Description

Title of the Invention: HUMIDIFIER, AIR CONDITIONING APPARATUS, AND FLOW PATH MEMBER

Technical Field

[0001] The present disclosure relates to a humidifier, an air conditioning apparatus, and a flow path member.

Background Art

[0002] In semiconductor manufacturing facilities, fluctuations in temperature and/or humidity affect yield. For example, a film forming state of a resist used during semiconductor manufacturing changes depending on temperature or humidity. When such a change in the film forming state occurs, variations occur in the quality of products, which may cause the yield to fluctuate. Therefore, high-precision temperature control and humidity control are usually performed in semiconductor manufacturing facilities.

[0003] In view of the background described above, the present applicant has previously proposed techniques related to improvement in humidity control precision in Patent Documents 1 and 2.

Citation List

Patent Documents

[0004]

Patent Document 1: JP6159865B1

Patent Document 2: JP6140878B1

Summary of Invention

[0005] An air conditioning apparatus is generally used to control the temperature and humidity of a clean room in a semiconductor manufacturing facility, the inside of a manufacturing apparatus, or the like. Such an air conditioning apparatus usually supplies air to a clean room, a manufacturing apparatus, or the like after performing control such as cooling, heating, and humidification on the air. Here, the humidification is performed by, for example, supplying steam to the air directed toward the clean room or the like.

[0006] The present inventor has found that, when performing humidification of air as described above, if stagnation or turbulent flow occurs in the flow of the air, even when the air is supplied at a predetermined flow velocity, the humidification state changes, which may cause variations in the control precision of the humidity.

[0007] The present disclosure has been made in view of the above background, and an object thereof is to

provide a humidifier, an air conditioning apparatus, and a flow path member capable of precisely controlling the humidity of air.

[0008] The present disclosure relates to the following aspects.

[0009] <1>

A humidifier comprising:

a humidifier main body configured to supply steam or atomized moisture; and

a flow path member having an intake port configured to receive the steam or the atomized moisture from the humidifier main body, an inlet configured to receive air, and an outlet configured to allow the air received at the inlet to flow out, wherein

a wall portion of the flow path member extending from the inlet to the outlet forms a flow path of the air flowing from the inlet to the outlet,

the intake port is positioned to supply the steam or the atomized moisture to the air at a position upstream of the outlet in the flow path, and

the wall portion is at least partially formed with a tapered portion having a flow path cross-sectional area that gradually decreases toward the outlet.

[0010] <2>

The humidifier according to <1>, wherein the

tapered portion is formed at least in a range between the outlet and a part of the intake port closest to the inlet.

[0011] <3>

The humidifier according to <1> or <2>, wherein

the humidifier main body has a discharge portion configured to discharge the steam or the atomized moisture,

the intake port faces the discharge portion,

the inlet opens on one side in a direction intersecting a direction in which the intake port and the discharge portion face each other,

the outlet opens on the other side in the intersecting direction, and

the tapered portion is formed at least in a range corresponding to a length where the intake port is located in the intersecting direction.

[0012] <4>

The humidifier according to any one of <1> to <3>, wherein

the wall portion includes a pair of side wall portions spaced apart from each other in a horizontal direction,

the intake port is located between lower ends of the pair of side wall portions, and

the pair of side wall portions are formed to at

least partially approach each other toward the outlet, the pair of side wall portions forming the tapered portion.

[0013] <5>

The humidifier according to <4>, wherein

the wall portion further includes a top wall portion closing a space between upper ends of the pair of side wall portions, and

the outlet opens in the horizontal direction.

[0014] <6>

The humidifier according to <4> or <5>, wherein

the inlet and the outlet open in the horizontal direction, and

a partition plate is further provided to cover a range from a lower end of the outlet to a position equal to or lower than a center of the outlet in a vertical direction.

[0015] <7>

The humidifier according to any one of <1> to <6>, wherein an upstream end of the tapered portion forms the inlet.

[0016] <8>

An air conditioning apparatus comprising:

the humidifier according to any one of <1> to <7>; and

a temperature control module, wherein

the temperature control module includes:

an air guide duct portion connected to the inlet of the flow path member and configured to allow the air to flow into an inside of the flow path member from the inlet; and

a temperature control portion disposed inside the air guide duct portion and configured to control a temperature of the air.

[0017] <9>

The air conditioning apparatus according to <8>, wherein the air guide duct portion and the flow path member are connected so as to form an L-shape or a crank shape.

[0018] <10>

A flow path member comprising:

an intake port configured to receive steam or atomized moisture;

an inlet configured to receive air; and

an outlet configured to allow the air received at the inlet to flow out, wherein

a wall portion of the flow path member extending from the inlet to the outlet forms a flow path of the air flowing from the inlet to the outlet,

the intake port is positioned to supply the steam or the atomized moisture to the air at a position upstream of the outlet in the flow path, and

the wall portion is at least partially formed with

a tapered portion having a flow path cross-sectional area that gradually decreases from the inlet to the outlet.

[0019] According to the present disclosure, the humidity of air can be precisely controlled.

Brief Description of Drawings

[0020]

[Fig. 1] Fig. 1 is a side view of an air conditioning apparatus according to an embodiment.

