

DESCRIPTION

Fan Guard for Air Blower Unit

Field of the Invention

5 The present invention relates to fan guards for air blower unit having blower fans which are mounted at air outlets of the air blower unit.

Background of the Invention

10 There are air blower units provided in outdoor units of air conditioners, in which, for example, fan guards are provided at air outlets of blower fans for protecting the blower fans.

15 As the above fan guards, there are well known fan guards in which many radially arranged radial ribs and many coaxially arranged annular ribs are formed integrally by a synthetic resin. The radial ribs and the annular ribs of such fan guards made of a synthetic resin have flat sections along the direction of the rotation axis of the blower fans for maintaining the strength and reducing pressure loss of forced airflow flowing between the ribs.

20 As a function that the fan guards with such a structure are required to have, the fan guards should have enough strength to prevent fingers or foreign matters from entering in error between the annular ribs.

 Pushing an object of a given size with a given force expands the intervals of the annular ribs, so that the object enters. As the strength of the fan guards with the above structure to prevent this entering, strength at the outermost peripheral part where the intervals of the radial ribs become the widest is used as a reference value for design.

25 However, the intervals of the radial ribs of the fan guards of this type are narrower as it approaches the center, which invites increase in ventilating resistance and in noise. In order to tackle these disadvantages, a fan guard has been proposed which restrains

excessive increase in the ventilating resistance in the interior part by thinning the radial ribs inside a point where the intervals of the radial ribs are smaller as it goes inward and the rib density is twice as high as a reference, which means intervals of the radial ribs at the outermost periphery (for example, Japanese Patent Application Laid Open Publication
5 No. 2002-195610).

-Problems to be Solved-

Referring to fan guards of air blower units used in apparatuses provided outdoors, such as outdoor units for air conditioners, it is necessary to provide a function of
10 preventing breakage of the blower fan, which results from contact with the rear edge of a vane of the blower fan due to bending of the fan guard, in addition to the function of preventing foreign matters from entering between the annular ribs. The causes of the fan guard bending are that: an object such as a ball collides with the fan guard, to bend the central part of the fan guard; snow in winter accumulates on the fan guard where the rotary
15 shaft of the blower fan is arranged perpendicularly upward, so that the weight of the snow bends the fan guard.

The fan guards with the above structure are fixed at outer frames thereof to the unit bodies. Therefore, the radial ribs works more than the annular ribs for preventing deformation due to load application to the central parts of the fan guards. Hence, the
20 number, the arrangement, the shape of the section and the like of the radial ribs influence much the strength against bending.

However, in the case where the inner radial ribs are thinned in the fan guard as disclosed in the above gazette, the increase in the ventilating resistance is suppressed while the strength against bending at the central part decreases, with a result that the fan guard is
25 liable to be deformed due to load application to the central part. Thus, the vanes of the blower fan may come into contact with the thus deformed part of the fan guard.

The present invention has been made in view of the above problems and has its

object of preventing the increase in the ventilating resistance of the forced airflow while ensuring strength to prevent rib expansion and the strength to prevent bending of the fan guard.

Summary of the Invention

According to an aspect of the present invention, there is provided a fan guard of a blower unit which is provided with, between a blocking plate arranged at a central part and an outer frame arranged at an outer periphery, a plurality of annular ribs arranged coaxially in a radial direction at predetermined intervals with a center of the blocking plate as a center, and a plurality of radial ribs extending radially from the blocking plate 14 to the outer frame and arranged at regular intervals in a peripheral direction, and which is mounted at an air outlet of a blower unit having a blower fan, characterized in that : the radial ribs includes a plurality of inner ribs extending from the blocking plate to a substantial center in the radial direction and arranged at regular intervals in the peripheral direction, and a plurality of outer ribs extending from the substantial center in the radial direction to the outer frame and arranged at regular intervals in the peripheral direction, and the number of the inner ribs is set smaller than the number of the outer ribs.

According to embodiments of the present invention, sufficient strength to prevent expansion of the annular ribs in the radial direction when a foreign matter enters between the annular ribs may be ensured.

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Further, the inner ribs are connected to the blocking plate, whereby less number of the inner ribs than that of the outer ribs may invite no lowering of the strength at the central part of the fan guard. Moreover, sufficient strength to prevent bending of the fan guard at load application in the axial direction can be ensured and the increase in ventilating resistance of the forced airflow W from the blower fan can be suppressed.

As a result, the fan guard can be prevented from coming into contact with the blower fan due to deformation of the fan guard and noise and required input energy of the blower fan 3 can be reduced.

