

VENTILATION SYSTEM

Technical Field

[0001] The present disclosure relates to a ventilation system.

Background Art

[0002] Patent Literature 1 describes a ventilation device including a plurality of nozzles having the same length. Each nozzle has an inflow port and a vent. High-pressure air flows into the nozzles through the inflow ports, and the high-pressure air in the nozzles blows out through the vents. The plurality of nozzles are disposed with a gap therebetween such that the respective vents of the nozzles are on the same plane. The gap forms, outside the nozzles, a path for air drawn in streams of the high-pressure air blowing out through the vents. The ventilation device includes a damper mechanism capable of changing an opening area of the inflow port of each nozzle. The ventilation device adjusts the opening area of the inflow port of each nozzle, thereby adjusting a ventilation range.

[0003] In such a ventilation device of Patent Literature 1, the nozzles each have to be provided with the damper mechanism capable of changing the opening area of the inflow port thereof to allow a ventilation direction to be changed. This results in a complex nozzle structure.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2018-003658 A

Summary of Invention

[0005] It is an object of the present disclosure to provide a ventilation system capable of changing a ventilation direction with a simplified nozzle structure.

[0006] A ventilation system according to an aspect of the present disclosure includes a nozzle unit, a ventilation device, and a control device. The nozzle unit includes at least two nozzles each including a housing having a hollow elongated shape extending in alignment with a first direction, the at least two nozzles being arranged side by side in alignment with a second direction intersecting the first direction. The ventilation device is arranged above the nozzle unit and is

configured to blow air from a first end toward a second end of the nozzle unit in the first direction. The control device is configured to control the ventilation device. The housing of each of the at least two nozzles has a lower surface having a ventilation port extending in alignment with the first direction. The ventilation port is configured to allow air sent into the housing to be blown out of the housing through the ventilation port.

Brief Description of Drawings

[0007] FIG. 1 is a perspective view of a ventilation system of an embodiment;
FIG. 2 is a perspective view of a ventilation unit included in the ventilation system;
FIG. 3 is a sectional side view of the ventilation unit;
FIG. 4 is a bottom view of the ventilation unit;
FIG. 5A is a plan view of a right end of a nozzle included in the ventilation unit;
FIG. 5B is a plan view of a left end of the nozzle included in the ventilation unit;
FIG. 6 is a view of part of the ventilation unit;
FIG. 7 is a view of straightly downward airflow of the ventilation system;
FIG. 8 is a view of diagonal airflow of the ventilation system;
FIG. 9 is a perspective view of a ventilation unit included in a ventilation system of a first variation;
FIG. 10 is a sectional side view of the ventilation unit of the first variation;
FIG. 11 is a view of a straightly downward airflow of the ventilation system of the first variation;
FIG. 12 is a view of first diagonal airflow of the ventilation system of the first variation;
and
FIG. 13 is a view of second diagonal airflow of the ventilation system of the first variation.

Description of Embodiments

[0008] The present embodiment generally relates to ventilation systems. More specifically, the present disclosure relates to a ventilation system including at least two nozzles each having a hollow elongated shape, the at least two nozzles being arranged parallel to each other.

[0009] Note that the embodiment described below is a mere example of embodiments of the present disclosure. The present disclosure is not limited to the embodiment described below, and various modifications may be made to the embodiment described below as long as the effect of the present disclosure is produced.

[0010] Moreover, in the following description, unless otherwise indicated, X, Y, and Z axes orthogonal to one another are defined as shown in FIG. 1. For convenience, one of both directions aligned with the X axis is defined as a right direction, and the other is defined as a left direction. Further, one of both directions aligned with the Y axis is defined as a forward direction, and the other is defined as a backward direction. Furthermore, one of both directions aligned with the Z axis is defined as an upward direction, and the other is defined as a downward direction.

[0011] (Embodiment)

(1) Overview

FIG. 1 shows a ventilation system VS1 of the present embodiment. The ventilation system VS1 is used in a facility such as an office building, an office, a retail establishment, a factory, or a commercial facility. Moreover, the ventilation system VS1 may be used in, for example, a dwelling unit of a multi-family dwelling house or a detached house. The ventilation system VS1 is assumed to be installed in a building such as a facility or a dwelling house but may be installed in a structural object other than the building.

[0012] The ventilation system VS1 of the present embodiment includes a nozzle unit 1, a ventilation device 3, and a control device 4. The nozzle unit 1 includes at least two nozzles 10. The at least two nozzles 10 each include a housing 10a having a hollow elongated shape extending in alignment with a first direction. The at least two nozzles 10 are arranged side by side in alignment with a second direction intersecting the first direction. The ventilation device 3 is disposed above the nozzle unit 1 and blows air from a first end 1a toward a second end 1b of the nozzle unit 1 in the first direction. The control device 4 controls the ventilation device 3. The housing 10a of each of the at least two nozzles 10 has a lower surface having a ventilation port 10b extending in alignment with the first direction. The ventilation port 10b allows air sent into the housing 10a to be blown out of the housing 10a therethrough.