[Fig. 2] Fig. 2 is a perspective view of a cross section of the air conditioning apparatus shown in Fig. 1, as viewed obliquely from above.

[Fig. 3] Fig. 3 is a perspective view of a longitudinal section of the air conditioning apparatus shown in Fig. 1, as viewed obliquely from above.

[Fig. 4] Fig. 4 is a longitudinal sectional view of the air conditioning apparatus shown in Fig. 1.

[Fig. 5] Fig. 5 is a cross-sectional view of the air conditioning apparatus shown in Fig. 1.

[Fig. 6] Fig. 6 is a view showing graphs regarding the humidity of air whose humidity is controlled by the air conditioning apparatus shown in Fig. 1.

[Fig. 7] Fig. 7 is a longitudinal sectional view of an air conditioning apparatus according to a first modified example.

[Fig. 8] Fig. 8 is a longitudinal sectional view of an air conditioning apparatus according to a second modified example.

[Fig. 9] Fig. 9 is a longitudinal sectional view of an air conditioning apparatus according to a third modified example.

[Fig. 10] Fig. 10 is a view showing a fourth modified example, in which (A) is a longitudinal sectional view of an air conditioning apparatus according to the fourth modified example, and (B) is a cross-sectional view of the air conditioning apparatus according to the fourth modified example.

[Fig. 11] Fig. 11 is a view showing a fifth modified example, in which (A) is a longitudinal sectional view of an air conditioning apparatus according to the fifth modified example, and (B) is a longitudinal sectional view showing a modified example of the configuration of Fig. 11(A).

[Fig. 12] Fig. 12 is a longitudinal sectional view of an air conditioning apparatus according to a sixth modified example.

Description of Embodiments

[0021] Hereinafter, an embodiment will be described.

[0022] Fig. 1 is a side view of an air conditioning apparatus 1 according to an embodiment. The air

conditioning apparatus 1 includes a temperature control module 10, a humidifier 20, a blower 30, an air distribution box 40, and a frame 50.

[0023] The temperature control module 10, the humidifier 20, the blower 30, and the air distribution box 40 are supported by the frame 50. The frame 50 is installed on, for example, a floor surface along a horizontal plane in a state of supporting the temperature control module 10, the humidifier 20, the blower 30, and the air distribution box 40.

[0024] In the air conditioning apparatus 1, by driving the blower 30, air is first taken into the temperature control module 10. The air taken into the temperature control module 10 is sent from the temperature control module 10 to the humidifier 20, passes through the humidifier 20, and is then taken into the blower 30. Then, the air taken into the blower 30 is sent to the air distribution box 40, and is supplied from the air distribution box 40 to an object of temperature control.

[0025] In Fig. 1, an arrow indicated by reference sign UD indicates a vertical direction. An arrow indicated by reference sign H1 indicates a first horizontal direction in a horizontal plane. Reference sign H2 indicates a second horizontal direction in the horizontal plane orthogonal to both the vertical

direction UD and the first horizontal direction H1. In drawings other than Fig. 1 used in the following description, arrows or positions indicating the vertical direction UD, the first horizontal direction H1, and the second horizontal direction H2 are also shown at appropriate places.

[0026] (Temperature Control Module)

The temperature control module 10 includes an air guide duct portion 11, a cooling portion 12, and a heating portion 13. Fig. 2 is a perspective view of a cross section of the air conditioning apparatus 1 as viewed obliquely from above. Fig. 3 is a perspective view of a longitudinal section of the air conditioning apparatus 1 as viewed obliquely from above. As shown in Figs. 2 and 3, an introducing port 11A and a sending-out port 11B are formed in the air guide duct portion 11.

[0027] In the temperature control module 10, air is introduced into the inside of the air guide duct portion 11 from the introducing port 11A. In the present embodiment, the air introduced into the air guide duct portion 11 passes through the cooling portion 12 and the heating portion 13 in this order. The air can be cooled and dehumidified by the cooling portion 12, and can be heated by the heating portion 13. Then, the air that has passed through the heating portion 13 is sent to the humidifier 20 from the

sending-out port 11B.

[0028] The introducing port 11A is provided at a lower portion of the air guide duct portion 11, and the sending-out port 11B is provided at an upper portion of the air guide duct portion 11. Therefore, the air introduced into the air guide duct portion 11 flows upward toward the sending-out port 11B. Specifically, the introducing port 11A and the sending-out port 11B open in opposite directions to each other in the first horizontal direction H1. Thereby, the air introduced into the air guide duct portion 11 flows upward toward the sending-out port 11B along a crank-shaped or S-shaped path. However, the forming positions of the introducing port 11A and the sending-out port 11B are not particularly limited, and for example, the positions of the introducing port 11A and the sending-out port 11B in the vertical direction UD do not have to be shifted from each other.

[0029] In the present embodiment, the introducing port 11A is covered with a filter 14 (see Fig. 1). Thereby, air from which particles have been removed through the filter 14 is introduced into the inside of the air guide duct portion 11 from the introducing port 11A.

[0030] The cooling portion 12 may be an evaporator in a cooling circuit in which a compressor, a

condenser, an expansion valve, and an evaporator are connected by piping in this order so as to circulate a heat medium. Further, the cooling portion 12 may be a heat exchange portion through which cooling water such as brine cooled by an evaporator in a cooling circuit passes. Further, the heating portion 4 may be an electric heater or the like, or may be configured to utilize a part of the heat medium that has reached a high temperature in the above-mentioned cooling circuit.

