



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
01.12.2021 Bulletin 2021/48

(51) Int Cl.:
F04D 29/28 ^(2006.01)

(21) Application number: **19910985.1**

(86) International application number:
PCT/JP2019/001661

(22) Date of filing: **21.01.2019**

(87) International publication number:
WO 2020/152748 (30.07.2020 Gazette 2020/31)

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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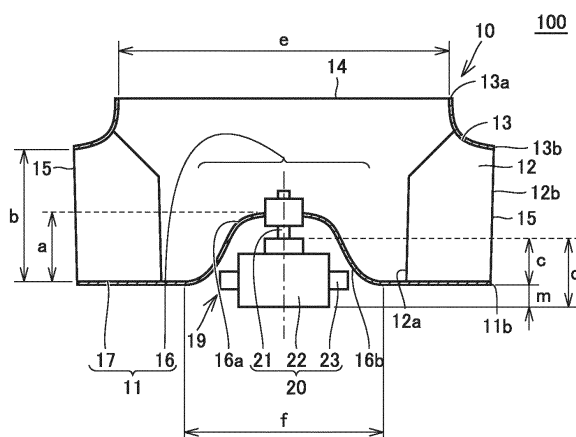
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(54) **FAN BLOWER, INDOOR UNIT, AND AIR CONDITIONER**

(57) A blower (100) includes: a motor (20) including a rotation shaft (21) and a drive unit (22); and a centrifugal fan (10) including a main plate (11) fixed to the rotation shaft (21), a side plate (13) having an annular shape and spaced apart from the main plate (11) in an extending direction in which the rotation shaft extends, and a plurality of vanes (12) disposed between the main plate (11) and the side plate (13). The main plate (11) has a protruding portion (16) disposed centrally in a radial direction and protruding toward the side plate (13) in the extending

direction. The protruding portion (16) has a protruding surface (16a) and a recessed surface (16b) in which at least a part of the drive unit (22) is accommodated. A height (a) of the protruding portion (16) in the extending direction is less than a half of a width (b) of an air outlet (15) in the extending direction. A width (c) of a portion of the drive unit (22) in the extending direction that is disposed inside the recessed portion (19) is greater than a half of a width (d) of the drive unit (22) in the extending direction.

FIG.2



Description

TECHNICAL FIELD

[0001] The present invention relates to a blower, an indoor unit, and an air conditioner.

BACKGROUND ART

[0002] Blowers equipped with centrifugal fans have been known. International Publication No. WO2006/126408 discloses a blower including: a main plate and a shroud (a side plate) disposed at a distance from each other in an extending direction of a rotation shaft; and a plurality of vanes disposed between the main plate and the shroud. The main plate has a central portion in the radial direction that is formed in a protruding shape with respect to an outer circumferential portion in a view of a centrifugal fan seen from an air inlet. The central portion of the main plate is formed in a recessed shape with respect to the outer circumferential portion in a view of the centrifugal fan seen from the opposite side of the air inlet. A motor for rotating the blower is accommodated in the recessed portion in the central portion. Each vane of the centrifugal fan has an inner circumferential end portion provided on the protruding portion.

CITATION LIST

PATENT LITERATURE

[0003] PTL 1: International Publication No. WO2006/126408

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] However, the protruding portion in the main plate prevents the airflow from flowing through the air inlet of the centrifugal fan and passing between the vanes toward the main plate in the extending direction. This reduces the pressure between the vanes on the main plate side in the extending direction, and thereby, the airflow is pulled toward the main plate, so that the air velocity distribution between the vanes in the extending direction becomes nonuniform. Consequently, the air-blowing efficiency decreases and the noise increases. This problem is more significant as the central portion is higher in the extending direction.

[0005] On the other hand, when the central portion of the main plate is reduced in height in the extending direction, the protruding portion of the motor disposed outside the recessed portion in the main plate is increased in the extending direction. Thus, the blower is increased in size in the extending direction.

[0006] A main object of the present invention is to provide a blower for which air-blowing efficiency reduction,

noise increase, and size increase are simultaneously suppressed as compared with conventional blowers.

SOLUTION TO PROBLEM

[0007] A blower according to the present invention includes: a motor having a rotation shaft and a drive unit configured to rotate the rotation shaft; and a centrifugal fan having a main plate fixed to the rotation shaft, a side plate having an annular shape and spaced apart from the main plate in an extending direction in which the rotation shaft extends, and a plurality of vanes disposed between the main plate and the side plate, the centrifugal fan being configured to be rotated by the motor. The centrifugal fan has an air outlet located between an outer circumferential end portion of the main plate in a radial direction and an outer circumferential end portion of the side plate in the radial direction. The main plate has a protruding portion located centrally in the radial direction and protruding toward the side plate in the extending direction. The protruding portion has a protruding surface formed in a protruding shape, and a recessed surface located opposite to the protruding surface. At least a part of the drive unit is accommodated in a recessed portion surrounded by the recessed surface. A height "a" of the protruding portion in the extending direction is less than a half of a width "b" of the air outlet in the extending direction. A width "c" of a portion of the drive unit in the extending direction that is disposed inside the recessed portion is greater than a half of a width "d" of the drive unit in the extending direction.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] The present invention can provide a blower, for which air-blowing efficiency reduction, noise increase, and size increase are simultaneously suppressed as compared with conventional blowers.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a perspective view showing a blower according to the first embodiment.

Fig. 2 is a cross-sectional view of the blower shown in Fig. 1, which is taken along a rotation shaft.

Fig. 3 is a graph showing the relation between a ratio a/b of the blower according to the first embodiment and a fan input.

Fig. 4 is a cross-sectional view of a blower according to the second embodiment, which is taken along a rotation shaft.

Fig. 5 is a cross-sectional view of a blower according to the third embodiment, which is taken along a rotation shaft.

Fig. 6 is a cross-sectional view of a blower according to the fourth embodiment, which is taken along a

rotation shaft.

Fig. 7 is a cross-sectional view of a blower according to the fifth embodiment, which is taken along a rotation shaft.

Fig. 8 is a cross-sectional view of a blower and an indoor unit according to the sixth embodiment, which is taken along a rotation shaft.

Fig. 9 is a diagram showing an air conditioner including the blower according to any one of the first to sixth embodiments.

DESCRIPTION OF EMBODIMENTS

[0010] The embodiments of the present invention will be hereinafter described with reference to the accompanying drawings, in which the same or corresponding components are denoted by the same reference characters, and the description thereof will not be repeated.

First Embodiment

[0011] As shown in Figs. 1 and 2, a blower 100 according to the first embodiment includes a centrifugal fan 10 and a motor 20. Centrifugal fan 10 includes a main plate 11, a plurality of vanes 12, and a side plate 13. Motor 20 includes a rotation shaft 21, a drive unit 22, and a support portion 23. In the following, an extending direction in which rotation shaft 21 extends, a radial direction and a circumferential direction with respect to the extending direction will be simply referred to as the extending direction, the radial direction, and the circumferential direction, respectively.

[0012] Centrifugal fan 10 has an optional number of order of rotational symmetry with respect to rotation shaft 21. Centrifugal fan 10 has: an air inlet 14 located centrally in the radial direction and opened in the extending direction; and an air outlet 15 located outwardly of air inlet 14 in the radial direction and opened in the direction crossing the extending direction.

