Patent Literature

[0003]

Patent Literature 1: Japanese Patent No. 4906555

Summary of Invention

Technical Problem

[0004]

However, in the centrifugal fan in Patent Literature 1, which can improve the noise problem, may suffer from a decrease in the air-sending efficiency because of insufficient pressure recovery from the dynamic pressure to the static pressure when the extension rate of the circumferential wall of the scroll casing to a predetermined direction cannot be sufficiently secured due to a restriction in the external dimensions depending on the place of installation.

[0005]

An object of the present disclosure, which has been made to solve the above-mentioned problems, is to obtain a centrifugal fan, an air-sending device, an air-conditioning apparatus, and a refrigeration cycle apparatus configured to reduce noise and improve the air-sending efficiency.

Solution to Problem

[0006]

According to an embodiment of the present disclosure, there is provided a centrifugal fan comprising: a fan including a main plate having a disk-shape, and a plurality of blades installed on a circumferential portion of the main plate; and a scroll casing configured to house the fan, the scroll casing including a discharge portion forming a discharge port from which an air flow generated by the fan is discharged, and a scroll portion including a side wall covering the fan in an axis direction of a rotational shaft of the fan, and provided with a suction port configured to suction air, a circumferential wall encircling the fan in a radial direction of the rotational shaft, and a tongue portion provided between the discharge portion and the circumferential wall, and configured to guide the air flow generated by the fan to the discharge port. In comparison with a centrifugal fan including a standard circumferential wall having a

spiral shape defined by a predetermined extension rate in cross-section perpendicular to the rotational shaft of the fan, in the circumferential wall, at a first end being a boundary between the circumferential wall and the tongue portion and at a second end being a boundary between the circumferential wall and the discharge portion, a distance L1 between an axis of the rotational shaft and the circumferential wall is equal to a distance L2 between the axis of the rotational shaft and the standard circumferential wall, the distance L1 is greater than or equal to the distance L2 between the first end and the second end of the circumferential wall, the circumferential wall includes a plurality of extended portions between the first end and the second end of the circumferential wall, and the plurality of extended portions include maximum points each have a length being a difference LH between the distance L1 and the distance L2. At an angle θ shifted from a first reference line in a direction of rotation of the fan between the first reference line and a second reference line in cross-section perpendicular to the rotational shaft of the fan, the first reference line connecting the axis of the rotational shaft and the first end to each other, the second reference line connecting the axis of the rotational shaft and the second end to each other. The plurality of extended portions include two extended portions in a section in which the angle θ is 90 degrees or more and less than an angle α formed by the second reference line. The distance L1 is greater than the distance L2 in the circumferential wall forming a region between the two extended portions.

Advantageous Effects of Disclosure

[0007]

In the centrifugal fan according to an embodiment of the present disclosure, in comparison with the centrifugal fan including the standard circumferential wall having a logarithmic spiral shape in cross-section perpendicular to the rotational shaft of the fan, in the circumferential wall, at the first end and at the second end, the distance L1 is equal to the distance L2. In the circumferential wall, between the first end and the second end of the circumferential wall, the distance L1 is greater than or equal to the distance L2. The circumferential wall includes the plurality of extended portions between the first end and the second end of the circumferential wall,

and the plurality of extended portions include maximum points each having a length being a difference LH between the distance L1 and the distance L2. Therefore, in the centrifugal fan, even when the extension rate of the circumferential wall of the scroll casing to a predetermined direction cannot be sufficiently secured due to the restriction in the external dimensions depending on the place of installation, the distance of an air passage in which the distance between the axis of the rotational shaft and the circumferential wall is extended can be increased because the circumferential wall includes the configuration above in the extendable direction. As a result, the centrifugal fan can convert the dynamic pressure to the static pressure by reducing

CLAIMS

[Claim 1]