[0031] (Humidifier)

The humidifier 20 includes a humidifier main body 21 and a flow path member 22. The flow path member 22 forms a flow path for flowing the air sent from the temperature control module 10. The humidifier main body 21 supplies steam to the air flowing through the flow path member 22.

[0032] As shown in Figs. 2 and 3, the humidifier main body 21 has a vessel 21A for storing water, and a heater portion 21B provided in the vessel 21A. The humidifier main body 21 generates steam by heating the water in the vessel 21A with the heater portion 21B. The humidifier main body 21 has a discharge portion 21A1 formed by a portion opening upward in the vessel 21A, and discharges steam upward from the discharge portion 21A1.

[0033] In the present embodiment, the humidifier main body 21 is of a type that generates steam by heating water, but the type of the humidifier main body 21 is not particularly limited. For example, the humidifier main body 21 may be of a type that discharges atomized moisture by ultrasonic vibration.

[0034] The flow path member 22 has an intake port 22a for receiving steam from the humidifier main body 21, an inlet 22b for receiving air, and an outlet 22c for allowing the air received at the inlet 22b to flow out. The flow path member 22 is arranged such that the intake port 22a faces the discharge portion 21A1 of the humidifier main body 21. Specifically, in the present embodiment, the intake port 22a and the discharge portion 21A1 face each other in the vertical direction, and the flow path member 22 receives steam from the humidifier main body 21 from below via the intake port 22a.

[0035] The flow path member 22 has a wall portion 23 extending from the inlet 22b to the outlet 22c. The wall portion 23 forms a flow path of the air flowing from the inlet 22b to the outlet 22c. The intake port 22a is positioned such that the steam from the humidifier main body 21 is supplied to the air in the flow path at a position upstream of the outlet 22c in the flow path formed by the wall portion 23.

[0036] The wall portion 23 in the present embodiment includes a pair of side wall portions 24, 24, a top wall portion 25, and an end wall portion 26. The pair of side wall portions 24, 24 are arranged above the humidifier main body 21. The pair of side wall portions 24, 24 rise upward from the humidifier main body 21 side, and are arranged spaced apart from each other in the second horizontal direction H2. In the present embodiment, the pair of side wall portions 24, 24 extend parallel to the vertical direction UD.

[0037] The top wall portion 25 closes a space between upper ends of the pair of side wall portions 24, 24. The pair of side wall portions 24, 24 direct one end thereof toward the temperature control module 10 side in the first horizontal direction H1, which is orthogonal to the second horizontal direction H2 in which the side wall portions 24, 24 are spaced apart from each other in a horizontal plane. The end wall portion 26 is provided between the other ends of the pair of side wall portions 24, 24 in the first horizontal direction H1.

[0038] In the present embodiment, lower ends of the pair of side wall portions 24, 24 are in contact with an upper portion of the vessel 21A of the humidifier main body 21. Then, the intake port 22a is located between the lower ends of the pair of side wall

portions 24, 24. Specifically, in the present embodiment, the lower ends of the pair of side wall portions 24, 24 form the intake port 22a by being spaced apart from each other.

[0039] The inlet 22b is formed between one ends of the pair of side wall portions 24, 24 directed toward the temperature control module 10 side in the first horizontal direction H1. Specifically, the one ends of the pair of side wall portions 24, 24 in the first horizontal direction H1 form the inlet 22b by being spaced apart from each other. The outlet 22c is formed in the end wall portion 26. The outlet 22c is formed in a circular shape (perfect circle) as an example in the present embodiment. The inlet 22b opens towards one side in a direction (the first horizontal direction H1 in this example) intersecting a direction in which the intake port 22a and the discharge portion 21A1 face each other (the vertical direction UD in this example). The outlet 22c opens towards the other side in the direction intersecting the direction in which the intake port 22a and the discharge portion 21A1 face each other. In the present embodiment, the inlet 22b, the intake port 22a, and the outlet 22c are arranged in this order from the upstream side toward the downstream side in the air flowing direction. However, the inlet 22b and the intake port 22a may be formed at the same

position in the air flowing direction.

[0040] As shown in Fig. 2, in the present embodiment, a flange portion 27 projecting outward (the side opposite to the flow path side) is provided at each of the one ends of the pair of side wall portions 24, 24 directed toward the temperature control module 10 side. The flange portion 27 is in contact with and fixed to the wall surface of the peripheral portion of the sending-out port 11B in the temperature control module 10 (the air guide duct portion 11). Thereby, the temperature control module 10 and the flow path member 22 are connected in the present embodiment.

[0041] In the present embodiment, the air guide duct portion 11 of the temperature control module 10 and the flow path member 22 are connected so as to form an L-shape. Thereby, the air flowing from the temperature control module 10 to the flow path member 22 mainly flows upward in the temperature control module 10, and then flows in a lateral direction (a horizontal direction in this example) through the flow path member 22.

