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(54) **AXIAL FLOW WIND WHEEL, AIR CONDITIONER OUTDOOR UNIT AND AIR CONDITIONER**

(57) An axial flow wind wheel (30), comprising a hub (31) and a plurality of blades (33), the plurality of blades being provided at intervals along a circumferential direction of the hub, each blade having a front edge (331), a tail edge (332) and an outer edge (333), an intersection point between the front edge and the outer edge being a first intersection point (A), an intersection point between the tail edge and the outer edge being a second intersection point (B), the projections of the first intersection points of the plurality of blades in a plane perpendicular to an axial direction of the hub being located on the same circumferential line, and the projections of the second intersection points of the plurality of blades in the plane perpendicular to the axial direction of the hub being located on the same circumferential line, the radius of the circle where the first intersection points are located being greater than the radius of the circle where the second intersection points are located. The axial flow wind wheel can improve the air supply volume, reduce noise, increase the heat exchange efficiency of an air conditioner, and reduce the power of the motor. An air conditioner outdoor unit and an air conditioner, comprising the axial flow wind wheel.

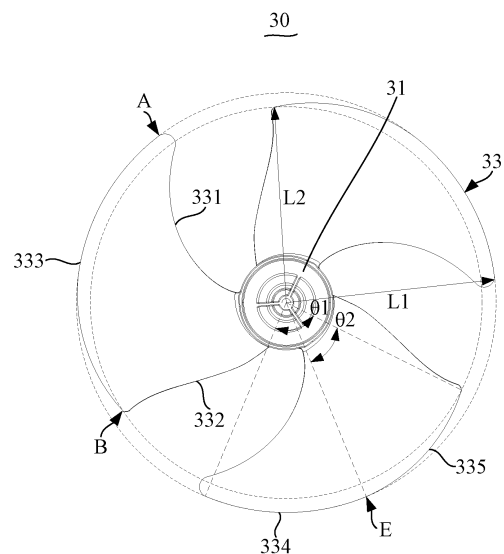


FIG. 4

Description**TECHNICAL FIELD**

- 5 **[0001]** The present disclosure relates to the field of fans, and in particular to an axial turbine, and an air conditioner outdoor unit and an air conditioner applying the axial turbine.

BACKGROUND

- 10 **[0002]** The heat exchange efficiency of the heat exchanger of the air conditioner directly affects the overall performance of the air conditioner. The turbine of the existing air conditioner is composed of a circular hub with a rotation center and several blades radially arranged on the periphery of the hub. The turbine is driven to rotate by a motor, and the air flows in from the leading edge of the blade, and then flows out from the trailing edge of the blade after the pressure is increased by the work of the blade.
- 15 **[0003]** The existing turbine generally includes a hub and blades. The blade has a leading edge, an outer edge and a trailing edge. The trailing edge of the blade is basically a straight line, and the projections of the outer edge of the blade in a plane perpendicular to the axial direction of the hub are on one circumferential line. During the operation of the turbine, the high-speed air flow is mixed with the outside air along the air guide ring under the action of the turbine. Since the outside air is static air, the high-speed air flow interacts with the outside air, which produces loud noise. In order to
- 20 increase the air supply volume and increase the efficiency of the heat exchanger, the speed of the turbine should be increased. However, increasing the rotation speed of the turbine results in greater air flow velocity, greater interaction force with the external static air, louder noise of the turbine, and increased rotation speed leads to an increase in the power of the motor.

SUMMARY

- 25 **[0004]** The present disclosure provides an axial turbine, which aims to increase the air supply volume of the axial turbine, and reduce the noise of the axial turbine, and increase the heat exchange efficiency of the air conditioner and reduce the power of the motor.
- 30 **[0005]** The present disclosure provides an axial turbine, including a hub and a plurality of blades, wherein: the plurality of blades are spaced along a circumferential direction of the hub; each of the plurality of blades includes a leading edge, a trailing edge and an outer edge; an intersection of the leading edge and the outer edge is a first intersection, and an intersection of the trailing edge and the outer edge is a second intersection; projections of first intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, projections of second
- 35 intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line; and a radius of a circle defining the first intersections is larger than a radius of a circle defining the second intersections.
- [0006]** In an embodiment, the radius of the circle defining the first intersections is L_1 , the radius of the circle defining the second intersections is L_2 , and $0\text{mm} < L_1 - L_2 \leq 7\text{mm}$.
- [0007]** In an embodiment, $190\text{mm} \leq L_1 \leq 240\text{mm}$.
- 40 **[0008]** In an embodiment, the outer edge of each of the plurality of blades includes a first segment and a second segment connected to each other; an intersection of the first segment and the second segment is a third intersection; an intersection of the first segment and the leading edge is the first intersection; an intersection of the second segment and the trailing edge is the second intersection; and projections of third intersections and the first intersections in a plane perpendicular to the axial direction of the hub are on one circumferential line or projections of third intersections and the
- 45 second intersections in a plane perpendicular to the axial direction of the hub are on one circumferential line.
- [0009]** In an embodiment, a line connecting the first intersection and the center of the hub is a first line, a line connecting the second intersection and the center of the hub is a second line, and a line connecting the third intersection and the center of the hub is a third line; and an angle between projections of the first line and the second line in a plane perpendicular to the axial direction of the hub is θ_1 , an angle between projections of the second line and the third line
- 50 in a plane perpendicular to the axial direction of the hub is θ_2 , $\theta_2 \leq 1/\theta_1$.
- [0010]** In an embodiment, an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$.
- [0011]** In an embodiment, the leading edge has a concave arc shape from the first intersection to the fourth intersection, and the trailing edge has a convex arc shape from the second intersection to the fifth intersection.
- 55 **[0012]** In an embodiment, a vertical distance between the projection of the first intersection in the axial direction of the hub and the projection of the second intersection in the axial direction of the hub is in the range of 130mm to 160mm.
- [0013]** In an embodiment, the axial turbine includes three blades, and the three blades are evenly distributed along

the circumferential direction of the hub.

