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(54) TOTAL HEAT EXCHANGER AND VENTILATION SYSTEM USING THE SAME

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(57) **ABSTRACT**

A total heat exchanger having a structure capable of achieving an enhancement in total heat efficiency, and a ventilation system using the total heat exchanger are disclosed. The total heat exchanger includes an air supply duct for guiding outdoor air to an indoor space, an air discharge duct for guiding indoor air to the outdoors, an air supply fan arranged at one side of the air supply duct, the air supply fan sucking the outdoor air, and supplying the sucked air to the indoor space, an air discharge fan arranged at one side of the air discharge duct, the air discharge fan sucking the indoor air, and discharging the sucked air to the outdoors, and a heat exchanging element arranged at a region where the indoor air and the outdoor air cross each other, the heat exchanging element heat-exchanging the indoor air with the outdoor air. The heat exchanging element has a shape causing the indoor air and the outdoor air to flow through the heat exchanging element while forming an acute angle with respect to each other.

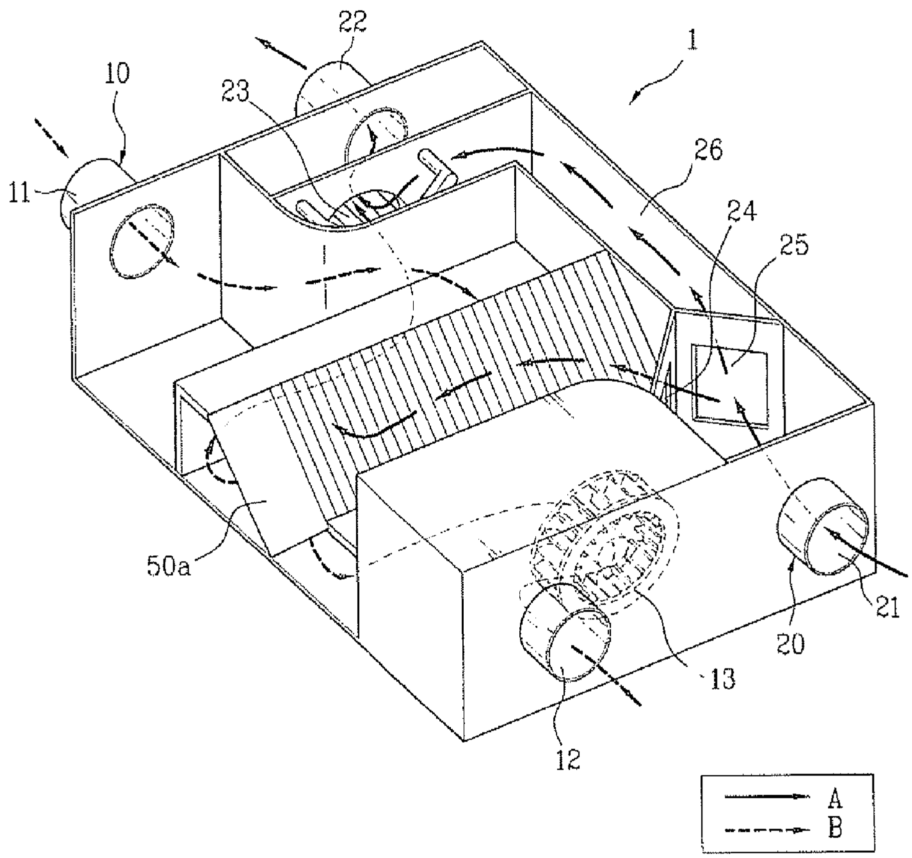


FIG. 1

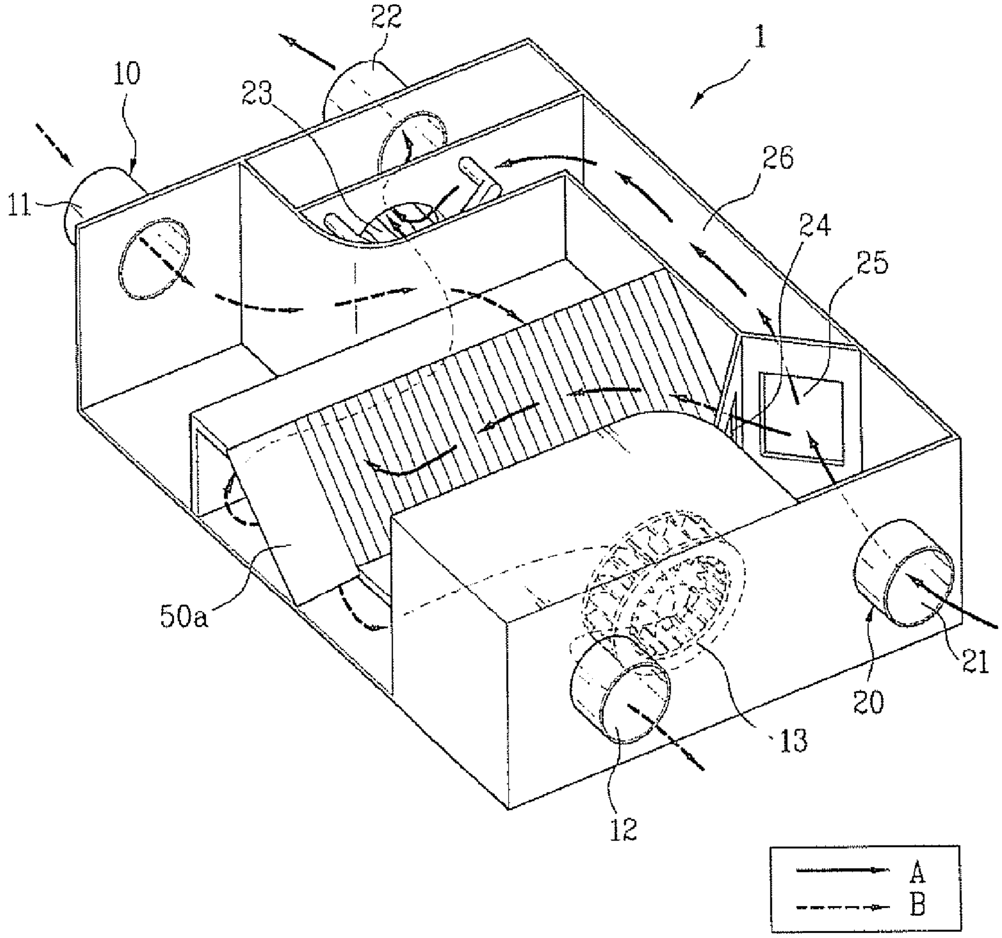


FIG. 2

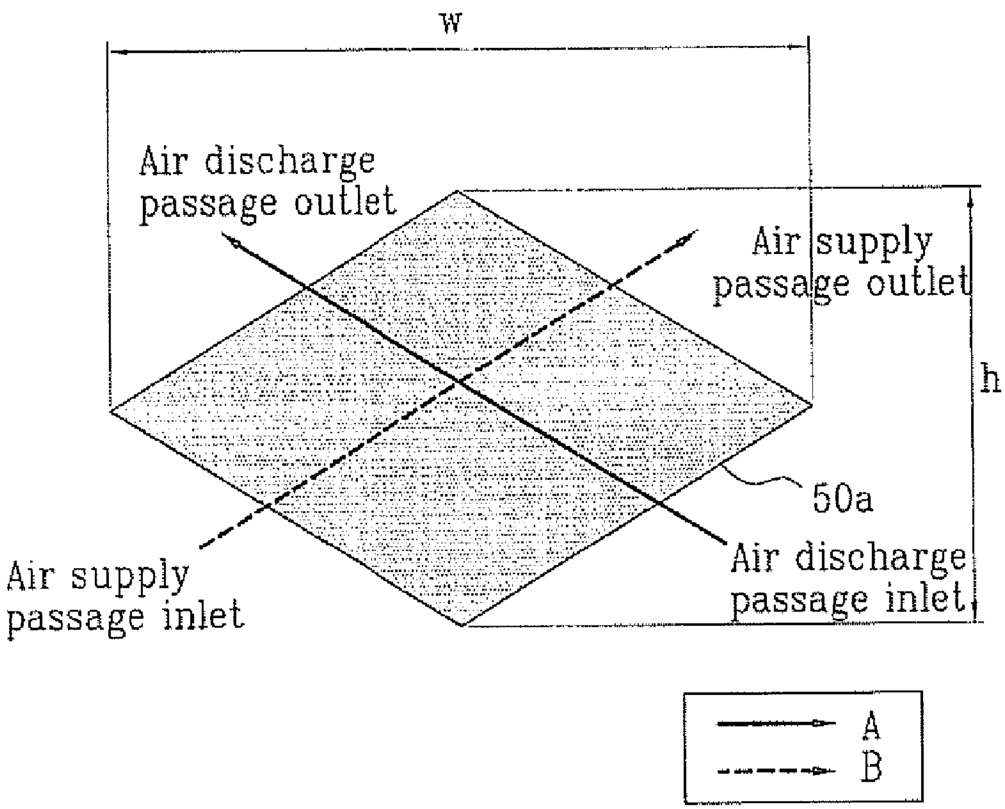

W
Air discharge passage outlet
Air supply passage outlet
h
50a
Air supply passage inlet
Air discharge passage inlet
A
B

