

DESCRIPTION

CROSS FLOW FAN AND METHOD OF MANUFACTURING CROSS FLOW FAN

5 Field

[0001] The present invention relates to a cross flow fan used as a fan of an air conditioner or the like, and a method of manufacturing the cross flow fan.

10 Background

[0002] There is a known cross flow fan that includes holding plates disposed at intervals in the shaft direction and arcuate blades each inserted into a corresponding one of many arcuate grooves formed on the outer periphery of the holding plates (see Patent Literature 1, for example). Such a cross flow fan has a structure in which a hornlike projection formed by the arcuate grooves undergoes compressive deformation upon being pressed and bent toward the center of the holding plate to fix the blade in the
20 groove.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Application
25 Laid-open No. 2014-088819

Summary

Technical Problem

[0004] However, because the cross flow fan of Patent
30 Literature 1 fixes the blade in the groove by causing the hornlike projection formed by the arcuate grooves to undergo compressive deformation upon being pressed and bent toward the center of the holding plate, when a minute gap

is formed in the outer periphery of the holding plate due to the machining accuracy of the holding plate, it is difficult to bring all the hornlike projections into completely close contact with the blades. Such a cross
5 flow fan thus has less force of holding the blade at a site where the hornlike projection is not brought into completely close contact with the blade, so that the blade moves during rotation due to the external force such as a centrifugal force and rubs the surface holding the blade in
10 the groove of the holding plate to possibly cause minute noise.

[0005] The present invention has been made in view of the above, and an object of the present invention is to obtain a cross flow fan that can reduce minute noise and a
15 method of manufacturing the cross flow fan.

Solution to Problem

[0006] In order to solve the above problem and achieve the object, a cross flow fan according to an aspect of the
20 present invention includes a rotary shaft; at least a pair of holding plates; and an arcuate blade. The holding plates are disposed at an interval in a direction in which the rotary shaft extends. The arcuate blade is inserted and fixed in a plurality of arcuate holes formed in an
25 outer periphery of the holding plates. The holding plates each include an outer peripheral edge region provided in a region on an outer peripheral side relative to the holes, a contact portion to support the blade in contact with the blade, and a non-contact portion not in contact with the
30 blade.

Advantageous Effects of Invention

[0007] According to the present invention, an effect is

obtained where the cross flow fan that can reduce minute noise and the method of manufacturing the cross flow fan can be obtained.

5 Brief Description of Drawings

[0008] FIG. 1 is a perspective view of a cross flow fan according to a first embodiment.

FIG. 2 is a front view of the cross flow fan according to the first embodiment as viewed from a direction
10 orthogonal to a direction along a rotary shaft.

FIG. 3 is a front view of a holding plate used in the cross flow fan according to the first embodiment, as viewed from the direction along the rotary shaft.

FIG. 4 is an enlarged view of arcuate holes in the
15 holding plate of FIG. 3.

FIG. 5 is a front view of part of the holding plate in which arcuate blades are inserted and fixed in the arcuate holes, as viewed from the direction along the rotary shaft.

FIG. 6 is an explanatory diagram of important
20 parameters that determine air blowing performance of the blade used in the cross flow fan according to the first embodiment.

FIG. 7 is a flowchart illustrating an example of a method of manufacturing the cross flow fan according to the
25 first embodiment.

FIG. 8 is a front view of part of a holding plate used in a cross flow fan according to a second embodiment, as viewed from the direction along the rotary shaft.

FIG. 9 is a front view of part of the holding plate of
30 the cross flow fan according to the second embodiment, as viewed from the direction along the rotary shaft.

FIG. 10 is a front view of part of a holding plate used in a cross flow fan according to a third embodiment,

as viewed from the direction along the rotary shaft.

FIG. 11 is a front view of part of the holding plate of the cross flow fan according to the third embodiment, as viewed from the direction along the rotary shaft.

5 FIG. 12 is a view illustrating an example of the shape of an end in the direction along the rotary shaft of a blade that is used in a cross flow fan according to a fourth embodiment.

10 Description of Embodiments

[0009] Hereinafter, a cross flow fan and a method of manufacturing the cross flow fan according to embodiments of the present invention will be described in detail with reference to the drawings. Note that the description of
15 the embodiments below does not limit the present invention.

[0010] First Embodiment.

FIG. 1 is a perspective view of a cross flow fan 100 according to a first embodiment. FIG. 2 is a front view of the cross flow fan 100 according to the first embodiment as
20 viewed from a direction orthogonal to the direction along a rotary shaft 16. Note that in FIGS. 1 and 2, reference numerals are assigned only to some parts and not assigned to the other parts. The cross flow fan 100 has a cylindrical shape to draw in air from the direction
25 perpendicular to the rotary shaft 16 and blow out a planar air stream. The cross flow fan 100 is used as a fan for an air conditioner, an air swing fan, an air purifier, a window fan, or the like.

[0011] As illustrated in FIGS. 1 and 2, the cross flow
30 fan 100 includes at least a pair of circular holding plates 10 disposed at intervals in the shaft direction and blades 14 inserted into a plurality of arcuate holes 12 formed in the outer periphery of the holding plate 10 as illustrated

in FIG. 5. The shaft direction is a direction in which the rotary shaft 16 extends. The rotary shaft 16 is attached to the holding plates 10. The rotary shaft 16 being rotationally driven causes the holding plates 10 to rotate together with the blades 14. The cross flow fan 100 functions as a fan when the rotary shaft 16 is rotationally driven.

[0012] FIG. 3 is a front view of a holding plate 10' used in the cross flow fan 100 according to the first embodiment, as viewed from the direction along the rotary shaft 16. FIG. 4 is an enlarged view of arcuate holes 12' in the holding plate 10' of FIG. 3. FIGS. 3 and 4 illustrate the holding plate 10' before the blades 14 are fixed thereto. FIG. 5 is a front view of part of the holding plate 10 in which the arcuate blades 14 are inserted and fixed in the arcuate holes 12, as viewed from the direction along the rotary shaft 16. FIG. 5 illustrates the holding plate 10 after the blades 14 are fixed thereto. Note that in FIGS. 3, 4, and 5, reference numerals are assigned only to some parts and not assigned to the other parts.

[0013] As illustrated in FIG. 3, the arcuate holes 12', arranged on the circumference around the center of rotation of the rotary shaft 16, are formed in an outer periphery 10o' of the holding plate 10'. That is, the outer periphery 10o' is a region in which the arcuate holes 12' are formed. The holding plate 10' is in a state in which the blades 14 are not fixed in the holes 12'. The blade 14 is a plate-like member extending in a first direction, where the dimension of the blade 14 in the first direction is larger than the dimension thereof in a direction orthogonal to the first direction. The first direction of the blade 14 will be hereinafter referred to as a

longitudinal direction as appropriate. The hole 12' has a shape similar to the cross-sectional shape of the blade 14 cut along a plane orthogonal to the longitudinal direction of the blade 14. As illustrated in FIG. 4, the holding
5 plate 10' includes an outer peripheral edge region 10e' in a region radially outward of the outer periphery 10o'. The outer peripheral edge region 10e' is in contact with the holes 12'. The outer peripheral edge region 10e' includes the edge of the holding plate 10'. The arcuate holes 12'
10 are thus completely closed.