The radial ribs may include a plurality of extending ribs extending from the blocking plate to the outer frame and arranged at regular intervals in the peripheral direction in the fan guard of the first invention. The inner ribs can be arranged between the extending ribs, and the inner ribs and the extending ribs can be arranged at regular intervals in the peripheral direction. Further, the outer ribs can be arranged between the extending ribs and the outer ribs, and the extending ribs can be arranged at regular intervals in the peripheral direction.

The blocking plate and the outer frame can be connected with each other by means of the plural extending rib whereby strength against the load application in the axial direction to the fan guard 4 can be increased.

A thickness t' of the extending ribs can be set greater than each thickness t'' of the inner ribs and the outer ribs.

The rigidity of the extending ribs can be increased, which can increase strength to prevent deformation of the fan guard.

A length D of the extending ribs in a flow direction of forced airflow W from the blower fan can be set longer than each length D' of the inner ribs and the outer ribs in the flow

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direction of the forced air flow W in the second invention.

The rigidity of the extending ribs can be further increased, which can further increase the strength to prevent deformation of the fan guard.

One of the annular ribs functions as a boundary annular rib

serving as a boundary of an inner region Z_i and an outer region Z_o to which the inner ribs and the outer ribs can be connected. Further, a thickness t of the annular ribs in the inner region Z_i can increase gradually from the central part to the boundary annular rib. A thickness t of the boundary annular rib can be the greatest and a thickness t of outer annular ribs located outside the boundary rib can decrease. In addition, a thickness t of the annular ribs in the outer region Z_o can increase from the thinner annular ribs toward the outer periphery.

Sufficient strength to prevent expansion of the annular ribs in the radial direction can be ensured because the thickness t of the annular ribs can be set greater correspondingly as the intervals of the inner ribs and the outer ribs can increase. Further, the thickness t of the boundary annular rib, which serves as the boundary between the inner region and the outer region Z_o to which the inner ribs and the outer ribs are connected, can be the greatest, whereby the boundary annular rib exhibits a function as an outer frame for the inner ribs and a function as an inner frame for the outer ribs. Thus, the strength of the fan guard 4 can be increased as a whole.

A chord direction of the radial ribs in a rib section on a plane F parallel to a rotary shaft of the blower fan can incline with respect to a rotation axis. Further, an inclined angle α' of the radial ribs in the chord direction can change in the radial direction so that the incline angle α' corresponds to an inclined angle α of the forced airflow W of the blower fan 3.

In other words, the radial ribs can incline with respect to the rotation axis on the reference plane F parallel to the rotary shaft of the blower fan and the inclined angle α' of the radial ribs can change in the radial direction so as to correspond to

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the inclined angle of the forced airflow W of the blower fan .

The forced airflow W from the blower fan can flow

along the radial ribs of the fan guard in the entire region in the radial direction of the fan guard. As a result, interference between the forced airflow and the radial ribs, which may be caused in the case where there is a region where the inclined angle of the forced airflow does not agree with the inclined angle of the radial ribs (that is, the blocking plate side and the vicinity of the outer periphery), may not be caused, resulting in reduction of noise and pressure loss.

A range of the inclined angle α' of the radial ribs can include: a constant region where the inclined angle α' can be the smallest at a center between the blocking plate and the outer frame and can be substantially constant in a predetermined region; a decreasing region on the blocking plate side with respect to the constant region where the inclined angle α' can decrease as it goes from the blocking plate toward the constant region; and an increasing region on the outer frame side with respect to the constant region where the inclined angle α' can increase as it goes toward the outer frame.

The change in the inclined angle α (see FIG. 16) of the forced airflow W with respect to the radial direction point (dimensionless $R = \text{radius}/\text{radius of fan guard}$) can agree with the inclined angle α' of the radial ribs in the entire region in the radial direction. As a result, the interference between the forced airflow and the radial ribs, which can be caused in the case where there is a region where the inclined angle α of the forced airflow W does not agree with the inclined angle α' of the radial ribs (that is, the blocking plate side and the vicinity of the outer periphery), can hardly be caused, resulting in reduction of noise and pressure loss.

The inclined angle α' of the radial ribs can change within a range from 20 degrees to 50 degrees.

The inclined angle α' of the radial ribs can be appropriately set in the entire region in the radial direction, with a result that noise and pressure loss can be reduced.

The annular ribs located outside the substantial center in the radial direction can incline outward and an inclined angle β thereof can gradually decrease as it approaches the annular ribs in the vicinity of the outermost periphery.

The forced airflow W from the blower fan (that is, outwardly expanding flow) can flow along the annular ribs. Accordingly, interference between the annular ribs and the forced airflow W can be reduced and the flow direction of the forced airflow W flowing between the annular ribs can be corrected in the axial direction in the vicinity of the outermost periphery. As a result, no phenomenon of blocking the forced airflow W may be caused, thereby contributing to the reduction of pressure loss.