FIG. 3A

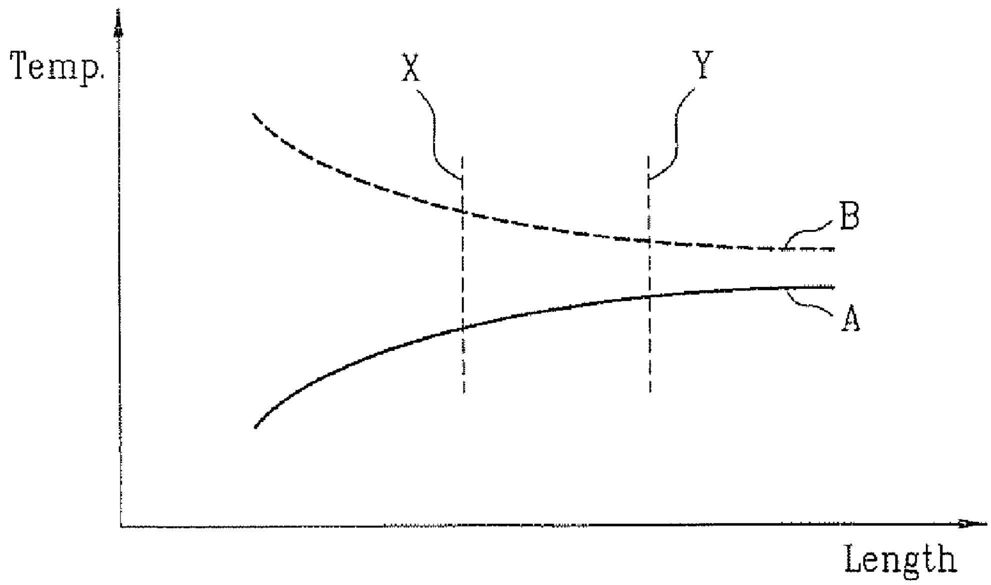


FIG. 3B

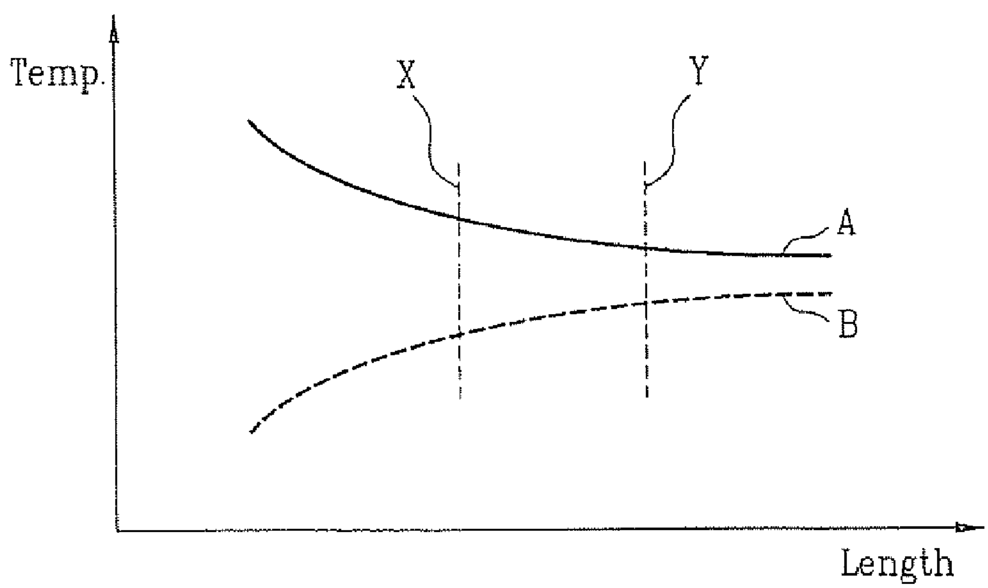


FIG. 4

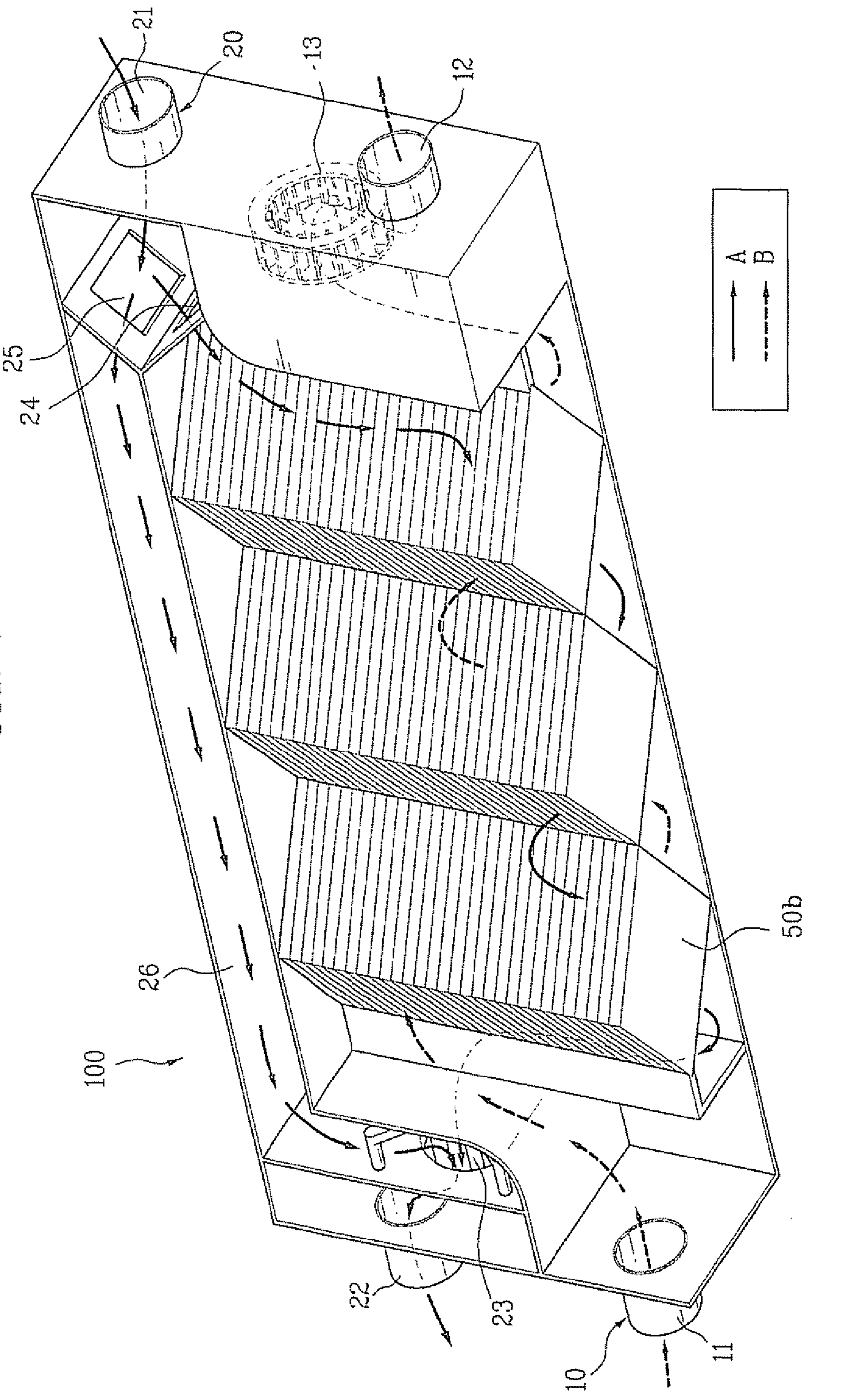


FIG. 5