[0013] In the ventilation system VS1 having the configuration described above, the control device 4 controls the ventilation device 3, thereby changing the ventilation direction without providing each nozzle with a damper mechanism as disclosed in Patent Literature 1. That is, the ventilation system VS1 is capable of changing the ventilation direction with a simplified structure of each nozzle 10.

[0014] Note that in the present embodiment, the first direction corresponds to a left/right direction aligned with the X axis, and the second direction corresponds to a forward/backward direction aligned with the Y axis.

[0015] (2) Details

As shown in FIG. 1, the ventilation system VS1 is installed in a room R1. The room R1 is a space, such as a working space, a meeting room, a rest room, a waiting room, a reception room, or a living room in which a person or people are present. The room R1 has an upper surface which is a ceiling R11, and the room R1 has a lower surface which is a floor R12.

[0016] The ventilation system VS1 includes the nozzle unit 1, the ventilation device 3, and the control device 4. The nozzle unit 1 includes eight nozzles 10. Moreover, the ventilation system VS1 preferably further includes a first nozzle ventilator 21 and a second nozzle ventilator 22. In this embodiment, the nozzle unit 1, the first nozzle ventilator 21, and the second nozzle ventilator 22 are included in a ventilation unit U1.

[0017] Moreover, the ventilation system VS1 preferably includes an operation device 5 and a human detecting sensor 6.

[0018] (2.1) Ventilation Unit

The ventilation unit U1 is fixed to a lower surface of the ceiling R11 with, for example, a hanger bolt or a wire which is not shown. As shown in FIGS. 2 to 4, the ventilation unit U1 includes the nozzle unit 1, the first nozzle ventilator 21, and the second nozzle ventilator 22.

[0019] The nozzle unit 1 includes the eight nozzles 10. The nozzles 10 include the respective housings 10a each having a hollow rectangular plate shape with a long side extending in the left/right direction aligned with the X axis. Each housing 10a has a lower surface having, as the ventilation port 10b, a rectangular opening with a long side extending in the left/right direction. The ventilation port 10b is formed in the lower surface of the housing 10a at the center in the forward/backward direction. The housings 10a of the eight nozzles 10 are arranged parallel to each other in the forward/backward direction aligned with the Y axis. The housing 10a of one nozzle 10 has a front surface which faces a rear surface of the housing 10a of another nozzle 10 disposed forward of, and adjacent to, the one nozzle 10. The housing 10a of the one nozzle 10 has a rear surface which faces a front surface of the housing 10a of still another nozzle 10 disposed rearward of, and adjacent to, the one nozzle 10. The housings 10a are made of, for example, a resin material but may be made of a light-weight metal material such as aluminum.

[0020] The housings 10a each have an internal space in which a partition plate 10c is disposed at a center part in the longitudinal direction of a corresponding one of the housings 10a. The partition plate 10c divides the internal space of the housing 10a into two spaces, namely, a right space 10d which is a space on the right and a left space 10e which is a space on the left.

[0021] As shown in FIG. 5A, each housing 10a has a right end having an opening 10f. The right space 10d communicates with the outside of the housing 10a via the opening 10f. As shown

in FIG. 5B, the housing 10a has a left end having an opening 10g. The left space 10e communicates with the outside of the housing 10a via the opening 10g.

[0022] As shown in FIGS. 3, 4, 5A, and 5B, on the lower surface under each of the right space 10d and the left space 10e are disposed a plurality of fins 10h side by side in alignment with the X axis at regular intervals in the left/right direction. The fins 10h each have a plate shape extending upward from the lower surface under each of the right space 10d and the left space 10e and close a lower portion of each of the right space 10d and the left space 10e (part of a lower side of each of the right space 10d and the left space 10e) when viewed in a direction aligned with the X axis. As shown in FIG. 4, when the housings 10a of the nozzles 10 are seen from below, the plurality of fins 10h are located to separate the ventilation port 10b at regular intervals in alignment with the X axis.

[0023] The first nozzle ventilator 21 is a cross flow fan. As shown in FIGS. 2 to 4, the first nozzle ventilator 21 includes: a housing 21a in the shape of a hollow parallelepiped; and a fan 21b in the housing 21a. The first nozzle ventilator 21 is disposed at the right end (first end) 1a of the nozzle unit 1. The housing 21a has a left surface facing a right end surface of the nozzle unit 1. The housing 21a is connected to a duct which is not shown, and the housing 21a is supplied with air through the duct. The left surface of the housing 21a has a ventilation port 21c (see FIG. 3). Air blown out leftward through the ventilation port 21c by rotation of the fan 21b flows into the right space 10d through the opening 10f of each nozzle 10 of the nozzle unit 1. That is, the first nozzle ventilator 21 sends air through the opening 10f of each nozzle 10 into the right space 10d, thereby generating, in the right space 10d, interior airflow F11 (see FIG. 3) flowing leftward from the opening 10f. The interior airflow F11 is rectified by the fins 10h in the right space 10d and blows out downward through the ventilation port 10b formed in the lower surface of the housing 10a. Note that as shown in FIG. 5A, the width of the lower portion of the right space 10d in the forward/backward direction preferably narrows downward.