[0013] Main plate 11 is fixed to rotation shaft 21. Side plate 13 is disposed opposite to motor 20 with respect to main plate 11 in the extending direction. Main plate 11 has a protruding portion 16 located centrally in the radial direction and protruding toward air inlet 14 in a view of main plate 11 seen from the side plate 13 side. Protruding portion 16 protrudes toward side plate 13 in the extending direction, i.e., protrudes in the direction opposite to motor 20. Main plate 11 further includes a flat portion 17, for example, provided to surround protruding portion 16 in the radial direction and extending in the direction perpendicular to the rotation shaft. An outer circumferential end portion 11b is formed, for example, as an outer circumferential end portion of flat portion 17. Protruding portion 16 and flat portion 17 are integrally provided. The boundary between protruding portion 16 and flat portion 17 corresponds to a connection point between: an outer circumferential end portion of protruding portion 16 having a curved end surface in a cross section along rotation

shaft 21; and an inner circumferential end portion of flat portion 17 having a flat end surface in the cross section along rotation shaft 21.

[0014] Protruding portion 16 has: a top portion located most distant from flat portion 17 in the extending direction and in the radial direction; and an outer circumferential end portion as a bottom portion connected to the inner circumferential end portion of flat portion 17. A boss portion 30 fixed to rotation shaft 21 is attached to the top portion of protruding portion 16. Thereby, main plate 11 is fixed to rotation shaft 21 with boss portion 30 interposed therebetween.

[0015] Flat portion 17 is provided annularly in the circumferential direction. Flat portion 17 has: an inner circumferential end portion connected to the outer circumferential end portion of protruding portion 16; and an outer circumferential end portion that forms outer circumferential end portion 11b of main plate 11.

[0016] Protruding portion 16 has: a protruding surface 16a protruding with respect to flat portion 17 in a view of main plate 11 seen from the side plate 13 side; and a recessed surface 16b on the side opposite to protruding surface 16a and recessed with respect to flat portion 17 in a view of main plate 11 seen from the opposite side of side plate 13. Protruding portion 16 has a recessed portion 19 surrounded by recessed surface 16b and located inwardly of flat portion 17 in a view of main plate 11 seen from the opposite side of side plate 13.

[0017] Protruding surface 16a has a first curved surface 16aa, a second curved surface 16ab, and a conical surface 16ac, for example. First curved surface 16aa is located closer to air inlet 14 than conical surface 16ac in the extending direction, and located closer to the inner circumferential side than conical surface 16ac in the radial direction. Second curved surface 16ab is located closer to air outlet 15 than conical surface 16ac in the extending direction, and located closer to the outer circumferential side than conical surface 16ac in the radial direction.

[0018] The inner circumferential end portion of first curved surface 16aa in the radial direction is connected to boss portion 30, for example. The outer circumferential end portion of first curved surface 16aa in the radial direction is connected to the inner circumferential end portion of conical surface 16ac in the radial direction, for example. The outer circumferential end portion of conical surface 16ac in the radial direction is connected to the inner circumferential end portion of second curved surface 16ab in the radial direction, for example. The outer circumferential end portion of second curved surface 16ab in the radial direction is connected to the inner circumferential end portion of flat portion 17, for example. The boundary between first curved surface 16aa and conical surface 16ac corresponds to a connection point between: the outer circumferential end portion of first curved surface 16aa having a curved end surface in a cross section along rotation shaft 21; and an inner circumferential end portion of conical surface 16ac having

a straight end surface in the cross section along rotation shaft 21. The boundary between conical surface 16ac and second curved surface 16ab corresponds to a connection point between: the outer circumferential end portion of conical surface 16ac having a straight end surface in the cross section along rotation shaft 21; and the inner circumferential end portion of second curved surface 16ab having a curved end surface in the cross section along rotation shaft 21.

[0019] First curved surface 16aa is formed in a protruding shape in a view of main plate 11 seen from the side plate 13 side. Second curved surface 16ab is formed in a recessed shape in a view of main plate 11 seen from the side plate 13 side. Conical surface 16ac is formed as a conical surface centered on rotation shaft 21. The center of curvature of first curved surface 16aa is located close to recessed surface 16b with respect to main plate 11. In other words, the center of curvature of first curved surface 16aa is located opposite to air inlet 14 with respect to first curved surface 16aa in the extending direction. The center of curvature of second curved surface 16ab is located close to protruding surface 16a with respect to main plate 11. In other words, the center of curvature of second curved surface 16ab is located close to air inlet 14 with respect to second curved surface 16ab in the radial direction.

[0020] Each of vanes 12 is disposed between main plate 11 and side plate 13. Each vane 12 connects flat portion 17 of main plate 11 and side plate 13, for example. Vanes 12 are spaced apart from each other in the circumferential direction. The inner circumferential end portion of each vane 12 is located, for example, on the outer circumferential side with respect to the outer circumferential end portion of protruding portion 16.

[0021] Side plate 13 is formed annularly in the circumferential direction. Side plate 13 has: an inner circumferential end portion 13a provided to form air inlet 14 in centrifugal fan 10; and an outer circumferential end portion 13b provided to form air outlet 15 between side plate 13 and main plate 11. Inner circumferential end portion 13a is disposed more distant from flat portion 17 of main plate 11 than outer circumferential end portion 13b in the extending direction. In the cross section along rotation shaft 21, side plate 13 has a curved shape having the center of curvature located on the outer circumferential side with respect to side plate 13 in the radial direction. Each vane 12 is connected to side plate 13, for example, across a range from a portion of side plate 13 located closer to flat portion 17 than inner circumferential end portion 13a to outer circumferential end portion 13b of side plate 13. The inner circumferential end portion of each vane 12 is located on the inner circumferential side with respect to inner circumferential end portion 13a of side plate 13, for example.

[0022] Air inlet 14 is configured as an opening surrounded by inner circumferential end portion 13a of side plate 13. In a view of centrifugal fan 10 seen in the extending direction, the planar shape of air inlet 14 is a

circle centered on rotation shaft 21. Centrifugal fan 10 has a plurality of air outlets 15 disposed side by side in the circumferential direction. Each air outlet 15 is disposed between outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13 in the extending direction, and also disposed between two vanes 12 adjacent to each other in the circumferential direction.

[0023] As described above, rotation shaft 21 of motor 20 is fixed to main plate 11 of centrifugal fan 10 with boss portion 30 interposed therebetween. Drive unit 22 accommodates a stator and a rotor that rotates together with rotation shaft 21 with respect to the stator. Drive unit 22 has a portion accommodated in recessed portion 19 surrounded by recessed surface 16b of main plate 11. Drive unit 22 has, for example, a first portion 22a accommodated in the recessed portion and a second portion 22b disposed outside the recessed portion. First portion 22a and second portion 22b are disposed side by side in the extending direction.

[0024] Support portion 23 is disposed outside drive unit 22 in the radial direction and fixed to at least one of first portion 22a and second portion 22b of drive unit 22. Support portion 23 has, for example, a portion accommodated in the recessed portion and a portion disposed outside the recessed portion. Support portion 23 is fixed to a housing (not shown) of blower 100 by a fixing member (not shown). For example, a heat exchanger (not shown) is fixed to the housing. The heat exchanger is disposed so as to face air outlet 15 in the radial direction.