[0014] The present disclosure further provides an air conditioner outdoor unit, including:

a housing including a receiving cavity, the housing being defined with an installation opening communicating with the receiving cavity;
an air guide ring installed at the installation opening; and
the axial turbine as described above, the axial turbine being provided in the housing, an air outlet surface of the axial turbine being opposite to the installation opening.

[0015] In an embodiment, the blade of the axial turbine is partially extended into the air guide ring, an axial width of the air guide ring is d , and a length of the blade extending into the air guide ring is between $2/5d$ and $1/2d$.

[0016] In an embodiment, a vertical distance between the first intersection and an inner wall of the air guide ring is between 6mm and 10mm.

[0017] The present disclosure further provides an air conditioner, including:

the axial turbine as described above; or
the air conditioner outdoor unit as described above.

[0018] In technical solutions of the present disclosure, the axial turbine includes a hub and a plurality of blades, the plurality of blades are spaced along a circumferential direction of the hub, and each of the plurality of blades includes a leading edge, a trailing edge and an outer edge. The projection of the outer edge in a plane perpendicular to the axial direction of the hub is changed, such that the projections of the outer edge in a plane perpendicular to the axial direction of the hub are not on one circumferential line, thereby increasing the air supply volume of the axial turbine, reducing the noise of the axial turbine, and increasing the heat exchange efficiency of the air conditioner and reducing the power of the motor without increasing the speed of the axial turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In order to more clearly illustrate the embodiments of the present disclosure, drawings used in the embodiments will be briefly described below. The drawings in the following description are only some embodiments of the present disclosure. It is appreciated by those skilled in the art that other figures can be obtained according to the structures shown in the drawings without creative work.

FIG. 1 is a schematic structural diagram of an air conditioner outdoor unit according to an embodiment of the present disclosure.

FIG. 2 is a schematic structural diagram of an axial turbine according to an embodiment of the present disclosure.

FIG. 3 is a schematic structural diagram of the axial turbine from another perspective according to an embodiment of the present disclosure.

FIG. 4 is a schematic structural diagram of the axial turbine according to another embodiment of the present disclosure.

Description of reference signs

[0020]

Table 1

reference sign	name	reference sign	name
100	air conditioner outdoor unit	331	leading edge
10	air guide ring	332	trailing edge
20	housing	333	outer edge
21	installation opening	334	first segment
22	receiving cavity	335	second segment
23	bracket	A	first intersection
24	motor	B	second intersection

(continued)

reference sign	name	reference sign	name
30	axial turbine	E	third intersection
31	hub	C	fourth intersection
33	blade	D	fifth intersection

[0021] The realization of the objective, functional characteristics, and advantages of the present disclosure are further described with reference to the accompanying drawings.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] The technical solutions of the embodiments of the present disclosure will be described in more detail below with reference to the accompanying drawings. The embodiments to be described are only some rather than all of the embodiments of the present disclosure. All other embodiments obtained by persons skilled in the art based on the embodiments of the present disclosure without creative efforts shall fall within the scope of the present disclosure.

[0023] It should be noted that if there is a directional indication (such as up, down, left, right, front, rear...) in the embodiments of the present disclosure, the directional indication is only used to explain the relative positional relationship, movement, etc. of the components in a certain posture (as shown in the drawings). If the specific posture changes, the directional indication will change accordingly.

[0024] In the present disclosure, unless expressly stipulated and limited otherwise, the terms "connected", "fixed", etc. should be interpreted broadly. For example, "fixed" can be a fixed connection, a detachable connection, or a whole; can be a mechanical connection or an electrical connection; can be a direct connection or an indirect connection through an intermediary, and can be a communication between two elements or an interaction relationship between two elements, unless specifically defined otherwise. A person of ordinary skill in the art can understand the specific meaning of the above-mentioned terms in the present disclosure according to specific situations.

[0025] It should be noted that, the descriptions associated with, e.g., "first" and "second," in the present disclosure are merely for descriptive purposes, and cannot be understood as indicating or suggesting relative importance or impliedly indicating the number of the indicated technical feature. Therefore, the feature associated with "first" or "second" can expressly or impliedly include at least one such feature. In addition, the technical solutions between the various embodiments can be combined with each other, insofar as they are feasible to those of ordinary skill in the art. When the combination of technical solutions is contradictory or cannot be achieved, it should be considered that such a combination of technical solutions does not exist, nor is it within the scope of the present disclosure.

[0026] The present disclosure proposes an axial turbine 30 applied to an air conditioner.

[0027] As shown in FIG. 2 and FIG. 4, in the present disclosure, the axial turbine 30 includes a hub 31 and a plurality of blades 33. The plurality of blades 33 are spaced along a circumferential direction of the hub 31. Each of the plurality of blades 33 includes a leading edge 331, a trailing edge 332 and an outer edge 333. An intersection of the leading edge 331 and the outer edge 333 is a first intersection A, and an intersection of the trailing edge 332 and the outer edge 333 is a second intersection B. Projections of first intersections A of the plurality of blades 33 in a plane perpendicular to an axial direction of the hub 31 are on one circumferential line. Projections of second intersections B of the plurality of blades 33 in a plane perpendicular to an axial direction of the hub 31 are on one circumferential line. A radius of a circle defining the first intersections A is larger than a radius of a circle defining the second intersections.

[0028] Specially, the hub 31 of the axial turbine 30 is mounted on an output shaft of the motor and is driven by the motor. In order to better realize the installation of the hub 31 and the motor, a mounting hole (not shown) is defined in the center of the hub 31, and the output shaft of the motor is mounted in the mounting hole and is fixedly connected to the hub 31 of the axial turbine 30. When the motor drives the axial turbine 30 to rotate, air flows in from the leading edge 331 of the blade 33, and flows out from the trailing edge 332 of the blade 33 after the pressure is increased by the work of the blade 33.