A centrifugal fan, comprising:

a fan including a main plate having a disk-shape, and a plurality of blades installed on a circumferential portion of the main plate; and

a scroll casing configured to house the fan,

the scroll casing including

a discharge portion forming a discharge port from which an air flow generated by the fan is discharged, and

a scroll portion including

a side wall covering the fan in an axis direction of a rotational shaft of the fan, and provided with a suction port configured to suction air,

a circumferential wall encircling the fan in a radial direction of the rotational shaft, and

a tongue portion provided between the discharge portion and the circumferential wall, and configured to guide the air flow generated by the fan to the discharge port,

in comparison with a centrifugal fan including a standard circumferential wall having a spiral shape defined by a predetermined extension rate in cross-section perpendicular to the rotational shaft of the fan,

in the circumferential wall, at a first end being a boundary between the circumferential wall and the tongue portion and at a second end being a boundary between the circumferential wall and the discharge portion, a distance L1 between an axis of the rotational shaft and the circumferential wall being equal to a distance L2 between the axis of the rotational shaft and the standard circumferential wall,

the distance L1 being greater than or equal to the distance L2 between the first end and the second end of the circumferential wall,

the circumferential wall including a plurality of extended portions between the first end and the second end of the circumferential wall, the plurality of extended portions

comprising maximum points each having a length being a difference LH between the distance L1 and the distance L2,

at an angle θ shifted from a first reference line in a direction of rotation of the fan between the first reference line and a second reference line in cross-section perpendicular to the rotational shaft of the fan, the first reference line connecting the axis of the rotational shaft and the first end to each other, the second reference line connecting the axis of the rotational shaft and the second end to each other,

the plurality of extended portions include:

two extended portions in a section in which the angle θ is 90 degrees or more and less than an angle α formed by the second reference line; and

the distance L1 is greater than the distance L2 in the circumferential wall forming a region between the two extended portions.

[Claim 2]

The centrifugal fan of claim 1, wherein,

the two extended portions include:

a maximum point in a section in which the angle θ is 90 degrees or more and less than 180 degrees; and

an other maximum point in a section in which the angle θ is 180 degrees or more and less than the angle α formed by the second reference line.

[Claim 3]

The centrifugal fan of claim 1 or claim 2, wherein:

the plurality of extended portions include:

the two extended portions and an other extended portion,

the two extended portions and the other extended portion include

a first extended portion including the first maximum point P1 in the section in which the angle θ is 0 degrees or more and less than 90 degrees;

a second extended portion including the second maximum point P2 in the section in which the angle θ is 90 degrees or more and less than 180 degrees; and

a third extended portion including the third maximum point P3 in the section in which the angle θ is 180 degrees or more and less than the angle α formed by the second reference line;

when a point at which the difference LH is smallest in a section in which the angle θ is 0 degrees or more and equal to or less than an angle at which the first maximum point P1 is positioned is a first minimum point U1;

a point at which the difference LH is smallest in a section in which the angle θ is 90 degrees or more and equal to or less than an angle at which the second maximum point P2 is positioned is a second minimum point U2;

a point at which the difference LH is smallest in a section in which the angle θ is 180 degrees or more and equal to or less than an angle at which the third maximum point P3 is positioned is a third minimum point U3;

a difference L11 between the distance L1 at the first maximum point P1 and the distance L1 at the first minimum point U1 relative to an increase $\theta 1$ of the angle θ from the first minimum point U1 to the first maximum point P1 is an extension rate A;

a difference L22 between the distance L1 at the second maximum point P2 and the distance L1 at the second minimum point U2 relative to an increase $\theta 2$ of the angle θ from the second minimum point U2 to the second maximum point P2 is an extension rate B; and

a difference L33 between the distance L1 at the third maximum point P3 and the distance L1 at the third minimum point U3 relative to an increase $\theta 3$ of the angle θ from the third minimum point U3 to the third maximum point P3 is an extension rate C,

a relationship of the extension rate B > the extension rate C, and the extension rate B $\geq$ the extension rate A > the extension rate C, or a relationship of the extension rate B > the extension rate C, and the extension rate B > the extension rate C $\geq$ the extension rate A is satisfied.