[0014] The hole 12' includes an inner peripheral side portion 12i', an outer peripheral side portion 12o', and a central region 12c' as illustrated in FIG. 4. The inner peripheral side portion 12i' is a part of the hole 12'
15 formed in a region on the inner peripheral side of the outer periphery 10o'. The outer peripheral side portion 12o' is a part of the hole 12' formed in a region on the outer peripheral side of the outer periphery 10o'. The central region 12c' is a part between the inner peripheral
20 side portion 12i' and the outer peripheral side portion 12o' of the hole 12'. A width 12w' is the width of the hole 12'. The width 12w' of the hole 12' is the width in the direction perpendicular to the direction of extension of the arcuate hole 12' and parallel to the surface of the
25 holding plate 10'. Although the width 12w' is indicated in the central region 12c' in FIG. 4, the present specification uses the width 12w' to describe the widths of all the inner peripheral side portion 12i', the outer peripheral side portion 12o', and the central region 12c'
30 of the hole 12'.

[0015] The blade 14 has an arcuate shape when viewed from the longitudinal direction. The blade 14 includes a convex curved surface on one surface and a concave curved

surface on the other surface. In the first embodiment, a plate thickness 14w of the blade 14 illustrated in FIG. 5 is constant along the direction of extension of the arcuate blade 14. The plate thickness 14w of the blade 14 may vary
 5 along the direction of extension of the arcuate blade 14. The plate thickness 14w is the dimension of the blade 14 in the direction perpendicular to the plate surface of the blade 14.

[0016] The width 12w' is larger than the plate thickness
 10 14w of the blade 14 at any position along the direction of extension of the arcuate blade 14. The blade 14 can thus be inserted into the hole 12'. An inner peripheral surface of the hole 12' facing the convex curved surface of the blade 14 inserted into the hole has a concave curved shape
 15 following the convex curved surface of the blade 14. An inner peripheral surface of the hole 12' facing the concave curved surface of the blade 14 inserted into the hole preferably includes a portion with the width 12w' larger than that of the convex curved shape following the concave
 20 curved surface of the blade 14.

[0017] In the first embodiment, the inner peripheral surface of the central region 12c' of the hole 12' facing the concave curved surface of the blade 14 inserted into the hole has a linear shape. This facilitates machining of
 25 the hole 12' and makes it easy to expand the width 12w' of the central region 12c'; therefore, it is preferable for the hole 12' to have such a shape.

[0018] In the first embodiment, the hole 12' includes a recess 12ix' and a protrusion 12iy' on the inner peripheral
 30 surface of the inner peripheral side portion 12i' facing the concave curved surface of the blade 14 inserted into the hole. The recess 12ix' is provided in the vicinity of a tip 12is' of the inner peripheral side portion 12i' of

the hole 12'. The protrusion 12iy' is provided adjacent to the recess 12ix'. The hole 12' including the recess 12ix' allows part of the concave curved surface at a tip 14is of an inner peripheral side portion 14i of the blade 14 in FIG. 5 to escape to the recess 12ix' when the blade 14 is inserted into the hole 12'. Therefore, the recess 12ix' allows the tip 14is of the inner peripheral side portion 14i of the blade 14 to easily come into contact with the tip 12is' of the inner peripheral side portion 12i' of the hole 12'. As a result, the hole 12' can improve the accuracy of the position of the tip 14is of the inner peripheral side portion 14i of the blade 14 inserted into the hole.

[0019] The blades 14 are inserted into the holes 12' and the outer peripheral edge region 10e' is crushed toward the blades 14, so that the holding plate 10' is deformed into the holding plate 10 in which the blades 14 are inserted and fixed in the holes 12. The outer peripheral edge region 10e' is crushed toward the blades 14 and deformed into an outer peripheral edge region 10e. The outer peripheral edge region 10e' is crushed toward the blades 14, so that the holes 12' are deformed into the holes 12 in which the blades 14 are inserted and fixed. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 10e' is crushed toward the blades 14, so that the inner peripheral side portions 12i', the outer peripheral side portions 12o', and the central regions 12c' are deformed into inner peripheral side portions 12i, outer peripheral side portions 12o, and central regions 12c illustrated in FIG. 5, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 10e' is crushed toward the blades 14, so that the recesses 12ix' and the protrusions 12iy' are formed into

recesses 12ix and protrusions 12iy illustrated in FIG. 5, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 10e' is crushed toward the blades 14, so that the width 12w' of the holes 12' is changed to a width 12w of the holes 12 illustrated in FIG. 5.

[0020] As illustrated in FIG. 5, the arcuate holes 12, arranged on the circumference around the center of rotation of the rotary shaft 16, are formed in an outer periphery 10o of the holding plate 10. That is, the outer periphery 10o is a region in which the arcuate holes 12 are formed. The holding plate 10 is in a state in which the blades 14 are fixed in the holes 12. The hole 12 has a shape similar to the shape of the blade 14 as seen from the shaft direction of the blade 14. The holding plate 10 includes the outer peripheral edge region 10e in a region on the outer peripheral side relative to the outer periphery 10o. The outer peripheral edge region 10e includes the edge of the holding plate 10. The arcuate holes 12 are thus completely closed.

[0021] The holes 12 each include the inner peripheral side portion 12i, the outer peripheral side portion 12o, and the central region 12c as illustrated in FIG. 5. The inner peripheral side portion 12i is a part formed in a region on the inner peripheral side of the hole 12 in the outer periphery 10o. The outer peripheral side portion 12o is a part formed in a region on the outer peripheral side of the hole 12 in the outer periphery 10o. The central region 12c is a part between the inner peripheral side portion 12i and the outer peripheral side portion 12o. The width 12w is the width of the hole 12 in the central region 12c. The width of the hole 12 is the width in the direction perpendicular to the direction of extension of

the arcuate hole 12. Although the width 12w is indicated in the central region 12c in FIG. 5, the present specification uses the width 12w to describe the widths of all the inner peripheral side portion 12i, the outer peripheral side portion 12o, and the central region 12c of the hole 12.