[0042] In the present embodiment, the wall portion 23 of the flow path member 22 as described above is at least partially formed with a tapered portion 23t having a flow path cross-sectional area that gradually decreases toward the outlet 22c. As shown in Figs. 1 to

3, in the present embodiment, the pair of side wall portions 24, 24 and the top wall portion 25 form the tapered portion 23t. Hereinafter, the tapered portion 23t will be described in detail.

[0043] Fig. 4 is a longitudinal sectional view of the air conditioning apparatus 1. Fig. 5 is a cross-sectional view of the air conditioning apparatus 1. Referring also to these Figs. 4 and 5, in the present embodiment, the pair of side wall portions 24, 24 are formed to at least partially approach each other toward the outlet 22c. Thereby, the tapered portion 23t is formed. Specifically, the pair of side wall portions 24, 24 in the present embodiment are formed to approach each other toward the outlet 22c throughout their entire extent in the first horizontal direction. Note that the pair of side wall portions 24, 24 may be configured to partially have a portion where the flow path cross-sectional area is constant toward the outlet 22c. Further, in the present embodiment, the upstream end of the tapered portion 23t forms the inlet 22b.

[0044] The tapered portion 23t guides the air such that the air flowing in from the temperature control module 10 is directed toward the center or the inside of the outlet 22c. Further, the tapered portion 23t has a function of increasing the flow velocity of the air by gradually decreasing the flow path cross-sectional

area. In the present embodiment, when viewed from above, both of the pair of side wall portions 24, 24 are inclined with respect to a straight line connecting the center of the inlet 22b and the center of the outlet 22c. However, one of the pair of side wall portions 24, 24 may extend parallel to the straight line connecting the center of the inlet 22b and the center of the outlet 22c, and the other of the pair of side wall portions 24, 24 may extend while being inclined with respect to the straight line connecting the center of the inlet 22b and the center of the outlet 22c.

[0045] In Figs. 4 and 5, reference sign P indicates a part closest to the inlet 22b in the intake port 22a. In the present embodiment, the part P closest to the inlet 22b in the intake port 22a corresponds to the lower end of the inlet 22b. The tapered portion 23t is formed at least in a range between the outlet 22c and the part P closest to the inlet 22b in the intake port 22a, in other words, formed so as to be located at least between the part P and the outlet 22c. Specifically, the tapered portion 23t in the present embodiment is formed at least in a range corresponding to a length where the intake port 22a is located in the first horizontal direction H1, in other words, formed so as to be located at least between both ends of the

intake port 22a in the first horizontal direction H1. More specifically, the tapered portion 23t extends so as to continuously decrease the flow path cross-sectional area from the upstream end forming the inlet 22b to the downstream end connected to the peripheral portion of the outlet 22c (the end wall portion 26 in this example), and traverses the entire intake port 22a.

[0046] As shown in Fig. 5, the pair of side wall portions 24 are arranged inside both ends of the upward opening portion in the vessel 21A in the second horizontal direction H2. Therefore, ranges between both ends in the second horizontal direction H2 of the portion opening upward in the vessel 21A and the pair of side wall portions 24 are not covered by the flow path member 22. In the present embodiment, a lid member 70 is provided in such ranges not covered by the flow path member 22 in the upward opening portion of the vessel 21A. Thereby, unnecessary diffusion of steam from the humidifier main body 21 can be suppressed.

[0047] In the present embodiment, the pair of side wall portions 24, 24 are rectangular plate-like bodies. Thereby, the tapered portion 23t can be easily formed without taking much time and effort. Further, the pair of side wall portions 24, 24, which are plate-like bodies, are formed to approach each other toward the

outlet 22c, whereby the tapered portion 23t is formed. In this case, since the flow path cross-sectional area of the flow path formed between the pair of side wall portions 24 gradually decreases with a smooth rate of change, the flow of air becomes smooth.

[0048] Further, as shown in Figs. 3 and 4, the humidifier 20 in the present embodiment has a partition plate 28 covering a part of the outlet 22c. In Fig. 4, reference sign L indicates the position of the upper end of the partition plate 28. Reference sign C2 indicates the center axis line of the outlet 22c. As is clear from Fig. 4, the partition plate 28 covers a range from the lower end of the outlet 22c to a position equal to or lower than the center of the outlet 22c in the vertical direction. Specifically, the partition plate 28 extends upward from the lower end of the outlet 22c and covers a range from the lower end to a position below the center of the outlet 22c in the vertical direction.

[0049] The partition plate 28 prevents water condensed from steam from mixing with air and flowing out from the outlet 22c. Stagnation and turbulent flow tend to occur in the flow of air at positions around the vessel 21A in the humidifier 20. Then, steam coming into contact with such stagnation or turbulent flow tends to condense (liquefy). The partition plate 28

prevents moisture (water) that may be generated around the vessel 21A in this manner from flowing downstream. Thereby, humidification control can be stabilized. The partition plate 28 may be a metal plate or a porous material plate.

[0050] Further, in the present embodiment, since the inlet 22b of the flow path member 22 overlaps with the peripheral portion of the sending-out port 11B of the temperature control module 10, the opening range of the inlet 22b through which air can flow is smaller than the actual size of the inlet 22b. Here, reference sign C1 in Fig. 4 indicates the center axis line of the opening range of the inlet 22b. As is clear from Fig. 4, the center position of the opening range of the inlet 22b in the vertical direction is located above the center position of the outlet 22c in the vertical direction. In this case, since the amount of air flowing toward the humidifier main body 21 side can be suppressed, the occurrence of stagnation or turbulent flow on the side close to the vessel 21A can be suppressed.

