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(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

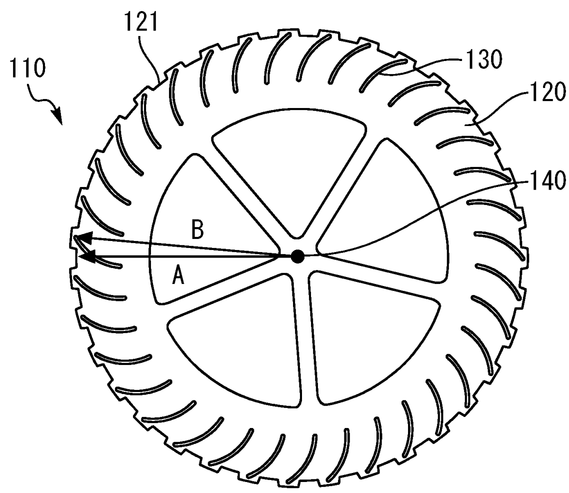
(72) Inventors:
- **KONO, Atsushi**
  Tokyo 100-8310 (JP)
- **TERAMOTO, Takuya**
  Tokyo 100-8310 (JP)
- **ADACHI, Naho**
  Tokyo 100-8310 (JP)

(74) Representative: **Pfenning, Meinig & Partner mbB**
Patent- und Rechtsanwälte
Joachimsthaler Straße 10-12
10719 Berlin (DE)

(54) **CROSS-FLOW FAN, BLOWING DEVICE, AND REFRIGERATION CYCLE DEVICE**

(57) To provide a cross flow fan that can achieve an increase in air volume without causing an increase in size. Therefore, a cross flow fan (100) includes a plurality of support rings (120) arranged at a predetermined interval in a direction of a rotation axis (140), and a plurality of blades (130) provided between adjacent support rings (120), located close to an outer circumference of the support ring (120), and spaced apart in the circumferential direction. The support ring (120) has cutouts (121) cut from the outer circumference end toward the inner circumference side, at each position between the adjacent blades (130). An outer diameter of the support ring (120) at the cutout (121) is smaller than a distance from the rotation axis (140) to an outer end of the blade (130).

FIG. 4



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Description

Technical Field

[0001] The present disclosure relates to a cross flow fan, a blowing device, and a refrigeration cycle device.

Background Art

[0002] There is a known cross flow fan that includes fixing plates and blades that are resin molded integrally with the fixing plates, an outer circumference ends of the blades extending outward from the fixing plates (see Patent Literature 1, for example).

Citation List

Patent Literature

[0003] [PTL 1] JP S62-038895 A

Summary of the Invention

Problems to be Solved by the Invention

[0004] The cross flow fan disclosed in Patent Literature 1 includes support rings (fixing plates) and blades fixed to the support rings, and the outer end of each blade protrudes outward from the outer circumference ends of the support rings. In other words, over the entire circumference of the support rings, the support rings are present only inward of the outer ends of the blades in a radial direction. In the prior art having such a configuration, a portion of air flow that passes through between blades goes around the end of the blade at portions having no support ring, and leaks from a positive pressure surface to a negative pressure surface and hence, an air volume is reduced.

[0005] The present disclosure has been made to solve such a problem. The object of the present disclosure is to provide a cross flow fan, a blowing device, and a refrigeration cycle device that can achieve an increase in air volume without causing an increase in size of the fan.

Solution to Problem

[0006] A cross flow fan according to the present disclosure includes: a plurality of support rings arranged at a predetermined interval in a direction of a rotation axis; and a plurality of blades provided between adjacent support rings, located close to an outer circumference of a support ring of the adjacent support rings, and spaced apart in a circumferential direction, a support ring of the plurality of support rings having cutouts cut from an outer circumference end toward an inner circumference side, a cutout of the cutouts being arranged at each position between adjacent blades, an outer diameter of the support ring at the cutout being smaller than a distance from the rotation axis to an outer end of a blade of the plurality of blades.

[0007] Or, a cross flow fan according to the present disclosure includes: a plurality of support rings arranged at a predetermined interval in a direction of a rotation axis; and a plurality of blades provided between the adjacent support rings, located close to an outer circumference of the support ring, and spaced apart in a circumferential direction, a surface of the support ring to which the blades are connected having a plurality of protruding portions and a plurality of recessed portions alternately arranged in a circumferential direction, the blades being connected to the plurality of recessed portions of the support ring.

[0008] A blowing device according to the present disclosure includes: the cross flow fan as described above.

[0009] A refrigeration cycle device according to the present disclosure includes: the cross flow fan as described above; and a heat exchanger configured to perform heat exchange between an air flow generated by the cross flow fan and a refrigerant.

Advantageous Effects of the Invention

[0010] According to the cross flow fan, the blowing device, and the refrigeration cycle device according to the present disclosure, it is possible to obtain an advantageous effect of achieving an increase in air volume without causing an increase in size of the fan.

Brief Description of the Drawings

[0011]

Fig. 1 is a diagram showing the configuration of a refrigeration cycle device according to Embodiment 1.

Fig. 2 is a cross-sectional view showing the configuration of indoor equipment of an air-conditioning apparatus being an example of the refrigeration cycle device and a blowing device according to Embodiment 1.

Fig. 3 is a front view of a cross flow fan according to Embodiment 1.

Fig. 4 is a cross-sectional view showing an example of an impeller of the cross flow fan according to Embodiment 1.

Fig. 5 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 6 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 7 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 8 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 9 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 10 is a cross-sectional view showing an example of the impeller of the cross flow fan according to Embodiment 1.

Fig. 11 is a perspective view showing a modification of the impeller of the cross flow fan according to Embodiment 1.

Fig. 12 is a front view showing the modification of the impeller of the cross flow fan according to Embodiment 1.

Fig. 13 is an enlarged cross-sectional view of a main part, showing the modification of the impeller of the cross flow fan according to Embodiment 1.

Fig. 14 is a perspective view showing a modification of the impeller of the cross flow fan according to Embodiment 1.

Description of Embodiment

[0012] Modes for carrying out a cross flow fan, a blowing device, and a refrigeration cycle device according to the present disclosure will be described with reference to attached drawings. In the respective drawings, identical or corresponding components are given the same reference symbols, and the repeated description will be simplified or omitted when appropriate. In the description made hereinafter, for the sake of convenience, the positional relationship of respective structures may be expressed with reference to the states shown in the drawings. The present disclosure is not limited to the following embodiments, and respective embodiments may be freely combined, optional constitutional elements of the respective embodiments may be modified, or optional constitutional elements of the respective embodiments may be omitted without departing from the gist of the present disclosure.

Embodiment 1.

[0013] An embodiment 1 of the present disclosure will be described with reference to Fig. 1 to Fig. 14. Fig. 1 is a diagram showing the configuration of a refrigeration cycle device. Fig. 2 is a cross-sectional view showing the configuration of indoor equipment of an air-conditioning apparatus being an example of the refrigeration cycle device and a blowing device. Fig. 3 is a front view of a cross flow fan. Fig. 4 to Fig. 10 are cross-sectional views showing examples of an impeller of the cross flow fan. Fig. 11 is a perspective view showing a modification of the impeller of the cross flow fan. Fig. 12 is a front view showing the modification of the impeller of the cross flow fan. Fig. 13 is an enlarged cross-sectional view of a main part, showing the modification of the impeller of the cross flow fan. Fig. 14 is a perspective view showing a modification of the impeller of the cross flow fan.

[0014] Fig. 1 shows a configuration of the air-conditioning apparatus being an example of the refrigeration cycle device that includes the cross flow fan according to the present disclosure. Examples of the refrigeration cycle device that includes the cross flow fan according to the present disclosure include a showcase in addition to the air-conditioning apparatus. As will be described later, the air-conditioning apparatus has a function of blowing air. Accordingly, the air-conditioning apparatus described herein is also an example of a blowing device that includes the cross flow fan according to the present disclosure. Examples of the blowing device that includes the cross flow fan according to the present disclosure include for example a circulator and a tower fan in addition to the air-conditioning apparatus.

[0015] As shown in Fig. 1, the air-conditioning apparatus being the refrigeration cycle device according to the present embodiment includes indoor equipment 10 and outdoor equipment 20. The indoor equipment 10 is installed inside a room that is the target of air conditioning, that is, in a room. The outdoor equipment 20 is installed outside the room, that is, outdoors. The indoor equipment 10 includes an indoor equipment heat exchanger 11 and a cross flow fan 100. The outdoor equipment 20 includes an outdoor equipment heat exchanger 21, an outdoor equipment fan 22, a compressor 23, an expansion valve 24, and a four-way valve 25.

