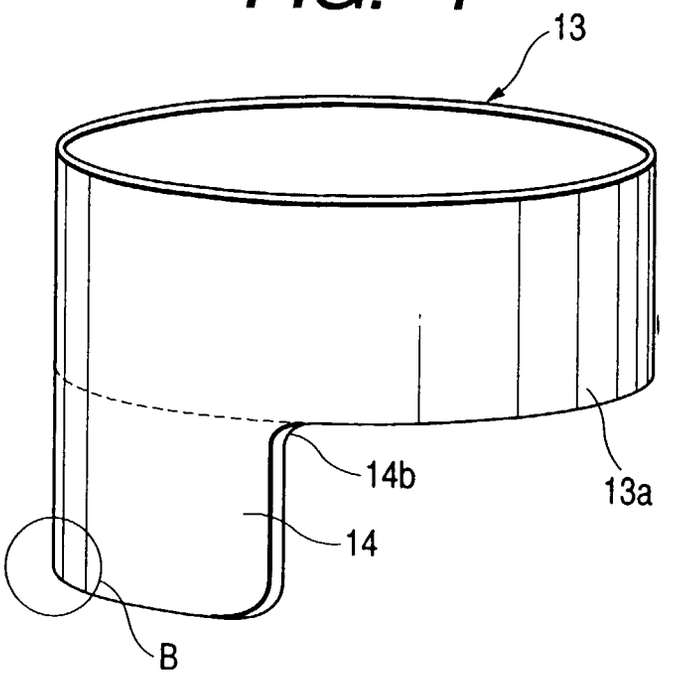


FIG. 5

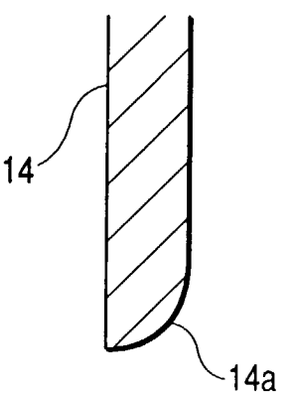


FIG. 6

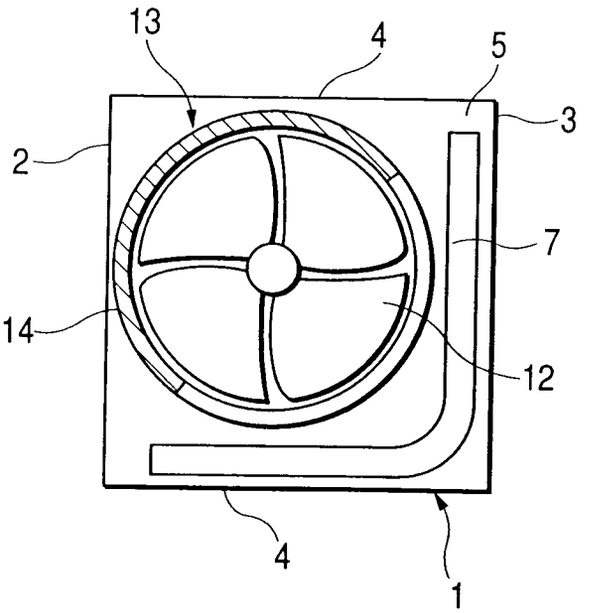


FIG. 7