[0051] (Blower / Air Distribution Box)

As shown in Fig. 1, the blower 30 includes a casing 31 and an impeller 32 rotatably accommodated in the casing 31. The blower 30 is a centrifugal blower as an example, and sends out air drawn in the axial direction

of the impeller 32 in the radial direction outward. The blower 30 is connected to the outlet 22c of the humidifier 20 via a connection pipe 60. The blower 30 has a blowout port opening upward and sends air upward. Note that the blower 30 is not limited to a centrifugal type, and may be an axial flow type.

[0052] The air distribution box 40 is arranged above the blower 30. The air distribution box 40 has one or a plurality of supply ports (not shown). The air distribution box 40 receives air sent out from the blower 30, and supplies air to an external object of temperature control from the one or a plurality of supply ports. The object of temperature control is, for example, a clean room or a semiconductor manufacturing apparatus, but is not particularly limited.

[0053] (Operation of the air conditioning apparatus)

Next, the operation of the air conditioning apparatus 1 according to the present embodiment will be described with reference to Figs. 2 to 5 and the like.

[0054] In the air conditioning apparatus 1, by driving the blower 30, air is taken into the inside of the temperature control module 10 (the air guide duct portion 11) from the introducing port 11A of the temperature control module 10. The air taken into the inside of the temperature control module 10 passes through the cooling portion 12 and the heating portion

13 in this order. At this time, the air can be cooled and dehumidified by the cooling portion 12, and can be heated by the heating portion 13. Then, the air that has passed through the heating portion 13 is sent to the humidifier 20 from the sending-out port 11B.

[0055] The air sent from the sending-out port 11B to the humidifier 20 flows through the flow path formed by the wall portion 23 of the flow path member 22 from the inlet 22b of the flow path member 22. The air that has flowed into the flow path formed by the wall portion 23 passes so as to traverse the humidifier main body 21. At this time, the air is mixed with steam supplied into the flow path from the intake port 22a of the flow path member 22. Thereby, humidification is performed on the air. Then, the humidified air heads toward the outlet 22c.

[0056] Then, in the present embodiment, the wall portion 23 forming the flow path of air is formed with the tapered portion 23t whose flow path cross-sectional area gradually decreases toward the outlet 22c.

[0057] Such tapered portion 23t guides the air such that the air flowing in from the temperature control module 10 is directed toward the center or the inside of the outlet 22c. Thereby, a situation where air mixed with steam collides with the portion on the outer peripheral side of the outlet 22c (the end wall portion

26) can be avoided. In this case, the occurrence of air stagnation or turbulent flow can be suppressed. Further, it can be suppressed that air collides with the portion on the outer peripheral side of the outlet 22c, steam in the air condenses, and concentrated moisture (water) flows to the downstream side. In particular, the tapered portion 23t can guide the air mixed with steam toward the center or the inside of the outlet 22c without forming a structure where obstacles such as corners or steps suddenly appear, or a portion where the flow path cross-sectional area suddenly changes, so that the occurrence of stagnation or turbulent flow can be effectively suppressed.

[0058] Further, the tapered portion 23t can increase the flow velocity of air by gradually decreasing the flow path cross-sectional area, and even when stagnation or turbulent flow occurs, the stagnation or turbulent flow can be suppressed by the accelerated air flow.

[0059] After passing through the humidifier 20, the air is taken into the blower 30. Then, the air taken into the blower 30 is sent to the air distribution box 40, and is supplied from the air distribution box 40 to the object of temperature control. The air supplied in this manner has its humidity precisely controlled by the provided tapered portion 23t, and is supplied to

the object of temperature control.

[0060] Fig. 6 shows graphs regarding the humidity of air whose humidity is controlled by the air conditioning apparatus 1 shown in Fig. 1. Specifically, Fig. 6(A) is a graph regarding the humidity of air whose humidity is controlled by the air conditioning apparatus 1, and Fig. 6(B) is a graph regarding the humidity of air whose humidity is controlled by an air conditioning apparatus according to a comparative example. In the air conditioning apparatus of the comparative example, the tapered portion 23t is not formed, and a configuration is adopted in which configurations corresponding to the side wall portions 24 extend straight from the temperature control module 10 side in parallel with each other.

[0061] Figs. 6(A) and 6(B) show results of performing humidity control for a certain humidity (%RH) as a target value, in which the vertical axis indicates use humidity (%RH) which is the humidity of air after being supplied from the air distribution box 40, and the horizontal axis indicates time.

[0062] As shown in Fig. 6(A), in the humidity control by the air conditioning apparatus 1 according to the present embodiment, variation with respect to the target humidity can be suppressed within an extremely small range. On the other hand, in the

comparative example, variation with respect to the target humidity is larger than the result of the embodiment. From such results, it can be confirmed that the tapered portion 23t is beneficial.