[0016] The indoor equipment 10 and the outdoor equipment 20 are connected with each other by refrigerant pipes 30. The refrigerant pipes 30 are provided between the indoor equipment heat exchanger 11 of the indoor equipment 10 and the outdoor equipment heat exchanger 21 of the outdoor equipment 20 in a state that allows circulation. A refrigerant is sealed in the refrigerant pipes 30. An example of the refrigerant sealed in the refrigerant pipes 30 includes difluoromethane (CH_2F_2:R32).

[0017] The refrigerant pipes 30 sequentially connect the indoor equipment heat exchanger 11, the four-way valve 25, the compressor 23, the outdoor equipment heat exchanger 21, and the expansion valve 24. Accordingly, a refrigerant circuit is formed in which a refrigerant circulates between the indoor equipment heat exchanger 11 and the outdoor equipment heat exchanger 21.

[0018] The compressor 23 is equipment that compresses a supplied refrigerant to increase the pressure and the temperature of the refrigerant. For the compressor 23, a rotary compressor, a scroll compressor, a reciprocating compressor, or the like may be used, for example. The expansion valve 24 expands the refrigerant, condensed by the outdoor equipment heat exchanger 21, to reduce the pressure of the refrigerant.

[0019] The indoor equipment heat exchanger 11 causes the refrigerant that flows into the indoor equipment heat exchanger 11 to exchange heat with air around the indoor equipment heat exchanger 11. The cross flow fan 100 blows air in such a way as to cause indoor air to pass through an area around the indoor equipment heat exchanger 11, thus promoting heat exchange between the refrigerant and air in the indoor equipment heat exchanger 11, and sending the air heated or cooled by the heat exchange into the room again. The outdoor equipment heat exchanger 21 causes the refrigerant that flows into the outdoor equipment heat exchanger 21 to exchange heat with air around the outdoor equipment heat exchanger 21. The outdoor equipment fan 22 blows air in such a way as to cause outdoor air to pass through an area around the outdoor equipment heat exchanger 21, thus promoting heat exchange between the refrigerant and air in the outdoor equipment heat exchanger 21.

[0020] In the refrigerant circuit having such a configuration, heat exchange between a refrigerant and air is performed in each of the indoor equipment heat exchanger 11 and the outdoor equipment heat exchanger 21 and hence, the refrigerant circuit serves as a heat pump that transfers heat between the indoor equipment 10 and the outdoor equipment 20. When the four-way valve 25 is switched, a circulating direction of the refrigerant in the refrigerant circuit is reversed, so that a cooling operation and a heating operation of the air-conditioning apparatus can be switched.

[0021] As shown in Fig. 2, the indoor equipment 10 includes a housing 12. The housing 12 is installed in the room. The indoor equipment heat exchanger 11 and the cross flow fan 100 are housed in the housing 12. An upper surface portion of the housing 12 has an air inlet 13. The air inlet 13 is an opening through which air is taken into the housing 12 from the outside. A lower surface of the housing 12 has an air outlet 14. The air outlet 14 is an opening through which air is discharged to the outside from the inside of the housing 12.

[0022] An air passage extending from the air inlet 13 to the air outlet 14 is formed in the housing 12. A filter 15 is installed in the air inlet 13. The filter 15 is provided to remove relatively large refuse, dust, dirt, and the like from air that flows into the housing 12 through the air inlet 13.

[0023] In the air passage in the housing 12, the indoor equipment heat exchanger 11 is installed on the downwind side of the filter 15. The indoor equipment heat exchanger 11 performs heat exchange with air flowing through the air passage in the housing 12, thus heating or cooling the air flowing through the air passage. Whether air is heated or cooled depends on whether the air-conditioning apparatus is performing a heating operation or a cooling operation.

[0024] In the above-described air passage, the cross flow fan 100 is installed on the downwind side of the indoor equipment heat exchanger 11. The cross flow fan 100 is provided to generate, in the air passage in the housing 12, an air flow directing to the air outlet 14 from the air inlet 13. In the housing 12, a rear guide 17 is provided on the rear surface side of the impeller of the cross flow fan 100. Further, in the housing 12, a stabilizer 18 is provided on the front surface side of the impeller of the cross flow fan 100. The rear guide 17 is disposed to have a helical shape in which a distance from the impeller of the cross flow fan 100 increases as the rear guide 17 approaches the air outlet 14 from the indoor equipment heat exchanger 11. Due to the rear guide 17 and the stabilizer 18, during rotation of the impeller of the cross flow fan 100, it is possible to achieve a flow of air in which air is suctioned from an area having the smallest flow passage resistance, that is, an area close to the indoor equipment heat exchanger 11, and the air is blown out toward an area having the second smallest flow passage resistance, that is, an area close to the air outlet 14.

[0025] An up-down vane 16 is provided to the air outlet 14. The up-down vane 16 is provided to adjust a blowing angle of air to be blown out from the air outlet 14. By changing the direction of the up-down vane 16, the indoor equipment 10 can change an air blowing direction in an up-down direction. Although not shown in the drawing, a left-right vane is also provided to the air outlet 14. The left-right vane is provided to adjust a blowing angle of air to be blown out from the air outlet 14 in a left-right direction.

[0026] When the cross flow fan 100 is operated, an air flow directing toward the air outlet 14 from the air inlet 13 is generated in the air passage, so that air is suctioned from the air inlet 13 and the air is blown out from the air outlet 14. The air suctioned from the air inlet 13 forms an air flow that passes through the filter 15, the indoor equipment heat exchanger 11, and the cross flow fan 100 in this order along the air passage in the housing 12, and is blown out from the air outlet 14. At this point of operation, the up-down vane 16 and the left-right vane disposed on the downwind side of the cross flow fan 100 adjust a direction of air to be blown out from the air outlet 14, that is, the air blowing direction. The indoor equipment 10 of the air-conditioning apparatus having the above-mentioned configuration blows air into a room. The indoor equipment 10 can change the temperature and the direction of the air flow to be blown.

[0027] As shown in Fig. 3, the cross flow fan 100 includes an impeller 110 and a motor 150. The impeller 110 includes support rings 120, blades 130, and a rotation axis 140. The motor 150 rotates the impeller 110 about the rotation axis 140.

[0028] The impeller 110 includes a plurality of support rings 120. The support ring 120 is a flat plate member having a ring shape. The plurality of support rings 120 are arranged at predetermined intervals in a direction parallel to the rotation axis 140 (hereinafter also referred to as "direction of the rotation axis 140"). The rotation axis 140 of the impeller 110 is provided in such a way as to penetrate through the center of the ring shape of each of the plurality of support rings 120. The plurality of blades 130 are provided between adjacent support rings 120. The plurality of blades 130 are provided at a position close to the outer circumference of the support ring 120. The plurality of blades 130 are aligned in a spaced-apart manner along the circumferential direction of the support ring 120.

[0029] Each of the plurality of blades 130 have the same cross sectional shape. Referring to Fig. 10, for example, each of the plurality of blades 130 has a positive pressure surface 131 and a negative pressure surface 132, and an outer end 133 and an inner end 134. The positive pressure surface 131 is the surface of the blade 130 that faces in a rotation direction. The negative pressure surface 132 is the surface of the blade 130 that faces in a direction opposite to the rotation direction. The outer end 133 is the end of the blade 130 that is farthest from the rotation axis 140. The inner end 134 is the end of the blade 130 that is closest to the rotation axis 140.

[0030] When attention is focused on the support rings 120 disposed at intermediate positions, excluding both ends, as shown in Fig. 3, the blades 130 are connected to each of both flat plate surfaces of each support ring 120 at the intermediate position. One surface of the support ring 120 is assumed as a first surface, and the other surface of the support ring 120 is assumed as a second surface. That is, the second surface is the surface on the back side of the first surface. In this case, the blades 130 are connected to the first surface of the support ring 120, and the blades 130 are also connected to the second surface of the same support ring 120. In the configuration example shown in Fig. 3, positions of the blades 130 connected to the first surface of the support ring 120 and positions of the blades 130 connected to the second surface of the same support ring 120 are located in such a way as to prevent overlapping.

[0031] In the cross flow fan 100 according to the present embodiment, the support ring 120 has cutouts 121. Next, the configurations of the support ring 120 particularly relating to the cutouts 121 will be described with reference to Fig. 4 to Fig. 9. The cutouts 121 are cut from the outer circumference end of the support ring 120 toward the inner circumference side. Each of the cutouts 121 is provided at each position between adjacent blades 130 on the one surface of the support ring 120. The outer end 133 of each blade 130 is disposed on the support ring 120 at a portion at which the cutout 121 is not formed. In these configuration examples, the number of cutouts 121 formed on one support ring 120 is equal to the number of blades 130 connected to the support ring 120.