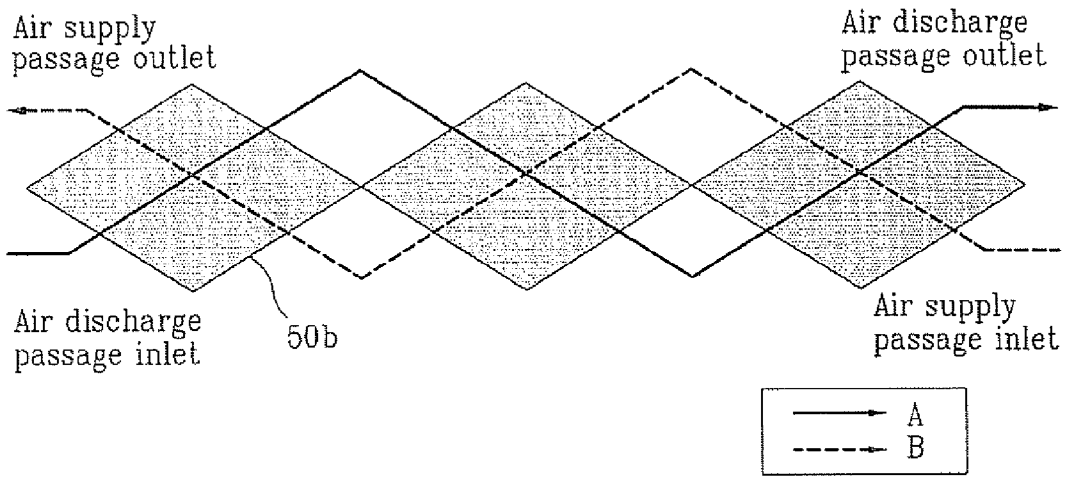

Air supply
passage outlet
Air discharge
passage outlet
Air discharge
passage inlet
50b
Air supply
passage inlet
A
B