[Claim 4]

The centrifugal fan of claim 1 or claim 2, wherein:

the plurality of extended portions include:

the two extended portions and an other extended portion,

the two extended portions and the other extended portion include

a first extended portion including the first maximum point P1 in the section in which the angle θ is 0 degrees or more and less than 90 degrees;

a second extended portion including the second maximum point P2 in the section in which the angle θ is 90 degrees or more and less than 180 degrees; and

a third extended portion including the third maximum point P3 in the section in which the angle θ is 180 degrees or more and less than the angle α formed by the second reference line;

when a point at which the difference LH is smallest in a section in which the angle θ is 0 degrees or more and equal to or less than an angle at which the first maximum point P1 is positioned is a first minimum point U1;

a point at which the difference LH is smallest in a section in which the angle θ is 90 degrees or more and equal to or less than an angle at which the second maximum point P2 is positioned is a second minimum point U2;

a point at which the difference LH is smallest in a section in which the angle θ is 180 degrees or more and equal to or less than an angle at which the third maximum point P3 is positioned is a third minimum point U3;

a difference L11 between the distance L1 at the first maximum point P1 and the distance L1 at the first minimum point U1 relative to an increase $\theta 1$ of the angle θ from the first minimum point U1 to the first maximum point P1 is an extension rate A;

a difference L22 between the distance L1 at the second maximum point P2 and the distance L1 at the second minimum point U2 relative to an increase $\theta 2$ of the angle θ from the second minimum point U2 to the second maximum point P2 is an extension rate B; and

a difference L33 between the distance L1 at the third maximum point P3 and the distance L1 at the third minimum point U3 relative to an increase $\theta 3$ of the angle θ from the third minimum point U3 to the third maximum point P3 is an extension rate C,

a relationship of the extension rate C > the extension rate B $\geq$ the extension rate A is satisfied.

[Claim 5]

The centrifugal fan of claim 1 or claim 2, wherein:

the plurality of extended portions include:

the two extended portions and an other extended portion,

the two extended portions and the other extended portion include

a first extended portion including a first maximum point P1 in the section in which the angle θ is 0 degrees or more and less than 90 degrees;

a second extended portion including a second maximum point P2 in the section in which the angle θ is 90 degrees or more and less than 180 degrees; and

a third extended portion including a third maximum point P3 in the section in which the angle θ is 180 degrees or more and less than the angle α formed by the second reference line; and

the distance L1 is greater than the distance L2 in the circumferential wall forming a region from the second extended portion to the third extended portion.

[Claim 6]

The centrifugal fan of claim 3 or claim 4, wherein, when:

a difference L44 between the distance L1 at the second minimum point U2 and the distance L1 at the first maximum point P1 relative to an increase θ11 of the angle θ from the first maximum point P1 to the second minimum point U2 is an extension rate D;

a difference L55 between the distance L1 at the third minimum point U3 and the distance L1 at the second maximum point P2 relative to an increase θ22 of the angle θ from the second maximum point P2 to the third minimum point U3 is an extension rate E;

a difference L66 between the distance L1 at the angle α and the L1 at the third maximum point P3 relative to an increase θ33 of the angle θ from the third maximum point P3 to the angle α is an extension rate F; and

the distance L2 between the axis of the rotational shaft and the standard circumferential wall relative to the increase of the angle θ is an extension rate J,

the extension rate J > the extension rate D $\geq$ 0, the extension rate J > the extension rate E $\geq$ 0, and the extension rate J > the extension rate F $\geq$ 0 are satisfied.

[Claim 7]

The centrifugal fan of any one of claims 1 to 6, wherein the circumferential wall bulges out, at a position facing the circumferential portion of the main plate, in a direction parallel to the rotational shaft, and the distance L1 is greatest at a position facing the circumferential portion of the main plate in the direction parallel to the rotational shaft in the circumferential wall.

[Claim 8]

The centrifugal fan of any one of claims 1 to 7, wherein the circumferential wall has a protruding portion in a circumferential direction of the rotational shaft, the protruding portion protruding to the radial direction of the rotational shaft.

[Claim 9]

An air-sending device, comprising:

the centrifugal fan of any one of claims 1 to 8; and

a case configured to accommodate the centrifugal fan.

[Claim 10]

An air-conditioning apparatus, comprising:

the centrifugal fan of any one of claims 1 to 8; and

a heat exchanger disposed in a position facing a discharge port of the centrifugal fan.

[Claim 11]

A refrigeration cycle apparatus, comprising the centrifugal fan of any one of claims 1 to 8.