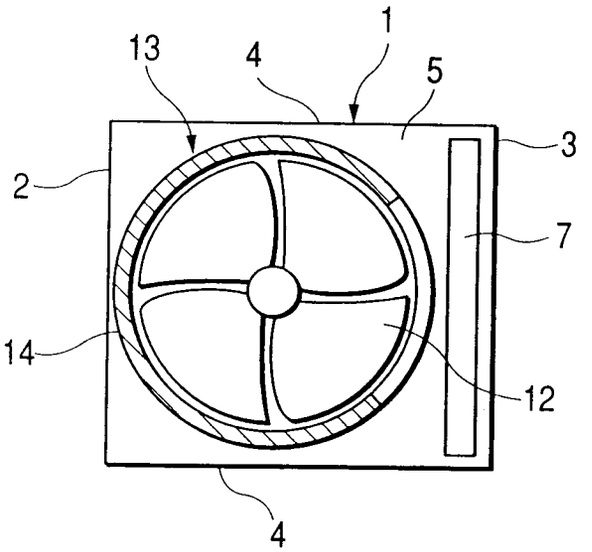


FIG. 8

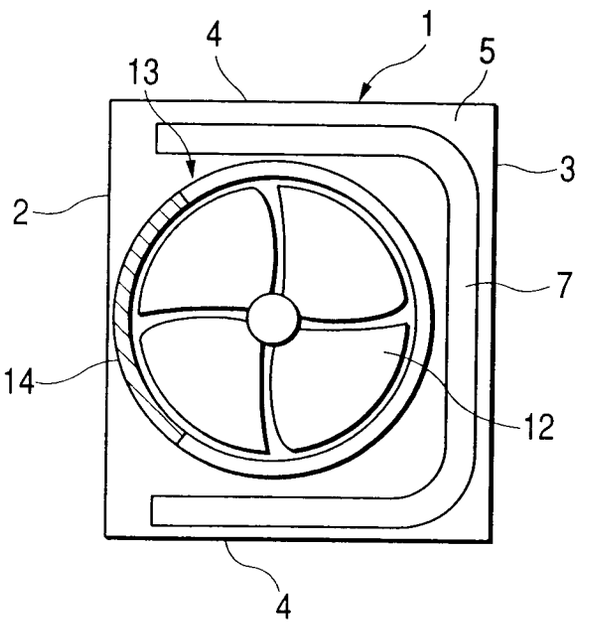


FIG. 9

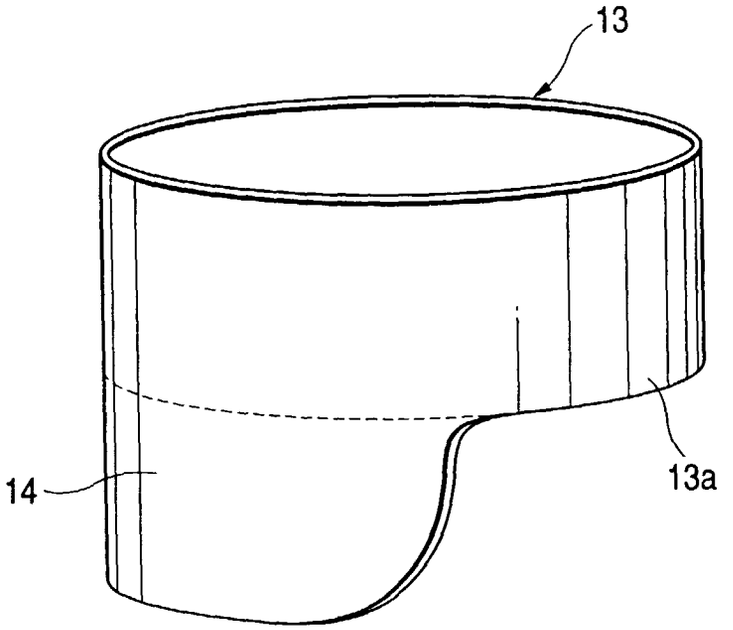


FIG. 10

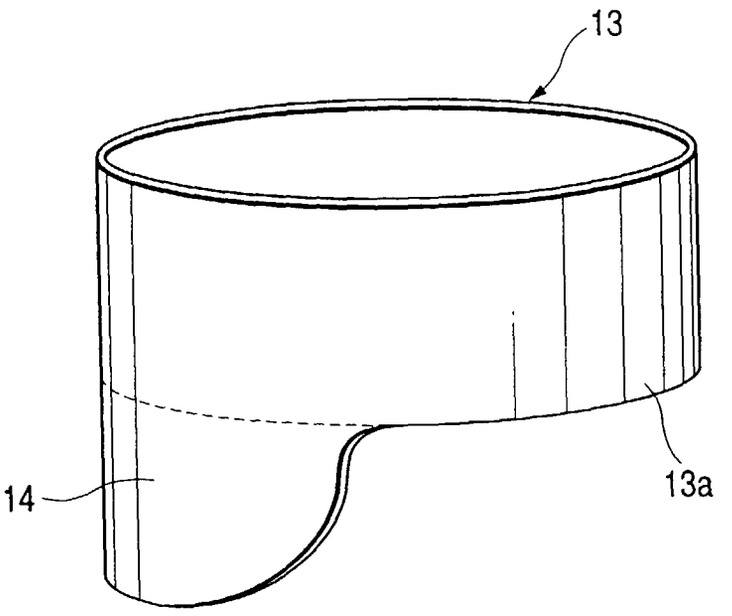