[0029] The plurality of blades 33 may be evenly spaced relative to the circumferential direction of the hub 31, and the plurality of blades 33 may also be non-uniformly spaced relative to the circumferential direction of the hub 31. In this embodiment, there are three blades 33, and the three blades are evenly spaced along the circumferential direction of the hub 31. The leading edge 331, the trailing edge 332 and the outer edge 333 of the blade 33 form a fan-shaped blade 33, the outer edge 333 has a convex arc shape from the first intersection A to the second intersection B. In this embodiment, an area of the fan-shaped blade 33 gradually increases from an end connected to the hub 31 to an end connected to the outer edge 333. That is, the line between the leading edge 331 and the trailing edge 332 gradually increases from the end connected to the hub 31 to the end connected to the outer edge 333. As such, the air supply volume of the axial

turbine 30 can be increased.

[0030] It can be appreciated that, in this embodiment, the outer edge 333 has a convex arc shape from the first intersection A to the second intersection B. That is, the line between the outer edge 333 and the center of the hub 31 gradually increases from the first intersection A to the second intersection B. As such, it is beneficial to ensure that the air supply volume of the axial turbine 30 can be increased, the noise of the axial turbine 30 can be reduced, the heat exchange efficiency of the air conditioner can be increased and the power of the motor can be reduced without increasing the speed of the axial turbine 30.

[0031] Projections of the outer edge of the blade of the existing turbine in a plane perpendicular to the axial direction of the hub are on one circumferential line. During the operation of the turbine, the high-speed air flow is mixed with the outside air along the air guide ring under the action of the turbine. Since the outside air is static air, the high-speed air flow interacts with the outside air, which produces loud noise. In order to increase the air supply volume and increase the efficiency of the heat exchanger, the speed of the turbine should be increased. However, increasing the rotation speed of the turbine results in greater air flow velocity, greater interaction force with the external static air, louder noise of the turbine, and increased rotation speed leads to an increase in the power of the motor.

[0032] In the present disclosure, the structure of the blade 33 of the axial turbine 30 is optimized, the intersection of the leading edge 331 and the outer edge 333 is the first intersection A, and the intersection of the trailing edge 332 and the outer edge 333 is the second intersection B. Projections of the first intersections A of the plurality of blades 33 in a plane perpendicular to an axial direction of the hub 31 are on one circumferential line. Projections of the second intersections B of the plurality of blades 33 in a plane perpendicular to an axial direction of the hub 31 are on one circumferential line. A radius of a circle defining the first intersections A is larger than a radius of a circle defining the second intersections B. That is, the projections of the outer edge 333 in a plane perpendicular to the axial direction of the hub 31 are changed, such that projections of the outer edge 333 in a plane perpendicular to the axial direction of the hub 31 are not on one circumferential line, thereby increasing the air supply volume of the axial turbine 30, reducing the noise of the axial turbine 30, and increasing the heat exchange efficiency of the air conditioner and reducing the power of the motor without increasing the speed of the axial turbine 30.

[0033] In an embodiment, as shown in FIG. 2 to FIG. 4, the radius of the circle defining the first intersections A is L1, the radius of the circle defining the second intersections B is L2, and $0\text{mm} < L1 - L2 \leq 7\text{mm}$. As an alternative implementation of this embodiment, the difference between the radius L1 of the circle defining the first intersections A and the radius L2 of the circle defining the second intersections B is 1mm, 2mm, 3mm, 4mm, 5mm, 6mm, and 7mm. As a preferred implementation of this embodiment, $L1 - L2 = 5\text{mm}$. In this case, without increasing the rotation speed, the axial flow turbine 30 has improved air supply volume and improved noise reduction effect, and the air conditioner heat exchange efficiency and the reduction of the motor power are also improved.

[0034] In an embodiment, as shown in FIG. 3 and FIG. 4, L1 is between 190mm and 240mm. That is, the diameter of the largest circle formed by the projection of the blade 33 of the axial turbine 30 in a plane perpendicular to the axial direction of the hub 31 is within the range of 380mm to 480mm. In an embodiment, L1 is 190mm, 200mm, 210mm, 220mm, 230mm, 240mm.

[0035] As shown in FIG. 4, in another embodiment of the present disclosure, the outer edge 333 of each of the plurality of blades 33 includes a first segment 334 and a second segment 335 connected to each other. An intersection of the first segment 334 and the second segment 335 is a third intersection E. An intersection of the first segment 334 and the leading edge 331 is the first intersection A. An intersection of the second segment 335 and the trailing edge 332 is the second intersection B. Projections of third intersections E and the first intersections A or projections of third intersections E and the second intersections B in a plane perpendicular to the axial direction of the hub 31 are on one circumferential line. It can be appreciated that only part of the projection of the outer edge 333 of each blade 33 in a plane perpendicular to the axial direction of the hub 31 are on one circumferential line, the projections of other parts of the outer edge 333 in a plane perpendicular to the axial direction of the hub 31 are not on one circumferential line.

[0036] Specially, in a first implementation of this embodiment, as shown in FIG. 4, the projections of the third intersections E and the first intersections A in a plane perpendicular to the axial direction of the hub 31 are on one circumferential line. That is, the projections of the first segment 334 of the outer edge 333 in the plane perpendicular to the axial direction of the hub 31 are on one circumferential line. The projections of the second segment 335 of the outer edge 333 in the plane perpendicular to the axial direction of the hub 31 are not on one circumferential line.

[0037] In a second implementation of this embodiment, the projections of the third intersections E and the second intersections B in a plane perpendicular to the axial direction of the hub 31 are on one circumferential line. That is, the projections of the second segment 335 of the outer edge 333 in the plane perpendicular to the axial direction of the hub 31 are on one circumferential line. The projections of the first segment 334 of the outer edge 333 in the plane perpendicular to the axial direction of the hub 31 are not on one circumferential line. As such, without increasing the rotation speed, the air supply volume of the axial turbine 30 can be increased, the noise of the axial turbine 30 can be reduced, the heat exchange efficiency of the air conditioner can be increased, and the motor power can be reduced.