[0063] According to the air conditioning apparatus 1 according to the present embodiment described above, the humidifier 20 includes the humidifier main body 21 that supplies steam, and the flow path member 22. The flow path member 22 has the intake port 22a configured to receive steam from the humidifier main body 21, the inlet 22b configured to receive air, and the outlet 22c configured to allow the air received at the inlet 22b to flow out. Then, the wall portion 23 of the flow path member 22 extending from the inlet 22b to the outlet 22c forms a flow path of the air flowing from the inlet 22b to the outlet 22c. The intake port 22a is positioned so as to supply steam to air at a position upstream of the outlet 22c in the flow path. Then, the wall portion 23 is at least partially formed with the tapered portion 23t whose flow path cross-sectional area gradually decreases toward the outlet 22c.

[0064] In such a configuration, the air flowing in from the temperature control module 10 is guided by the tapered portion 23t so as to be directed toward the center or the inside of the outlet 22c. Thereby, a situation where air mixed with steam collides with the

portion on the outer peripheral side of the outlet 22c (the end wall portion 26) can be avoided. In this case, the occurrence of air stagnation or turbulent flow can be suppressed. Further, it can be suppressed that air collides with the portion on the outer peripheral side of the outlet 22c, steam in the air condenses, and concentrated moisture (water) flows to the downstream side. In particular, the tapered portion 23t can guide the air mixed with steam toward the center or the inside of the outlet 22c without forming a structure where obstacles such as corners or steps suddenly appear, or a portion where the flow path cross-sectional area suddenly changes, so that the occurrence of stagnation or turbulent flow can be effectively suppressed.

[0065] Further, the tapered portion 23t can increase the flow velocity of air by gradually decreasing the flow path cross-sectional area, and even when stagnation or turbulent flow occurs, the stagnation or turbulent flow can be suppressed by the accelerated air flow.

[0066] Thus, according to the present embodiment, the occurrence of stagnation or turbulent flow in the flow of air whose humidity is controlled can be effectively suppressed, so that the humidity of air can be precisely controlled.

[0067] Further, the tapered portion 23t in the present embodiment is formed at least in a range between the outlet 22c and the part P closest to the inlet 22b in the intake port 22a. Specifically, the humidifier main body 21 has the discharge portion 21A1 that discharges steam, and the intake port 22a faces the discharge portion 21A1. The inlet 22b opens on one side in a direction (the first horizontal direction H1) intersecting a direction in which the intake port 22a and the discharge portion 21A1 face each other, and the outlet 22c opens on the other side in the intersecting direction. Then, the tapered portion 23t is formed at least in a range where the intake port 22a is located in the intersecting direction (the first horizontal direction H1).

In this case, the occurrence of stagnation or turbulent flow around the intake port 22a, which may have a large influence on the humidification state when stagnation or turbulent flow occurs, can be effectively suppressed. Therefore, the control precision of humidity can be effectively improved.

[0068] Further, in the present embodiment, the wall portion 23 includes a pair of side wall portions 24, 24 arranged spaced apart from each other in the second horizontal direction H2. The intake port 22a is located

between the lower ends of the pair of side wall portions 24, 24. Then, the pair of side wall portions 24, 24 form the tapered portion 23t by being formed to at least partially approach each other toward the outlet 22c. Further, the upstream end of the tapered portion 23t forms the inlet 22b.

In this case, the flow path member 22 having the tapered portion 23t does not have a complicated structure, and the tapered portion 23t can be easily formed.

[0069] Further, in the present embodiment, the wall portion 23 further includes a top wall portion 25 closing a space between upper ends of the pair of side wall portions 24, 24, and the outlet 22c opens in a horizontal direction.

In this case, air can be caused to flow toward the outlet 22c without waste. In particular, in the present embodiment, air having an upward component may flow into the humidifier 20, but the top wall portion 25 can prevent air from flowing in an undesired direction.

[0070] Further, the humidifier 20 is further provided with a partition plate 28 covering a range from the lower end of the outlet 22c to a position equal to or lower than the center of the outlet 22c in the vertical direction. The partition plate 28 prevents water condensed from steam from mixing with air and

flowing out from the outlet 22c. Stagnation and turbulent flow tend to occur in the flow of air at positions around the vessel 21A in the humidifier 20. Steam coming into contact with such stagnation or turbulent flow tends to condense (liquefy). The partition plate 28 prevents moisture that may be generated around the vessel 21A in this manner from flowing downstream. Thereby, humidification control can be stabilized.

[0071] (Modified Examples)

Hereinafter, modified examples of the above-described embodiment will be described. Components similar to those of the above-described embodiment in the modified examples are denoted by the same reference signs, and redundant descriptions thereof will be omitted.

[0072] (First Modified Example)

Fig. 7 is a longitudinal sectional view of an air conditioning apparatus 1r1 according to a first modified example. In the first modified example, the structure of the flow path member 22 in the humidifier 20 is different from that of the above-described embodiment. In the flow path member 22 according to the first modified example, the wall portion 23 has a pair of first side wall portions 241, 241 facing each other and spaced apart from each other in the first horizontal direction H1, and a pair of second side wall

portions 242, 242 facing each other and spaced apart from each other in the second horizontal direction H2.

[0073] The first side wall portions 241, 241 and the second side wall portions 242, 242 are connected so as to form a flow path having a rectangular cross section. A top wall portion 25 is provided at upper ends of the first side wall portions 241, 241 and upper ends of the second side wall portions 242, 242. An intake port 22a for steam is formed by lower ends of the first side wall portions 241, 241 and lower ends of the second side wall portions 242, 242. An inlet 22b is formed in one of the first side wall portions 241, 241 closer to the temperature control module 10. An outlet 22c is formed in the top wall portion 25.