[0022] The blades 14 inserted and fixed in the holes 12 each include the inner peripheral side portion 14i, an outer peripheral side portion 14o, and a central region 14c as illustrated in FIG. 5. The inner peripheral side portion 14i is a part of the blade 14 disposed in a region on the inner peripheral side of the outer periphery 10o. That is, the inner peripheral side portion 14i of the blade 14 is disposed in the inner peripheral side portion 12i of the hole 12. The outer peripheral side portion 14o is a part of the blade 14 disposed in a region on the outer peripheral side of the outer periphery 10o. That is, the outer peripheral side portion 14o of the blade 14 is disposed in the outer peripheral side portion 12o of the hole 12. The central region 14c is a part of the blade 14 disposed between the inner peripheral side portion 14i and the outer peripheral side portion 14o. That is, the central region 14c of the blade 14 is disposed in the central region 12c of the hole 12. The width 12w of the hole 12 in the central region 12c is larger than the plate thickness 14w of the blade 14. Note that the width of the hole 12 is the dimension in the direction perpendicular to the direction of extension of the arcuate hole 12 and parallel to the surface of the holding plate 10.

[0023] The holding plate 10 includes a first contact portion 18i, a second contact portion 18o, and a third contact portion 18c, at which the blade 14 is supported in contact with the holding plate 10, on the inner peripheral

surface of the hole 12. The holding plate 10 includes a first non-contact portion 20a, a second non-contact portion 20b, and a third non-contact portion 20c, at which the blade 14 is not in contact with the holding plate 10, on the inner peripheral surface of the hole 12. The blade 14 is supported and fixed by the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c.

[0024] The first contact portion 18i is formed on the inner peripheral surface of the inner peripheral side portion 12i of the hole 12. The first contact portion 18i is a region in which the tip 14is of the inner peripheral side portion 14i of the blade 14 is fixed by a tip 12is of the inner peripheral side portion 12i of the hole 12. The holding plate 10 fixes and supports the tip 14is of the inner peripheral side portion 14i of the blade 14 at the first contact portion 18i.

[0025] With the blade 14 being inserted in the hole 12, the outer peripheral edge region 10e' is crushed toward the blade 14 to cause the tip 14is of the inner peripheral side portion 14i of the blade 14 to be pressed against the tip 12is' of the inner peripheral side portion 12i' of the hole 12'. The tip 12is' is formed into the tip 12is when the tip 14is is pressed thereagainst. The first contact portion 18i is formed at the tip 12is when the tip 12is' is formed into the tip 12is.

[0026] The second contact portion 18o is formed on the inner peripheral surface of the outer peripheral side portion 12o of the hole 12. The second contact portion 18o is a region in which the outer peripheral side portion 14o of the blade 14 is fixed by the outer peripheral side portion 12o of the hole 12. The holding plate 10 fixes and supports the outer peripheral side portion 14o of the blade

14 at the second contact portion 18o.

[0027] With the blade 14 being inserted into the hole 12, the outer peripheral edge region 10e' is crushed toward the blade 14 to cause the outer peripheral side portion 12o' of the hole 12' to be deformed into the outer peripheral side portion 12o of the hole 12 having the shape along the outer peripheral side portion 14o of the blade 14. There is no gap between the outer peripheral side portion 14o of the blade 14 and the outer peripheral side portion 12o of the hole 12. The second contact portion 18o is formed at the outer peripheral side portion 12o of the hole 12 when the outer peripheral side portion 12o' of the hole 12' is deformed into the outer peripheral side portion 12o of the hole 12 having the shape along the outer peripheral side portion 14o of the blade 14.

[0028] The third contact portion 18c is formed on the inner peripheral surface of the inner peripheral side portion 12i of the hole 12. The third contact portion 18c is a region in which a part of the concave curved surface of the inner peripheral side portion 14i of the blade 14 is fixed by the protrusion 12iy of the hole 12. The holding plate 10 fixes and supports the part of the concave curved surface of the inner peripheral side portion 14i of the blade 14 at the third contact portion 18c.

[0029] With the blade 14 being inserted in the hole 12, the outer peripheral edge region 10e' is crushed toward the blade 14 to cause the protrusion 12iy' of the hole 12' to be formed into the protrusion 12iy. The protrusion 12iy can improve the accuracy of the position of the tip 14is of the inner peripheral side portion 14i of the blade 14. The third contact portion 18c is formed at the protrusion 12iy when the protrusion 12iy' of the hole 12' is formed into the protrusion 12iy.

[0030] The first non-contact portion 20a is formed on the side facing the convex curved surface of the blade 14 in the region between the first contact portion 18i and the second contact portion 18o on the inner peripheral surface of the hole 12. The first non-contact portion 20a includes a side of the central region 12c that faces the convex curved surface of the blade 14. The first non-contact portion 20a includes a side of the inner peripheral side portion 12i that faces the convex curved surface of the blade 14 relative to the tip 12is. The first non-contact portion 20a is a region in which a gap is secured between the inner peripheral surface of the hole 12 and the blade 14. The inner peripheral surface of the hole 12 in the first non-contact portion 20a has a concave curved shape following the convex curved surface of the blade 14. The first non-contact portion 20a is formed as a result of the formation of the first contact portion 18i and the second contact portion 18o when the outer peripheral edge region 10e' is crushed toward the blade 14.

[0031] The second non-contact portion 20b is formed on the side facing the concave curved surface of the blade 14 in the region between the first contact portion 18i and the second contact portion 18o on the inner peripheral surface of the hole 12. Specifically, the second non-contact portion 20b is formed on the side facing the concave curved surface of the blade 14 in the region between the second contact portion 18o and the third contact portion 18c on the inner peripheral surface of the hole 12. The second non-contact portion 20b includes a side of the central region 12c that faces the concave curved surface of the blade 14. The second non-contact portion 20b is a region in which a gap is secured between the inner peripheral surface of the hole 12 and the blade 14. The second non-

contact portion 20b is formed as a result of the formation of the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c when the outer peripheral edge region 10e' is crushed toward the blade 14.

5 [0032] The inner peripheral surface of the hole 12 in the second non-contact portion 20b is a region not contributing to holding of the blade 14 and thus may be of any shape as long as the gap is secured between the inner peripheral surface of the hole 12 and the blade 14. The inner peripheral surface of the hole 12 in the second non-contact portion 20b has a linear shape in the first embodiment. The inner peripheral surface of the hole 12 in the second non-contact portion 20b may have a shape close to the linear shape. The inner peripheral surface of the hole 12 having the linear shape is preferable because this facilitates machining of the hole 12' before deformed into the hole 12 and makes it easy to secure the gap between the inner peripheral surface of the hole 12 and the blade 14.

15 [0033] The third non-contact portion 20c is formed on the side facing the concave curved surface of the blade 14 in the region between the first contact portion 18i and the second contact portion 18o on the inner peripheral surface of the hole 12. Specifically, the third non-contact portion 20c is formed on the side facing the concave curved surface of the blade 14 in the region between the first contact portion 18i and the third contact portion 18c on the inner peripheral surface of the hole 12. The third non-contact portion 20c includes a side of the inner peripheral side portion 12i that faces the concave curved surface of the blade 14. More specifically, the third non-contact portion 20c is formed in the region of the recess 12ix on the inner peripheral surface of the hole 12. The

third non-contact portion 20c is a region in which a gap is secured between the inner peripheral surface of the hole 12 and the blade 14. The recess 12ix can improve the accuracy of the position of the tip 14is of the inner peripheral side portion 14i of the blade 14. The third non-contact portion 20c is formed as a result of the formation of the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c when the outer peripheral edge region 10e' is crushed toward the blade 14.