[0038] In an embodiment, as shown in FIG. 4, a line connecting the first intersection A and the center of the hub 31

is a first line (not shown), a line connecting the second intersection B and the center of the hub 31 is a second line (not shown), a line connecting the third intersection and the center of the hub 31 is a third line (not shown). An angle between the projections of the first line and the second line in a plane perpendicular to the axial direction of the hub 31 is θ_1 , an angle between the projections of the second line and the third line in a plane perpendicular to the axial direction of the hub 31 is θ_2 , $\theta_2 \leq 1/2\theta_1$. That is, the section of the outer edge 333 whose projections in a plane perpendicular to the axial direction of the hub 31 are on one circumferential line is less than or equal to 1/2 of the outer edge 333. In an embodiment, $\theta_2 = 1/2\theta_1$, in this case, the air supply volume of the axial turbine 30 is better, and the noise reduction effect is better, and the heat exchange efficiency of the air conditioner and the power reduction of the motor are better.

[0039] In an embodiment, as shown in FIG. 2, an intersection of the leading edge 331 and the hub 31 is a fourth intersection C, and an intersection of the trailing edge 332 and the hub 31 is a fifth intersection D. An angle between a line connecting the fourth intersection C and the fifth intersection D and the plane perpendicular to the axial direction of the hub 31 is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$. In an embodiment, θ_3 is 20° , 22° , 24° , 25° , 26° , 28° , 30° . The range of θ_3 affects the arrangement of the blades 33 in the axial direction of the hub 31. If θ_3 is too large or too small, the air supply volume and noise of the axial turbine 30 will be affected. When θ_3 is in the range of 20° to 30° , the air supply volume and noise effect of the axial turbine 30 is better.

[0040] In an embodiment, as shown in FIG. 2 to FIG. 4, the leading edge 331 is concave arc shape from the first intersection A to the fourth intersection C. The leading edge 331 is a concave arc shape, and when the axial turbine 30 rotates, it is beneficial for air to flow in from the leading edge 331 of the blade 33. The trailing edge 332 has a convex arc shape from the second intersection B to the fifth intersection D. The trailing edge 332 is a convex arc shape, and when the axial turbine 30 rotates, it is beneficial for air to flow out from the trailing edge 332 of the blade 33, and it has the effect of reducing noise.

[0041] In an embodiment, a vertical distance between the projection of the first intersection A in the axial direction of the hub 31 and the projection of the second intersection B in the axial direction of the hub 31 is between 130mm and 160mm. It can be appreciated that, in the axial direction of the hub 31, a distance between a plane of the projection of the first intersection A in the axial direction of the hub 31 and a plane of the projection of the second intersection B in the axial direction of the hub 31 is between 130mm and 160mm. The distance may be 130mm, 140mm, 150mm, and 160mm.

[0042] The experimental results of the axial turbine 30 of the present disclosure and the turbine of the related art at the same air volume are as follows.

[0043] The projections of the outer edge of the blade of the existing turbine in the plane perpendicular to the axial direction of the hub 31 are on one circumferential line. The parameter of the existing turbine is: the radius of the circle where the outer edge is projected in the plane perpendicular to the axial direction of the hub 31 is 210mm, the vertical distance between the projections of the two ends of the outer edge in the axial direction of the hub 31 is 143mm.

[0044] The parameters of the axial turbine 30 proposed in this application are as follows. The radius L1 of the circle defining the first intersection A is 210mm. The vertical distance between the projection of the first intersection A in the axial direction of the hub 31 and the projection of the second intersection B in the axial direction of the hub 31 is 143mm. The difference value between L1 and L2 is 5mm.

[0045] Comparison results between the existing turbine and the axial turbine 30 of the present disclosure

Table 2

air volume (m ³ /h)	motor power required by existing turbine (W)	noise of existing turbine (dBA)	motor power required by axial turbine 30 (W)	noise of axial turbine 30 (dBA)
2000	34.3	46.1	31.6	39.7
2047	35.6	46.5	33.1	46.1
2071	37.3	46.9	35	46.4
2107	38.3	47.2	35.7	46.8
2138	39.7	47.6	36.9	47.2

[0046] It can be seen from the above experimental comparison results that the axial turbine 30 in the present disclosure has a power reduction of about 2.5W and a noise reduction of about 0.4dBA compared with existing turbines. It can be seen that, without increasing the rotation speed, the axial turbine 30 can increase the air supply volume and reduce the noise, and has the effect of increasing the heat exchange efficiency of the air conditioner and reducing the power of the motor.

[0047] As shown in FIG. 1, the present disclosure further provides an air conditioner outdoor unit 100, including:

a housing 20, the housing has a receiving cavity 22, and the housing 20 is provided with an installation opening 21 communicating with the receiving cavity 22;

an air guide ring 10, the air guide ring 10 is installed at the installation opening 21,

an axial turbine 30, the axial turbine 30 is the above-mentioned axial turbine 30, the axial turbine 30 is provided in the housing 20, and the air outlet surface of the axial turbine 30 is opposite to the installation opening 21.

[0048] The specific structure of the axial turbine 30 refers to the above-mentioned embodiments. Since the air conditioner outdoor unit 100 adopts all the technical solutions of all the above-mentioned embodiments, it has at least all the effects brought by the technical solutions of the above-mentioned embodiments, which will not be repeated here.

[0049] It can be appreciated that the housing 20 is provided with a bracket 23 for installing the axial turbine 30 and a motor 24 provided on the bracket 23. When the axial turbine 30 is installed on the bracket 23, the hub 31 of the axial turbine 30 is fixedly connected with the output shaft of the motor 24, and the air outlet surface of the axial turbine 30 is opposite to the installation opening 21. That is, the air outlet surface of the axial turbine 30 is opposite to the air duct of the air guide ring 10.

[0050] In other implementations of the present embodiment, part of the axial turbine 30 is accommodated in the air duct. The housing 20 is usually made of metal materials, so the air guide ring 10 and the housing 20 are integrally formed by a stamping forming method. The stamping forming method is a common method in metal forming, and the formed part has a smaller wall thickness and lighter weight, which helps reduce the mass of the housing 20 and the air guide ring 10.