FIG. 6

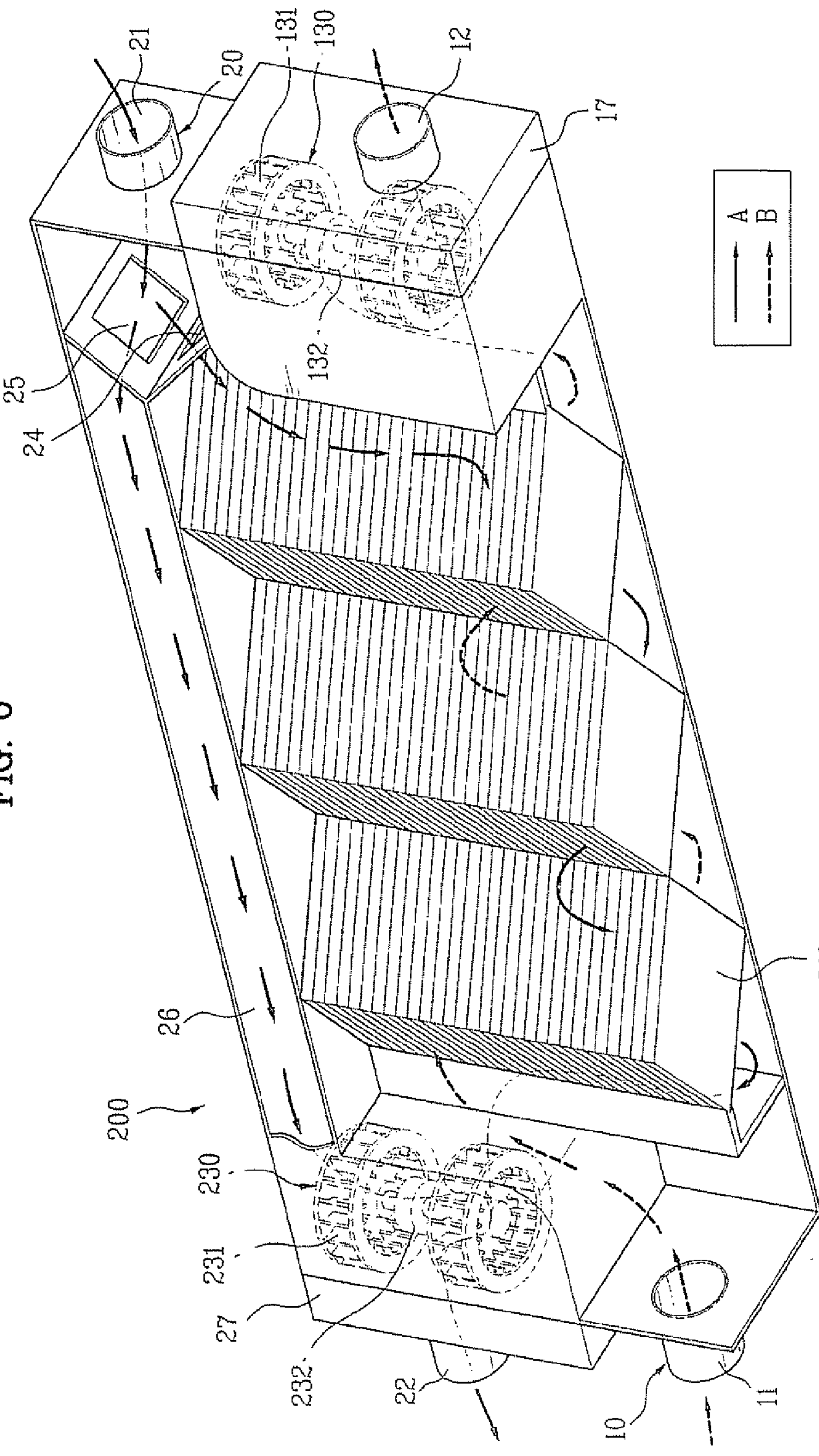
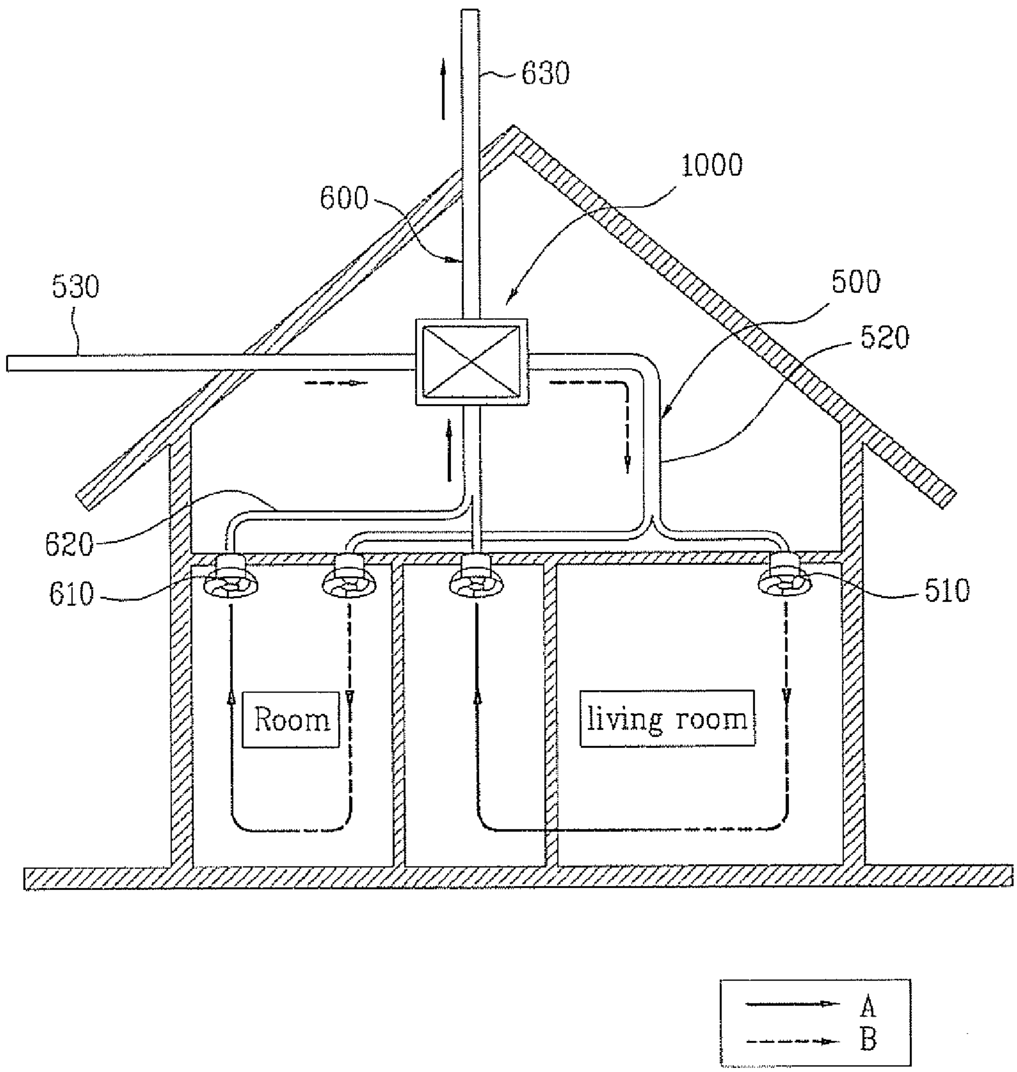


FIG. 7



TOTAL HEAT EXCHANGER AND VENTILATION SYSTEM USING THE SAME

[0001] This application claims the benefit of Korean Patent Application No. P2005-46326, filed on May 31, 2005, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a total heat exchanger and a ventilation system using the same, and more particularly, to a total heat exchanger which has an improved structure so as to have an increased heat exchange area, thereby being capable of achieving an enhancement in total heat efficiency, and a ventilation system using the total heat exchanger.