10 [0034] FIG. 6 is an explanatory diagram of important parameters that determine air blowing performance of the blade 14 used in the cross flow fan 100 according to the first embodiment. A specific shape of the blade 14 is determined according to the air blowing performance
15 required of the blade 14. The important parameters that determine the air blowing performance of the blade 14 include an exit angle θ_o , a mounting angle θ_i , a blade inner diameter, and a blade outer diameter.

[0035] The blade inner diameter is the diameter of an
20 inner peripheral surface R_i of the blade 14. As illustrated in FIG. 6, the inner peripheral surface R_i of the blade 14 is a cylindrical surface drawn around the center of rotation of the rotary shaft 16 illustrated in FIGS. 1 and 2 by the tip 14is of the inner peripheral side
25 portion 14i of the blade 14, as seen from the shaft direction. The blade outer diameter is the diameter of an outer peripheral surface R_o of the blade 14. As illustrated in FIG. 6, the outer peripheral surface R_o of the blade 14 is a cylindrical surface drawn around the
30 center of rotation of the rotary shaft 16 illustrated in FIGS. 1 and 2 by a tip 14os of the outer peripheral side portion 14o of the blade 14, as seen from the shaft direction.

[0036] As illustrated in FIG. 6, the exit angle θ_o is the angle of orientation of the tip 14os of the outer peripheral side portion 14o of the blade 14 relative to a tangent at the tip 14os of the outer peripheral side portion 14o of the blade 14 on the outer peripheral surface Ro of the blade 14. As illustrated in FIG. 6, the mounting angle θ_i is the angle of a straight line connecting the tip 14os of the outer peripheral side portion 14o of the blade 14 and the tip 14is of the inner peripheral side portion 14i of the blade 14 relative to a straight line connecting the tip 14os of the outer peripheral side portion 14o of the blade 14 and the center of rotation of the rotary shaft 16 illustrated in FIGS. 1 and 2.

[0037] Next, a method of manufacturing the cross flow fan 100 will be described. FIG. 7 is a flowchart illustrating an example of the method of manufacturing the cross flow fan 100 according to the first embodiment. The method of manufacturing the cross flow fan 100 according to the first embodiment includes a hole forming step S12, a blade inserting step S14, and a blade fixing step S16. Hereinafter, the hole forming step S12 will simply be referred to as step S12, the blade inserting step S14 as step S14, and the blade fixing step S16 as step S16.

[0038] The arcuate holes 12' into which the blades 14 can be inserted are formed in the outer periphery 10o' of a disk-like plate that is the material of the holding plate 10' (step S12). The disk-like plate is formed into the holding plate 10' when the holes 12' are formed in step S12. In step S12, the holes 12' are each formed to have the width 12w' larger than the plate thickness 14w of the blade 14 at any position along the direction of extension of the arcuate holes. In step S12, the inner peripheral surface of the hole 12' facing the convex curved surface of the

blade 14 inserted into the hole is formed to have the concave curved shape following the convex curved surface of the blade 14.

[0039] In step S12, the inner peripheral surface of the hole 12' facing the concave curved surface of the blade 14 inserted into the hole is preferably formed into a shape with the width 12w' larger than that of the convex curved shape following the concave curved surface of the blade 14. Specifically, in step S12, the inner peripheral surface of the central region 12c' facing the concave curved surface of the blade 14 inserted into the hole is preferably formed in a linear shape. In step S12, the recess 12ix' and the protrusion 12iy' are preferably formed on the inner peripheral surface of the inner peripheral side portion 12i' facing the concave curved surface of the blade 14 inserted into the hole.

[0040] One blade 14 is inserted into each of the arcuate holes 12' formed in step S12 (step S14). The blade 14 is easily inserted into the hole 12' in step S14 since the width 12w' of the hole 12' is formed to be larger than the plate thickness 14w of the blade 14 in step S12.

[0041] In step S12, the inner peripheral surface of the hole 12' facing the convex curved surface of the blade 14 inserted into the hole is formed in the concave curved shape following the convex curved surface of the blade 14. Therefore, the insertion of the blade 14 into the hole 12' in step S14 allows the region formed in the concave curved shape on the inner peripheral surface of the hole 12' to face the convex curved surface of the blade 14.

[0042] In the first embodiment, in step S12, the inner peripheral surface of the hole 12' facing the concave curved surface of the blade 14 inserted into the hole is formed in the shape with the width 12w' larger than that of

the convex curved shape following the concave curved surface of the blade 14. The blade 14 can thus be easily inserted into the hole 12'. Moreover, the insertion of the blade 14 into the hole 12' in step S14 allows the region
5 formed in the linear shape on the inner peripheral surface of the hole 12' to face the concave curved surface of the blade 14.

[0043] In the first embodiment, in step S12, the recess 12ix' and the protrusion 12iy' are formed on the inner
10 peripheral surface of the inner peripheral side portion 12i' facing the concave curved surface of the blade 14 inserted into the hole. Therefore, when the blade 14 is inserted into the hole 12', part of the concave curved surface at the tip 14is of the inner peripheral side
15 portion 14i of the blade 14 can escape to the recess 12ix'. Thus, when the blade 14 is inserted into the hole 12' in step S14, the tip 14is of the inner peripheral side portion 14i of the blade 14 is easily brought into contact with the tip 12is' of the inner peripheral side portion 12i' of the
20 hole 12'. As a result, the accuracy of the position of the tip 14is of the inner peripheral side portion 14i of the blade 14 inserted into the hole can be improved.

[0044] When the blade 14 is inserted into the hole 12' in the holding plate 10', the outer peripheral edge region
25 10e' of the holding plate 10' is crushed toward the blade 14. Such processing causes the holding plate 10' to be deformed to fix the blade 14 (step S16). The outer peripheral edge region 10e' is deformed into the outer peripheral edge region 10e. The holding plate 10' is
30 deformed into the holding plate 10. The hole 12' is deformed into the hole 12. The inner peripheral side portion 12i', the outer peripheral side portion 12o', and the central region 12c' of the hole 12' are deformed into

the inner peripheral side portion 12i, the outer peripheral side portion 12o, and the central region 12c of the hole 12, respectively. The recess 12ix' is formed into the recess 12ix. The protrusion 12iy' is formed into the protrusion 12iy. In step S16, the tip 12is' is formed into the tip 12is when the tip 14is of the inner peripheral side portion 14i of the blade 14 is pressed against the tip 12is'. The width 12w' of the hole 12' changes to the width 12w of the hole 12.