FIG. 11

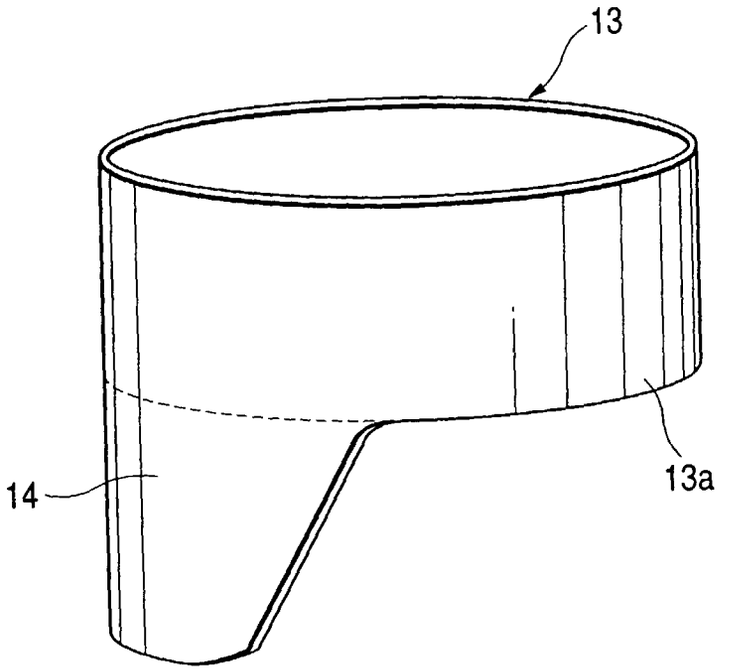


FIG. 12

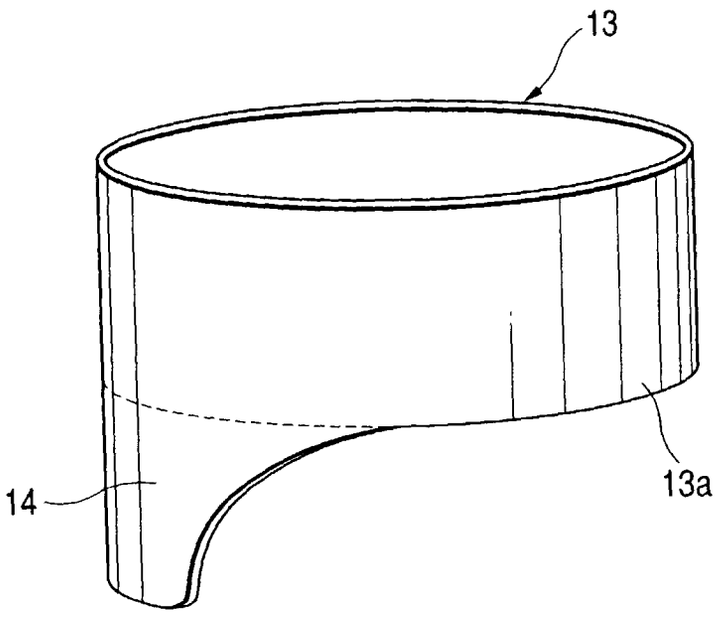


FIG. 13

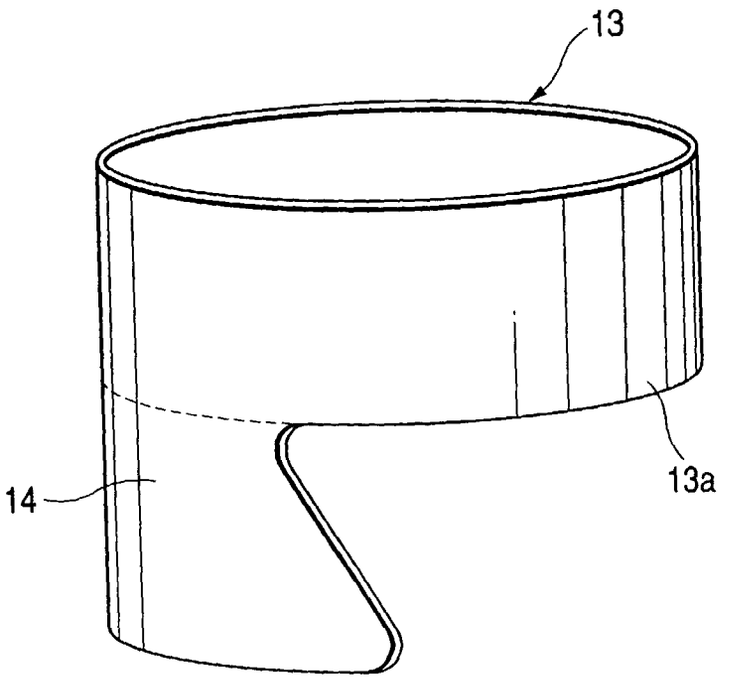