[0032] An outer diameter of the support ring 120 at the cutout 121 is smaller than a distance from the rotation axis 140 to the outer end of the blade 130. The outer diameter of the support ring 120 at the cutout 121 is, for example, a distance from the rotation axis 140 to the cutout bottom of the cutout 121 (the deepest portion of the cutout). In other words, it can be also said that the cutout bottom of the cutout 121 is the portion of the support ring 120 having the smallest outer diameter.

[0033] According to the cross flow fan 100 having the above-mentioned configuration, by providing the cutouts 121 to the support ring 120 at a position close to the outer ends 133 of the blades 130, air flow from between the blades 130 also flows into spaces in the cutouts 121. Therefore, at a portion at which each cutout 121 is provided, air flow from between the blades 130 easily flows into the area downstream of the support ring 120. In contrast, the cutouts 121 are not provided to the support ring 120 at a position close to the inner ends 134 of the blades 130 and hence, it is possible to suppress generation of a flow that goes around the inner end 134 of the blade 130. Accordingly, it is possible to reduce low wind speed areas in the area downstream of the support ring 120 and hence, it is possible to achieve an increase in air volume of the cross flow fan 100 without causing an increase in size of the fan. It is also possible to obtain an advantageous effect of reducing noise when a comparison is made at the same fan input.

[0034] In the configuration examples shown in Fig. 4 and Fig. 5, the cutouts 121 have a trapezoidal shape. Fig. 4 shows the configuration example of the support ring 120 disposed at both ends in the direction of the rotation axis 140. When the description is made with reference to Fig. 4, each cutout 121 is provided at each position between the adjacent blades 130. The outer end 133 of each blade 130 is disposed on the support ring 120 at a portion at which the cutout 121 is not formed. An outer diameter A of the support ring 120 at the cutout 121 is smaller than a distance B from the rotation axis 140 to the outer end of the blade 130.

[0035] Fig. 5 shows the configuration example of the support ring 120 at the intermediate position, excluding both ends. As described above, positions of the blades 130 connected to the first surface, being the one surface of the support ring 120 at the intermediate position, and positions of the blades 130 connected to the second surface, being the other surface of the same support ring 120, are located in such a way as to prevent overlapping. Therefore, as shown in Fig. 5, two cutouts 121 are disposed between blades 130 connected to the first surface of the support ring 120. In the same manner, two cutouts 121 are disposed between blades 130 connected to the second surface of the support ring 120.

[0036] In the configuration examples shown in Fig. 6 and Fig. 7, the cutouts 121 have a V shape. Each cutout 121 is disposed in a side of the rotation direction than the intermediate position between adjacent blades 130. A portion of each cutout 121 extends along the shape of the negative pressure surface 132 of each blade 130. Fig. 6 shows the configuration example of a support ring 120 at both ends in the direction of the rotation axis 140. Fig. 7 shows the configuration example of a support ring 120 at the intermediate position, excluding both ends. When the description is made with reference to Fig. 6, each cutout 121 is provided at each position between adjacent blades 130. The outer end 133 of each blade 130 is disposed on the support ring 120 at a portion at which the cutout 121 is not formed. The outer diameter A of the support ring 120 at the cutout 121 is smaller than the distance B from the rotation axis 140 to outer end of the blade 130.

[0037] An arrow shown in Fig. 6 indicates the rotation direction of the impeller 110. Each cutout 121 is disposed in the side of the rotation direction than the intermediate position between adjacent blades 130. That is, a distance from the cutout 121 to the positive pressure surface 131 of the blade 130 in the counter-rotation direction is larger than a distance from the cutout 121 to the negative pressure surface 132 of the blade 130 in the rotation direction. At a portion indicated by "C" in the drawing, the cutout 121 extends along the negative pressure surface 132 of the blade 130.

[0038] The positive pressure surface 131 side of each blade 130 has a high pressure and hence, if the cutout 121 is provided in the vicinity of the positive pressure surface 131 side of each blade 130, an air flow easily leaks from the cutouts 121. Such a configuration causes turbulence of the air flow to be easily generated due to a flow that goes around the outer end 133 of the blade 130. In view of the above, each cutout 121 is disposed in the side of the rotation direction than the intermediate position between adjacent blades 130. With such a configuration, it is possible to suppress the generation of a flow that goes around the outer end 133 of the blade 130 on the positive pressure surface 131 side of the blade 130.

[0039] In the configuration examples shown in Fig. 8 and Fig. 9, cutouts 121 have a V shape. The width of each cutout 121 in the rotation direction from the portion of a support ring 120 having the smallest outer diameter is smaller than the width of the cutout 121 in the counter-rotation direction from the portion of the support ring 120 having the smallest outer diameter. Fig. 8 shows the configuration example of the support ring 120 at both ends in the direction of the rotation axis 140. Fig. 9 shows the configuration example of the support ring 120 at the intermediate position, excluding both ends. When the description is made with reference to Fig. 8, each cutout 121 is provided at each position between adjacent blades 130. The outer end 133 of each blade 130 is disposed on the support ring 120 at a portion at which the cutout 121 is not formed. An outer diameter A of the support ring 120 at the cutout 121 is smaller than a distance B from the rotation axis 140 to the outer end of the blade 130.

[0040] An arrow shown in Fig. 8 indicates the rotation direction of the impeller 110. The width of the cutout 121 in the rotation direction from the portion of the support ring 120 having the smallest outer diameter, that is, from the cutout bottom, is indicated by "E" in the drawing. The width of the cutout 121 in the counter-rotation direction from the cutout bottom is indicated by "F" in the drawing. The width E in the rotation direction from the cutout bottom is smaller than the width F in the counter-rotation direction from the cutout bottom. In the same manner as the configuration examples shown in Fig. 6 and Fig. 7, also in the configuration examples shown in Fig. 8 and Fig. 9, a portion of each cutout 121 extends along the shape of the negative pressure surface 132 of the blade 130.

[0041] In each cutout 121 having a V shape as shown in Fig. 8 and Fig. 9, in an area indicated by "F" in Fig. 8, an inclined surface is formed on the outer circumference of the support ring 120, the inclined surface approaching the rotation axis 140 as the inclined surface extends in the rotation direction. When the inclined surface on the outer circumference of the support ring 120 pushes air, a centrifugal force acts on the air and hence, an air flow blown out toward the area downstream of the support ring 120 is accelerated by the centrifugal force and hence, it is possible to further increase an air volume. In the configuration examples shown in Fig. 8 and Fig. 9, the width of the cutout 121 in the rotation direction from the cutout bottom is smaller than the width of the cutout 121 in the counter-rotation direction from the cutout bottom. Accordingly, inclination of each inclined surface, which approaches the rotation axis 140 as the inclined surface extends in the rotation direction, is small and hence, it is possible to suppress turbulence caused by collision of air flows caused when the inclined surfaces push air. In contrast, in an area indicated by "E" in Fig. 8, an inclined surface is formed on the outer circumference of the support ring 120, the inclined surface being away from the rotation axis 140 as the inclined surface extends in the rotation direction. Due to a negative pressure generated on the inclined surfaces on the outer circumference of the support ring 120, an air flow can be easily drawn into the area downstream of the support ring 120 and hence, it is possible to further reduce low wind speed areas in the area downstream of the support ring 120.

[0042] In the configurations as shown in Fig. 6 to Fig. 9 in which a portion of each cutout 121 extends along the shape of the negative pressure surface 132 of the blade 130, the end surface of the support ring 120 at a portion of each cutout 121 that extends along the shape of the negative pressure surface 132 of the blade 130 may integrally form a blade surface with the negative pressure surface 132 of the blade 130. With such a configuration, it is possible to increase the area of the negative pressure surface 132 of each blade 130 by an amount corresponding to the thickness of the support ring 120. Accordingly, it is possible to achieve an increase in air volume by increasing the effective area of blades for generating air flow.

[0043] As a modification of the cross flow fan 100 according to the present embodiment, the positions of the blades 130 connected to the first surface, being the one surface of the support ring 120 at the intermediate position, and the positions of the blades 130 connected to the second surface, being the other surface of the same support ring 120, may be located in such a way as to overlap with each other. In this case, the configuration of the support ring 120 is equal to the configuration of the support ring 120 at both ends in the direction of the rotation axis 140, which has been described heretofore. That is, as shown in Fig. 4, Fig. 6, and Fig. 8, one cutout 121 is disposed at each position between blades 130 connected to the first surface of the support ring 120. In the same manner, one cutout 121 is also disposed at each position between blades 130 connected to the second surface of the support ring 120. In this case, the number of cutouts 121 formed on one support ring 120 is equal to the number of blades 130 connected to one surface of the support ring 120.

[0044] Next, the description will be made with reference to Fig. 10. As shown in Fig. 10, an inner diameter of the support ring 120 having a ring shape is assumed as "D1". Further, a distance from the rotation axis 140 to the inner end of the blade 130 is assumed as "D2". In the cross flow fan 100 according to the present embodiment, it is preferable to set the inner diameter D1 of the support ring 120 to be equal to or more than half of the distance D2 from the rotation axis 140 to the inner end of the blade 130, that is, equal to or more than D2/2, and equal to or less than the distance D2 from the rotation axis 140 to the inner end of the blade 130.