[0004] 2. Discussion of the Related Art

[0005] Generally, air present in a confined space, for example, an indoor space, is gradually contaminated as time passes in accordance with repeated respiration of living beings in the indoor space. Accordingly, it is necessary to frequently replace contaminated air in the indoor space with fresh outdoor air. To this end, a ventilation system using a total heat exchanger is typically used.

[0006] In particular, various ventilation systems are used in houses, large buildings, and factories, in order to ventilate indoor spaces. Ventilation systems include an air supply fan for supplying outdoor air to an indoor space, an air discharge fan for discharging indoor air to the outdoors, and a duct for guiding the outdoor air to the indoor space while guiding the indoor air to the outdoors. Such a ventilation system may also include a total heat exchanger for recovering a part of thermal energy contained in the indoor air discharged to the outdoors.

[0007] However, the total heat exchanger has the following problems.

[0008] First, the height of the total heat exchanger, which is installed in the interior of a ceiling, is restricted because the ceiling is designed to have a restricted thickness. For this reason, the height of a heat exchanging element built in the total heat exchanger to perform heat exchange between indoor air and outdoor air is restricted. As a result, the heat exchange area of the heat exchanging element is reduced, thereby causing the total heat efficiency of the total heat exchanger to be relatively lowered.

[0009] Second, the flow rate of air passing through the heat exchanging element is too high to enable the heat exchanging element to effectively perform a desired heat exchanging operation. As a result, a degradation in the efficiency of the total heat exchanger occurs.

[0010] Third, there is a problem in that an increase in flow resistance occurs because the flow directions of indoor air and outdoor air passing through the heat exchanging element are greatly varied.

SUMMARY OF THE INVENTION

[0011] Accordingly, the present invention is directed to a total heat exchanger and a ventilation system using the same that substantially obviate one or more problems due to limitations and disadvantages of the related art.

[0012] An object of the present invention is to provide a total heat exchanger having an increased total heat efficiency, and a ventilation system using the total heat exchanger.

[0013] Another object of the present invention is to provide a total heat exchanger capable of achieving a reduction in flow resistance, and a ventilation system using the total heat exchanger.

[0014] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0015] To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a total heat exchanger comprises: an air supply duct for guiding outdoor air to an indoor space; an air discharge duct for guiding indoor air to the outdoors; at least one air supply fan arranged at one side of the air supply duct, the air supply fan sucking the outdoor air, and supplying the sucked air to the indoor space; at least one air discharge fan arranged at one side of the air discharge duct, the air discharge fan sucking the indoor air, and discharging the sucked air to the outdoors; and at least one heat exchanging element arranged at a region where the indoor air and the outdoor air cross each other, the heat exchanging element heat-exchanging the indoor air with the outdoor air, wherein the heat exchanging element has a shape causing the indoor air and the outdoor air to flow through the heat exchanging element while forming an acute angle from each other.

[0016] The heat exchanging element may have a cross-sectional height smaller than a cross-sectional width of the heat exchanging element.

[0017] The heat exchanging element may have a substantially-polygonal cross section.

[0018] The heat exchanging element may have a substantially-diamond cross section.

[0019] The at least one heat exchanging element may comprise a plurality of heat exchanging elements arranged in series in a flow direction of air in the total heat exchanger.

[0020] The heat exchanging elements may guide an air flow passing through the air supply duct and an air flow passing through the air discharge duct such that the air flows pass through the heat exchanging elements in a zig-zag manner.

[0021] The total heat exchanger may further comprise an air-discharge-side bypass passage branched from the air discharge duct, and adapted to guide the indoor air to be directly discharged to the outdoors by a forcible suction force of the air discharge fan, without passing through the heat exchanging element.

[0022] The total heat exchanger may further comprise an air-supply-side bypass passage branched from the air supply duct, and adapted to guide the outdoor air to be directly discharged to the indoor space by a forcible suction force of the air supply fan, without passing through the heat exchanging element.

[0023] The total heat exchanger may further comprise a filter unit arranged in the air supply duct, and adapted to remove foreign matter contained in the outdoor air.

[0024] The air supply fan may include a rotating shaft extending perpendicularly to a discharge direction of the outdoor air discharged to the indoor space.

[0025] The at least one air supply fan may comprise a plurality of air supply fans. In this case, the total heat exchanger may further comprise a dual-axial motor for simultaneously driving the air supply fans.

[0026] The air discharge fan may include a rotating shaft extending perpendicularly to a discharge direction of the indoor air discharged to the outdoors.

[0027] The at least one air discharge fan may comprise a plurality of air discharge fans. In this case, the total heat exchanger may further comprise a dual-axial motor for simultaneously driving the air discharge fans.

[0028] The total heat exchanger may further comprise an air supply chamber for storing air discharged by the air supply fan, and an air discharge chamber for storing air discharged by the air discharge fan.

[0029] In another aspect of the present invention, a ventilation system comprises: an air supply duct for guiding outdoor air to an indoor space; an air discharge duct for guiding indoor air to the outdoors; an air supply fan arranged at one side of the air supply duct, the air supply fan sucking the outdoor air, and supplying the sucked air to the indoor space; an air discharge fan arranged at one side of the air discharge duct, the air discharge fan sucking the indoor air, and discharging the sucked air to the outdoors; a heat exchanging element arranged at a region where the indoor air and the outdoor air cross each other, the heat exchanging element heatexchanging the indoor air with the outdoor air; a first extension duct including a first diffuser for diffusing the outdoor air supplied from the air supply duct into the indoor space; and a second extension duct including a second diffuser spaced apart from the first diffuser by a predetermined distance, wherein the heat exchanging element has a shape causing the indoor air and the outdoor air to flow through the heat exchanging element while forming an acute angle from each other.

[0030] The first extension duct may further include a first lower extension duct for connecting the air supply duct to the indoor space, and a first upper extension duct for connecting the air supply duct to the outdoors.

[0031] The second extension duct may further include a second lower extension duct for connecting the air discharge duct to the indoor space, and a second upper extension duct for connecting the air discharge duct to the outdoors.