[0074] Then, in the first modified example, portions above the inlet 22b in the first side wall portions 241, 241 are formed to approach each other toward the outlet 22c. Thereby, a tapered portion 23t whose flow path cross-sectional area gradually decreases toward the outlet 22c is formed. Also in the first modified example, the tapered portion 23t is formed at least in a range between the outlet 22c and a part P closest to the inlet 22b in the intake port 22a.

[0075] Further, in the first modified example, the flow path member 22 is provided so as to project upward with respect to the temperature control module 10.

Thereby, the air guide duct portion 11 of the temperature control module 10 and the flow path member 22 are connected so as to form a crank shape.

[0076] Also in the first modified example described above, effects similar to those of the above-described embodiment can be obtained. In particular, since the flow velocity of air increases in the tapered portion 23t, it becomes difficult for air to flow toward the humidifier main body 21 side. This makes it difficult for stagnation or turbulent flow of air to occur on the humidifier main body 21 side. As a result, the influence of stagnation or turbulent flow on humidification control can be suppressed.

[0077] (Second Modified Example)

Fig. 8 is a longitudinal sectional view of an air conditioning apparatus 1r2 according to a second modified example. In the second modified example, the structure of the flow path member 22 in the humidifier 20 is different from that of the above-described embodiment. In the flow path member 22 according to the second modified example, the top wall portion 25 of the wall portion 23 extends obliquely downward from the temperature control module 10 toward the outlet 22c.

[0078] Also in the second modified example, effects similar to those of the above-described embodiment can be obtained. Further, it is advantageous in that

condensation of steam above the outlet 22c can be effectively suppressed.

[0079] (Third Modified Example)

Fig. 9 is a longitudinal sectional view of an air conditioning apparatus 1r3 according to a third modified example. In the third modified example, the connection manner between the temperature control module 10 and the humidifier 20 is different from that of the above-described embodiment. In the third modified example, the temperature control module 10 and the humidifier 20 are linearly connected to each other.

[0080] Also in the third modified example, effects similar to those of the above-described embodiment can be obtained.

[0081] (Fourth Modified Example)

Fig. 10 is a view showing a fourth modified example. Specifically, Fig. 10(A) is a longitudinal sectional view of an air conditioning apparatus 1r4 according to the fourth modified example, and Fig. 10(B) is a cross-sectional view of the air conditioning apparatus 1r4.

[0082] In the fourth modified example, the structure of the flow path member 22 in the humidifier 20 is different from that of the above-described embodiment. In the flow path member 22 according to the fourth modified example, the wall portion 23 is composed of only a pair of side wall portions 24, 24. An intake

port 22a is formed by lower ends of the pair of side wall portions 24, 24. An inlet 22b is formed by upstream ends of the pair of side wall portions 24, 24. An outlet 22c is formed by downstream ends of the pair of side wall portions 24, 24. Then, the pair of side wall portions 24, 24 are arranged to approach each other toward the outlet 22c, whereby a tapered portion 23t is formed.

[0083] Further, in the fourth modified example, the pair of side wall portions 24, 24 are respectively installed on the upper portion of the vessel 21A of the humidifier main body 21. Then, the pair of side wall portions 24, 24 are covered by a case 80 from above and from a horizontal direction. The case 80 is connected to the temperature control module 10 and is also connected to the connection pipe 60.

[0084] Also in the fourth modified example, effects similar to those of the above-described embodiment can be obtained. Further, it is advantageous in that the tapered portion 23t can be formed extremely easily. In particular, it is advantageous in that the tapered portion 23t can be easily added to an existing air conditioning apparatus that does not include the tapered portion 23t.

[0085] (Fifth Modified Example)

Fig. 11 is a view showing a fifth modified example.

Specifically, Fig. 11(A) is a longitudinal sectional view of an air conditioning apparatus 1r5 according to the fifth modified example. In the fifth modified example, similarly to the first modified example, the wall portion 23 has a pair of first side wall portions 241, 241 facing each other and spaced apart from each other in the first horizontal direction H1, and a pair of second side wall portions 242, 242 facing each other and spaced apart from each other in the second horizontal direction H2. However, in the fifth modified example, the formation mode of the tapered portion 23t is different from that of the first modified example.

[0086] Specifically, in the fifth modified example, the pair of first side wall portions 241, 241 and the second side wall portions 242, 242 are parallel to each other. By providing a pair of inner members 243, 243 extending so as to approach each other toward the outlet 22c inside such a pair of first side wall portions 241, 241 and second side wall portions 242, 242, a tapered portion 23t is formed.

[0087] Further, Fig. 11(B) is a modified example of Fig. 11(A). In the configuration of Fig. 11(B), a tapered portion 23t is formed by one inner member 243. The inner member 243 is provided so as to approach one of the pair of first side wall portions 241, 241 (the first side wall portion on the temperature control

module 10 side) as approaching the outlet 22c. Thereby, the tapered portion 23t is formed.