[0024] The second nozzle ventilator 22 is a cross flow fan. As shown in FIGS. 2 to 4, the second nozzle ventilator 22 includes: a housing 22a in the shape of a hollow parallelepiped; and a fan 22b in the housing 22a. The second nozzle ventilator 22 is disposed at the left end (second end) 1b of the nozzle unit 1. The housing 22a has a right surface facing a left end surface of the nozzle unit 1. The housing 22a is connected to a duct which is not shown, and the housing 22a is supplied with air through the duct. The right surface of the housing 22a has a ventilation port 22c (see FIG. 3). Air blown out rightward through the ventilation port 22c by rotation of the fan 22b flows into the left space 10e through the opening 10g of each nozzle 10 of the nozzle unit 1.

That is, the second nozzle ventilator 22 sends air through the opening 10f of each nozzle 10 into the left space 10e, thereby generating, in the left space 10e, interior airflow F12 (see FIG. 3) flowing rightward from the opening 10g. The interior airflow F12 is rectified by the fins 10h in the left space 10e and blows out downward through the ventilation port 10b formed in the lower surface of the housing 10a. Note that as shown in FIG. 5B, the width of the lower portion of the left space 10e in the forward/backward direction preferably narrows downward.

[0025] That is, as shown in FIG. 6, each of the eight nozzles 10 included in the nozzle unit 1 blows air downward through the ventilation port 10b having an elongated shape and formed in the lower surface of a corresponding one of the housings 10a, thereby producing ventilation airflow F2. Note that FIG. 6 shows arbitrary two nozzles 10 of the eight nozzles 10 included in the nozzle unit 1, the two nozzles 10 being arranged side by side in alignment with the Y axis in the forward/backward direction.

[0026] In this embodiment, a draw-in pathway 91 shown in FIG. 6 is formed between the two nozzles 10 adjacent to each other in the forward/backward direction. The draw-in pathway 91 is a space provided between a rear surface of the housing 10a of a forward one of the two nozzles 10 in the forward/backward direction and a front surface of the housing 10a of a back one of the two nozzles 10 in the forward/backward direction such that the space is open upward and downward. When each of the two nozzles 10 arranged side by side produces the ventilation airflow F2 blowing out downward through the ventilation port 10b, a negative pressure is produced in the draw-in pathway 91, and air in an upper space 92 which is a space above the two nozzles 10 is drawn in the draw-in pathway 91 downward from above. The air drawn in the draw-in pathway 91 downward from above blows out downward through the draw-in pathway 91. The air blowing out downward through the draw-in pathway 91 produces draw-in airflow F3 flowing downward from the draw-in pathway 91.

[0027] As a result, the draw-in airflow F3 is generated between the two streams of the ventilation airflow F2 produced by the two nozzles 10 adjacent to each other below the nozzle unit 1, and downward airflow F1 which is a combination of the streams of the ventilation airflow F2 and the draw-in airflow F3 is produced. The downward airflow F1 blows downward out of the nozzle unit 1.

[0028] When the flow rate of the downward airflow F1 at the ventilation port 10b is defined as the ventilation amount of the nozzle unit 1, the ventilation amount of the nozzle unit 1 increases as the rotational velocity of each of the fans 21b and 22b increases, and the ventilation amount of the nozzle unit 1 decreases as the rotational velocity of each of the fans 21b and 22b decreases.

The rotational velocity of each of the fans 21b and 22b is controlled by the control device 4.

[0029] (2.2) Ventilation Device

The ventilation device 3 is a cross flow fan. The ventilation device 3 is disposed above the nozzle unit 1, sucks air therearound, and blows the air from the right end (first end) 1a toward the left end (second end) 1b of the nozzle unit 1.

[0030] Specifically as shown in FIG. 3, the ventilation device 3 is arranged above the first nozzle ventilator 21 (or above the right end 1a of the nozzle unit 1). The ventilation device 3 is fixed to a lower surface of the ceiling R11 with, for example, a hanger bolt or a wire which is not shown. The ventilation device 3 includes: a housing 3a in the shape of a hollow parallelepiped; and a fan 3b in the housing 3a. The housing 3a has a left surface having a ventilation port 3c. Air blown out leftward through the ventilation port 3c by rotation of the fan 3b is ventilation airflow F21 flowing from right to left above the nozzle unit 1.