[0032] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0034] **FIG. 1** is a schematic perspective view illustrating an inner structure of a total heat exchanger according to a first embodiment of the present invention;

[0035] **FIG. 2** is a schematic sectional view illustrating the heat exchanging element shown in **FIG. 1** and air flows passing through the heat exchanging element;

[0036] **FIG. 3A** is a graph schematically depicting a temperature variation depending on the flow lengths of indoor air and outdoor air during a cooling operation for cooling an indoor space;

[0037] **FIG. 3B** is a graph schematically depicting a temperature variation depending on the flow lengths of indoor air and outdoor air during a heating operation for heating an indoor space;

[0038] **FIG. 4** is a schematic perspective view illustrating an inner structure of a total heat exchanger according to a second embodiment of the present invention;

[0039] **FIG. 5** is a schematic sectional view illustrating the heat exchanging element shown in **FIG. 4** and air flows passing through the heat exchanging element;

[0040] **FIG. 6** is a schematic perspective view illustrating an inner structure of a total heat exchanger according to a third embodiment of the present invention; and

[0041] **FIG. 7** is a schematic view illustrating a ventilation system equipped with a total heat exchanger according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0042] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0043] In FIGS. **1** to **7**, solid line arrows A represent a flow of indoor air, and broken line arrows B represent a flow of outdoor air.

[0044] **FIG. 1** is a schematic perspective view illustrating an exemplary embodiment of a total heat exchanger according to the present invention. **FIG. 2** is a schematic sectional view illustrating a heat exchanging element shown in **FIG. 1**. **FIG. 3A** is a graph schematically depicting a temperature variation depending on the flow lengths of indoor air and outdoor air during a cooling operation for cooling an indoor space. **FIG. 3B** is a graph schematically depicting a temperature variation depending on the flow lengths of indoor air and outdoor air during a heating operation for heating an indoor space.

[0045] Hereinafter, a first embodiment of the total heat exchanger according to the present invention will be described with reference to FIGS. 1 to 3B.

[0046] The total heat exchanger includes an air supply duct 10 for guiding outdoor air to an indoor space, an air discharge duct 20 for guiding indoor air to the outdoors, and a heat exchanging element 50*a* for heat-exchanging the indoor air with the outdoor air. The total heat exchanger may further include an air supply fan 13 for sucking the outdoor air, and supplying the sucked air to the indoor space, and an air discharge fan 23 for sucking the indoor air, and discharging the sucked air to the outdoors.

[0047] The heat exchanging element 50*a* is arranged at a region where an outdoor air flow guided by the air supply duct 10 and an indoor air flow guided by the air discharge duct 20 cross each other. The heat exchanging element 50*a* heat-exchanges the indoor air with the outdoor air through exchange of sensible heat using a temperature difference between the indoor air and outdoor air and exchange of latent heat using a humidity difference between the indoor air and outdoor air.

[0048] In detail, a first heat exchanging passage (not shown) and a second heat exchanging passage (not shown), through which the indoor air and outdoor air pass, respectively, are formed in the heat exchanging element 50*a*. The first and second heat exchanging passages are defined by a heat exchanging membrane (not shown) having excellent thermal characteristics.

[0049] Accordingly, when indoor air and outdoor air, which have temperature and humidity differences, pass through the associated heat exchanging passages, respectively, heat exchange occurs between the indoor air and outdoor air via the heat exchanging membrane.

[0050] A filter (not shown) may be arranged at one side of the heat exchanging element 50*a*. The filter functions to filter air to remove foreign matter contained in the air. The filter may be detachably coupled to the heat exchanging element 50*a*.

[0051] An air supply duct inlet 11 is provided at one end of the air supply duct 10. The air supply duct inlet 11 communicates with the outdoors. An air supply duct outlet 12 is provided at the other end of the air supply duct 10. The air supply duct outlet 12 communicates with the indoor space. Similarly, an air discharge duct inlet 21 is provided at one end of the air discharge duct 20. The air discharge duct inlet 21 communicates with the indoor space. An air discharge duct outlet 22 is provided at the other end of the air discharge duct 20. The air discharge duct outlet 22 communicates with the outdoors.

[0052] The air supply fan 13 is arranged in the air supply duct 10, to forcibly suck outdoor air from the outdoors, and to supply the sucked air to the indoor space. The air discharge fan 23 is arranged in the air discharge duct 20, to forcibly suck contaminated air from the indoor space, and to discharge the sucked air to the outdoors.

[0053] Both the air supply fan 12 and the air discharge fan 23 are mounted in an air supply fan housing and an air discharge fan housing, respectively. Motors (not shown) are arranged at the front sides of the air supply fan housing and air discharge fan housing, respectively.

[0054] Operation of the ventilation system configured as described above will now be described.

[0055] When electric power is applied to the air discharge fan 23, in order to ventilate indoor air contaminated to a certain level, the indoor air is introduced into the air discharge duct 20 through the air discharge duct inlet 21. The indoor air introduced in the air discharge duct 20 flows across the heat exchanging element 50*a* in a diagonal direction of the heat exchanging element 50*a*.

[0056] After flowing across the heat exchanging element 50*a*, the indoor air is guided along the air discharge duct 20, and is then discharged to the outdoors through the air discharge duct outlet 22. Simultaneously with the above-described flow of the indoor air, outdoor air is introduced into the air supply duct 10 through the air supply duct outlet 22. The outdoor air introduced in the air supply duct 10 flows across the heat exchanging element 50*a* in a diagonal direction of the heat exchanging element 50*a*.

[0057] After flowing across the heat exchanging element 50*a*, the outdoor air is guided along the air supply duct 10, and is then supplied to the indoor space through the air supply duct outlet 12. The indoor air and outdoor air, which flow in the above-described manner, heat-exchange while flowing across the heat exchanging element 50*a*. Thus, the outdoor air is supplied to the indoor space under the condition in which the outdoor air is maintained at an appropriate temperature.

[0058] Meanwhile, the indoor air is discharged to the outdoors mainly via two flow paths. That is, in association with a first flow path, the air introduced into the air discharge duct 20 through the air discharge duct inlet 21 passes through a first air discharge duct guide hole 24, and heat-exchanges with the outdoor air introduced into the air supply duct 20 via the air supply duct inlet 11, and is then discharged to the outdoors. On the other hand, in association with a second flow path, the air introduced into the air discharge duct 20 through the air discharge duct inlet 21 is directly discharged to the outdoors by the suction force of the air discharge fan 23, without passing through the heat exchanging element 50*a*.

[0059] In association with the latter case, the total heat exchanger further includes an air-discharge-side bypass passage 26 for guiding the indoor air to be directly discharged through the air discharge duct outlet 22. The indoor air introduced into the air discharge duct 20 through the air discharge duct inlet 21 flows along the air-discharge-side bypass passage 26 after passing through a second air discharge duct guide hole 25, and is then discharged to the outdoors. A damper may be arranged at the air discharge duct inlet 21, in order to guide the indoor air to the air-discharge-side bypass passage 26.

[0060] In accordance with the above-described configuration, it is possible to reduce pressure loss caused by the heat exchanging element by preventing the indoor air and outdoor air from passing through the heat exchanging element when the temperature and humidity differences between the indoor air and outdoor air is small, as in the spring and autumn seasons. Accordingly, the load applied to the fan can be reduced. As a result, it is possible to achieve a reduction in power consumption, and thus, to achieve saving of energy.