10 [0045] In step S16, the hole 12' is deformed into the hole 12, so that the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c that support and fix the blade 14 are formed on the inner peripheral surface of the hole 12. In step S16, the hole 15 12' is deformed into the hole 12, so that the first non-contact portion 20a, the second non-contact portion 20b, and the third non-contact portion 20c, which are not in contact with the blade 14, are formed on the inner peripheral surface of the hole 12.

20 [0046] Specifically, the first contact portion 18i is formed at the tip 12is when the tip 12is' is formed into the tip 12is. The outer peripheral side portion 12o' is deformed into the outer peripheral side portion 12o, so that the second contact portion 18o is formed at the outer peripheral side portion 12o of the hole 12. The protrusion 25 12iy' is formed into the protrusion 12iy, so that the third contact portion 18c is formed at the protrusion 12iy. Formation of the first contact portion 18i and the second contact portion 18o causes formation of the first non- 30 contact portion 20a on the side facing the convex curved surface of the blade 14 in the region between the first contact portion 18i and the second contact portion 18o on the inner peripheral surface of the hole 12. Formation of

the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c causes formation of the second non-contact portion 20b on the side facing the concave curved surface of the blade 14 in the region
5 between the second contact portion 18o and the third contact portion 18c on the inner peripheral surface of the hole 12. Formation of the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c causes formation of the third non-contact portion 20c
10 on the side facing the concave curved surface of the blade 14 in the region between the first contact portion 18i and the third contact portion 18c on the inner peripheral surface of the hole 12.

[0047] As described above, the holding plate 10 of the
15 cross flow fan 100 includes the outer peripheral edge region 10e as well as the first contact portion 18i, the second contact portion 18o, and the third contact portion 18c, at which the blade 14 is supported in contact with the holding plate 10. The cross flow fan 100 thus reduces
20 motion of the blades 14 in the holes 12 of the holding plate 10 such as vibration of the blades 14 in the holes 12 of the holding plate 10, when the blades 14 are rotated around the rotary shaft 16.

[0048] The holding plate 10 of the cross flow fan 100 is
25 further provided with the first non-contact portion 20a, the second non-contact portion 20b, and the third non-contact portion 20c, at which the blade 14 is not in contact with the holding plate 10. The cross flow fan 100 thus reduces rubbing of the blades 14 against the holes 12
30 in the holding plate 10 when the blades 14 are rotated around the rotary shaft 16.

[0049] Accordingly, the cross flow fan 100 can reduce minute noise generated when the blades 14 are rotated

around the center of rotation of the rotary shaft 16. The cross flow fan 100 according to the first embodiment can thus prevent deterioration in durability of the blades 14 to be able to reduce the running cost.

5 [0050] In the cross flow fan 100, the holding plate 10 fixes and supports the tip 14is of the inner peripheral side portion 14i of the blade 14 at the first contact portion 18i, and fixes and supports the outer peripheral side portion 14o including the tip 14os of the blade 14 at
10 the second contact portion 18o. Thus, when rotating the blades 14 around the rotary shaft 16, the cross flow fan 100 can maintain the important parameters determining the air blowing performance of the blades 14 such as the exit angle θ_o , the mounting angle θ_i , the blade inner diameter, and the blade outer diameter that are specified by the tip
15 14is of the inner peripheral side portion 14i and the tip 14os of the outer peripheral side portion 14o of the blade 14. The cross flow fan 100 can therefore maintain the air blowing performance even when the blades 14 are rotated
20 around the rotary shaft 16.

[0051] The cross flow fan 100 is provided with the recess 12ix' in the hole 12' in the process of manufacturing the fan, so that, in the blade inserting step S14, the part of the concave curved surface at the tip 14is
25 of the inner peripheral side portion 14i of the blade 14 can escape to the recess 12ix'. As a result, the cross flow fan 100 can improve the accuracy of the position of the tip 14is of the inner peripheral side portion 14i of the blade 14. The cross flow fan 100 can also determine
30 the blade inner diameter accurately.

[0052] Formation of the recess 12ix and the protrusion 12iy in the cross flow fan 100 causes formation of the third contact portion 18c and the third non-contact portion

20c in the holding plate 10. Accordingly, the cross flow fan 100 can stably support the blades 14 with the holding plate 10.

[0053] Second Embodiment.

5 FIG. 8 is a front view of part of a holding plate 30' used in a cross flow fan according to a second embodiment, as viewed from the direction along the rotary shaft 16. FIG. 9 is a front view of a holding plate 30 of the cross flow fan according to the second embodiment, as viewed from
10 the direction along the rotary shaft 16. Note that in FIGS. 8 and 9, reference numerals are assigned only to some parts and not assigned to the other parts. The cross flow fan according to the second embodiment is obtained by changing the holding plate 10 of the cross flow fan 100 according to
15 the first embodiment to the holding plate 30. In the cross flow fan according to the second embodiment, configurations similar to those of the first embodiment are assigned a group of reference numerals identical to those of the first embodiment and thus will not be described in detail.

20 [0054] As illustrated in FIG. 8, the arcuate holes 12', arranged on the circumference around the center of rotation of the rotary shaft 16, are formed in an outer periphery 30o' of the holding plate 30'. That is, the outer periphery 30o' is a region in which the arcuate holes 12'
25 are formed. The holding plate 30' is in a state in which the blades 14 are not fixed in the holes 12'. As illustrated in FIG. 8, the holding plate 30' includes an outer peripheral edge region 30e' in a region radially outward of the outer periphery 30o'. The outer peripheral edge region 30e' is in contact with the holes 12'. The
30 outer peripheral edge region 30e' includes the edge of the holding plate 30'. The outer peripheral edge region 30e' includes outer peripheral edge protrusions 32' at the edge

of the holding plate 30'.

[0055] The blades 14 are inserted into the holes 12' and the outer peripheral edge region 30e' is crushed toward the blades 14, so that the holding plate 30' is deformed into
5 the holding plate 30 in which the blades 14 are inserted and fixed in the holes 12 as illustrated in FIG. 9. The outer peripheral edge region 30e' is crushed toward the blades 14 and deformed into an outer peripheral edge region 30e illustrated in FIG. 9. The outer peripheral edge
10 protrusions 32' are crushed toward the blades 14 and deformed into outer peripheral edge protrusions 32 illustrated in FIG. 9. The outer peripheral edge region 30e' is crushed toward the blades 14, so that the holes 12' are deformed into the holes 12 in which the blades 14 are
15 inserted and fixed, as illustrated in FIG. 9. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 30e' is crushed toward the blades 14, so that the inner peripheral side portions 12i', the outer peripheral side portions 12o', and the central regions 12c'
20 are deformed into the inner peripheral side portions 12i, the outer peripheral side portions 12o, and the central regions 12c illustrated in FIG. 9, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 30e' is crushed toward the blades 14,
25 so that the recesses 12ix' and the protrusions 12iy' are formed into the recesses 12ix and the protrusions 12iy illustrated in FIG. 9, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 30e' is crushed toward the blades 14, so that the
30 width 12w' of the holes 12' is changed to the width 12w of the holes 12 illustrated in FIG. 9.