[0025] As shown in Fig. 2, the longest distance in the extending direction between the top portion and the bottom portion of protruding surface 16a of protruding portion 16 is referred to as a height "a" of protruding portion 16 with respect to flat portion 17 of main plate 11. The longest distance in the extending direction between outer circumferential end portion 11b of flat portion 17 of main plate 11 and outer circumferential end portion 13b of side plate 13 is equal to a width "b" of air outlet 15 in the extending direction. The ratio a/b of height "a" to width "b" is less than 1/2. Preferably, the ratio a/b is less than 1/3. Width "b" of air outlet 15 in the extending direction is, for example, equal to or less than the width in the extending direction of the heat exchanger disposed to face air outlet 15 in the radial direction.

[0026] As shown in Fig. 2, a width "c" in the extending direction of first portion 22a disposed inside recessed portion 19 of drive unit 22 is greater than a half of width "d" of drive unit 22 in the extending direction. In other words, width "c" is greater than a width "m" in the extending direction of second portion 22b of drive unit 22 that is disposed outside recessed portion 19 (that is, width "m" corresponds to the difference between width "d" and width "c"). Width "m" may be zero. In other words, drive unit 22 may be entirely disposed inside recessed portion 19. In this case, width "c" is equal to the width of the entire drive unit 22 in the extending direction and is greater than zero.

[0027] As shown in Fig. 2, the longest distance between inner circumferential end portions 13a of side plate 13 that are located to face each other in the radial direction will be referred to as an inner diameter "e" of air inlet 14. The longest distance between the outer circumferential end portions of protruding portion 16 that are located to sandwich rotation shaft 21 therebetween in the radial direction will be referred to as a width "f" of protruding portion 16. Inner diameter "e" of air inlet 14 is greater than width "f" of protruding portion 16, for example. Height "a" of protruding portion 16 is equal to or greater than a half of width "f" of protruding portion 16 and equal to or less than width "f", for example. Width "b" is less than inner diameter "e".

[0028] The use of blower 100 is not particularly limited but is suitable, for example, for a blower disposed inside an indoor unit of an air conditioner and configured to blow air into an indoor heat exchanger. In this case, the heat exchanger is disposed, for example, to face air outlet 15 in the radial direction (see Fig. 8).

<Functions and Effects>

[0029] Blower 100 includes: motor 20 including rotation shaft 21 and drive unit 22 configured to rotate rotation shaft 21; and centrifugal fan 10 including main plate 11 fixed to rotation shaft 21, side plate 13 having an annular shape and spaced apart from main plate 11 in the extending direction, and a plurality of vanes 12 disposed between main plate 11 and side plate 13, in which centrifugal fan 10 is rotated by motor 20. Side plate 13 has an opening located centrally in the radial direction and providing air inlet 14 in centrifugal fan 10. Main plate 11 has protruding portion 16 disposed centrally in the radial direction and protruding toward air inlet 14 in the extending direction in a view of main plate 11 seen from the side plate 13 side. Air outlet 15 of centrifugal fan 10 is provided between outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13. Protruding portion 16 has: protruding surface 16a formed in a protruding shape in a view of main plate 11 seen from the side plate 13 side; and recessed surface 16b on the side opposite to protruding surface 16a. At least a part of drive unit 22 is accommodated in recessed portion 19 surrounded by recessed surface 16b. Height "a" of protruding portion 16 in the extending direction is less than a half of width "b" of air outlet 15 in the extending direction. Width "c" in the extending direction of the portion of drive unit 22 that is disposed inside recessed portion 19 is greater than a half of width "d" of drive unit 22 in the extending direction.

[0030] When the ratio a/b is equal to or greater than $1/2$, the amount of air between the plurality of vanes 12 on the main plate 11 side in the extending direction is reduced, and thus, the gas having flowed into the outer circumferential side of air inlet 14 is hard to flow along side plate 13. Consequently, the air velocity distribution between vanes 12 becomes nonuniform, thereby in-

creasing the airflow resistance between vanes 12. Fig. 3 is a graph showing the relation between the above-mentioned ratio a/b and the electric power supplied to the blower such that the amount of air blown out from the blower reaches the prescribed amount of air (this electric power will be hereinafter referred to as a fan input). In Fig. 3, the horizontal axis shows the above-mentioned ratio a/b and the vertical axis shows the normalized fan input. As shown in Fig. 3, when the ratio a/b is equal to or greater than $1/2$, the fan input increases and the air-blowing efficiency decreases as compared with the case where the ratio a/b is less than $1/2$. In this case, the noise of the blower also increases.

[0031] Further, when height "a" is reduced to thereby set the ratio a/b to be less than $1/2$, width "m" exceeds above width "c", with the result that blower 100 is increased in size in the extending direction. Further, when width "b" is increased to thereby set the ratio a/b to be less than $1/2$, blower 100 is also increased in size in the extending direction.

[0032] In contrast, in blower 100, the ratio a/b is less than $1/2$ and width "c" is greater than a half of width "d". Thus, as shown in Fig. 3, in blower 100, the fan input is reduced to thereby improve the air-blowing efficiency and also reduce the noise, as compared with the case where the ratio a/b is equal to or greater than $1/2$.

[0033] Further, since width "m" is less than width "c", the size increase of blower 100 in the extension direction is suppressed. Also, protruding portion 16 and motor 20 each are formed in a flat shape, thereby achieving blower 100 in which the ratio a/b is less than $1/2$ and width "c" is greater than a half of width "d". Motor 20 is formed in a flattened shape, for example, by disposing support portion 23 of motor 20 outwardly of drive unit 22 in the radial direction in comparison with a motor fixed to a blower without using support portion 23. For the reasons as described above, in blower 100, air-blowing efficiency reduction, noise increase, and size increase are simultaneously suppressed.

[0034] Preferably, the ratio a/b is less than $1/3$. In this way, as compared with the case where the ratio a/b is equal to or greater than $1/3$ and less than $1/2$, the air velocity distribution between vanes 12 in the extending direction becomes further uniform, the airflow resistance between vanes 12 decreases, and the fan input is further reduced.

Second Embodiment

[0035] As shown in Fig. 4, a blower 101 according to the second embodiment has basically the same configuration as that of blower 100 according to the first embodiment, except that height "a" of protruding portion 16 is less than a half of width "f" of protruding portion 16.

[0036] The longest distance in the extending direction between the top portion and the bottom portion on recessed surface 16b of protruding portion 16 is less than a half of width "f" of protruding portion 16. Inner diameter

"e" of air inlet 14 is greater than width "f" of protruding portion 16.

[0037] When blower 100 including protruding portion 16 having height "a" equal to or greater than a half of width "f" of protruding portion 16 is compared with blower 101 having the same inner diameter "e" as that of blower 100, protruding portion 16 of blower 101 is flatter than protruding portion 16 of blower 100.

[0038] In blower 101, height "a" is less than a half of width "f" of protruding portion 16. Accordingly, protruding portion 16 is formed flatter than that in the case where height "a" is equal to or greater than a half of width "f" of protruding portion 16. Thus, as compared with the case where height "a" is equal to or greater than a half of width "f" of protruding portion 16, blower 101 is less in height "a" but is greater in volume of recessed portion 19. Consequently, in blower 101, air-blowing efficiency reduction, noise increase, and size increase are further suppressed as compared with the case where height "a" is equal to or greater than a half of width "f" of protruding portion 16 in blower 100.