The outer frame can be in parallel to or inclines inward with respect to the rotary shaft of the blower fan and an inclined angle of an outermost annular rib out of the annular ribs can be substantially equal to an inclined angle of the outer frame in the first or second invention.

The forced airflow W can smoothly flow between the outermost annular rib and the outer frame. As a result, noise increase can be suppressed and pressure loss can be reduced.

According to embodiments of the present invention, sufficient strength to prevent expansion of the annular ribs in the radial direction when a foreign matter enters between the annular ribs can be ensured

Further, the inner ribs are connected to the blocking plate, whereby less number of the inner ribs than the number of the outer ribs may invite no lowering

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of the strength at the central part of the fan guard, may ensure the strength to prevent bending of the fan guard at load application in the axial direction and may suppress the increase in the

ventilating resistance of the forced airflow W from the blower fan. As a result, contact of the fan guard into the blower fan due to deformation of the fan guard can be prevented and reduction of noise and required input energy of the blower fan 3 can be implemented.

The blocking plate and the outer frame can be connected by means of the plural radial ribs (extending ribs), whereby the strength against the load application in the axial direction to the fan guard can be increased.

The rigidity of the extending ribs can be increased, which can increase the strength against deformation of the fan guard.

The rigidity of the extending ribs can be further increased, which can further increase the strength against deformation of the fan guard.

The thickness t of the annular ribs can be greater as the intervals of the inner ribs and the outer ribs increase, whereby sufficient strength to prevent expansion of the annular ribs in the radial direction can be ensured. In addition, the thickness t of the boundary annular rib, which serves as the boundary between the inner region Z_i and the outer region Z_o to which the inner ribs and the outer ribs are connected, can be the greatest, whereby the boundary annular rib can exhibit a function as an outer frame for the inner ribs. Also, the boundary annular rib can exhibit a function as an inner frame for the outer ribs, which can means increase in the strength of the fan guard as a whole.

The interference between the forced airflow and the radial ribs, which can be caused in the case where there is a region where the inclined angle α of the forced airflow W does not agree with the inclined angle α' of the radial ribs (that is, the blocking plate side and the vicinity of outer periphery), may not be caused, resulting in reduction of noise and pressure loss.

The change in the inclined angle α (see FIG. 16) of the forced airflow W with respect to the radial direction point (dimensionless $R = \text{radius}/\text{radius of fan guard}$) can agree with the inclined angle α' of the radial ribs in the entire region in the radial direction. As a result, the interference between the radial ribs and the forced airflow, which can be caused in the case where there is a region where the inclined angle α of the forced airflow W does not agree with the inclined angle α' of the radial ribs (that is, the blocking plate side and the vicinity of the outer periphery), can hardly be caused, resulting in reduction of noise and pressure loss.

The inclined angle α' of the radial ribs can be appropriately set in the entire region in the radial direction, with a result that noise and pressure loss can be reduced.

The forced airflow W from the blower fan (that is, outwardly expanding flow) can flow along the annular ribs. Accordingly, the interference between the annular ribs and the forced airflow W can be reduced and the flow direction of the forced airflow W flowing between the annular ribs can be corrected in the vicinity of the outermost periphery. As a result, no phenomenon of blocking the forced airflow W may be caused, thereby contributing to the reduction of pressure loss.

The forced airflow W smoothly can flow between the outermost annular ribs and the outer frame. As a result, the noise increase can be suppressed and pressure loss can be reduced.

Brief Description of the Drawings

FIG. 1 is a side view partly in section of a blower unit (outdoor unit) using a fan guard according to a first embodiment of the present invention.

FIG. 2 is a plan view showing the fan guard of the blower unit according to the first embodiment of the present invention.

FIG. 3 is a fragmentary enlarged perspective view showing an essential part of the

fan guard of the blower unit according to the first embodiment of the present invention.

FIG. 4 is a perspective view, a part of which is taken away, of the fan guard and a blower fan of the blower unit according to the first embodiment of the present invention.

FIG. 5 is an explanatory drawing for determining the shape of radial ribs
5 composing the fan guard of the blower unit according to the first embodiment of the present invention.

FIG. 6 is a fragmentary enlarged section of an essential part of the fan guard of the blower unit according to the first embodiment of the present invention.

FIG. 7 is a fragmentary enlarged section of an essential part of a fan guard of a
10 blower unit in a modified example according to the first embodiment of the present invention.