[0056] As illustrated in FIG. 9, the arcuate holes 12, arranged on the circumference around the center of rotation

of the rotary shaft 16, are formed in an outer periphery 30o of the holding plate 30. That is, the outer periphery 30o is a region in which the arcuate holes 12 are formed. The holding plate 30 is in a state in which the blades 14 are
5 fixed in the holes 12. The hole 12 has a shape similar to the shape of the blade 14 as seen from the shaft direction of the blade 14. The holding plate 30 includes the outer peripheral edge region 30e in a region on the outer peripheral side relative to the outer periphery 30o. The
10 outer peripheral edge region 30e includes the edge of the holding plate 30. The outer peripheral edge region 30e includes the outer peripheral edge protrusions 32 at the edge of the holding plate 30.

[0057] A method of manufacturing the cross flow fan
15 according to the second embodiment having the above configuration will be described. The method of manufacturing the cross flow fan according to the second embodiment is obtained by changing the blade fixing step S16 of the method of manufacturing the cross flow fan 100 according to the
20 first embodiment.

[0058] In the blade fixing step according to the second embodiment, the outer peripheral edge region 30e' of the holding plate 30' in which the blades 14 are inserted in the holes 12' is crushed toward the blades 14 to deform the
25 holding plate 30' and fix the blades 14. In the blade fixing step according to the second embodiment, the outer peripheral edge protrusions 32' are crushed toward the blades 14 inserted in the holes 12' to be deformed such that the outer peripheral edge protrusions 32' protrude toward the holes 12'.
30 In the blade fixing step according to the second embodiment, the outer peripheral edge protrusions 32' are deformed into the outer peripheral edge protrusions 32. In the blade fixing step according to the

second embodiment, the outer peripheral edge region 30e' is deformed into the outer peripheral edge region 30e. In the blade fixing step according to the second embodiment, the holding plate 30' is deformed into the holding plate 30.

5 [0059] As described above, in the cross flow fan according to the second embodiment, the outer peripheral edge region 30e is formed in the holding plate 30 and the outer peripheral edge region 30e includes the outer peripheral edge protrusions 32 at the edge of the holding plate 30.

10 Accordingly, the cross flow fan according to the second embodiment firmly fixes the outer peripheral side portion 140 of the blade 14 at the outer peripheral side portion 120 of the hole 12. That is, the cross flow fan according to the second embodiment holds the blades 14 with a stronger force

15 by the holding plate 30. As a result, the cross flow fan according to the second embodiment further reduces motion of the blades 14 in the holes 12 of the holding plate 30 such as vibration of the blades 14 in the holes 12 of the holding plate 30, when the blades 14 are rotated around the rotary

20 shaft 16. Moreover, the cross flow fan according to the second embodiment can better maintain the air blowing performance when the blades 14 are rotated around the rotary shaft 16.

[0060] Third Embodiment.

25 FIG. 10 is a front view of part of a holding plate 40' used in a cross flow fan according to a third embodiment, as viewed from the direction along the rotary shaft 16. FIG. 11 is a front view of a holding plate 40 of the cross flow fan according to the third embodiment, as viewed from the

30 direction along the rotary shaft 16. Note that in FIGS. 10 and 11, reference numerals are assigned only to some parts and not assigned to the other parts. The cross flow fan according to the third embodiment is obtained by

changing the holding plate 10 of the cross flow fan 100 according to the first embodiment to the holding plate 40. In the cross flow fan according to the third embodiment, configurations similar to those of the first embodiment are assigned a group of reference numerals identical to those of the first embodiment and thus will not be described in detail.

[0061] As illustrated in FIG. 10, the arcuate holes 12', arranged on the circumference around the center of rotation of the rotary shaft 16, are formed in an outer periphery 40o' of the holding plate 40'. That is, the outer periphery 40o' is a region in which the arcuate holes 12' are formed. The holding plate 40' is in a state in which the blades 14 are not fixed in the holes 12'. As illustrated in FIG. 10, the outer periphery 40o' of the holding plate 40' includes outer peripheral holes 42' each in a region on the side facing the concave curved surface of the blade 14 relative to the outer peripheral side portion 12o' of the hole 12'. The holding plate 40' includes an outer peripheral edge region 40e' in a region on the outer peripheral side relative to the outer periphery 40o'. The outer peripheral edge region 40e' is in contact with the holes 12'. The outer peripheral edge region 40e' includes the edge of the holding plate 40'.

[0062] The blades 14 are inserted into the holes 12' and the outer peripheral edge region 40e' is crushed toward the blades 14, so that the holding plate 40' is deformed into the holding plate 40 in which the blades 14 are inserted and fixed in the holes 12 as illustrated in FIG. 11. The outer peripheral edge region 40e' of the holding plate 40' is crushed toward the blades 14, so that the regions of the outer peripheral side portions 12o' of the holes 12' in the holding plate 40' are deformed toward the outer peripheral

holes 42'. The outer peripheral holes 42' are crushed toward the blades 14 and deformed into outer peripheral holes 42 illustrated in FIG. 11. The outer peripheral edge region 40e' is crushed toward the blades 14 and deformed into an outer peripheral edge region 40e illustrated in FIG. 11. The outer peripheral edge region 40e' is crushed toward the blades 14, so that the holes 12' are deformed into the holes 12 in which the blades 14 are inserted and fixed, as illustrated in FIG. 11. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 40e' is crushed toward the blades 14, so that the inner peripheral side portions 12i', the outer peripheral side portions 12o', and the central regions 12c' are deformed into the inner peripheral side portions 12i, the outer peripheral side portions 12o, and the central regions 12c illustrated in FIG. 11, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 40e' is crushed toward the blades 14, so that the recesses 12ix' and the protrusions 12iy' are formed into the recesses 12ix and the protrusions 12iy illustrated in FIG. 11, respectively. The blades 14 are inserted into the holes 12' and the outer peripheral edge region 40e' is crushed toward the blades 14, so that the width 12w' of the holes 12' is changed to the width 12w of the holes 12 illustrated in FIG. 11.

[0063] As illustrated in FIG. 11, the arcuate holes 12, arranged on the circumference around the center of rotation of the rotary shaft 16, are formed in the outer periphery 40o of the holding plate 40. That is, the outer periphery 40o is a region in which the arcuate holes 12 are formed. The holding plate 40 is in a state in which the blades 14 are fixed in the holes 12. As illustrated in FIG. 11, the outer periphery 40o of the holding plate 40 includes the

outer peripheral holes 42 each in the region on the side facing the concave curved surface of the blade 14 relative to the outer peripheral side portion 12o of the hole 12. The hole 12 has a shape similar to the shape of the blade 14 as seen from the shaft direction of the blade 14. The holding plate 40 includes the outer peripheral edge region 40e in a region on the outer peripheral side relative to the outer periphery 40o. The outer peripheral edge region 40e includes the edge of the holding plate 40.