[0045] By setting the inner diameter D1 of the support ring 120 to be equal to or less than the distance D2 from the rotation axis 140 to the inner end of the blade 130, it is possible to suppress generation of turbulence of an air flow caused by an air flow that goes around the inner end 134 of the blade 130. Further, by setting the inner diameter D1 of the support ring 120 to be equal to or less than the distance D2 from the rotation axis 140 to the inner end of the blade 130, a circulating vortex generated in the impeller 110 is divided by the support ring 120 and hence, it is possible to suppress destabilization of the flow caused by circulating vortexes that form continuously and affect with each other. In contrast, a region in which the distance from the rotation axis 140 is equal to or less than D2/2 is less affected by circulating vortexes that form continuously. In view of the above, by setting the inner diameter D1 of the support ring 120 to be equal to or more than D2/2, the amount of a material necessary for the support ring 120 is reduced and hence, it is possible to achieve a reduction in weight. Accordingly, by setting the inner diameter D1 of the support ring 120 to be equal to or more than half of the distance D2 from the rotation axis 140 to the inner end of the blade 130, that is, equal to or more than D2/2, and equal to or less than the distance D2 from the rotation axis 140 to the inner end of the blade 130, it is possible to achieve both suppression of destabilization of the air flow in the impeller 110 and a reduction in weight of the impeller 110.

[0046] Next, a modification of the cross flow fan 100 according to the present embodiment will be described with reference to Fig. 11 to Fig. 13. In the present modification, as shown in Fig. 11 to Fig. 13, a support ring 120 is caused to have a corrugated plate shape instead of a flat plate shape. The surface of the support ring 120 to which the blades 130 are connected has a plurality of protruding portions 122 and a plurality of recessed portions 123 that are alternately arranged in the circumferential direction. Positions of the protruding portions 122 on the first surface of the support ring 120 correspond to the recessed portions 123 on the second surface. Positions of the recessed portions 123 on the first surface of the support ring 120 correspond to the protruding portions 122 on the second surface. In other words, the back side of each protruding portion 122 on the one surface of the support ring 120 forms the recessed portion 123. Further, the back side of each recessed portion 123 on the one surface of the support ring 120 forms the protruding portion 122. The protruding portions 122 and the recessed portions 123 are disposed to extend in the radial direction in a state of being bent in conformity with the cross sectional shapes of the blades 130.

[0047] The blades 130 are connected to the recessed portions 123 of the support ring 120. The end of each blade 130 is connected to each recessed portion 123 by welding, for example, so that the blades 130 are fixed to the support ring 120. In fixing the blades 130, it is preferable to provide a flat surface part to the bottom of each recessed portion 123, and to connect the end of each blade 130 to each flat surface part. With such a configuration, it is possible to increase welding strength of the blades 130 to the support ring 120.

[0048] As described above, the back side of each recessed portion 123 forms the protruding portion 122 and hence, the recessed portions 123 on the first surface of the support ring 120 and the recessed portions 123 on the second surface are inevitably disposed in such a way as to prevent overlapping. Accordingly, by connecting the blades 130 to the recessed portions 123 of the support ring 120, positions of the blades 130 connected to the first surface of the support ring 120 and positions of the blades 130 connected to the second surface are located in such a way as to prevent overlapping.

[0049] According to the modification of the cross flow fan 100 having the above-mentioned configuration, it is possible to increase the blade width, in the direction of the rotation axis 140, of each blade 130 disposed between the support rings 120 without significantly changing the entire width of the impeller 110 in the direction of the rotation axis 140. Therefore, it is possible to achieve an increase in air volume by increasing the effective area of blades for generating air flow.

[0050] As shown in Fig. 14, a configuration may be adopted in which the protruding portions 122 and the recessed portions 123 are provided to the support ring 120 having no cutout 121, and the blades 130 are connected to the recessed portions 123 of the support ring 120. Also in such a configuration, it is possible to increase the blade width, in the direction of the rotation axis 140, of each blade 130 disposed between the support rings 120 without significantly changing the entire width of the impeller 110 in the direction of the rotation axis 140. Therefore, it is possible to achieve an increase in air volume by increasing the effective area of blades for generating air flow.

Industrial Applicability

[0051] The present disclosure is applicable to a cross flow fan including a plurality of support rings arranged at predetermined intervals in the direction of a rotation axis, and a plurality of blades provided between adjacent support rings, located close to the outer circumference of the support ring, and spaced apart in the circumferential direction. The present disclosure is also applicable to a blowing device and a refrigeration cycle device that includes the cross flow fan.

Reference Signs List

[0052]

10	Indoor equipment
11	Indoor equipment heat exchanger
12	Housing
13	Air inlet
14	Air outlet
15	Filter
16	Up-down vane
17	Rear guide
18	Stabilizer
20	Outdoor equipment
21	Outdoor equipment heat exchanger
22	Outdoor equipment fan
23	Compressor
24	Expansion valve
25	Four-way valve
30	Refrigerant pipe
100	Cross flow fan
110	Impeller
120	Support ring
121	Cutout
122	Protruding portion
123	Recessed portions
130	Blade
131	Positive pressure surface
132	Negative pressure surface
133	Outer end
134	Inner end
140	Rotation axis
150	Motor

Claims

1. A cross flow fan comprising:

   a plurality of support rings arranged at a predetermined interval in a direction of a rotation axis; and
   a plurality of blades provided between adjacent support rings, located close to an outer circumference of a support ring of the adjacent support rings, and spaced apart in a circumferential direction,
   a support ring of the plurality of support rings having cutouts cut from an outer circumference end toward an inner circumference side, a cutout of the cutouts being arranged at each position between adjacent blades,
   an outer diameter of the support ring at the cutout being smaller than a distance from the rotation axis to an outer end of a blade of the plurality of blades.

2. The cross flow fan according to claim 1, wherein a portion of the cutout extends along a shape of a negative pressure surface of the blade.

3. The cross flow fan according to claim 2, wherein an end surface of the support ring at the portion of the cutout that extends along the shape of the negative pressure surface of the blade integrally forms a blade surface with the negative pressure surface of the blade.

4. The cross flow fan according to any one of claim 1 to claim 3, wherein a width of the cutout in a rotation direction from a portion of the support ring having a smallest outer diameter is smaller than a width of the cutout in a counter-rotation direction from the portion.

5. The cross flow fan according to any one of claim 1 to claim 3, wherein the cutout is disposed in a side of a rotation direction than an intermediate position of the adjacent blades.

6. The cross flow fan according to any one of claim 1 to claim 5, wherein the number of cutouts formed on the support ring is equal to the number of blades connected to the support ring.

7. The cross flow fan according to any one of claim 1 to claim 6, wherein an inner diameter of the support ring is equal to or more than half of a distance from the rotation axis to an inner end of the blade, and equal to or less than the distance from the rotation axis to the inner end of the blade.

8. The cross flow fan according to any one of claim 1 to claim 7, wherein positions of the blades connected to a first surface of the support ring and positions of the blades connected to a second surface are located in such a way as to prevent overlapping, the second surface being a back side of the first surface.

9. The cross flow fan according to any one of claim 1 to claim 8, wherein a surface of the support ring to which the blades are connected has a plurality of protruding portions and a plurality of recessed portions alternately arranged in the circumferential direction, and
   the blades are connected to the plurality of recessed portions of the support ring.

10. A cross flow fan comprising:

a plurality of support rings arranged at a predetermined interval in a direction of a rotation axis; and

a plurality of blades provided between the adjacent support rings, located close to an outer circumference of the support ring, and spaced apart in a circumferential direction,

a surface of the support ring to which the blades are connected having a plurality of protruding portions and a plurality of recessed portions alternately arranged in a circumferential direction, the blades being connected to the plurality of recessed portions of the support ring.

11. A blowing device comprising the cross flow fan according to any one of claim 1 to claim 10.

12. A refrigeration cycle device comprising: the cross flow fan according to any one of claim 1 to claim 10; and

a heat exchanger configured to perform heat exchange between an air flow generated by the cross flow fan and a refrigerant.