Third Embodiment

[0039] As shown in Fig. 5, a blower 102 according to the third embodiment has basically the same configuration as that of blower 100 according to the first embodiment, except that a width "h" of first curved surface 16aa in the radial direction is greater than a width "i" of second curved surface 16ab in the radial direction. Blower 102 may have the same configuration as that of blower 101 as long as width "h" of first curved surface 16aa in the radial direction is greater than width "i" of second curved surface 16ab in the radial direction.

[0040] First curved surface 16aa is greater in radius of curvature than second curved surface 16ab. Width "h" of first curved surface 16aa is less than a width "j" of conical surface 16ac in the radial direction, for example. The total sum of: twice the sum of width "h" of first curved surface 16aa, width "i" of second curved surface 16ab, and width "j" of conical surface 16ac; and the width of boss portion 30 in the radial direction is equal to width "f" of protruding portion 16.

[0041] In blower 102, since width "h" is greater than width "i", the gas having flowed from air inlet 14 into the vicinity of the top portion of protruding portion 16 flows smoothly along first curved surface 16aa and conical surface 16ac. Thereby, separation of the airflow on first curved surface 16aa and conical surface 16ac is less likely to occur. Further, the gas having flowed along conical surface 16ac changes its direction while flowing along second curved surface 16ab, and then, flows between vanes 12 toward main plate 11 in the extending direction. Thereby, as compared with the case where width "h" is less than width "i", the amount of air on the main plate 11 side in the extending direction increases, so that the air velocity distribution between vanes 12 becomes uniform, thereby reducing the airflow resistance

between vanes 12. Consequently, in blower 102, the air-blowing efficiency is further improved and the noise is further decreased as compared with the case where width "h" is less than width "i" in blower 100.

[0042] Further, when width "h" of first curved surface 16aa is less than width "j" of conical surface 16ac in the radial direction, even the airflow separated on first curved surface 16aa also readily flows along conical surface 16ac, that is, so-called reattachment is more likely to occur. Accordingly, blower 102 having width "h" less than width "j" is further higher in air-blowing efficiency than blower 102 having width "h" not smaller than width "j".

Fourth Embodiment

[0043] As shown in Fig. 6, a blower 103 according to the fourth embodiment has basically the same configuration as that of blower 100 according to the first embodiment, except that outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13 are curved in the direction opposite to air inlet 14 in the extending direction. Blower 103 may have the same configuration as that of blower 101 or blower 102 as long as outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13 are curved in the direction opposite to air inlet 14 in the extending direction.

[0044] Main plate 11 has, for example, a protruding portion 16, a flat portion 17, and a first curved portion 18 that curves in the direction opposite to air inlet 14 with respect to flat portion 17. The inner circumferential end portion of flat portion 17 is connected to the outer circumferential end portion of protruding portion 16. The outer circumferential end portion of flat portion 17 in the radial direction is connected to the inner circumferential end portion of first curved portion 18 in the radial direction. The outer circumferential end portion of first curved portion 18 in the radial direction forms outer circumferential end portion 11b of main plate 11. In a view of the cross section along rotation shaft 21, the center of curvature of first curved portion 18 is located on the inner circumferential side with respect to outer circumferential end portion 11b in the radial direction.

[0045] Side plate 13 has, for example, a second curved portion 24 having inner circumferential end portion 13a of side plate 13, and a third curved portion 25 having outer circumferential end portion 13b of side plate 13. In a view of the cross section along rotation shaft 21, the center of curvature of second curved portion 24 is located on the outer circumferential side with respect to inner circumferential end portion 13a of side plate 13 in the radial direction. In a view of the cross section along rotation shaft 21, the center of curvature of third curved portion 25 is located on the inner circumferential side with respect to outer circumferential end portion 13b of side plate 13 in the radial direction.

[0046] The inner circumferential end portion of each of vanes 12 is disposed between flat portion 17 of main

plate 11 and second curved portion 24 of side plate 13. The outer circumferential end portion of each of vanes 12 is disposed between outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13. In other words, a part of each of vanes 12 located on the air outlet 15 side is located between first curved portion 18 and third curved portion 25. The distance between first curved portion 18 and third curved portion 25 in the extending direction is constant, for example.

[0047] In blower 103, outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13 are curved in the direction opposite to air inlet 14 in the extending direction. Thus, blower 103 can smoothly blow the gas in the direction opposite to air inlet 14 in the extending direction. Accordingly, blower 103 is suitable for a unit that requires an air passage AF extending in the extending direction on the downstream side of this blower. In the air passage extending in the extending direction and formed downstream of blower 103, the airflow deviation is reduced and the pressure loss is reduced as compared with the air passage of the blower in which outer circumferential end portion 11b of main plate 11 and outer circumferential end portion 13b of side plate 13 are not curved in the direction opposite to air inlet 14 in the extending direction. Consequently, the air-blowing efficiency is higher when the above-mentioned unit is equipped with blower 103 than when the above-mentioned unit is equipped with the blower in which outer circumferential end portion 11b and outer circumferential end portion 13b do not curve in the direction opposite to air inlet 14 in the extending direction.

Fifth Embodiment

[0048] As shown in Fig. 7, a blower 104 according to the fifth embodiment has basically the same configuration as that of blower 100 according to the first embodiment except that, in a view of the cross section along rotation shaft 21, centrifugal fan 10 has: a first region R1 in which the distance between main plate 11 and side plate 13 along a straight line perpendicular to side plate 13 gradually decreases from air inlet 14 toward air outlet 15; and a second region R2 that is disposed closer to air outlet 15 than first region R1 and in which the distance between main plate 11 and side plate 13 along a straight line perpendicular to side plate 13 gradually increases from air inlet 14 toward air outlet 15. In blower 104, height "a" of protruding portion 16 is less than a half of width "f" of protruding portion 16, as in blower 101.

[0049] First region R1 is formed in side plate 13, for example, between: a portion located closer to inner circumferential end portion 13a than the connection portion with the inner circumferential end portion of each of vanes 12; and a portion closer to outer circumferential end portion 13b than the connection portion.

[0050] First region R1 is formed in side plate 13, for example, between: a first straight line perpendicular to a

portion located closer to air inlet 14 than the connection portion with the inner circumferential end portion of each of vanes 12; and a second straight line perpendicular to a portion located closer to air outlet 15 than the connection portion. A distance k between main plate 11 and side plate 13 on the first straight line is longer than a distance "l" between main plate 11 and side plate 13 on the second straight line. In first region R1, the distance between main plate 11 and side plate 13 on a straight line perpendicular to side plate 13 is equal to or greater than distance "l" and equal to or less than distance k, and gradually decreases from air inlet 14 toward air outlet 15.

[0051] Second region R2 is disposed closer to air outlet 15 than first region R1. Second region R2 is provided to be continuous with first region R1. Second region R2 is formed in side plate 13, for example, between outer circumferential end portion 13b and a portion located closer to outer circumferential end portion 13b than the connection portion with the inner circumferential end portion of each of vanes 12.