FIG. 14

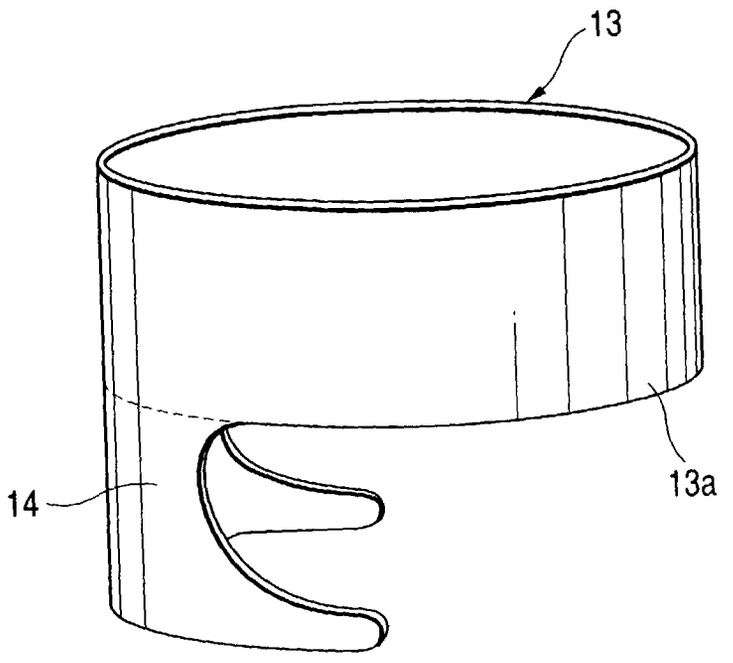


FIG. 15

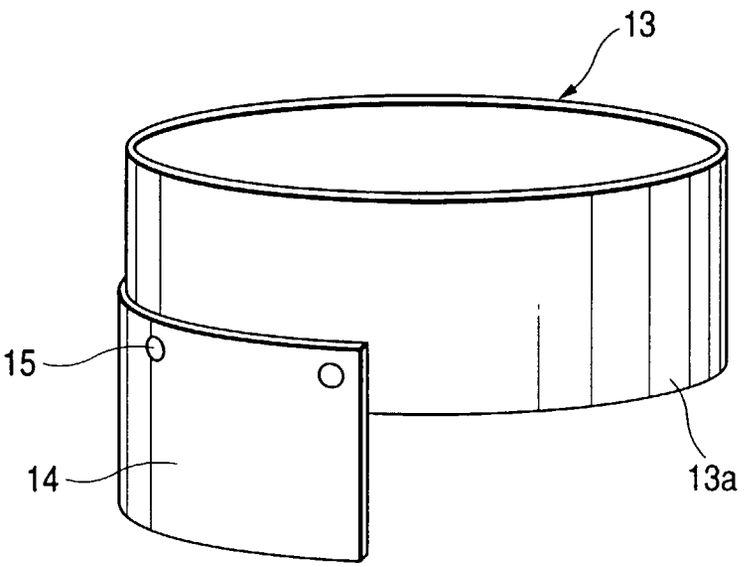


FIG. 16

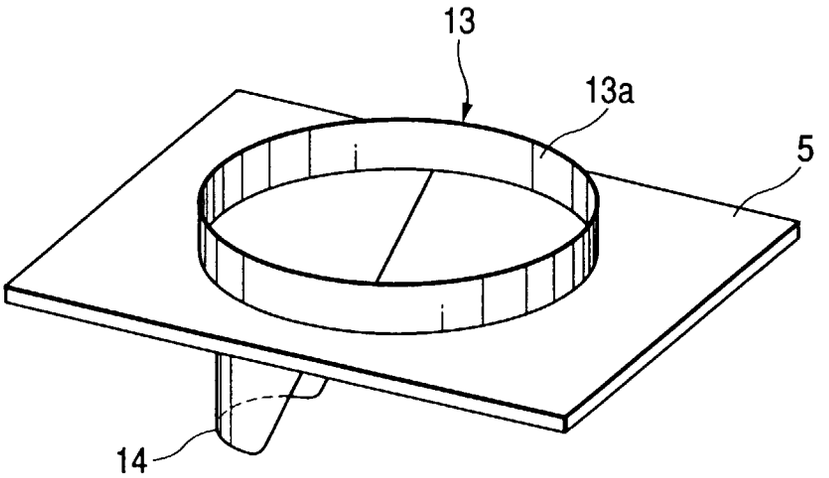


FIG. 17