[0061] Meanwhile, the total heat efficiency of the total heat exchanger depends on how efficiently the heat exchanging element **50***a* heat-exchanges the indoor air with the outdoor air. In order to obtain a desired total heat efficiency, accordingly, it is necessary to increase the cross-sectional area of the heat exchanging element **50***a*. However, there is a restriction in increasing the vertical length of the heat exchanging element **50***a*, namely, the cross-sectional height of the heat exchanging element **50***a*, due to restrictions in the design of the construction in which the total heat exchanger is installed.

[0062] Thus, the improvement in the total heat efficiency of the heat exchanging element **50***a* and the minimization of the cross-sectional height of the heat exchanging element **50***a* are in opposition to each other. However, the inventor found the fact that it is possible to increase the cross-sectional area of the heat exchanging element **50***a* without increasing the cross-sectional height of the heating exchanging element **50***a*, for an enhancement in the total heat efficiency of the total heat exchanger.

[0063] In detail, in accordance with the present invention, the heat exchanging element **50***a* is configured to cause indoor and outdoor air flows passing through the heat exchanging element **50***a* to form an acute angle θ therebetween. The heat exchanging element **50***a* is also configured such that the cross-sectional width w of the heat exchanging element **50***a* is larger than the cross-sectional height h of the heat exchanging element **50***a*. In this embodiment, the heat exchanging element **50***a* has a diamond shape, as shown in **FIG. 2**.

[0064] Of course, the heat exchanging element **50***a* may have other cross-sectional shapes. For example, the heat exchanging element **50***a* may have a curved or polygonal cross-sectional shape. Furthermore, the heat exchanging element **50***a* may have a cross-sectional shape having both a rectilinear portion and a curved portion.

[0065] When the cross-sectional width of the heat exchanging element **50***a* is larger than the cross-sectional height of the heat exchanging element **50***a*, the flow length of air flowing through the heat exchanging element **50***a* is increased, and the flow rate of the air is reduced. Accordingly, the indoor air and outdoor air passing through the heat exchanging element **50***a* can more efficiently heat-exchange with each other.

[0066] In addition, when the cross-sectional width of the heat exchanging element **50***a* is larger than the cross-sectional height of the heat exchanging element **50***a*, the variation in the directions of air flows passing through the air supply duct and air discharge duct is reduced. As a result, flow resistances in the air supply duct and air discharge duct are reduced.

[0067] Hereinafter, a variation in temperature depending on the length of the flow path defined in the heat exchanging element according to the present invention will be described with reference to **FIGS. 3A and 3B**.

[0068] In each of **FIGS. 3A and 3B**, "X" designates a temperature difference between the temperature of indoor air varying depending on the length of the flow path of a heat exchanging element, as depicted by a graph A and the temperature of outdoor air varying depending on the length of the flow path of the heat exchanging element, as depicted by a graph B, in the case in which the heating exchanging element has a conventional structure. In each of **FIGS. 3A and 3B**, "Y" designates a temperature difference between the temperature of indoor air varying depending on the length of the flow path of a heat exchanging element, as depicted by the graph A and the temperature of outdoor air varying depending on the length of the flow path of the heat exchanging element, as depicted by the graph B, in the case in which the heating exchanging element has a structure according to the present invention.

[0069] For an operation mode for cooling the indoor space, for example, in the summer season, the temperature of indoor air to be cooled is set to be relatively lower than the temperature of outdoor air, as shown in **FIG. 3A**. The difference between the indoor air temperature and the outdoor air temperature is reduced in accordance with heat exchange carried out by the heat exchanging element **50***a* of the total heat exchanger. The outdoor air, which has a relatively high temperature, heat-exchanges with the indoor air, which is discharged to the outdoors. As a result, the outdoor air is supplied to the indoor space in a state in which the temperature of the outdoor air has been lowered below the temperature of outdoor air present in the outdoors.

[0070] Referring to **FIG. 3A**, it can be seen that, in the case of the heat exchanging element having a cross-sectional shape according to the present invention, more effective heat exchange is carried out. Accordingly, it is possible to further reduce the temperature difference between the outdoor air supplied to the indoor space and the indoor air discharged to the outdoors, using the heat exchanging element according to the present invention.

[0071] For an operation mode for heating the indoor space, for example, in the winter season, the temperature of indoor air to be heated is set to be relatively higher than the temperature of outdoor air, as shown in **FIG. 3B**. Referring to **FIG. 3B**, it can be seen that, in the case of the heat exchanging element having a cross-sectional shape according to the present invention, more effective heat exchange is carried out, as compared to the conventional heat exchanging element.

[0072] Although the total heat exchanger according to this embodiment has been described as being installed in the interior of a ceiling, it may be installed at a side wall of a building.

[0073] Hereinafter, a second embodiment of the total heat exchanger according to the present invention will be described with reference to **FIGS. 4 and 5**.

[0074] The basic configuration of the second embodiment of the total heat exchanger according to the present invention is identical to that of the first embodiment as described above. In the second embodiment, however, the total heat exchanger includes a plurality of heat exchanging elements **50***b* arranged in series in a flow direction of air in the total heat exchanger.

[0075] As described above, there is a restriction in increasing the cross-sectional height of a heat exchanging element due to restrictions in the design of the construction in which the total heat exchanger is installed. When the heat exchanging elements **50***b* are arranged in series in a flow direction of air in the total heat exchanger, it is possible to achieve an enhancement in heat exchange efficiency without an increase in the cross-sectional height of the heat exchanging elements **50***b*.

[0076] As shown in **FIG. 4**, air flowing in each of the air supply duct **10** and air discharge duct **20** passes through the heat exchanging elements **50***b* in a zig-zag manner. Accordingly, the total heat exchanging area of the heat exchanging elements **50***b* and the length of the path, along which air flows, are increased.

[0077] In addition, the flow velocity of the air is gradually reduced as the air sequentially passes through the serially-arranged heat exchanging elements **50***b*. Such a reduction in flow velocity provides advantageous effects in terms of heat exchange. As a result, it is possible to enhance the total heat efficiency of the total heat exchanger by virtue of the increased total heat exchanging area and the reduced air flow velocity.

[0078] Meanwhile, it is preferred that the heat exchanging elements be detachably coupled to the total heat exchanger. By virtue of such a detachable structure, it is possible to achieve easy assembly and disassembly of the heat exchanging elements.