[0052] Second region R2 is formed, for example, between the second straight line and a third straight line perpendicular to outer circumferential end portion 13b of side plate 13. Distance "l" between main plate 11 and side plate 13 on the second straight line is shorter than the distance between main plate 11 and side plate 13 on the third straight line. The distance between main plate 11 and side plate 13 on the third straight line is equal to width "b", for example. In second region R2, the distance between main plate 11 and side plate 13 on the straight line perpendicular to side plate 13 is equal to or greater than distance "l" and equal to or less than distance "b", and also, gradually increases from air inlet 14 toward air outlet 15.

[0053] A part of each of vanes 12 located on the air inlet 14 side is disposed inside a region located close to air outlet 15 in first region R1. The remaining portion of each of vanes 12 located close to air outlet 15 is disposed inside second region R2.

[0054] In blower 104, the gas having flowed from air inlet 14 into centrifugal fan 10 flows through first region R1 and second region R2 in this order and reaches air outlet 15. In other words, the gas having flowed from air inlet 14 flows through the area located on the air inlet 14 side in first region R1, and then reaches the area between vanes 12. In first region R1, the distance between main plate 11 and side plate 13 on the straight line perpendicular to side plate 13 gradually decreases from air inlet 14 toward air outlet 15, to thereby stabilize the gas flowing between vanes 12, so that separation of the airflow in the vicinity of the inner circumferential end portion of each of vanes 12 is less likely to occur. Further, in second region R2, the distance between main plate 11 and side plate 13 on the straight line perpendicular to side plate 13 gradually increases from air inlet 14 toward air outlet 15, and therefore, the gas flowing through second region R2 is raised in pressure by the diffuser effect. Thereby, the air-blowing efficiency of blower 104 is further en-

hanced as compared with blower 100.

[0055] Further, in blower 104, height "a" is less than a half of width "b" as in blower 100. Thereby, the air velocity distribution between main plate 11 and side plate 13 in air outlet 15 becomes uniform. Thus, separation of the airflow on side plate 13 is less likely to occur also in second region R2 in which the diffuser effect is achieved. Therefore, the air-blowing efficiency of blower 104 is enhanced as compared with that of the blower including a centrifugal fan having only a diffuser shape.

Sixth Embodiment

[0056] As shown in Fig. 8, a blower 105 according to the sixth embodiment has basically the same configuration as that of blower 100 according to the first embodiment, except that width "b" is equal to or greater than a half of a width "n" in the extending direction of heat exchanger 40 disposed so as to face air outlet 15 in the radial direction. Blower 105 may have the same configuration as that of any one of blowers 101 to 104 as long as width "b" is equal to or greater than a half of width "n".

[0057] Blower 105 is provided in an indoor unit 200. Indoor unit 200 includes blower 105, a heat exchanger 40, and a housing 50. Indoor unit 200 is a ceiling-embedded type indoor unit, for example. The extending direction of blower 105 extends in the up-down direction, and the radial direction of blower 105 extends in the horizontal direction. Air inlet 14 opens downward.

[0058] Heat exchanger 40 is disposed so as to face air outlet 15 in the radial direction of blower 105.

[0059] Housing 50 accommodates blower 105 and heat exchanger 40. Blower 105 has a support portion 23 fixed to housing 50 by a fixing member 31. Below air inlet 14 of blower 105, housing 50 has an opening through which indoor air is taken into air inlet 14. A grill 51 is attached to the opening. On the outside of grill 51 in the radial direction, a plurality of air outlets 52 are provided, through which air having been blown out from air outlet 15 of blower 105 and heat-exchanged with refrigerant in heat exchanger 40 is blown into an indoor area. Heat exchanger 40 is disposed between each air outlet 52 and air outlet 15 of blower 105 inside housing 50. The upper end portion of heat exchanger 40 is connected to housing 50. The lower end portion of heat exchanger 40 is connected to a drain pan 53.

[0060] Width "b" of blower 105 is equal to or greater than a half of width "n" in the extending direction of heat exchanger 40 that is disposed to face air outlet 15 in the radial direction. Width "b" is equal to or less than width "n". Outer circumferential end portion 11b of main plate 11 of blower 105 is disposed, for example, above the central portion of heat exchanger 40 in the extending direction. Outer circumferential end portion 13b of side plate 13 of blower 105 is disposed, for example, below the central portion of heat exchanger 40 in the extending direction.

[0061] In the extending direction, outer circumferential

end portion 13b of side plate 13 is disposed more centrally in heat exchanger 40 than drain pan 53.

[0062] In blower 105, height "a" is less than a half of width "b" as in blower 100, and thereby, the air velocity distribution between main plate 11 and side plate 13 in air outlet 15 becomes uniform. Therefore, even when width "b" is as relatively wide as a half or more of width "n" of heat exchanger 40, separation of the airflow on side plate 13 is less likely to occur.

[0063] In blower 105, the difference between width "b" and width "n" is relatively small as compared with the case where width "b" of air outlet 15 is less than a half of width "n" of the heat exchanger. Thus, the air velocity distribution in heat exchanger 40 becomes uniform and the gas pressure loss is reduced.

[0064] Further, in blower 105, outer circumferential end portion 13b of side plate 13 is disposed more centrally in heat exchanger 40 than drain pan 53 in the extending direction. Accordingly, in indoor unit 200 including blower 105, the gas blown out from air outlet 15 is less likely to collide with drain pan 53, thereby suppressing an increase in airflow resistance inside indoor unit 200.

[0065] In indoor unit 200 including blower 105, air-blowing efficiency reduction, noise increase, and size increase are simultaneously suppressed as compared with the indoor unit including a conventional blower.

[0066] As shown in Fig. 9, blowers 100 to 105 according to the first to sixth embodiments may be applied to an air conditioner 300. Air conditioner 300 includes an indoor unit 200 and an outdoor unit 210, for example. Indoor unit 200 includes heat exchanger 40 and blowers 100 to 105. Outdoor unit 210 includes a compressor 211, an outdoor heat exchanger 212, an expansion valve 213, a four-way valve 214, and an outdoor blower 215. Indoor unit 200 and outdoor unit 210 are connected to each other through a plurality of refrigerant pipes. Indoor unit 200, outdoor unit 210, and the plurality of refrigerant pipes constitute a refrigerant circuit including compressor 211, outdoor heat exchanger 212, expansion valve 213, four-way valve 214, and heat exchanger 40. From a different point of view, air conditioner 300 includes at least one of blowers 100 to 105, an air passage provided downstream of air outlet 15 of at least one of blowers 100 to 105, and heat exchanger 40 disposed in the air passage. In air conditioner 300, blowers 100 to 105 each are used, for example, as a blower for blowing air to an indoor heat exchanger in an indoor unit. Indoor unit 200 including blowers 100, 101, and 103 to 105 has the same configuration as that of indoor unit 200 shown in Fig. 8, for example. In indoor unit 200 including blower 102, for example, the air passage provided downstream of air outlet 15 extends in the direction opposite to air inlet 14 in the extending direction with respect to air outlet 15, and also, heat exchanger 40 is disposed in the air passage.