FIG. 8 is a fragmentary enlarged section of an essential part of a fan guard of a blower unit in another modified example according to the first embodiment of the present invention.

FIG. 9 is an enlarged section of annular ribs of the fan guard of the blower unit
15 according to the first embodiment of the present invention.

FIG. 10 is a characteristic graph showing a change in thickness of the annular ribs, which corresponds to dimensionless R (radius/radius of fan guard), of the fan guard of the blower unit according to the first embodiment of the present invention.

FIG. 11 is a plan view showing a fan guard of a blower unit according to a second
20 embodiment of the present invention.

FIG. 12 is a plan view showing a fan guard of a blower unit according to a third embodiment of the present invention.

FIG. 13 is a plan view showing a fan guard of a blower unit according to a fourth
25 embodiment of the present invention.

FIG. 14 is a plan view showing a fan guard of a blower unit according to a fifth embodiment of the present invention.

FIG. 15 is a plan view showing a fan guard of a blower unit according to a sixth embodiment of the present invention.

FIG. 16 is a characteristic graph showing a relationship between the dimensionless R (radius/radius of fan guard) and an inclined angle α (degree) of forced airflow by an axial fan.

Best Mode for Carrying Out the Invention

Several preferred embodiments of the present invention will be described hereinafter with reference to accompanying drawings.

<First Embodiment>

FIG. 1 through FIG. 8 show a fan guard of a blower unit according to the first embodiment of the present invention.

The fan guard 4 is, as shown in Fig. 1, mounted to an outdoor unit A (one example of a blower unit) of an air conditioner. The outdoor unit A is of an up-blast type which sucks outside air from the side faces, cools or heats the thus sucked outside air by heat exchange with a refrigerant and blows the thus cooled or heated air upward.

The outdoor unit A is provided with a casing 1 in a rectangular shape in vertical section having air intake ports 5 on three side faces (only one side face is shown in FIG. 1), a heat exchanger 2 in a U-shape in section arranged along each of the air intake ports 5 in the casing 1, a blower fan 3 for sucking in and blowing out outside air, and a fan guard 4 arranged at the upper end opening part of the casing 1. Wherein, the outdoor unit A is provided with a control section arranged inside the casing 1 so as to face to the heat exchanger 2, and a compressor for compressing the refrigerant, though not shown in FIG. 1.

The casing 1 includes a casing body 6 in a rectangular shape of which upper part is opened, and an upper lid member 7 that covers the upper opening of the casing body 6. The casing body 6 is in a box shape made of a thin metal plate formed by, for example a

plating process.

The upper rid member 7 is an integrally formed component made of a synthetic resin and includes a mount portion 7a in a rectangular shape in section mounted on the upper opening of the casing body 6, and a wall portion 7b in a circular shape extended and narrowed in a tubular shape from the upper end of the mount portion 7a. The upper end of the wall portion 7b serves as an air outlet 9 to which the fan guard 4 is fitted. A bell mouth 10 substantially in a cylindrical shape of which upper and lower parts are expanded is provided inside the upper part of the mount portion 7a of the upper rid member 7.

The blower fan 3 is an axial fan composed of a cylindrical hub 11 located at the center and a plurality of vanes 12, 12 ... arranged around the hub 11, and is arranged inside the bell mouth 10. The blower fan 3 is driven and rotated by a fan motor 13 having a rotary shaft 13a pivotally mounted at the center of the hub 11. The fan motor 13 is mounted at the upper end of the casing body 6 by means of a support tool (not shown in the drawing).

As shown in FIG. 2, the fan guard 4 is provided with, between a circular blocking plate 14 arranged at the central part and an annular outer frame 15 arranged at the outer periphery, annular ribs 16, 16 ... arranged at predetermined intervals in the radial direction coaxially with the center of the blocking plate 14 as a center, and radial ribs 17, 17 ... extending radially from the blocking plate 14 toward the outer frame 15.

The radial ribs 17, 17 ... includes: a plurality (8 in the present embodiment) of extending ribs 17A, 17A ... extending from the blocking plate 14 to the outer frame 15; inner ribs 17B, 17B ... extending from the blocking plate 14 to the substantial center in the radial direction in an inner region Z_i ranged from the blocking plate 14 to the substantial center in the radial direction; and outer ribs 17C, 17C ... extending from the substantial center in the radial direction to the outer frame 15 in an outer region Z_o ranged from the substantial center in the radial direction to the outer frame 15.