[0031] When the flow rate of the ventilation airflow F21 at the ventilation port 3c is defined as the ventilation amount of the ventilation device 3, the ventilation amount of the ventilation device 3 increases as the rotational velocity of the fan 3b increases. Moreover, the ventilation amount of the ventilation device 3 decreases as the rotational velocity of the fan 3b decreases. The rotational velocity of the fan 3b is controlled by the control device 4.

[0032] (2.3) Control Device

The control device 4 controls at least the ventilation device 3. In the present embodiment, the control device 4 controls the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22.

[0033] The control device 4 performs wired or wireless communication with the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22, thereby controlling the ventilation amount of each of the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22. Moreover, the control device 4 performs wired or wireless communication with the operation device 5 and the human detecting sensor 6, thereby acquiring an operation signal from the operation device 5 and a sensor signal from the human detecting sensor 6. Note that the wired communication is wired communication, for example, over a twisted pair cable, a dedicated communication line, or a local area network (LAN) cable. The wireless communication is wireless communication compliant with the standard of, for example, Wi-Fi (registered trademark), Bluetooth (registered trademark), ZigBee (registered trademark), or low power radio (specified low power radio) requiring no license.

[0034] The operation device 5 includes a switch or a touch panel for giving respective

instructions to the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22 and receives an operation given by a user. The operation device 5 transmits, to the control device 4, an operation signal according to the operation given by the user. Specifically, the operation device 5 receives operations regarding, for example, operation, deactivation, and the ventilation direction. The control device 4 controls, based on the operation signal received from the operation device 5, the operation, the deactivation, and the ventilation amount during the operation of each of the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22.

[0035] The human detecting sensor 6 detects the presence or absence of a person and the position of the person in the room R1 and transmits a sensing result as a sensor signal to the control device 4. The control device 4 controls, based on the sensor signal received from the human detecting sensor 6, the operation, the deactivation, and the ventilation amount during the operation of each of the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22.

[0036] Thus, the control device 4 switches, based on the operation given by the user and received by the operation device 5 and the sensing result by the human detecting sensor 6, between the operation and the deactivation of each of the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22, and adjusts the ventilation amount of each of the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22 during the operation.

[0037] (2.4) Operation of Ventilation System

In the ventilation system VS1, the control device 4 controls the ventilation device 3, the first nozzle ventilator 21, and the second nozzle ventilator 22, thereby adjusting the direction of airflow produced below the nozzle unit 1. In the present embodiment, the control device 4 causes the first nozzle ventilator 21 and the second nozzle ventilator 22 to enter an operating state and then adjusts the operation, the deactivation, and the ventilation amount of the ventilation device 3, thereby changing the direction (ventilation direction) of the airflow produced below the nozzle unit 1.

[0038] (2.4.1) Straightly Downward Airflow

FIG. 7 shows straightly downward airflow F31 which is airflow produced below the nozzle unit 1 when the first nozzle ventilator 21 and the second nozzle ventilator 22 are in the operating state and the ventilation device 3 is in a deactivated state.

[0039] In this case, the downward airflow F1 is blowing downward out of the nozzle unit 1. In contrast, no ventilation airflow F21 is blowing out through the ventilation port 3c of the ventilation device 3. Thus, the downward airflow F1 blowing downward out of the nozzle unit 1 travels in

the straightly downward direction (vertically downward direction), and the straightly downward airflow F31 traveling in the straightly downward direction is produced below the nozzle unit 1.

[0040] (2.4.2) Diagonal Airflow

FIG. 8 shows diagonal airflow F32 which is airflow produced below the nozzle unit 1 when the first nozzle ventilator 21 and the second nozzle ventilator 22 are in the operating state and the ventilation device 3 is also in the operating state.

[0041] In this case, the downward airflow F1 is blowing downward out of the nozzle unit 1. Moreover, above the nozzle unit 1, the ventilation airflow F21 is blowing out leftward through the ventilation port 3c of the ventilation device 3. The ventilation airflow F21 flowing from right to left above the nozzle unit 1 is drawn downward in the downward airflow F1 blowing out of the nozzle unit 1, passes between the two nozzles 10 adjacent to each other in the forward/backward direction, and travels diagonally downward to the left. As a result, the downward airflow F1 is drawn in the ventilation airflow F21 traveling diagonally downward to the left below the nozzle unit 1, and the downward airflow F1 thus also travels diagonally downward to the left. Thus, the diagonal airflow F32 traveling diagonally downward to the left is produced below the nozzle unit 1.