[0088] Also in the fifth modified example, effects similar to those of the above-described embodiment can be obtained. Further, it is advantageous in that the tapered portion 23t can be formed extremely easily. In particular, it is advantageous in that the tapered portion 23t can be easily added to an existing air conditioning apparatus that does not include the tapered portion 23t. Note that in the example of Fig. 11, the inner member 243 is plate-like, but such a mode is not limited. The inner member 243 may be a block-like member.

[0089] (Sixth Modified Example)

Fig. 12 is a longitudinal sectional view of an air conditioning apparatus 1r6 according to a sixth modified example. In the sixth modified example, the structure of the flow path member 22 in the humidifier 20 is different from that of the above-described embodiment. In the flow path member 22 according to the sixth modified example, an intake port 22a is formed between lower ends of the pair of side wall portions 24, 24 in the wall portion 23. Then, a tapered portion 23t is formed only in a portion upstream of the intake port 22a in the wall portion 23.

[0090] Also in the sixth modified example, effects

similar to those of the above-described embodiment can be obtained.

[0091] The above-described embodiment and modified examples show examples for embodying the present invention, and the present invention can be implemented in various other modes. For example, various modified examples, substitutions, omissions, or combinations thereof can be made without departing from the scope of the present invention. Modes in which such modified examples, substitutions, omissions, etc. are performed are also included in the scope of the present invention, and are similarly included in the invention described in the claims and the equivalent scope thereof.

Description of Reference Signs

[0092]

1 ... air conditioning apparatus

10 ... temperature control module

11 ... air guide duct portion

11A ... introducing port

11B ... sending-out port

12 ... cooling portion

13 ... heating portion

14 ... filter

20 ... humidifier

21 ... humidifier main body

21A ... vessel

21A1 ... discharge portion

21B ... heater portion

22 ... flow path member

22a ... intake port

22b ... inlet

22c ... outlet

23 ... wall portion

23t ... tapered portion

24 ... side wall portion

25 ... top wall portion

26 ... end wall portion

27 ... flange portion

28 ... partition plate

30 ... blower

31 ... casing

32 ... impeller

40 ... air distribution box

50 ... frame

60 ... connection pipe

70 ... lid member

Claims

[Claim 1] A humidifier comprising:

a humidifier main body configured to supply steam or atomized moisture; and

a flow path member having an intake port configured to receive the steam or the atomized moisture from the humidifier main body, an inlet configured to receive air, and an outlet configured to allow the air received at the inlet to flow out, wherein

a wall portion of the flow path member extending from the inlet to the outlet forms a flow path of the air flowing from the inlet to the outlet,

the intake port is positioned to supply the steam or the atomized moisture to the air at a position upstream of the outlet in the flow path, and

the wall portion is at least partially formed with a tapered portion having a flow path cross-sectional area that gradually decreases toward the outlet.

[Claim 2] The humidifier according to claim 1, wherein the tapered portion is formed at least in a range between the outlet and a part of the intake port closest to the inlet.

[Claim 3] The humidifier according to claim 1, wherein

the humidifier main body has a discharge portion configured to discharge the steam or the atomized

moisture,

the intake port faces the discharge portion,

the inlet opens on one side in a direction intersecting a direction in which the intake port and the discharge portion face each other,

the outlet opens on the other side in the intersecting direction, and

the tapered portion is formed at least in a range corresponding to a length where the intake port is located in the intersecting direction.

[Claim 4] The humidifier according to claim 1, wherein

the wall portion includes a pair of side wall portions spaced apart from each other in a horizontal direction,

the intake port is located between lower ends of the pair of side wall portions, and

the pair of side wall portions are formed to at least partially approach each other toward the outlet, the pair of side wall portions forming the tapered portion.

[Claim 5] The humidifier according to claim 4, wherein

the wall portion further includes a top wall portion closing a space between upper ends of the pair of side wall portions, and

the outlet opens in the horizontal direction.

[Claim 6] The humidifier according to claim 4 or 5,

wherein

the inlet and the outlet open in the horizontal direction, and

a partition plate is further provided to cover a range from a lower end of the outlet to a position equal to or lower than a center of the outlet in a vertical direction.

[Claim 7] The humidifier according to claim 1, wherein an upstream end of the tapered portion forms the inlet.

[Claim 8] An air conditioning apparatus comprising:

the humidifier according to claim 1; and

a temperature control module, wherein

the temperature control module includes:

an air guide duct portion connected to the inlet of the flow path member and configured to allow the air to flow into an inside of the flow path member from the inlet; and

a temperature control portion disposed inside the air guide duct portion and configured to control a temperature of the air.

[Claim 9] The air conditioning apparatus according to claim 8, wherein the air guide duct portion and the flow path member are connected so as to form an L-shape or a crank shape.

[Claim 10] A flow path member comprising:

an intake port configured to receive steam or

atomized moisture;

an inlet configured to receive air; and

an outlet configured to allow the air received at the inlet to flow out, wherein

a wall portion of the flow path member extending from the inlet to the outlet forms a flow path of the air flowing from the inlet to the outlet,

the intake port is positioned to supply the steam or the atomized moisture to the air at a position upstream of the outlet in the flow path, and

the wall portion is at least partially formed with a tapered portion having a flow path cross-sectional area that gradually decreases from the inlet to the outlet.