In this case, the extending ribs 17A, 17A ... are arranged at regular intervals in the peripheral direction and three outer ribs 17C, 17C, 17C and two inner ribs 17B, 17B are

arranged at regular intervals in the peripheral direction between adjacent extending ribs 17A, 17A. In other words, this case is so set that $m=3$ wherein the number of the outer ribs 17C, 17C ... is m and the number of the inner ribs 17B, 17B ... is $m-1$. Specifically, the number of the inner ribs 17B, 17B ... is set to 8 smaller than the number of the outer ribs 17C, 17C ...

With the above arrangement, sufficient strength to prevent expansion of the annular ribs 16, 16 ... in the radial direction when a foreign matter enters between the annular ribs 16, 16 ... is ensured. Further, the inner ribs 17B are connected to the blocking plate 14, whereby less number of the inner ribs 17B than the number of the outer ribs 17C invites no lowering of the strength at the central part of the fan guard 4. Therefore, the strength to prevent bending of the fan guard 4 at load application in the axial direction to the fan guard 4 is ensured and increase in ventilating resistance of forced airflow W from the blower fan 3 is suppressed. As a result, contact of the fan guard 4 into the blower fan 3 due to deformation of the fan guard 4 is prevented and noise and required input energy of the blower fan 3 are reduce. In addition, the blocking plate 14 and the outer frame 15 are connected by means of the eight extending ribs 17A, 17A ..., whereby the strength against the load application in the axial direction to the fan guard 4 is increased.

Moreover, the blocking plate 14, the outer frame 15, the extending ribs 17A, 17A ..., the inner ribs 17B, 17B ..., the outer ribs 17C, 17C ... and the annular ribs 16, 16 ... are integrally formed of a synthetic resin (see FIG. 3). The outer frame 15 is formed in a sleeve shape with a larger diameter than the outer diameter of the vanes 12, 12 ... of the blower fan 3. The fan guard 4 is mounted by fitting the outer frame 15 to the air outlet 9 at the upper end of the wall portion 7b.

The extending ribs 17A, 17A ... and the inner ribs 17B, 17B ... are arranged radially in the radial direction from the blocking plate 14 and curves toward the downstream side of the rotational direction M of the blower fan 3. The outer ribs 17C, 17C ... are arranged radially in the radial direction in the outer region Z_0 of the fan guard 4 and

curves toward the downstream side of the rotational direction M of the blower fan 3. With this arrangement, the ribs 17A, 17B, 17C become easy to accord with the forced airflow blowing and radially expanding from the blower fan 3. Specifically, the ribs 17A, 17B, 17C curve toward the downstream side of the rotational direction M so as to form arcs (see FIG. 4).

In general, an inclined angle α of the turning forced airflow of the blower fan 3 (that is, an axial fan) is not constant in the entire region in the radial direction and changes in the radial direction. In detail, the inclined angle α of the forced airflow changes as in a downward curve with respect to a radial direction point (that is, dimensionless $R =$ radius/radius of fan guard), as shown in FIG. 16. Namely, the inclined angle α of the forced airflow changes in the curve that decreases gradually toward the outer periphery from the hub of the axial fan, is the smallest at the point slightly outside the center, becomes constant in a predetermined region and increases gradually in the vicinity of the outer periphery. In short, the inclined angle α gradually changes substantially within the range from 20 degrees to 50 degrees.

In the present embodiment, as shown in FIG. 5, the range of an inclined angle α' of the radial ribs (the extending ribs 17A, the inner ribs 17B and the outer ribs 17C) includes a constant region Z0 where the angle is the smallest (about 23 degrees, for example) at the center between the blocking plate 14 and the outer frame 15 and is substantially constant in a predetermined region, a decreasing region Z1 on the blocking plate 14 side with respect to the constant region Z0 and an increasing region Z2 on the outer frame 15 side with respect to the constant region Z0. In other words, the radial ribs (the extending ribs 17A, the inner ribs 17B and the outer ribs 17C) are inclined with respect to the rotation axis on a reference plane F parallel to the rotary shaft 13a of the blower fan 3 and the inclined angle α' of the radial ribs (the extending ribs 17A, the inner ribs 17B and the outer ribs 17C) changes in the radial direction gradually so as to correspond to the inclined angle α of the forced airflow W of the blower fan 3. Herein, it

is desirable that the incline angle α' of the radial ribs (the extending ribs 17A, the inner ribs 17B and the outer ribs 17C) changes gradually within the range from 20 degrees to 50 degrees.

In other words, the chord direction of the radial ribs 17, 17 ... in rib section on the plane F parallel to the rotary shaft 13a of the blower fan 3 inclines with respect to the rotation axis of the blowing fan 3 and the inclined angle α' of the ribs 17, 17 ... in the chord direction changes in the radial direction so as to correspond to the inclined angle α of the forced airflow W of the blower fan 3.