[0051] In an embodiment, as shown in FIG. 1, the blades 33 of the axial turbine 30 partially extend into the air guide ring 10, and the blades 33 extend into the air guide ring 10 from the leading edge 331 to the trailing edge 332. The axial width of the air guide ring 10 is d , that is, the height of the air guide ring 10 in the axial direction of the air guide ring 10. The length of the blade 33 extending into the air guide ring 10 is in the range of $2/5d$ to $1/2d$. Such a design is beneficial to reduce the noise of the axial turbine 30 during the rotation of the axial turbine 30. It can be appreciated that the length of the blades 33 of the axial turbine 30 extending into the air guide ring 10 may also be equal to the axial width d of the air guide ring 10.

[0052] As a preferred implementation of this embodiment, the vertical distance between the first intersection A and the inner wall of the air guide ring 10 is in the range of 6mm to 10mm. That is, the vertical distance between the largest circle formed by the projection of the blades 33 of the axial turbine 30 in a plane perpendicular to the axial direction of the hub 31 and the inner wall of the air guide ring 10 is in the range of 6mm to 10mm. The vertical distance may be 6mm, 7mm, 8mm, 9mm, and 10mm. As such, it is beneficial to protect the axial turbine 30 and the air guide ring 10, and prevent the axial turbine 30 from colliding with the inner wall of the air guide ring 10 during the rotation process and causing damage. Of course, the vertical distance is in the range of 6mm to 10mm. During the rotation of the axial turbine 30, it is beneficial to reduce the noise of the axial turbine 30 and ensure the air supply volume of the axial turbine 30.

[0053] In this embodiment, the air guide ring 10 can be integrally formed with the housing 20, which is beneficial to reduce the difficulty of production and manufacture, and improve the production efficiency. The air guide ring 10 may also be detachably connected to the housing 20. When one of the housing 20 and the air guide ring 10 is damaged, the damaged part can be removed for repair or replacement, thereby avoiding maintenance or replacement of the whole composed of the housing 20 and the air guide ring 10. The detachable connection mode may be a connection mode such as screws, pins, plug-in connections, snaps, etc., and this embodiment is not limited thereto. The air guide ring 10 and the housing 20 are integrally formed by injection molding. The injection molding method has a simple operation process, easy implementation, and high molding efficiency, which helps simplify the manufacturing process of the air guide ring 10, reduce the manufacturing cost of the air guide ring 10, and improve the production efficiency of the air guide ring 10.

[0054] The present disclosure also provides an air conditioner, including the above-mentioned axial turbine 30. The specific structure of the axial turbine 30 refers to the above-mentioned embodiments. Since the air conditioner adopts all the technical solutions of all the above embodiments, it has at least all the effects brought by the technical solutions of the above embodiments, and will not be repeated here.

[0055] The present disclosure also provides an air conditioner, including the above-mentioned air conditioner outdoor unit 100. The specific structure of the air conditioner outdoor unit 100 refers to the above-mentioned embodiments. Since the air conditioner adopts all the technical solutions of all the above embodiments, it has at least all the effects brought by the technical solutions of the above embodiments, and will not be repeated here.

[0056] The above are only some embodiments of the present disclosure, and do not limit the scope of the present disclosure thereto. Under the inventive concept of the present disclosure, equivalent structural transformations made according to the description and drawings of the present disclosure, or direct/indirect application in other related technical fields are included in the scope of the present disclosure.

Claims

1. An axial turbine, comprising a hub and a plurality of blades, wherein:

the plurality of blades are spaced along a circumferential direction of the hub;
 each of the plurality of blades includes a leading edge, a trailing edge and an outer edge;
 an intersection of the leading edge and the outer edge is a first intersection, and an intersection of the trailing edge and the outer edge is a second intersection;
 projections of first intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, projections of second intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line; and
 a radius of a circle defining the first intersections is larger than a radius of a circle defining the second intersections.

2. The axial turbine of claim 1, wherein the radius of the circle defining the first intersections is L_1 , the radius of the circle defining the second intersections is L_2 , and $0\text{mm} < L_1 - L_2 \leq 7\text{mm}$.

3. The axial turbine of claim 2, wherein $190\text{mm} \leq L_1 \leq 240\text{mm}$.

4. The axial turbine of claim 1, wherein:

the outer edge of each of the plurality of blades includes a first segment and a second segment connected to each other;
 a intersection of the first segment and the second segment is a third intersection;
 an intersection of the first segment and the leading edge is the first intersection;
 an intersection of the second segment and the trailing edge is the second intersection; and
 projections of third intersections and the first intersections in a plane perpendicular to the axial direction of the hub are on one circumferential line or projections of third intersections and the second intersections in a plane perpendicular to the axial direction of the hub are on one circumferential line.

5. The axial turbine of claim 4, wherein:

a line connecting the first intersection and a center of the hub is a first line, a line connecting the second intersection and the center of the hub is a second line, and a line connecting the third intersection and the center of the hub is a third line; and
 an angle between projections of the first line and the second line in a plane perpendicular to the axial direction of the hub is θ_1 , an angle between projections of the second line and the third line in a plane perpendicular to the axial direction of the hub is θ_2 , $\theta_2 \leq 1/2\theta_1$.

6. The axial turbine of claim 1, wherein:

an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and
 an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$,

7. The axial turbine of claim 2, wherein:

an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and
 an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$.

8. The axial turbine of claim 3, wherein:

an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and
 an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$.

9. The axial turbine of claim 4, wherein:

an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and
 an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$.

10. The axial turbine of claim 5, wherein:

an intersection of the leading edge and the hub is a fourth intersection, and an intersection of the trailing edge and the hub is a fifth intersection; and
 an angle between a line connecting the fourth intersection and the fifth intersection and the plane perpendicular to the axial direction of the hub is θ_3 , $20^\circ \leq \theta_3 \leq 30^\circ$.

11. The axial turbine of claim 6, wherein the leading edge has a concave arc shape from the first intersection to the fourth intersection, and the trailing edge has a convex arc shape from the second intersection to the fifth intersection.