10 [0064] A method of manufacturing the cross flow fan according to the third embodiment having the above configuration will be described. The method of manufacturing the cross flow fan according to the third embodiment is obtained by changing the blade fixing step S16 of the method of manufacturing the cross flow fan 100 according to the first embodiment.

[0065] In the blade fixing step according to the third embodiment, the outer peripheral edge region 40e' of the holding plate 40' in which the blades 14 are inserted in the holes 12' is crushed toward the blades 14 to deform the holding plate 40' and fix the blades 14. In the blade fixing step according to the third embodiment, the outer peripheral edge region 40e' of the holding plate 40' is crushed toward the blades 14, so that the regions of the outer peripheral side portions 12o' of the holes 12' in the holding plate 40' are deformed toward the outer peripheral holes 42'. In the blade fixing step according to the third embodiment, the outer peripheral holes 42' are deformed into the outer peripheral holes 42. In the blade fixing step according to the third embodiment, the outer peripheral edge region 40e' is deformed into the outer peripheral edge region 40e. In the blade fixing step according to the third embodiment, the holding plate 40' is

deformed into the holding plate 40.

[0066] As described above, the holding plate 40 of the cross flow fan according to the third embodiment is provided with the outer peripheral holes 42 each in the region of the outer periphery 40o on the side facing the concave curved surface of the blade 14 relative to the outer peripheral side portion 12o of the hole 12. Accordingly, the cross flow fan according to the third embodiment firmly fixes the outer peripheral side portion 14o of the blade 14 at the outer peripheral side portion 12o of the hole 12. That is, the cross flow fan according to the third embodiment holds the blades 14 with a stronger force by the holding plate 40. As a result, the cross flow fan according to the third embodiment further reduces motion of the blades 14 in the holes 12 of the holding plate 40 such as vibration of the blades 14 in the holes 12 of the holding plate 40, when the blades 14 are rotated around the rotary shaft 16. Moreover, the cross flow fan according to the third embodiment can better maintain the air blowing performance when the blades 14 are rotated around the rotary shaft 16.

[0067] Fourth Embodiment.

FIG. 12 is a view illustrating an example of the shape of an end in the direction along the rotary shaft 16 of a blade 54 used in a cross flow fan according to a fourth embodiment. The cross flow fan according to the fourth embodiment is obtained by changing the blades 14 of the cross flow fan 100 according to the first embodiment to the blades 54. In the cross flow fan according to the fourth embodiment, configurations similar to those of the first embodiment are assigned a group of reference numerals identical to those of the first embodiment and thus will not be described in detail.

[0068] An inner peripheral side portion 54i and an outer

peripheral side portion 54a of the blade 54 are chamfered at an end of the blade 54 in the direction of extension of the rotary shaft, or in a Z direction illustrated in FIG. 12. That is, the blade 54 includes a chamfered portion 56

5 processed in a chamfered shape at the end of the blade in the Z direction. The direction of extension of the rotary shaft is the aforementioned first direction and the longitudinal direction of the blade 54. The chamfered portion 56 monotonically reduces the cross sectional area

10 of the end of the blade 54 in the Z direction relative to the cross sectional area of the central portion of the blade 54 in the Z direction. Specifically, the cross sectional area of the end of the blade 54 in the Z direction is smaller than the cross sectional area of the

15 central portion of the blade 54 in the Z direction by the product of the plate thickness of the blade 54 and the chamfered length in the direction orthogonal to the Z direction of the blade 54. The chamfered portion 56 thus allows the blade 54 to be easily inserted into the hole 12

20 in the blade inserting step of a method of manufacturing the cross flow fan. That is, the chamfered portion 56 improves insertability of the blade 54 into the hole 12 in the blade inserting step of the method of manufacturing the cross flow fan.

25 [0069] The end of the blade 54 in the Z direction is processed into the chamfered shape in the fourth embodiment, but may be processed into an arcuate shape instead. In this case, the blade 54 includes an arcuate portion processed into the arcuate shape at the end of the blade in

30 the Z direction. As with the chamfered portion 56, the arcuate portion monotonically reduces the cross sectional area of the end of the blade 54 in the Z direction relative to the cross sectional area of the central portion of the

blade 54 in the Z direction. Thus, as with the chamfered portion 56, the arcuate portion allows the blade 54 to be easily inserted into the hole 12 in the blade inserting step of the method of manufacturing the cross flow fan.

5 That is, as with the chamfered portion 56, the arcuate portion improves insertability of the blade 54 into the hole 12 in the blade inserting step of the method of manufacturing the cross flow fan.

[0070] Although the fourth embodiment illustrates an
10 example in which the end of the blade 54 in the direction of extension of the rotary shaft is processed into the chamfered shape or the arcuate shape, a central region 54c, which is the central region between the inner peripheral side portion and the outer peripheral side portion, may be
15 processed into a shape protruding beyond the inner peripheral side portion 54i and the outer peripheral side portion 54o instead. In this case, the blade 54 includes a V-shaped portion in which the central region 54c at the end of the blade 54 in the direction of extension of the rotary
20 shaft extends beyond the inner peripheral side portion 54i and the outer peripheral side portion 54o. As with the chamfered portion 56 and the arcuate portion, the V-shaped portion monotonically reduces the cross sectional area of the end of the blade 54 relative to the cross sectional
25 area of the central portion of the blade 54. Thus, as with the chamfered portion 56 and the arcuate portion, the V-shaped portion allows the blade 54 to be easily inserted into the hole 12 in the blade inserting step of the method of manufacturing the cross flow fan. That is, as with the
30 chamfered portion 56 and the arcuate portion, the V-shaped portion improves insertability of the blade 54 into the hole 12 in the blade inserting step of the method of manufacturing the cross flow fan.

[0071] The blade 54 has a substantially uniform plate thickness in the first to fourth embodiments described above, but it may be of a blade shape with a thick center, for example. In this case, it is sufficient if the shape of the hole 12 is changed in accordance with the shape of the blade and the hole 12 has a width not allowing contact with the thickest portion of the blade.

[0072] The configurations illustrated in the aforementioned first, second, third, and fourth embodiments merely illustrate an example of the content of the present invention, and can thus be combined with another known technique or partially omitted and/or modified without departing from the scope of the present invention.