Moreover, the range of the inclined angle α' of the radial ribs 17, 17 ... includes the constant region Z0 where the inclined angle α' is the smallest at the center between the blocking plate 14 and the outer frame 15 and is substantially constant in the predetermined region, the decreasing region Z1 where the incline angle α' on the blocking plate 14 side with respect to the constant region Z0 decreases as it goes from the blocking plate 14 toward the constant region Z0, and the increasing region Z2 where the inclined angle α' on the outer frame 15 side with respect to the constant region Z0 increases as it approaches the outer frame 15.

With this arrangement, the change of the inclined angle α (see FIG. 16) of the forced airflow W with respect to the radial direction point (that is, dimensionless $R = \text{radius}/\text{radius of fan guard}$) agrees with the inclined angle α' of the radial ribs (the extending ribs 17A, the inner ribs 17B and the outer ribs 17C) in the entire range in the radial direction. As a result, interference between the forced airflow and the radial ribs, which is caused in the case where there is a region where the inclined angle of the forced airflow does not agree with the inclined angle of the radial ribs (that is, the blocking plate 14 side and the vicinity of the outer periphery) is hardly caused, thereby remarkably reducing noise and pressure loss.

The thickness t' of the extending ribs 17A, 17A ... is set greater than the thickness t'' of the inner ribs 17B, 17B ... and the outer ribs 17C, 17C ..., and the length D of the

extending ribs 17A, 17A ... in the flow direction of the forced airflow **W** is set longer than the length **D'** of the inner ribs 17B, 17B ... and the outer ribs 17C, 17C ... in the flow direction of the forced airflow **W** (see FIG. 3). With this arrangement, the rigidity of the extending ribs 17A, 17A ... is increased, resulting in increases in the strength against deformation of the fan guard 4.

In this embodiment, the annular ribs 16, 16 ... located outside of the substantial center in the radial direction inclines outward and the inclined angle β thereof gradually decreases in the vicinity of the outermost periphery, as shown in FIG. 6. In this case, the wall portion 7b of the upper rid member 7 and the outer frame 15 of the fan guard 4 inclines inward with respect to the rotary shaft 13a of the blower fan 3. With this arrangement, the outwardly expanding flow from the blower fan 3 (that is, the forced airflow **W**) flows along the annular ribs 16, 16 ..., whereby interference between the annular ribs 16 and the forced airflow **W** is reduced and the flow direction of the forced airflow **W** flowing between the annular ribs 16 is corrected in the axial direction in the vicinity of the outermost periphery, thereby causing no occlusion of the forced airflow **W** and reducing pressure loss.

It is desirable that the inclined angle β of the outermost annular rib 16A out of the annular ribs 16, 16 ... is set substantially equal to the inclined angle of the outer frame 15. In so doing, the forced airflow **W** smoothly flows between the outermost annular rib 16A and the outer frame 15, whereby noise increase is suppressed and the pressure loss is reduced. Wherein, the outer frame 15 may be arranged in parallel to the rotary shaft 13a of the blower fan 3.

Further, the annular ribs 16, 16 ... located outside the substantial center in the radial direction may incline outward at a predetermined angle β (for example, $\beta = 5$ degrees to 15 degrees), as shown in FIG. 7. Or, it is possible that the outer frame 15 is arranged in parallel to the rotary shaft 13a of the blower fan 3 and the annular ribs 16, 16 ... located outside the substantial center in the radial direction inclines outward at a

predetermined angle β (for example, $\beta = 5$ degrees to 15 degrees).

Meanwhile, in the present embodiment, as shown in FIG. 9 and FIG. 10, the thickness t of the annular ribs 16, 16 ... increases gradually from the central part to a boundary annular rib 16B, which serves as the boundary between the inner region Z_i and the outer region Z_o to which the inner ribs 17B, 17B ... and the outer ribs 17C, 17C ... are connected, is the greatest at the boundary annular rib 16B, decreases toward the outer annular ribs 16C located outside the boundary annular rib 16B, and then, increases gradually toward the outer periphery therefrom. With this arrangement, the thickness t of the annular ribs 16, 16 ... increases as the intervals of the inner ribs 17B, 17B ... and the outer ribs 17C, 17C ... increases, whereby the strength to prevent expansion of the annular ribs 16, 16 ... in the radial direction can be ensured. Further, the thickness t of the boundary annular rib 16B, which serves as the boundary between the inner region Z_i and the outer region Z_o to which the inner ribs 17B, 17B ... and the outer ribs 17C, 17C ... are connected, is the greatest, whereby the boundary annular rib 16B exhibits a function as an outer frame for the inner ribs 17B, 17B ... and a function as an inner frame for the outer ribs 17C, 17C ..., with a result that the strength of the fan guard 4 is increased as a whole.