12. The axial turbine of claim 7, wherein the leading edge has a concave arc shape from the first intersection to the fourth intersection, and the trailing edge has a convex arc shape from the second intersection to the fifth intersection.

13. The axial turbine of claim 9, wherein the leading edge has a concave arc shape from the first intersection to the fourth intersection, and the trailing edge has a convex arc shape from the second intersection to the fifth intersection.

14. The axial turbine of claim 10, wherein the leading edge has a concave arc shape from the first intersection to the fourth intersection, and the trailing edge has a convex arc shape from the second intersection to the fifth intersection.

15. The axial turbine of claim 6, wherein a vertical distance between the projection of the first intersection in the axial direction of the hub and the projection of the second intersection in the axial direction of the hub is in the range of 130mm to 160mm.

16. The axial turbine of claim 6, wherein the axial turbine includes three blades, and the three blades are evenly distributed along the circumferential direction of the hub.

17. An air conditioner outdoor unit, comprising:

a housing including a receiving cavity, the housing being defined with an installation opening communicating with the receiving cavity;
 an air guide ring installed at the installation opening; and
 an axial turbine provided in the housing, an air outlet surface of the axial turbine being opposite to the installation opening, the axial turbine including a hub and a plurality of blades, wherein the plurality of blades are spaced along a circumferential direction of the hub, each of the plurality of blades includes a leading edge, a trailing edge and an outer edge, an intersection of the leading edge and the outer edge is a first intersection, and an intersection of the trailing edge and the outer edge is a second intersection, projections of first intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, projections of second intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, a radius of a circle defining the first intersections is larger than a radius of a circle defining the second intersections.

18. The air conditioner outdoor unit of claim 17, wherein the blade of the axial turbine is partially extended into the air guide ring, an axial width of the air guide ring is d , and a length of the blade extending into the air guide ring is between $2/5d$ and $1/2d$.

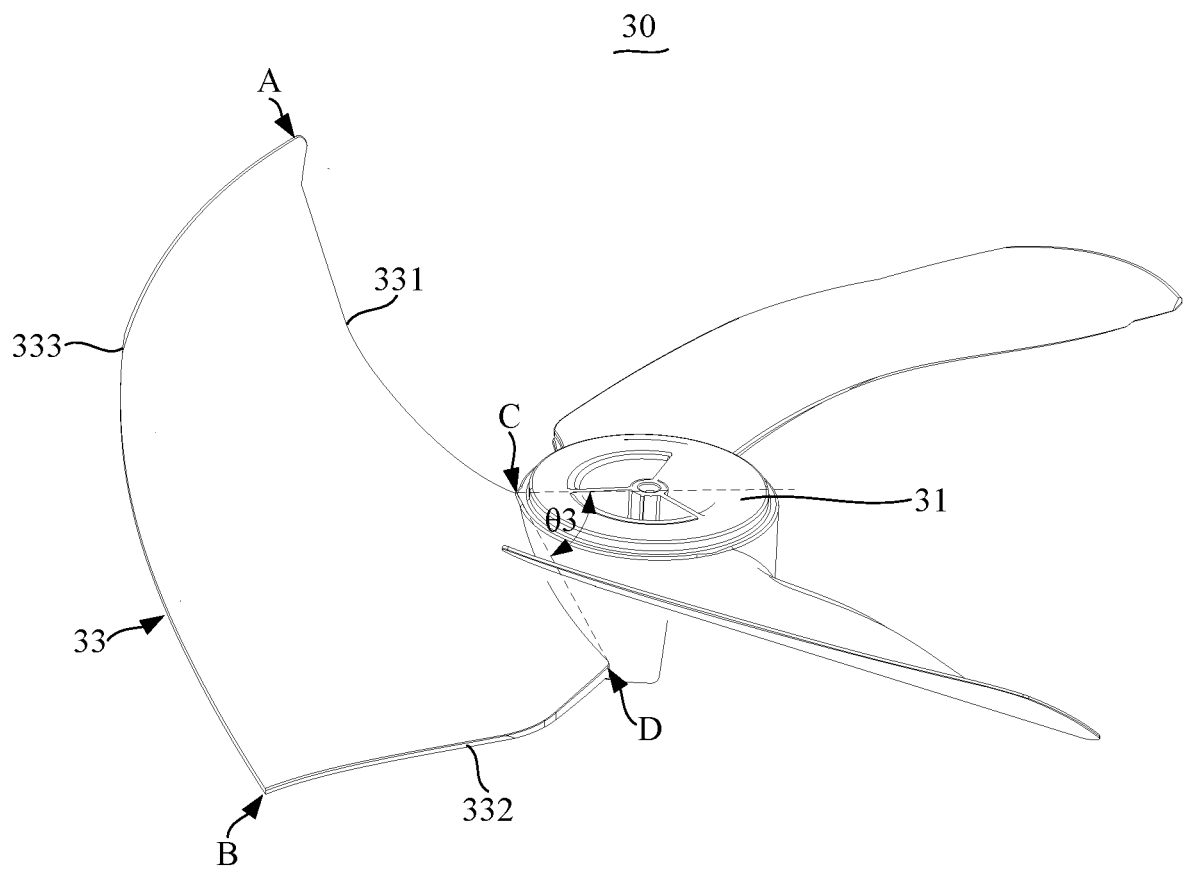
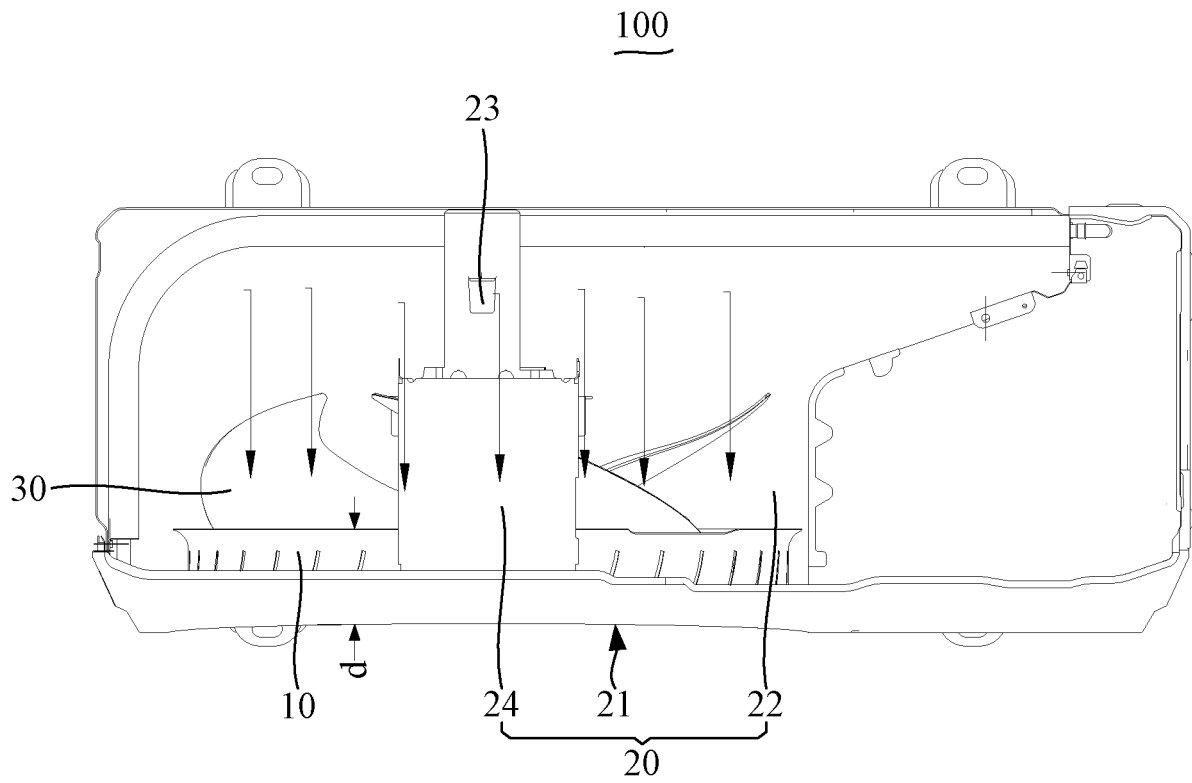
19. The air conditioner outdoor unit of claim 18, wherein a vertical distance between the first intersection and an inner wall of the air guide ring is between 6mm and 10mm.