[0042] As the ventilation amount of the ventilation device 3 increases (as the air volume of the ventilation airflow F21 increases), the traveling direction of the diagonal airflow F32 approaches the horizontal direction. Moreover, as the ventilation amount of the ventilation device 3 decreases (as the air volume of the ventilation airflow F21 decreases), the traveling direction of the diagonal airflow F32 approaches the straightly downward direction. That is, the control device 4 adjusts the ventilation amount of the ventilation device 3, thereby controlling the traveling direction of the diagonal airflow F32.

[0043] (2.4.3) Swing Airflow

The control device 4 periodically switches between the operation and the deactivation of the ventilation device 3, thereby periodically switching between the straightly downward airflow F31 (see FIG. 7) and the diagonal airflow F32 (see FIG. 8). As a result, the ventilation system VS1 can produce swing airflow by the straightly downward airflow F31 and the diagonal airflow F32 alternately generated below the nozzle unit 1.

[0044] Moreover, the control device 4 periodically increases and reduces the ventilation amount of the ventilation device 3, thereby periodically changing the traveling direction of the diagonal airflow F32 (see FIG. 8). The control device 4 alternately repeats an increasing time period for increasing the ventilation amount of the ventilation device 3 and a reducing time period for

reducing the ventilation amount of the ventilation device 3. As a result, the ventilation system VS1 can produce swing airflow in which the traveling direction of the diagonal airflow F32 continuously changes below the nozzle unit 1.

[0045] Note that the control device 4 periodically increases and reduces the ventilation amount of the ventilation device 3 between zero and a target value, thereby achieving swing airflow continuously changing between the straightly downward airflow F31 and the diagonal airflow F32.

[0046] As described above, in the ventilation system VS1, the control device 4 controls the ventilation device 3, thereby producing the straightly downward airflow F31 and the diagonal airflow F32. Moreover, the control device 4 switches between the operation and the deactivation of the ventilation device 3 or periodically changes the ventilation amount of the ventilation device 3, thereby producing the swing airflow. That is, the ventilation system VS1 is capable of changing the ventilation direction without providing each nozzle with a damper mechanism. That is, the ventilation system VS1 is capable of changing the ventilation direction with a simplified structure of each nozzle 10.

[0047] (3) First Variation

FIGS. 9 and 10 show a ventilation unit U2 as a variation of the ventilation unit. Note that the other configurations are similar to those of the embodiment described above, and similar components are denoted by the same reference signs as those in the embodiment, and the description thereof is omitted.

[0048] The ventilation unit U2 corresponds to the ventilation unit U1 further including a ventilation device 3 arranged above the second nozzle ventilator 22 (or above the left end 1b of the nozzle unit 1). Note that in the following description, the ventilation device 3 arranged above the first nozzle ventilator 21 is referred to as a first ventilation device 31, and the ventilation device 3 arranged above the second nozzle ventilator 22 is referred to as a second ventilation device 32.

[0049] The second ventilation device 32 has a housing 3a which has a right surface having a ventilation port 3c. Air blown out rightward through the ventilation port 3c by rotation of a fan 3b is ventilation airflow F22 (see FIG. 10) flowing from left to right above the nozzle unit 1.

[0050] In the present variation, the control device 4 switches, based on the operation given by the user and received by the operation device 5 and the sensing result by the human detecting sensor 6, between the operation and the deactivation of each of the first ventilation device 31, the second ventilation device 32, the first nozzle ventilator 21, and the second nozzle ventilator 22, and adjusts the ventilation amount of each of the first ventilation device 31, the second ventilation device 32, the first nozzle ventilator 21, and the second nozzle ventilator 22 during the operation.

Thus, the control device 4 causes the first nozzle ventilator 21 and the second nozzle ventilator 22 to enter an operating state and then controls the operation, the deactivation, and the ventilation amount of each of the first ventilation device 31 and the second ventilation device 32, thereby adjusting the direction (ventilation direction) of airflow to be produced below the nozzle unit 1.

[0051] (3.1) Straightly Downward Airflow

FIG. 11 shows straightly downward airflow F41 which is airflow produced below the nozzle unit 1 when the first nozzle ventilator 21 and the second nozzle ventilator 22 are in the operating state and the first ventilation device 31 and the second ventilation device 32 are in the deactivated state.

[0052] In this case, the downward airflow F1 is blowing downward out of the nozzle unit 1. In contrast, none of the ventilation airflow F21 and the ventilation airflow F22 is blowing out through the ventilation port 3c of the first ventilation device 31 and the second ventilation device 32, respectively. Thus, the downward airflow F1 blowing downward out of the nozzle unit 1 travels in the straightly downward direction (vertically downward direction), and the straightly downward airflow F41 traveling in the straightly downward direction is produced below the nozzle unit 1.

[0053] (3.2) First Diagonal Airflow

FIG. 12 shows first diagonal airflow F42 which is airflow produced below the nozzle unit 1 when the first nozzle ventilator 21 and the second nozzle ventilator 22 are in the operating state and the first ventilation device 31 is also in the operating state. At this time, the second ventilation device 32 is in the deactivated state.