[0067] The embodiments of the present invention having been described above may also be variously modified. Also, the scope of the present invention is not limited

to the above-described embodiments. The scope of the present invention is defined by the terms of the claims, and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

REFERENCE SIGNS LIST

[0068] 10 centrifuge fan, 11 main plate, 11b, 13b outer circumferential end portion, 12 vane, 13 side plate, 13a inner circumferential end portion, 14 air inlet, 15, 52 air outlet, 16 protruding portion, 16a protruding surface, 16aa first curved surface, 16ab second curved surface, 16b recessed surface, 17 flat portion, 18 first curved portion, 19 recessed portion, 20 motor, 21 rotation shaft, 22 drive unit, 22a first portion, 22b second portion, 23 support portion, 24 second curved portion, 25 third curved portion, 30 boss portion, 31 fixing member, 40 heat exchanger, 50 housing, 51 grill, 53 drain pan, 100, 101, 102, 103, 104, 105 blower, 200 indoor unit, 300 air conditioner.

Claims

1. A blower comprising:

a motor having a rotation shaft and a drive unit configured to rotate the rotation shaft; and a centrifugal fan having

a main plate fixed to the rotation shaft, a side plate having an annular shape and spaced apart from the main plate in an extending direction in which the rotation shaft extends, and a plurality of vanes disposed between the main plate and the side plate, the centrifugal fan being configured to be rotated by the motor, wherein

the centrifugal fan has an air outlet located between an outer circumferential end portion of the main plate in a radial direction with respect to the rotation shaft and an outer circumferential end portion of the side plate in the radial direction,

the main plate has a protruding portion located centrally in the radial direction and protruding toward the side plate in the extending direction, the protruding portion has a protruding surface formed in a protruding shape, and a recessed surface located opposite to the protruding surface,

at least a part of the drive unit is disposed inside a recessed portion surrounded by the recessed surface,

a height "a" of the protruding portion in the extending direction is less than a half of a width

"b" of the air outlet in the extending direction, and a width "c" of the at least a part of the drive unit in the extending direction that is disposed inside the recessed portion is greater than a half of a width "d" of the drive unit in the extending direction.

2. The blower according to claim 1, wherein

the centrifugal fan is provided with an air inlet surrounded by an inner circumferential end portion of the side plate in a radial direction with respect to the rotation shaft, an inner diameter "e" of the air inlet is greater than a width "f" of the protruding portion in the radial direction, the height "a" is less than a half of the width "f", and the vanes each have an inner circumferential end portion located outside the protruding portion in the radial direction.

3. The blower according to claim 1 or 2, wherein

the centrifugal fan is provided with an air inlet surrounded by an inner circumferential end portion of the side plate in a radial direction with respect to the rotation shaft, in a cross section along the rotation shaft, the protruding surface of the protruding portion has a conical surface centered on the rotation shaft, a first curved surface located closer to the air inlet than the conical surface, and a second curved surface located closer to the air outlet than the conical surface, in a view of the main plate seen from the side plate, the first curved surface is formed in a protruding shape, and the second curved surface is formed in a recessed shape, and a width "h" of the first curved surface in the radial direction is greater than a width "i" of the second curved surface in the radial direction.

4. The blower according to any one of claims 1 to 3, wherein the outer circumferential end portion of the main plate and the outer circumferential end portion of the side plate are curved in a direction opposite to the air outlet in the extending direction.

5. The blower according to any one of claims 1 to 3, wherein

the centrifugal fan is provided with an air inlet surrounded by an inner circumferential end portion of the side plate in a radial direction with respect to the rotation shaft, and in a cross section along the rotation shaft, the centrifugal fan has:

a first region in which a distance between the main plate and the side plate on a straight line perpendicular to the side plate gradually decreases from the air inlet toward the air outlet; and 5

a second region that is disposed closer to the air outlet than the first region, and in which a distance between the main plate and the side plate on a straight line perpendicular to the side plate gradually increases 10

from the air inlet toward the air outlet.

6. An indoor unit comprising:

the blower according to any one of claims 1 to 5; and 15

a heat exchanger disposed to face the air outlet in the radial direction, wherein the width "b" is equal to or greater than a half of a width "n" of the heat exchanger in the extending 20

direction.

7. The indoor unit according to claim 6, further comprising:

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a drain pan connected to one end of the heat exchanger in the extending direction, wherein in the extending direction, the outer circumferential end portion of the side plate is located more centrally in the heat exchanger than the 30

drain pan.

8. An air conditioner comprising:

the blower according to any one of claims 1 to 5; and 35

a heat exchanger disposed in an air passage downstream of the air outlet of the blower.