20. An air conditioner, comprising:

an axial turbine, the axial turbine including a hub and a plurality of blades, wherein: the plurality of blades are

spaced along a circumferential direction of the hub, each of the plurality of blades includes a leading edge, a trailing edge and an outer edge, an intersection of the leading edge and the outer edge is a first intersection, and an intersection of the trailing edge and the outer edge is a second intersection, projections of first intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, projections of second intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, a radius of a circle defining the first intersections is larger than a radius of a circle defining the second intersections; or
an air conditioner outdoor unit, including:

a housing including a receiving cavity, the housing being provided with an installation opening communicating with the receiving cavity;
an air guide ring installed at the installation opening; and
an axial turbine provided in the housing, an air outlet surface of the axial turbine being opposite to the installation opening, the axial turbine including a hub and a plurality of blades, wherein the plurality of blades are spaced along a circumferential direction of the hub, each of the plurality of blades includes a leading edge, a trailing edge and an outer edge, an intersection of the leading edge and the outer edge is a first intersection, and an intersection of the trailing edge and the outer edge is a second intersection, projections of first intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, projections of second intersections of the plurality of blades in a plane perpendicular to an axial direction of the hub are on one circumferential line, a radius of a circle defining the first intersections is larger than a radius of a circle defining the second intersections.