[0054] In this case, the downward airflow F1 is blowing downward out of the nozzle unit 1. Moreover, above the nozzle unit 1, the ventilation airflow F21 is blowing leftward out of the ventilation port 3c of the first ventilation device 31. The ventilation airflow F21 flowing from right to left above the nozzle unit 1 is drawn downward in the downward airflow F1 blowing out of the nozzle unit 1, passes between the two nozzles 10 adjacent to each other in the forward/backward direction, and travels diagonally downward to the left. As a result, the downward airflow F1 is drawn in the ventilation airflow F21 traveling diagonally downward to the left below the nozzle unit 1, and the downward airflow F1 thus also travels diagonally downward to the left. Thus, the first diagonal airflow F42 traveling diagonally downward to the left is produced below the nozzle unit 1.

[0055] As the ventilation amount of the first ventilation device 31 increases (as the air volume of the ventilation airflow F21 increases), the traveling direction of the first diagonal airflow F42 approaches the horizontal direction. Moreover, as the ventilation amount of the first ventilation

device 31 decreases (as the air volume of the ventilation airflow F21 decreases), the traveling direction of the first diagonal airflow F42 approaches the straightly downward direction. That is, the control device 4 adjusts the ventilation amount of the first ventilation device 31, thereby controlling the traveling direction of the first diagonal airflow F42.

[0056] (3.3) Second Diagonal Airflow

FIG. 13 shows second diagonal airflow F43 which is airflow produced below the nozzle unit 1 when the first nozzle ventilator 21 and the second nozzle ventilator 22 are in the operating state and the second ventilation device 32 is also in the operating state. At this time, the first ventilation device 31 is in the disabled state.

[0057] In this case, the downward airflow F1 is blowing downward out of the nozzle unit 1. Moreover, above the nozzle unit 1, the ventilation airflow F22 is blowing rightward through the ventilation port 3c of the second ventilation device 32. The ventilation airflow F22 flowing from left to right above the nozzle unit 1 is drawn downward in the downward airflow F1 blowing out of the nozzle unit 1, passes between the two nozzles 10 adjacent to each other in the forward/backward direction, and travels diagonally downward to the right. As a result, the downward airflow F1 is drawn in the ventilation airflow F22 traveling diagonally downward to the right below the nozzle unit 1, and the downward airflow F1 also travels diagonally downward to the right. Thus, the second diagonal airflow F43 traveling diagonally downward to the right is produced below the nozzle unit 1.

[0058] As the ventilation amount of the second ventilation device 32 increases (as the air volume of the ventilation airflow F22 increases), the traveling direction of the second diagonal airflow F43 approaches the horizontal direction. Moreover, as the ventilation amount of the second ventilation device 32 decreases (as the air volume of the ventilation airflow F22 decreases), the traveling direction of the second diagonal airflow F43 approaches the straightly downward direction. That is, the control device 4 adjusts the ventilation amount of the second ventilation device 32, thereby controlling the traveling direction of the second diagonal airflow F43.

[0059] (3.4) Swing Airflow

The control device 4 can switch between the operation and the deactivation of each of the first ventilation device 31 and the second ventilation device 32. Thus, the control device 4 preferably alternately switches between an operation period of the first ventilation device 31 and an operation period of the second ventilation device 32, thereby periodically switching between the first diagonal airflow F42 (see FIG. 12) and the second diagonal airflow F43 (see FIG. 13). As a result, the ventilation system VS1 can produce swing airflow by the first diagonal airflow

F42 and the second diagonal airflow F43 alternately generated below the nozzle unit 1. That is, the ventilation system VS1 controls the first ventilation device 31 and the second ventilation device 32, thereby extending a range within which the ventilation direction is changeable.

[0060] Moreover, when alternately switching between an operation period of the first ventilation device 31 and an operation period of the second ventilation device 32, the control device 4 may provide, between the operation period of the first ventilation device 31 and the operation period of the second ventilation device 32, a complete deactivation period during which both the first ventilation device 31 and the second ventilation device 32 are deactivated. In this case, the ventilation system VS1 can achieve, below the nozzle unit 1, swing airflow by repeated generation of streams of airflow in the order of: first diagonal airflow F42 → straightly downward airflow F41 → second diagonal airflow F43 → straightly downward airflow F41 → first diagonal airflow F42. Thus, the ventilation system VS1 can produce smooth swing airflow.