(Second Embodiment)

FIG. 11 shows a fan guard of a blower fan according to the second embodiment of the present invention.

In this case, the radial ribs 17, 17 ... include the inner ribs 17B, 17B ... extending from the blocking plate 14 to the substantial center in the radial direction in the inner region Z_i ranging from the blocking plate 14 to the substantial center in the radial direction, and the outer ribs 17C, 17C ... extending from the substantial center in the radial direction to the outer frame 15 in the outer region Z_o ranging from the substantial center in the radial direction to the outer frame 15. The outer ribs 17C, 17C ... and the inner ribs 17B, 17B ... are arranged at regular intervals in the peripheral direction. The number of the

inner ribs 17B, 17B ... is smaller than the number of the outer ribs 17C, 17C ... (1/2 in the present embodiment).

With this arrangement, sufficient strength to prevent expansion of the annular ribs 16, 16 ... in the radial direction when a foreign matter enters between the annular ribs 16, 16 ... is ensured. Also, the inner ribs 17B are connected to the blocking plate 14, whereby
 5 less number of the inner ribs 17B than the number of the outer ribs 17C invites no lowering of the strength at the central part of the fan guard 4. Hence, the strength to prevent bending of the fan guard 4 at load application in the axial direction to the fan guard 4 can be ensured and the increase in the ventilating resistance of the forced airflow W from
 10 the blower fan 3 can be suppressed.

As a result, contact of the fan guard 4 into the blower fan 3 due to deformation of the fan guard 4 is prevented and noise and required input energy of the blower fan 3 are reduced.

It should be noted that the intervals of the inner ribs 17B, 17B ... and the outer ribs
 15 17C, 17C ... in the peripheral direction (in other words, the number of ribs) are set so that a foreign matter (fingers, for example) hardly enters, and the number of the inner ribs 17B, 17B ... is set smaller than the number of the outer ribs 17C, 17C ... Because the other constitution, operation and effects are the same as those in the first embodiment, the explanation thereof is omitted.

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(Third Embodiment)

FIG. 12 shows a fan guard of a blower unit according to the third embodiment of the present invention.

In this case, the number of the extending ribs 17A, 17A ... is set to 12. The
 25 number of the outer ribs 17C, 17C ... between the adjacent extending ribs 17A, 17A is set to 2 ($m=2$). Accordingly, the number of the inner ribs 17B, 17B ... is set to 1/2 of the number of the outer ribs 17C, 17C... Wherein, the blocking plate 14 may be in the shape

of a rectangle. With this arrangement, the strength of the fan guard 4 is increased by the increased number of the extending ribs 17A, 17A ... Because the other constitution, operation and effects are the same as those in the first embodiment, the explanation thereof is omitted.

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(Fourth Embodiment)

FIG. 13 shows a fan guard of a blower unit according to the fourth embodiment of the present invention.

In this case, the number of the extending ribs 17A, 17A ... is set to 6. The number
 10 of the outer ribs 17C, 17C ... between the adjacent extending ribs 17A, 17A is set to 4 ($m=4$). Accordingly, the number of the inner ribs 17B, 17B ... is set to be 6 smaller than the number of the outer ribs 17C, 17C... Wherein, the blocking plate 14 may be in the shape of a rectangle. With this arrangement, the strength of the fan guard 4 is slightly lowered by the reduced number of the extending ribs 17A, 17A ... Because the other
 15 constitution, operation and effects are the same as those in the first embodiment, the explanation thereof is omitted.

(Fifth Embodiment)

FIG. 14 shows a fan guard of a blower unit according to the fifth embodiment of
 20 the present invention.

In this case, the outer frame 15 of the fan guard 4 is in the shape of a rectangle. The number of the extending ribs 17A, 17A ... is set to 12, and the number of the outer ribs 17C, 17C ... between the adjacent extending ribs 17A, 17A is set to 2 ($m=2$). Accordingly, the number of the inner ribs 17B, 17B ... is set to 1/2 of the number of the
 25 outer ribs 17C, 17C... Wherein, the blocking plate 14 may be in the shape of a rectangle. With this arrangement, the strength of the fan guard 4 is increased by the increased number of the extending ribs 17A, 17A ... Because the other constitution, operation and effects

are the same as those in the first embodiment, the explanation thereof is omitted.

(Sixth Embodiment)

FIG. 15 shows a fan guard of a blower unit according to the sixth embodiment of
5 the present invention.