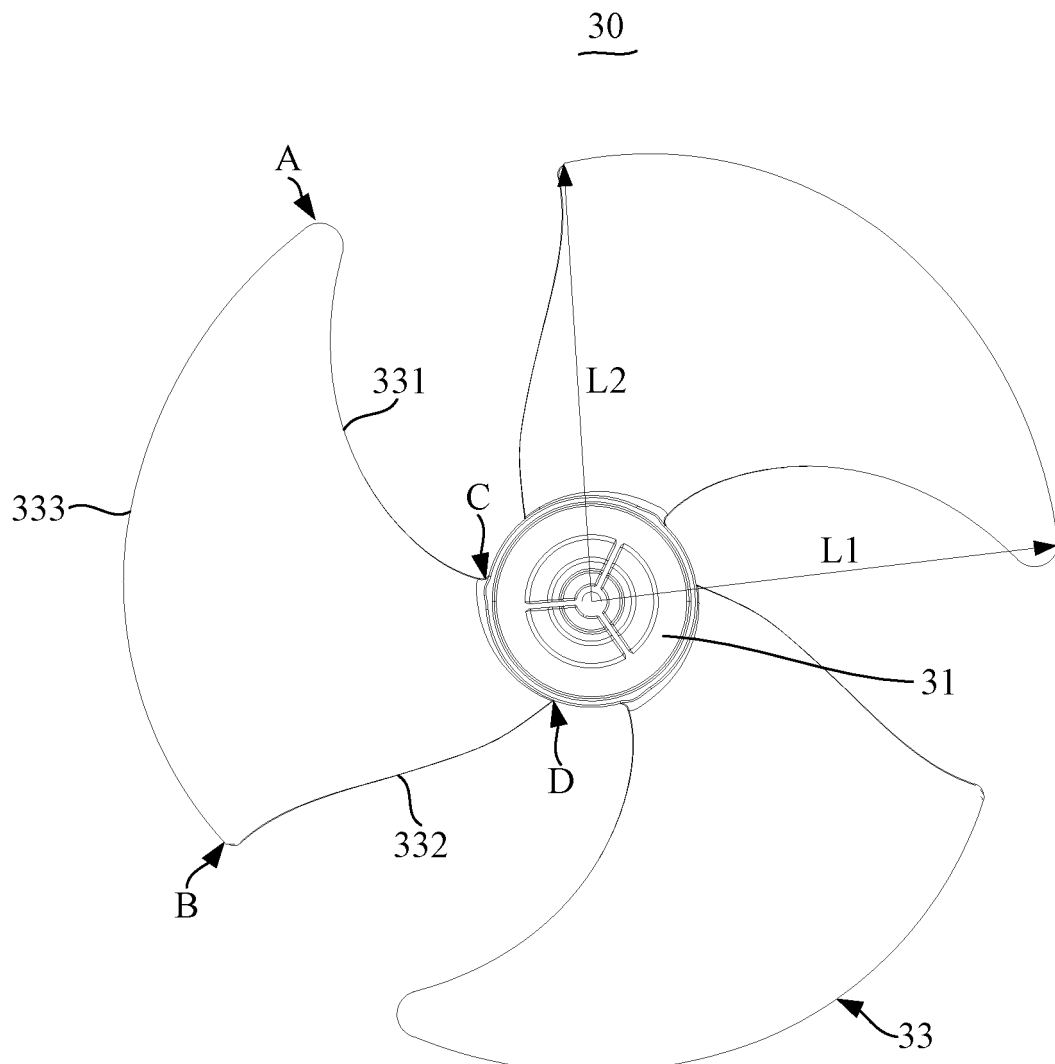


FIG. 3

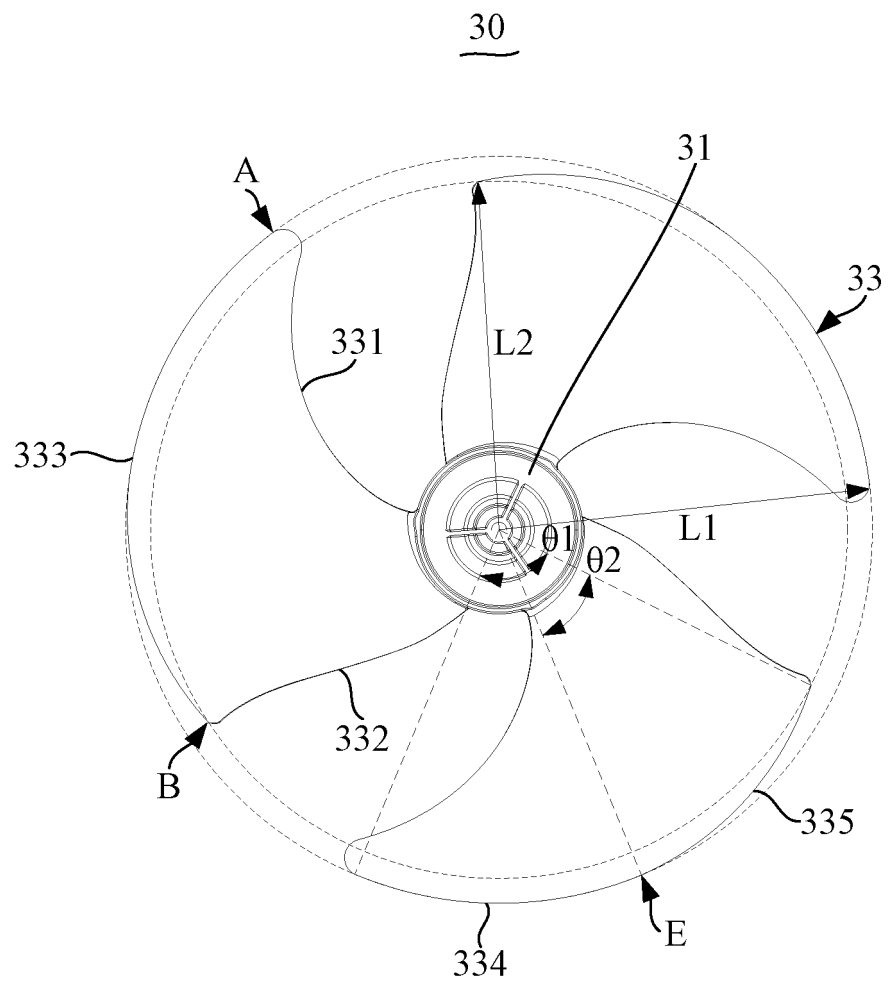


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/097379

5	A. CLASSIFICATION OF SUBJECT MATTER F04D 29/38(2006.01)i; F04D 29/66(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F04D29; CPC:F04D29/384; F04D29/388; F04D29/661; F04D29/666 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNABS, CNTXT, SIPOABS, DWPI: 扇叶, 叶片, 叶尖, 风叶, 风轮, 圆周, 半径, 同圆, 投影, 大, 小, 不同, 重叠wheel, blade?, fan, leaf, radius, semidiameter, circum, circumferen+, circle, shadow, differ+, great+, large+, big+, short+, small+	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
25	Category*	Citation of document, with indication, where appropriate, of the relevant passages
30		Relevant to claim No.
35	:X	CN 102536899 A (LG ELECTRONICS INC.) 04 July 2012 (2012-07-04) description, paragraphs [0029]-[0051], and figures 3-7
40	X	CN 1908445 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 07 February 2007 (2007-02-07) description, page 4, line 12 to page 5, line 1, and figures 1-2
45	X	CN 204082663 U (SHUN KUANG CO., LTD.) 07 January 2015 (2015-01-07) description, paragraphs [0044]-[0050], and figures 3-5
50	A	CN 101140087 A (TOSHIBA CARRIER CORPORATION) 12 March 2008 (2008-03-12) entire document
55	A	JP 2005105865 A (DAIKIN INDUSTRIES, LTD.) 21 April 2005 (2005-04-21) entire document
	A	JP 2006077632 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 23 March 2006 (2006-03-23) entire document
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 10 January 2019		Date of mailing of the international search report 30 January 2019
Name and mailing address of the ISA/CN State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China		Authorized officer
Facsimile No. (86-10)62019451		Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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