[0061] Moreover, the control device 4 preferably increases the ventilation amount of the first ventilation device 31 from zero to a first target value and then reduces the ventilation amount to zero during the operation period of the first ventilation device 31. In this case, the traveling direction of the first diagonal airflow F42 continuously changes below the nozzle unit 1. Similarly, the control device 4 preferably increases the ventilation amount of the second ventilation device 32 from zero to a second target value and then reduces the ventilation amount to zero during the operation period of the second ventilation device 32. In this case, the traveling direction of the second diagonal airflow F43 continuously changes below the nozzle unit 1. Thus, the ventilation system VS1 can smoothly change the ventilation direction, thereby achieving swing airflow in which the traveling direction of each of the first diagonal airflow F42 and the second diagonal airflow F43 continuously changes.

[0062] Specifically, during the operation period of the first ventilation device 31, the traveling direction of the first diagonal airflow F42 gradually changes from the straightly downward direction to the left direction and then gradually returns from the left direction to the straightly downward direction. When the traveling direction of the first diagonal airflow F42 returns to the straightly downward direction, the operation period of the first ventilation device 31 ends, and the operation period of the second ventilation device 32 starts. During the operation period of the second ventilation device 32, the traveling direction of the second diagonal airflow F43 gradually changes from the straightly downward direction to the right direction and then gradually returns from the right direction to the straightly downward direction. When the traveling direction of the second diagonal airflow F43 returns to the straightly downward direction, the operation period of

the second ventilation device 32 ends, and the operation period of the first ventilation device 31 starts. Repeating the operation described above achieves the swing airflow in which the traveling direction of each of the first diagonal airflow F42 and the second diagonal airflow F43 continuously changes.

[0063] Moreover, the control device 4 may continuously adjust the ratio between the ventilation amount of the first ventilation device 31 and the ventilation amount of the second ventilation device 32, thereby continuously changing the ventilation direction of the swing airflow.

[0064] As described above, the control device 4 controls the first ventilation device 31 and the second ventilation device 32 in the first variation, thereby producing the straightly downward airflow F41, the first diagonal airflow F42, and the second diagonal airflow F43. Moreover, the control device 4 switches between the operation and the deactivation of each of the first ventilation device 31 and the second ventilation device 32 or periodically changes the ventilation amount of each of the first ventilation device 31 and the second ventilation device 32, thereby producing the swing airflow. That is, the ventilation system VS1 is capable of changing the ventilation direction without providing each nozzle with a damper mechanism. That is, the ventilation system VS1 is capable of changing the ventilation direction with a simplified structure of each nozzle 10.

[0065] (4) Second Variation

Each of the first nozzle ventilator 21, the second nozzle ventilator 22, and the ventilation device 3 may be a component other than the cross flow fan and may be, for example, a sirocco fan or a propeller fan.

[0066] Moreover, air suction of each of the first nozzle ventilator 21, the second nozzle ventilator 22, and the ventilation device 3 may be air suction via a duct or suction of air around the housing.

[0067] Each of the ventilation units U1 and U2 may include, as an alternative to the ventilation device 3, a duct through which high-pressure air flows. In this case, each nozzle 10 of the nozzle unit 1 is supplied with air from the duct.

[0068] The nozzle unit 1 includes at least two nozzles 10.

[0069] Moreover, a structural component to which each of the ventilation units U1 and U2 is to be attached is not limited to the ceiling R11 but may be another structural component such as a mount disposed at an upper part in the room R1.

[0070] Moreover, each of the configurations of the embodiment and the variations described above may accordingly be combined with each other, and the effect of each configuration can likewise be obtained.

[0071] (5) Summary

A ventilation system (VS1) of a first aspect according to the embodiment described above includes a nozzle unit (1), a ventilation device (3), and a control device (4). The nozzle unit (1) includes at least two nozzles (10). The at least two nozzles (10) each include a housing (10a) having a hollow elongated shape extending in alignment with a first direction, the at least two nozzles (10) being arranged side by side in alignment with a second direction intersecting the first direction. The ventilation device (3) is arranged above the nozzle unit (1) and is configured to blow air from a first end (1a) toward a second end (1b) of the nozzle unit (1) in the first direction. The control device (4) is configured to control the ventilation device (3). The housing (10a) of each of the at least two nozzles (10) has a lower surface having a ventilation port (10b) extending in alignment with the first direction. The ventilation port (10b) is configured to allow air sent into the housing (10a) to be blown out of the housing (10a) through the ventilation port (10b).

[0072] The ventilation system (VS1) described above is capable of changing a ventilation direction with a simplified structure of the nozzles (10).

[0073] In a ventilation system (VS1) of a second aspect according to the embodiment described above and referring to the first aspect, the control device (4) is preferably configured to adjust a ventilation amount of the ventilation device (3).

[0074] The ventilation system (VS1) described above adjusts the ventilation amount of the ventilation device (3), thereby smoothly changing the ventilation direction.

[0075] In a ventilation system (VS1) of a third aspect according to the embodiment described above and referring to the first or second aspect, the control device (4) is preferably configured to periodically increase and reduce a ventilation amount of the ventilation device (3).