15 Reference Signs List

[0073] 10, 10', 30, 30', 40, 40' holding plate; 10o, 10o', 30o, 30o', 40o, 40o' outer periphery; 10e, 10e', 30e, 30e', 40e, 40e' outer peripheral edge region; 12, 12' hole; 12c, 12c' central region; 12i, 12i' inner peripheral side portion; 12is, 12is' tip; 12ix, 12ix' recess; 12iy, 12iy' protrusion; 12o, 12o' outer peripheral side portion; 12w, 12w' width; 14, 54 blade; 14c, 54c central region; 14i, 54i inner peripheral side portion; 14is, 14os tip; 14o, 54o outer peripheral side portion; 14w plate thickness; 16 rotary shaft; 18i first contact portion; 18o second contact portion; 18c third contact portion; 20a first non-contact portion; 20b second non-contact portion; 20c third non-contact portion; 32, 32' outer peripheral edge protrusion; 42, 42' outer peripheral hole; 56 chamfered portion; 100 cross flow fan; Ri inner peripheral surface; Ro outer peripheral surface; θ_i mounting angle; θ_o exit angle.

CLAIMS

1. A cross flow fan comprising:
 - a rotary shaft;
 - at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends;
 - and
 - an arcuate blade inserted into a plurality of arcuate holes formed in an outer periphery of the holding plates, wherein
 - the holding plates each include
 - an outer peripheral edge region provided in a region on an outer peripheral side relative to the holes,
 - and
 - a contact portion to support the blade in contact with the blade in the arcuate holes, and
 - the contact portion includes
 - a first contact portion to support an end of an inner peripheral side portion of the blade that is in contact with an end of an inner peripheral side portion of the holes, and
 - a second contact portion to support an end of an outer peripheral side portion of the blade that is in contact with an end of an outer peripheral side portion of the holes,
 - the holding plates are not in contact with the blade in a first region that is a region formed on a side facing a concave curved surface of the blade in the holes and is a region between the first contact portion and the second contact portion, and
 - the holding plates are not in contact with the blade in a second region that is a region formed on a side facing a convex curved surface of the blade in the holes and is a

region between the first contact portion and the second contact portion.

2. A cross flow fan comprising:

- a rotary shaft;

- at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends;
- and

- an arcuate blade inserted into a plurality of arcuate holes formed in an outer periphery of the holding plates, wherein

- the holding plates each include

- an outer peripheral edge region provided in a region on an outer peripheral side relative to the holes,

- a contact portion to support the blade in contact with the blade, and

- a non-contact portion not in contact with the blade, and

- a region facing a convex curved surface of the blade in the holes has a shape following the convex curved surface of the blade and is part of the non-contact portion.

3. The cross flow fan according to claim 1, wherein the first region includes a region having a linear shape.

4. A cross flow fan comprising:

- a rotary shaft;

- at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends;
- and

- an arcuate blade inserted into a plurality of arcuate holes formed in an outer periphery of the holding plates,

wherein

the holding plates each include

an outer peripheral edge region provided in a region on an outer peripheral side relative to the holes,

a contact portion to support the blade in contact with the blade, and

a non-contact portion not in contact with the blade, and

a recess is provided on an inner peripheral side of the region facing the concave curved surface of the blade in the holes.

5. A cross flow fan comprising:

a rotary shaft;

at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends; and

an arcuate blade inserted into a plurality of arcuate holes formed in an outer periphery of the holding plates, wherein

the holding plates each include

an outer peripheral edge region provided in a region on an outer peripheral side relative to the holes,

a contact portion to support the blade in contact with the blade, and

a non-contact portion not in contact with the blade, and

the outer peripheral edge region includes an outer peripheral edge protrusion in a region toward the outer peripheral side portion of the holes relative to the rotary shaft.

6. The cross flow fan according to any one of claims 1 to

5, wherein the outer periphery of the holding plates includes an outer peripheral hole in a region on a side facing the concave curved surface of the blade relative to the outer peripheral side portion of the holes.

7. The cross flow fan according to any one of claims 1 to 6, wherein an end of the blade in the direction in which the rotary shaft extends has a chamfered shape or an arcuate shape.

8. The cross flow fan according to any one of claims 1 to 6, wherein a central region between the inner peripheral side portion and the outer peripheral side portion of the blade of an end of the blade in the direction in which the rotary shaft extends has a shape extending beyond the inner peripheral side portion and the outer peripheral side portion in the direction in which the rotary shaft extends.

9. A method of manufacturing a cross flow fan including a rotary shaft, at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends, and a blade fixed to the holding plates, the method comprising:

- a hole forming step of forming a plurality of arcuate holes in an outer periphery of the holding plates to allow insertion of the blade into the holes;

- a blade inserting step of inserting the blade into the arcuate holes; and

- a blade fixing step of crushing a region on an outer peripheral side of the holding plates relative to the holes toward the blade inserted into the holes, so as to form, in the holding plates, a contact portion at which the blade is supported in contact with the holding plates and a non-

contact portion at which the blade is not in contact with the holding plates, and fixing the blade to the holding plates, wherein

the hole forming step includes forming a region facing a convex curved surface of the blade in the holes in the blade fixing step into a concave curved shape following the convex curved surface of the blade, and

the blade fixing step includes forming the region formed in the concave curved shape into part of the non-contact portion.

10. A method of manufacturing a cross flow fan including a rotary shaft, at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends, and a blade fixed to the holding plates, the method comprising:

a hole forming step of forming a plurality of arcuate holes in an outer periphery of the holding plates to allow insertion of the blade into the holes;

a blade inserting step of inserting the blade into the arcuate holes; and

a blade fixing step of crushing a region on an outer peripheral side of the holding plates relative to the holes toward the blade inserted into the holes, so as to form, in the holding plates, a contact portion at which the blade is supported in contact with the holding plates and a non-contact portion at which the blade is not in contact with the holding plates, and fixing the blade to the holding plates, wherein

in the hole forming step, a recess is provided on an inner peripheral side of the region facing the concave curved surface of the blade in the holes in the blade fixing step.

11. A method of manufacturing a cross flow fan including a rotary shaft, at least a pair of holding plates disposed at an interval in a direction in which the rotary shaft extends, and a blade fixed to the holding plates, the method comprising:

 a hole forming step of forming a plurality of arcuate holes in an outer periphery of the holding plates to allow insertion of the blade into the holes;

 a blade inserting step of inserting the blade into the arcuate holes; and

 a blade fixing step of crushing a region on an outer peripheral side of the holding plates relative to the holes toward the blade inserted into the holes, so as to form, in the holding plates, a contact portion at which the blade is supported in contact with the holding plates and a non-contact portion at which the blade is not in contact with the holding plates, and fixing the blade to the holding plates, wherein

 an outer peripheral protrusion is provided in a region on the outer peripheral side of the holding plates relative to the holes, and

 the blade fixing step includes crushing the outer peripheral protrusion toward the blade inserted into the holes so as to deform the outer peripheral protrusion such that the outer peripheral protrusion protrudes toward the holes.