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FIG.1

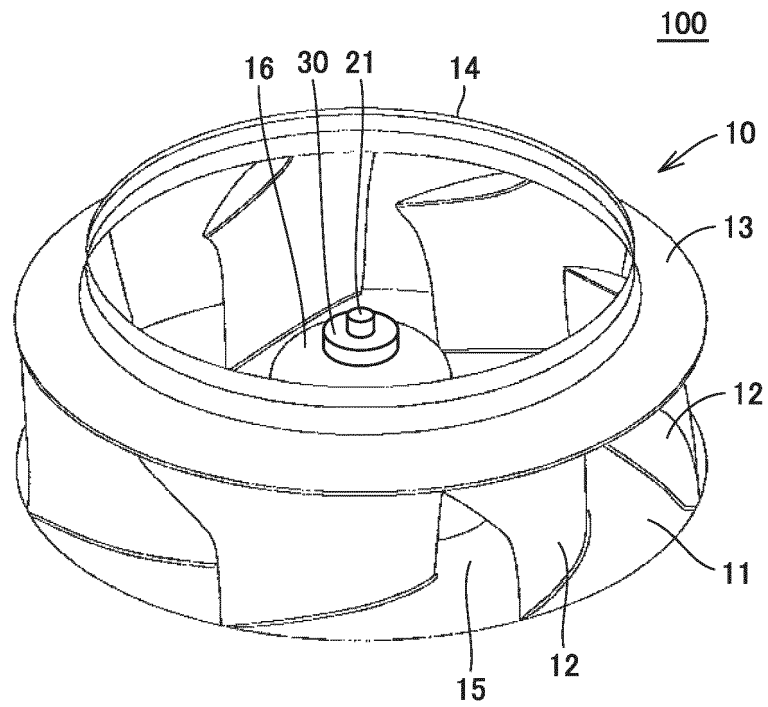


FIG.2

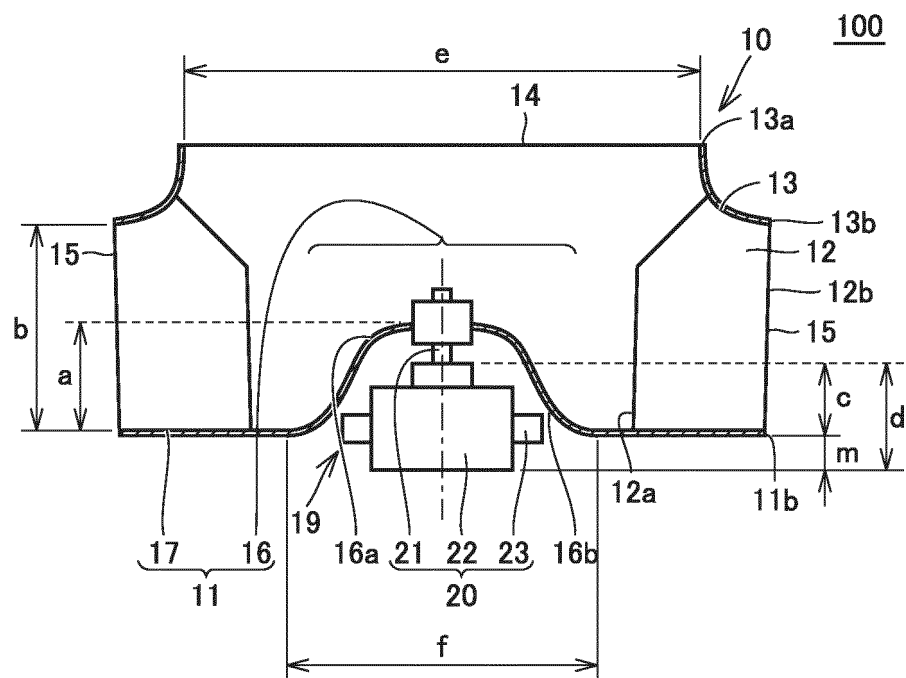


FIG.3

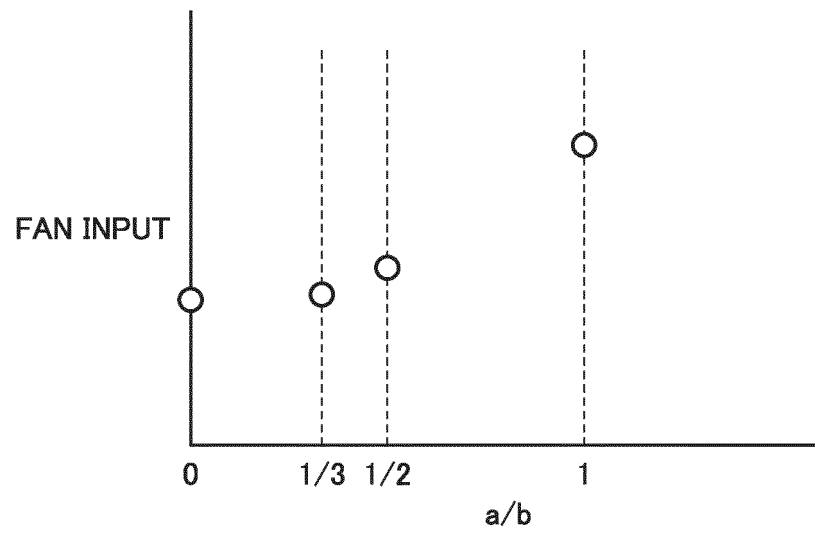


FIG.4

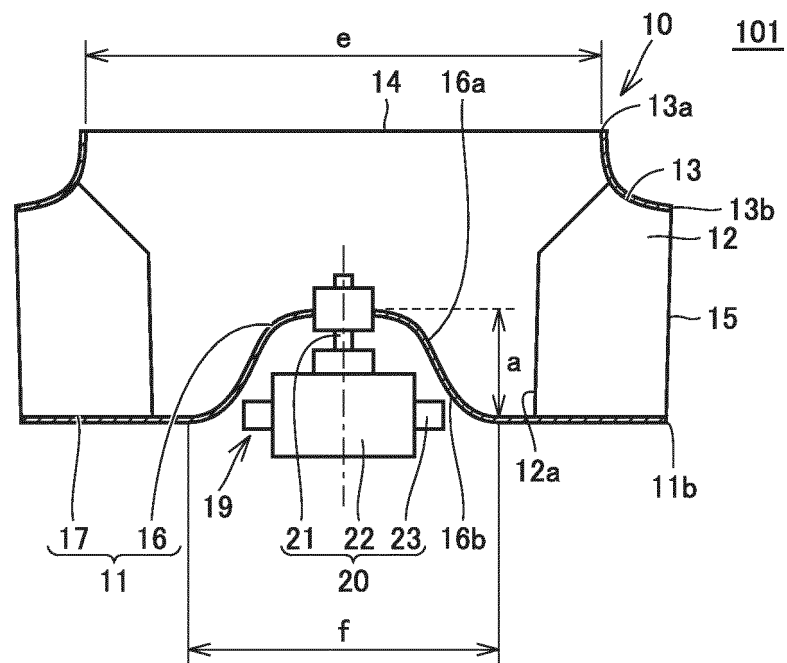


FIG.5

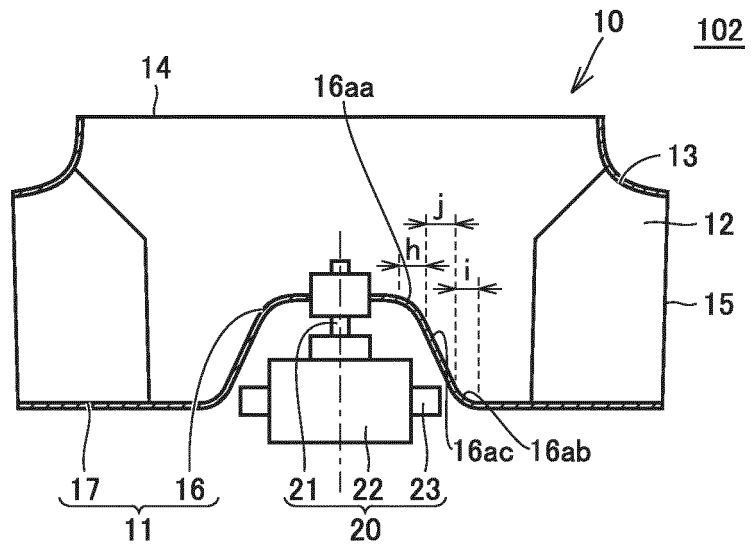


FIG.6

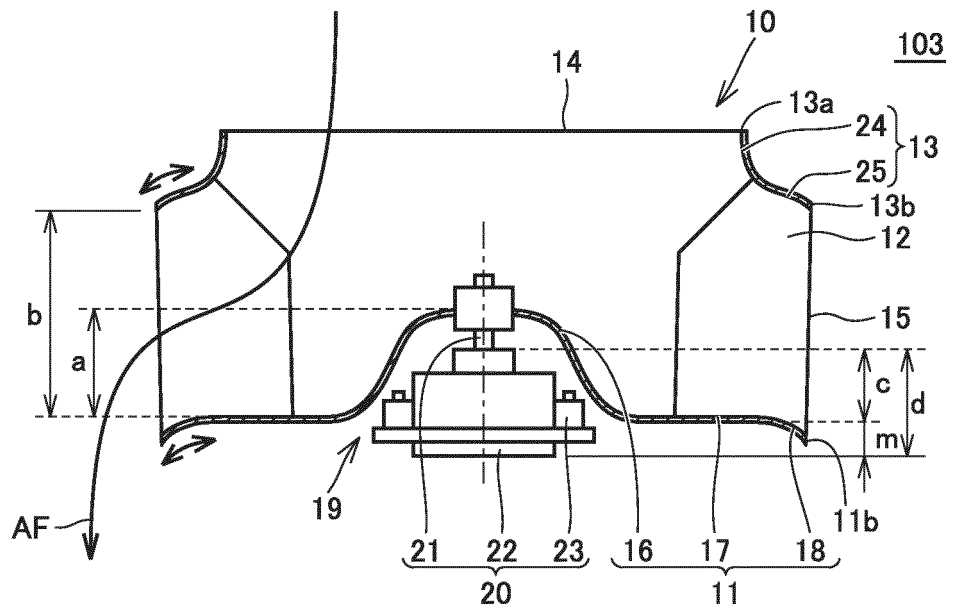


FIG.7

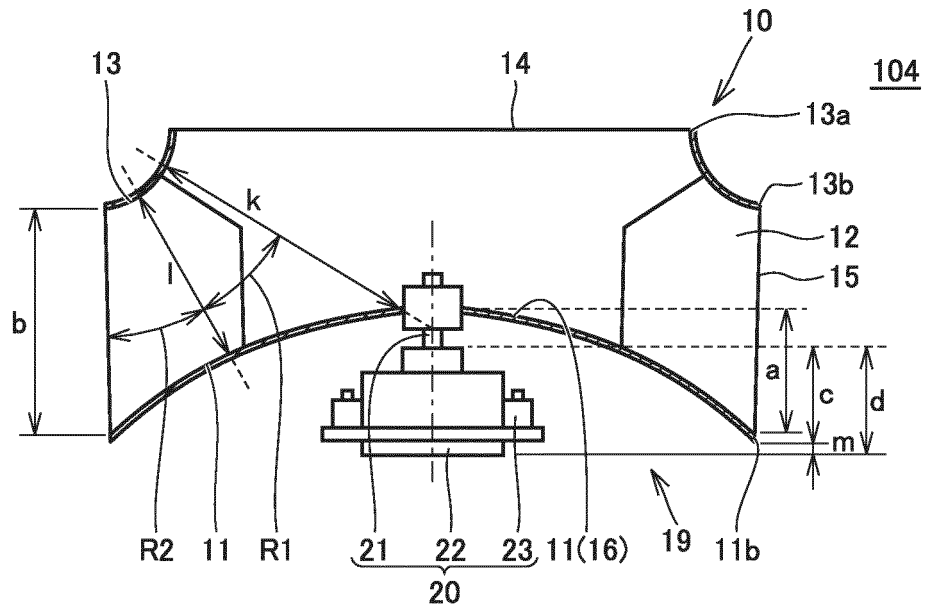


FIG.8

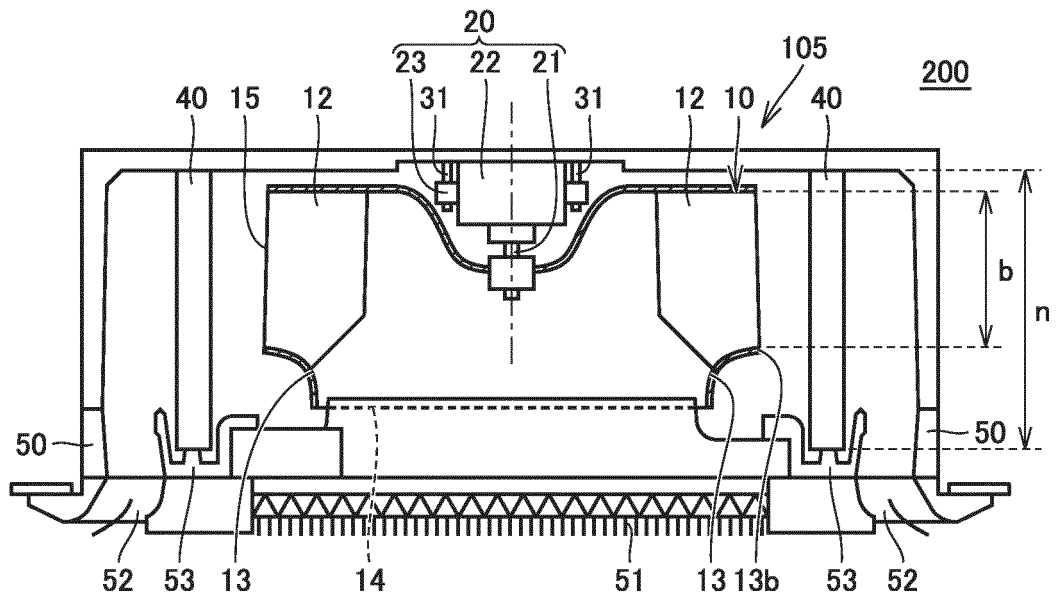
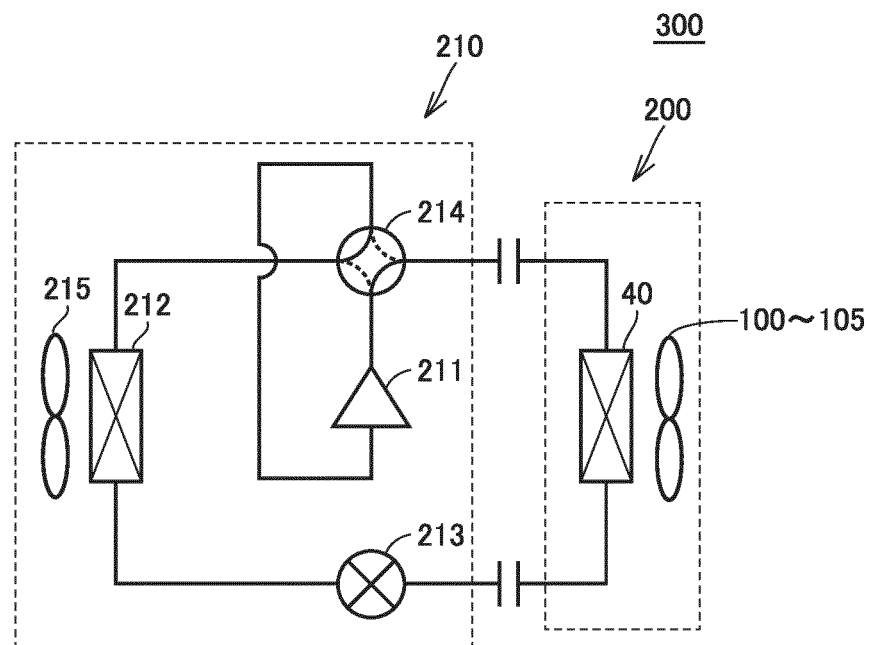


FIG.9



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/001661

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F04D29/28 (2006.01) i

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

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F04D29/28

15

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 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

20

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2005-133710 A (DAIKIN INDUSTRIES, LTD.) 26 May 2005, paragraphs [0041]-[0055], fig. 1, 5 (Family: none)	1-2, 6, 8 3-5, 7
Y	JP 2000-314391 A (MITSUBISHI ELECTRIC CORP.) 14 November 2000, paragraph [0033], fig. 1 & US 2002/0023728 A1, paragraph [0116], fig. 1 & CN 1280254 A & KR 10-2000-0062679 A	3
Y	JP 2016-522357 A (CRYOSTAR SAS) 28 July 2016, paragraphs [0019]-[0032], fig. 2 & US 2016/0146215 A1, paragraphs [0022]-[0040], fig. 2 & WO 2014/202903 A1 & FR 3007086 A1 & KR 10-2016-0021229 A & CN 105518307 A	4
Y	JP 9-228992 A (HITACHI, LTD.) 02 September 1997, paragraphs [0007]-[0012], fig. 1, 3, 5 (Family: none)	5, 7

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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

03 April 2019 (03.04.2019)

Date of mailing of the international search report

16 April 2019 (16.04.2019)

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Name and mailing address of the ISA/

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Patent documents cited in the description

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