[0076] The ventilation system (VS1) described above is configured to produce swing airflow.

[0077] In a ventilation system (VS1) of a fourth aspect according to the embodiment described above and referring to the first aspect, the ventilation device (3) is preferably a first ventilation device (31), and the ventilation system (VS1) preferably further includes a second ventilation device (32). The second ventilation device (32) is arranged above the nozzle unit (1) and is configured to blow air from the second end (1b) toward the first end (1a) in the first direction. The control device (4) is configured to control the first ventilation device (31) and the second ventilation device (32).

[0078] The ventilation system (VS1) described above controls the first ventilation device (31) and the second ventilation device (32), thereby extending a range within which the ventilation direction is changeable.

[0079] In a ventilation system (VS1) of a fifth aspect according to the embodiment described

above and referring to the fourth aspect, the control device (4) is preferably configured to alternately switch between an operation period of the first ventilation device (31) and an operation period of the second ventilation device (32).

[0080] The ventilation system (VS1) described above is configured to produce swing airflow in a further extended range.

[0081] In a ventilation system (VS1) of a sixth aspect according to the embodiment described above and referring to the fifth aspect, the control device (4) is preferably configured to provide, between the operation period of the first ventilation device (31) and the operation period of the second ventilation device (32), a complete deactivation period during which both the first ventilation device (31) and the second ventilation device (32) are deactivated.

[0082] The ventilation system (VS1) described above is configured to produce smooth swing airflow.

[0083] In a ventilation system (VS1) of a seventh aspect according to the embodiment described above and referring to any one of the fourth to sixth aspects, the control device (4) is preferably configured to adjust a ventilation amount of each of the first ventilation device (31) and the second ventilation device (32).

[0084] The ventilation system (VS1) described above adjusts the ventilation amount of each of the first ventilation device (31) and the second ventilation device (32), thereby smoothly changing the ventilation direction.

[0085] In a ventilation system (VS1) of an eighth aspect according to the embodiment described above and referring to the seventh aspect, the control device (4) is preferably configured to increase the ventilation amount of the first ventilation device (31) from zero to a first target value and then reduce the ventilation amount to zero during the operation period of the first ventilation device (31). The control device (4) is preferably configured to increase the ventilation amount of the second ventilation device (32) from zero to a second target value and then reduce the ventilation amount to zero during the operation period of the second ventilation device (32).

[0086] The ventilation system (VS1) described above is configured to smoothly change the ventilation direction.

Reference Signs List

- [0087] VS1 Ventilation System
- 1 Nozzle Unit
- 1a Right End (First End)

1b	Left End (Second End)
10	Nozzle
10a	Housing
10b	Ventilation Port
3	Ventilation Device
31	First Ventilation Device
32	Second Ventilation Device
4	Control Device

CLAIMS

1. A ventilation system comprising:
 - a nozzle unit including at least two nozzles, the at least two nozzles each including a housing having a hollow elongated shape extending in alignment with a first direction, the at least two nozzles being arranged side by side in alignment with a second direction intersecting the first direction;
 - a ventilation device arranged above the nozzle unit and configured to blow air from a first end toward a second end of the nozzle unit in the first direction; and
 - a control device configured to control the ventilation device,
 - the housing of each of the at least two nozzles having a lower surface having a ventilation port extending in alignment with the first direction,

The ventilation port is configured to allow air sent into the housing to be blown out of the housing through the ventilation port.
2. The ventilation system of claim 1, wherein
 - the control device is configured to adjust a ventilation amount of the ventilation device.
3. The ventilation system of claim 1 or 2, wherein
 - the control device is configured to periodically increase and reduce a ventilation amount of the ventilation device.
4. The ventilation system of claim 1, wherein
 - the ventilation device is a first ventilation device,
 - the ventilation system further includes a second ventilation device, the second ventilation device being arranged above the nozzle unit and being configured to blow air from the second end toward the first end in the first direction, and
 - the control device is configured to control the first ventilation device and the second ventilation device.
5. The ventilation system of claim 4, wherein
 - the control device is configured to alternately switch between an operation period of the

first ventilation device and an operation period of the second ventilation device.

6. The ventilation system of claim 5, wherein

the control device is configured to provide, between the operation period of the first ventilation device and the operation period of the second ventilation device, a complete deactivation period during which both the first ventilation device and the second ventilation device are stopped.

7. The ventilation system of any one of claims 4 to 6, wherein

the control device is configured to adjust a ventilation amount of each of the first ventilation device and the second ventilation device.

8. The ventilation system of claim 7, wherein

the control device is configured to

increase the ventilation amount of the first ventilation device from zero to a first target value and then reduce the ventilation amount to zero during the operation period of the first ventilation device and

increase the ventilation amount of the second ventilation device from zero to a second target value and then reduce the ventilation amount to zero during the operation period of the second ventilation device.