In this case, the outer frame 15 of the fan guard 4 is in the shape of a rectangle.
The number of the extending ribs 17A, 17A ... is set to 8, and the number of the outer ribs
17C, 17C ... between the adjacent extending ribs 17A, 17A is set to 3 ($m=3$). Accordingly,
the number of the inner ribs 17B, 17B ... is set to be 8 smaller than the number of the outer
10 ribs 17C, 17C... Wherein, the blocking plate 14 may be in the shape of a rectangle.
Because the other constitution, operation and effects are the same as those in the first
embodiment, the explanation thereof is omitted.

Industrial Applicability

15 As described above, the fan guard of the blower unit according to the present
invention is useful when applied to outdoor units of air conditioners, and is especially
suitable for outdoor units having annular ribs and radial ribs.

CLAIMS

1. A fan guard of a blower unit which is provided with, between a blocking plate arranged at a central part and an outer frame arranged at an outer periphery, a plurality of annular ribs arranged coaxially in a radial direction at predetermined intervals with a center of the blocking plate as a center, and a plurality of radial ribs extending radially from the blocking plate to the outer frame and arranged at regular intervals in a peripheral direction, and which is mounted at an air outlet of a blower unit (A) having a blower fan, characterized in that:

the radial ribs includes a plurality of inner ribs extending from the blocking plate to a substantial center in the radial direction and arranged at regular intervals in the peripheral direction, and a plurality of outer ribs extending from the substantial center in the radial direction to the outer frame and arranged at regular intervals in the peripheral direction, and

the number of the inner ribs is set smaller than the number of the outer ribs.

2. The fan guard of the blower unit of Claim 1, characterized in that:

the radial ribs include a plurality of extending ribs extending from the blocking plate to the outer frame and arranged at regular intervals in the peripheral direction,

the inner ribs are arranged between the extending ribs, and the inner ribs and the extending ribs are arranged at regular intervals in the peripheral direction, and

the outer ribs are arranged between the extending ribs and the outer ribs, and the extending ribs are arranged at regular intervals in the peripheral direction.

3. The fan guard of the blower unit of Claim 2, characterized in that:
a thickness (t') of the extending ribs is set greater than each thickness (t'') of the inner ribs and the outer ribs.
4. The fan guard of the blower unit of Claim 2, characterized in that:
a length (D) of the extending ribs in a flow direction of forced airflow (W) from the blower fan is set longer than each length (D') of the inner ribs and the outer ribs in the flow direction of the forced air flow (W).
5. The fan guard of the blower unit of Claim 1 or 2, characterized in that:
one of the annular ribs functions as a boundary annular rib serving as a boundary of an inner region (Z_i) and an outer region (Z_o) to which the inner ribs and the outer ribs are connected,
a thickness (t) of the annular ribs in the inner region (Z_i) increases gradually from the central part to the boundary annular rib, a thickness (t) of the boundary annular rib is the greatest, a thickness (t) of outer annular ribs located outside the boundary rib decreases and a thickness (t) of the annular ribs in the outer region (Z_o) increases from the thinner annular ribs toward the outer periphery.
6. The fan guard of the blower unit of Claim 1 or 2, characterized in that:
a chord direction of the radial ribs in a rib section on a plane (F) parallel to a rotary shaft of the blower fan inclines with respect to a rotation axis, and an inclined angle (α') of the radial ribs in the chord direction changes in the radial direction so that the incline angle (α') corresponds to an inclined angle (α) of the forced airflow (W) of the blower fan.

7. The fan guard of the blower unit of Claim 6, characterized in that:

a range of the inclined angle α' of the radial ribs includes: a constant region (ZO) where the inclined angle (α') is the smallest at a center between the blocking plate and the outer frame and is substantially constant in a predetermined region; a decreasing region (Z1) on the blocking plate side with respect to the constant region (ZO) where the inclined angle (α') decreases as it goes from the blocking plate toward the constant region (ZO); and an increasing region (Z2) on the outer frame side with respect to the constant region (ZO) where the inclined angle (α') increases as it goes toward the outer frame (ZO).

8. The fan guard of the blower unit of Claim 6, characterized in that:

the inclined angle (α') of the radial ribs changes in a range from 20 degrees to 50 degrees.

9. The fan guard of the blower unit of Claim 1 or 2, characterized in that:

the annular ribs located outside the substantial center in the radial direction inclines outward and an inclined angle (β) thereof gradually decreases as it approaches the annular ribs in a vicinity of an outermost periphery.

10. The fan guard of the blower unit of Claim 1 or 2, characterized in that:

the outer frame is in parallel to or inclines inward with respect to a rotary shaft of the blower fan, and

an inclined angle of an outermost annular rib out of the annular ribs is substantially equal to an inclined angle of the outer frame.