FIG. 1

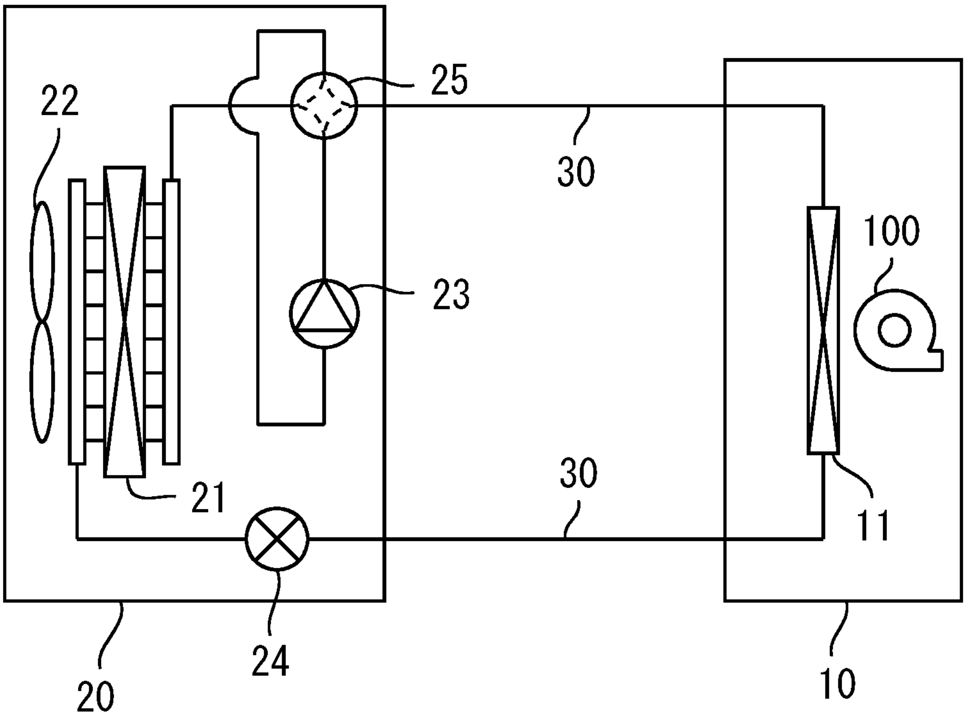


FIG. 2

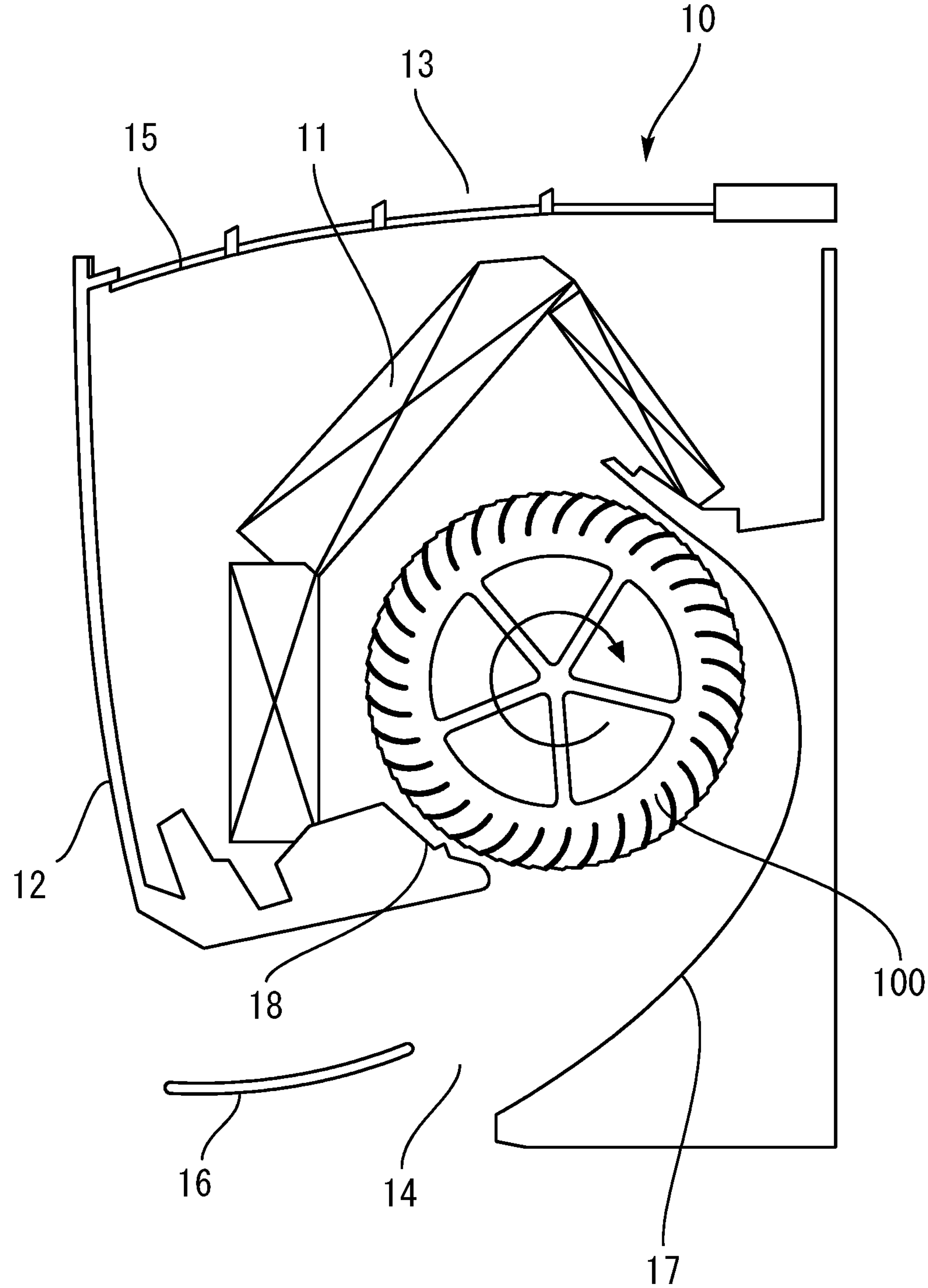


FIG. 3

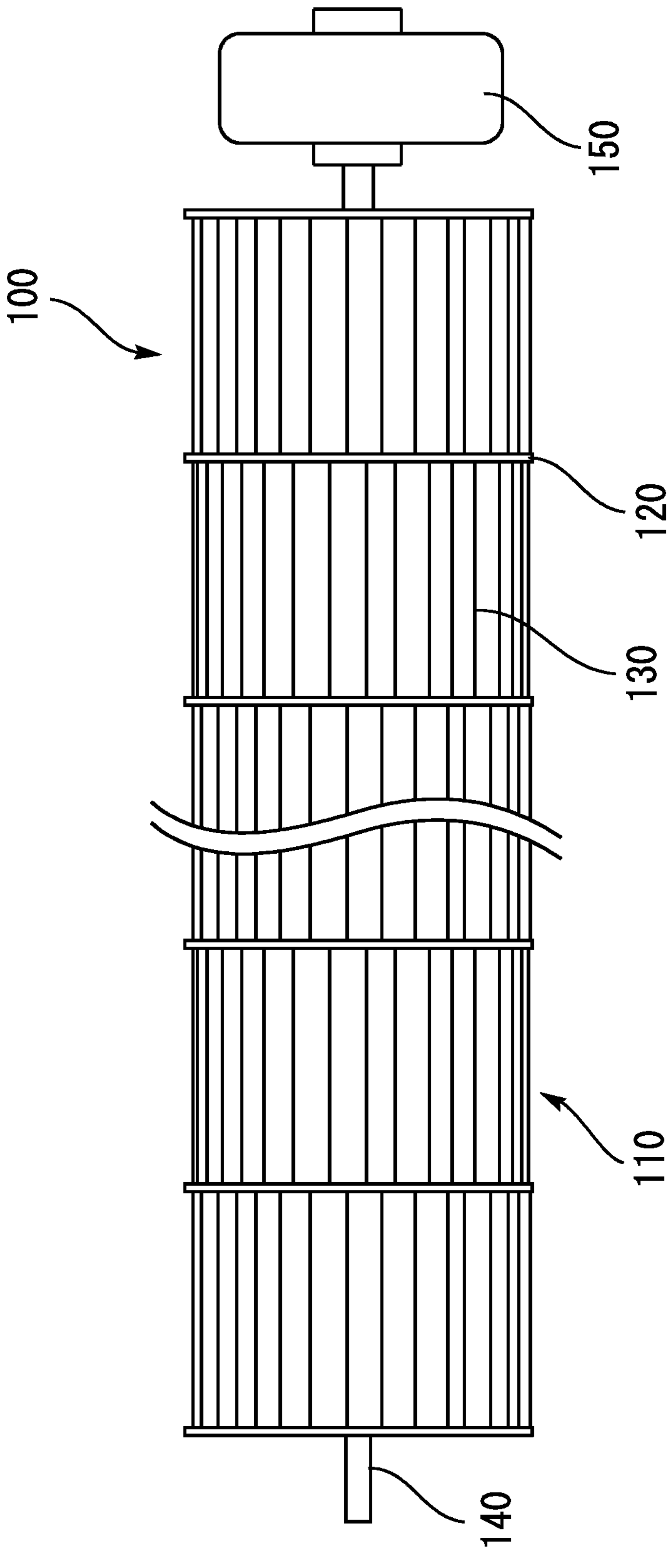


FIG. 4

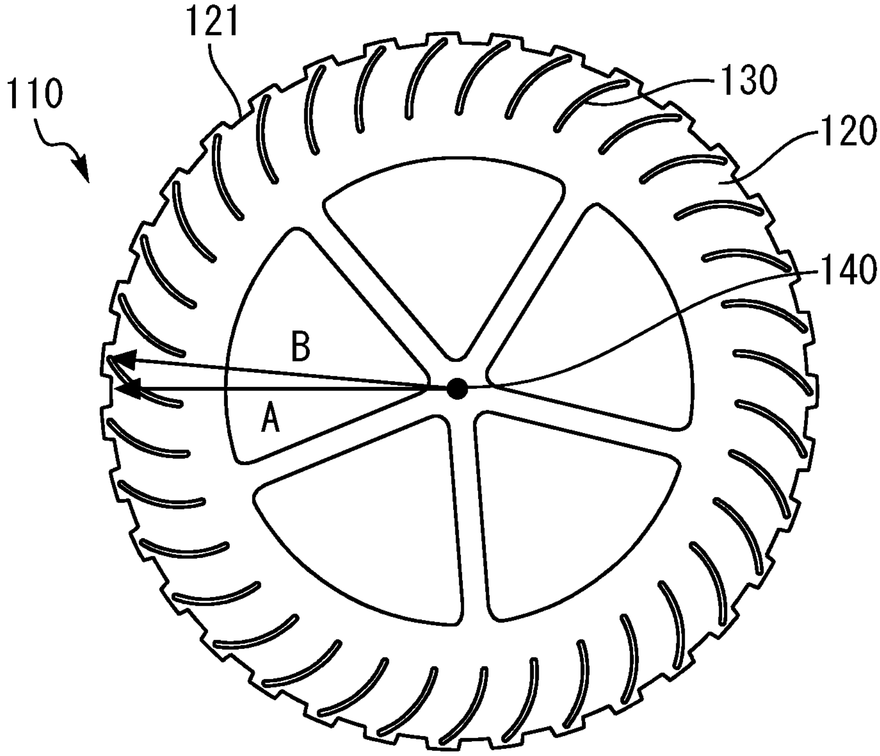


FIG. 5

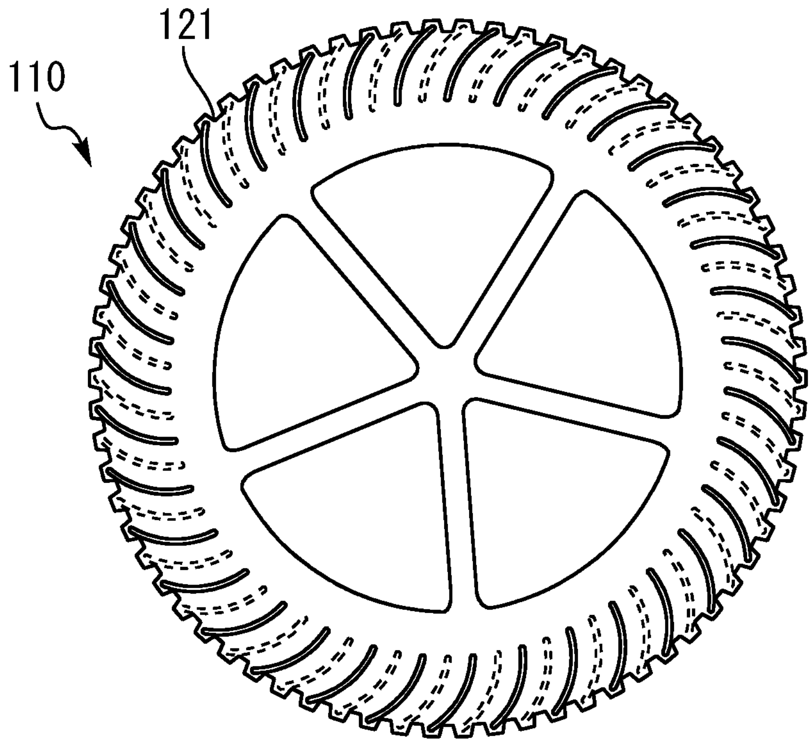


FIG. 6

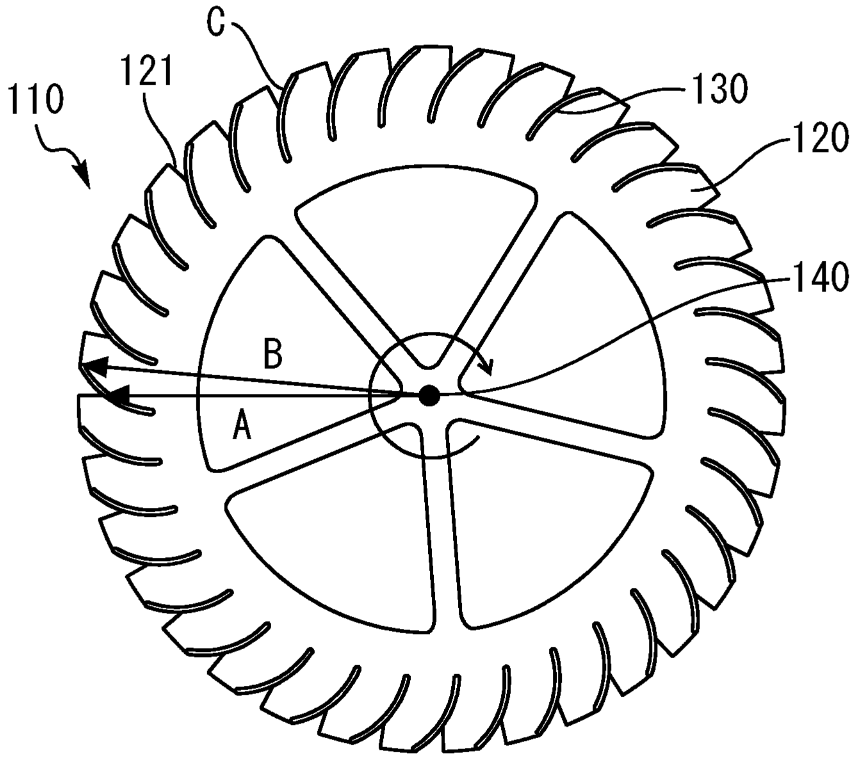


FIG. 7

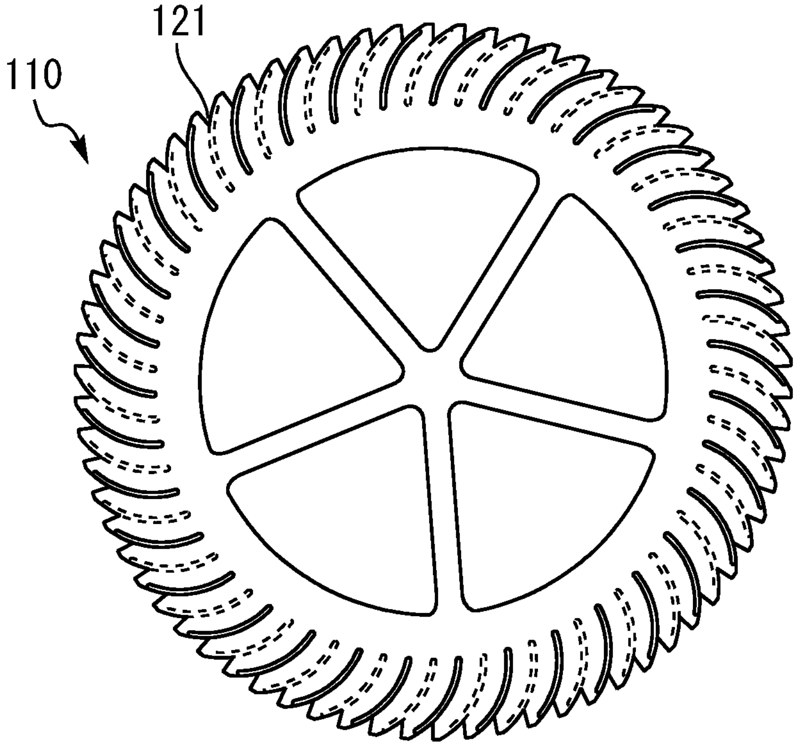


FIG. 8

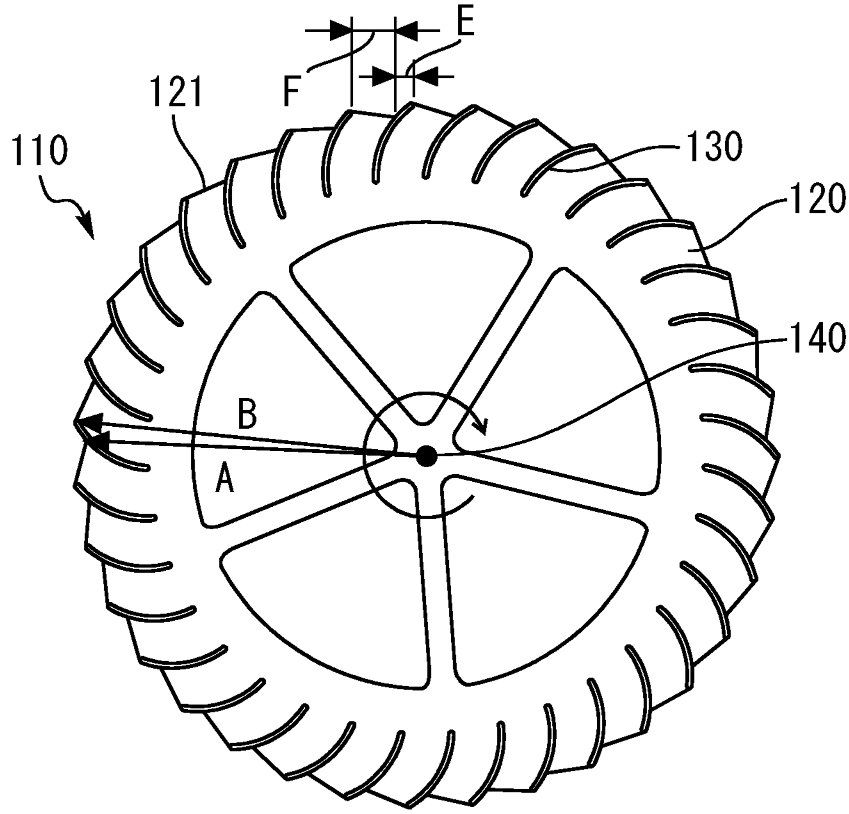


FIG. 9

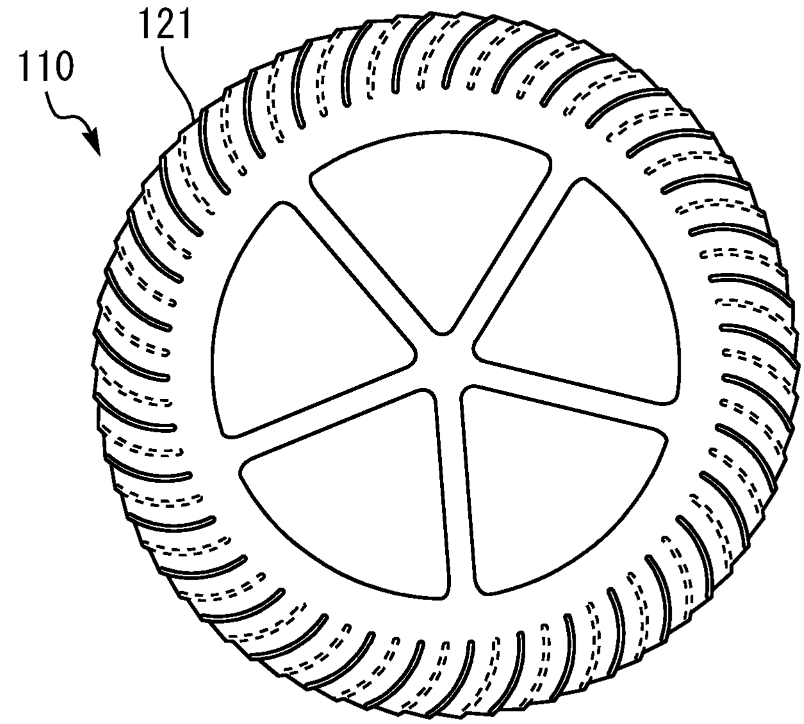


FIG. 10

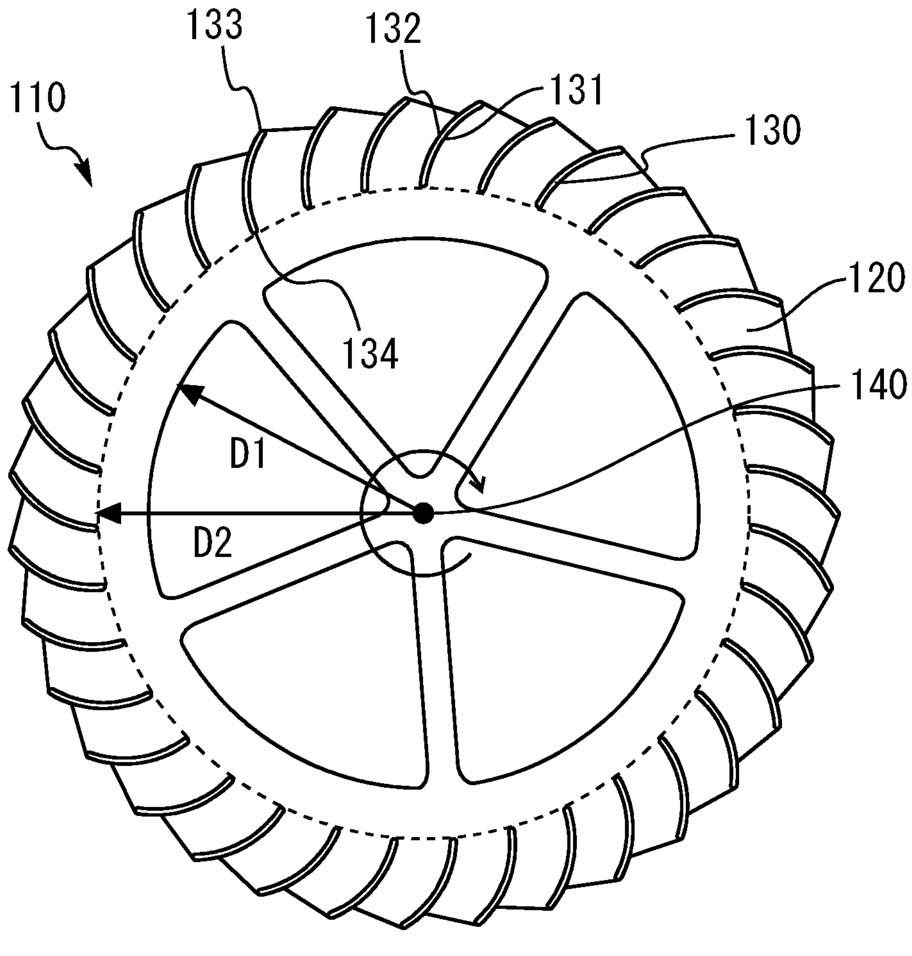


FIG. 11

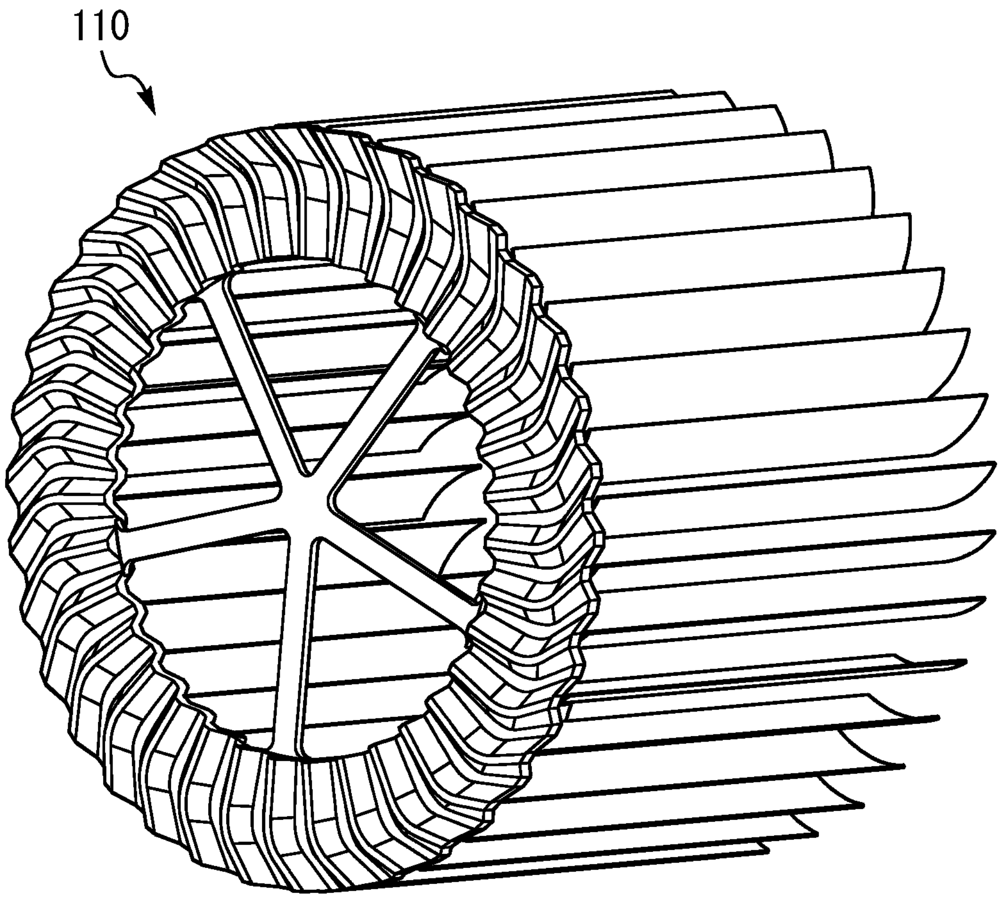


FIG. 12

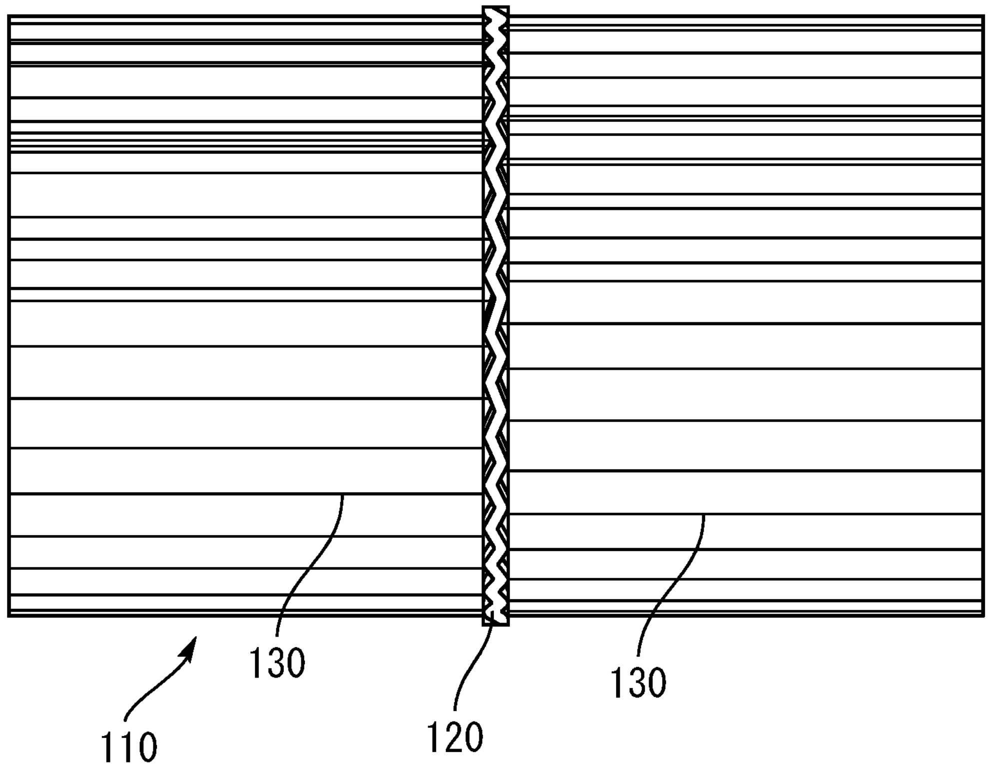


FIG. 13

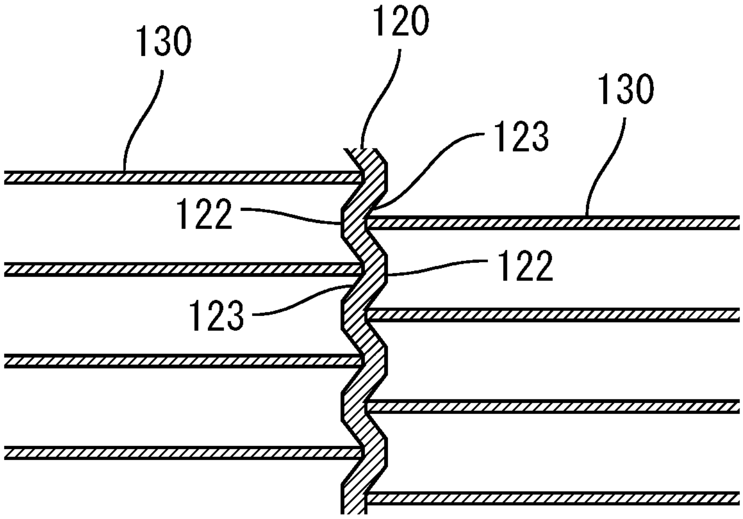
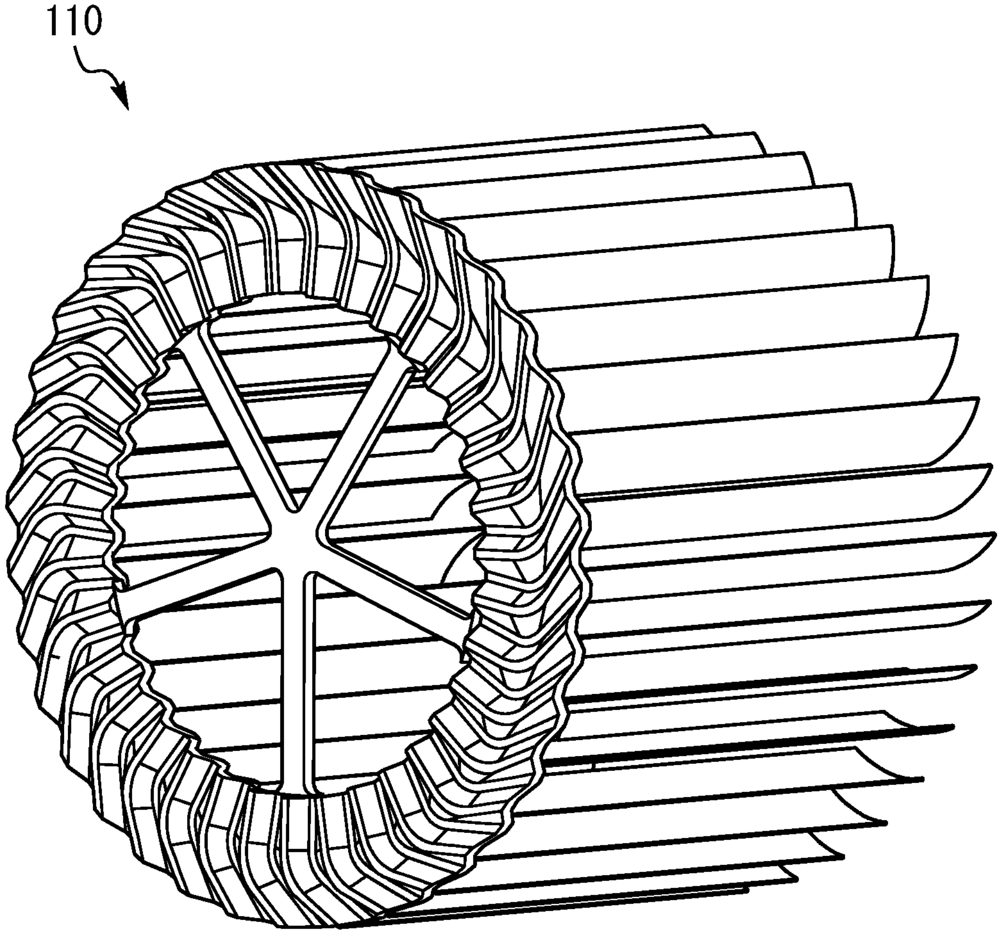


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/041402

A. CLASSIFICATION OF SUBJECT MATTER

F04D 17/04(2006.01)i
FI: F04D17/04 Z

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D17/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 59578/1974 (Laid-open No. 147904/1975) (KK NIWA SEISAKUSHO) 08 December 1975 (1975-12-08), page 3, lines 16-20	1, 6, 11
Y		8-10, 12
A		2-5, 7
Y	WO 2017/073593 A1 (DAIKIN INDUSTRIES, LTD.) 04 May 2017 (2017-05-04) paragraph [0038]	8-10, 12

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 December 2021	**28 December 2021**

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/041402

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 50-147904 U1	08 December 1975	(Family: none)	
WO 2017/073593 A1	04 May 2017	US 2018/0328367 A1 paragraph [0054] EP 3369935 A1 CN 108350893 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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