[0079] The total heat exchanger also includes an air-discharge-side bypass passage **26**. When the temperature and humidity differences between the indoor space and the outdoors are small, as in the spring or autumn season, indoor air is discharged to the outdoors via the air-discharge-side bypass passage **26** without passing through the heat exchanging elements **50***b*. In this case, there is no pressure loss through the heat exchanging elements **50***b*. Accordingly, it is possible to reduce the load applied to the air discharge fan, and thus, to reduce power consumption.

[0080] Although not shown, the total heat exchanger may also include an air-supply-side bypass passage for allowing outdoor air to be directly introduced into the indoor space. In this case, a damper is arranged at one end of the air-supply-side bypass passage, in order to control flow of outdoor air through the air-supply-side bypass passage. Accordingly, when it is unnecessary to heat-exchange indoor air with outdoor air, the outdoor air is guided to pass through the inlet of the air supply duct, and then to be directly introduced into the indoor space via the air-supply-side bypass passage.

[0081] The total heat exchanger may further include a filter unit (not shown) for filtering outdoor air flowing through the air supply duct, to remove foreign matter contained in the outdoor air. Accordingly, the outdoor air can be supplied to the indoor space in a clean state after passing through the filter unit.

[0082] The filter unit includes a dust-collecting filter which has a fiber mat structure, to collect foreign matter such as dust. The filter unit may also include an antibiotic filter for removing bacteria present in air, a photocatalytic collector for removing fine dust and volatile organic compounds passing through the filter, a deodorizing filter for deodorizing air, an anion generator, or a combination thereof.

[0083] Hereinafter, a third embodiment of the total heat exchanger according to the present invention will be described with reference to **FIG. 6**.

[0084] In accordance with this embodiment, the total heat exchanger includes an air-supply-side fan-motor assembly **130** and an air-discharge-side fan-motor assembly **230**.

[0085] The air-supply-side fan-motor assembly **130** includes a plurality of air supply fans **131** each having a rotating shaft extending perpendicularly to the discharge direction of outdoor air. similarly, the air-discharge-side fan-motor assembly **230** includes a plurality of air discharge fans **231** each having a rotating shaft extending perpendicularly to the discharge direction of indoor air.

[0086] The air supply fans **131** are driven by a single dual-axial motor **132**. Similarly, the air discharge fans **231** are driven by a single dual-axial motor **232**. Since the air supply fans **131** and air discharge fans **231** are driven by the associated dual-axial motors **132** and **232**, respectively, it is possible to produce an increase amount of air flow. In the illustrated case, the total heat exchanger includes two air supply fans **131** and two air discharge fans **231**.

[0087] The total heat exchanger also includes an air supply chamber **17** defined in the interior of the total heat exchanger at the side of the air supply fans **131**, and adapted to store air discharged by the air supply fans **131**, and an air discharge chamber **27** defined in the interior of the total heat exchanger at the side of the air discharge fans **231**, and adapted to store air discharged by the air discharge fans **231**. As the air supply chamber **17** and air discharge chamber **27** temporarily store air to be supplied and air to be discharged, respectively, air can flow uniformly through the air supply duct and air discharge duct.

[0088] Although the rotating shafts of the air supply fan **13** and air discharge fan **23** extend in directions identical to the discharge directions of outdoor air and indoor air, respectively, in the above-described embodiments, the rotating shafts of the air supply fans **131** and air discharge fans **231** extend perpendicularly to the discharge directions of the outdoor air and indoor air, respectively, in this embodiment.

[0089] Hereinafter, an exemplary embodiment of a ventilation system according to the present invention will be described with reference to **FIG. 7**.

[0090] The ventilation system according to this embodiment includes a total heat exchanger **1000** which has the same configuration as that of one of the above-described total heat exchangers. The ventilation system also includes a first extension duct **500** and a second extension duct **600**. The total heat exchanger **100** is arranged at a region where the first and second extension ducts **500** and **600** meet.

[0091] The first extension duct **500** includes a first lower extension duct **520** for enabling the air supply duct of the total heat exchanger **1000** to communicate with the indoor space, a first upper extension duct **530** for enabling the air supply duct of the total heat exchanger **1000** to communicate with the outdoors, and a first diffuser **510** for diffusing outdoor air supplied to the indoor space.

[0092] In detail, the first lower extension duct **520** is connected, at one end thereof, to the air supply duct of the total heat exchanger **1000**, and is connected, at the other end thereof, to the first diffuser **510** partially opened to the indoor space. Of course, the first diffuser **510** may be completely opened to the indoor space.

[**0093**] The second extension duct **600** includes a second lower extension duct **620** for enabling the air discharge duct of the total heat exchanger **1000** to communicate with the indoor space, a second upper extension duct **630** for enabling the air discharge duct of the total heat exchanger **1000** to communicate with the outdoors, and a second diffuser **610** for sucking indoor air into the second extension duct **600**.

[**0094**] In detail, the second lower extension duct **620** is connected, at one end thereof, to the air discharge duct of the total heat exchanger **1000**, and is connected, at the other end thereof, to the second diffuser **610** partially opened to the indoor space. Of course, the second diffuser **610** may be completely opened to the indoor space.

[**0095**] The second extension duct **600** functions to enable the air discharge duct of the total heat exchanger **1000** to communicate with the indoor space, and to enable the total heat exchanger **100** to communicate with the outdoors. The second diffuser **610** is mounted to an end of the second extension duct **600**.

[**0096**] As the ventilation system having the above-described configuration uses the total heat exchanger according to the present invention, the ventilation system can maintain a high total heat efficiency irrespective of the design of the construction in which the ventilation system is installed.

[**0097**] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A total heat exchanger comprising:

an air supply duct for guiding outdoor air to an indoor space;

an air discharge duct for guiding indoor air to the outdoors;

at least one air supply fan arranged at one side of the air supply duct, the air supply fan sucking the outdoor air, and supplying the sucked air to the indoor space;

at least one air discharge fan arranged at one side of the air discharge duct, the air discharge fan sucking the indoor air, and discharging the sucked air to the outdoors; and

at least one heat exchanging element arranged at a region where the indoor air and the outdoor air cross each other, the heat exchanging element heat-exchanging the indoor air with the outdoor air,

wherein the heat exchanging element has a shape causing the indoor air and the outdoor air to flow through the heat exchanging element while forming an acute angle with respect to each other.

2. The total heat exchanger according to claim 1, wherein the heat exchanging element has a cross-sectional height smaller than a cross-sectional width of the heat exchanging element.

3. The total heat exchanger according to claim 1, wherein the heat exchanging element has a substantially-polygonal cross section.

4. The total heat exchanger according to claim 3, wherein the heat exchanging element has a substantially-diamond cross section.

5. The total heat exchanger according to claim 1, wherein the at least one heat exchanging element comprises a plurality of heat exchanging elements arranged in series in a flow direction of air in the total heat exchanger.

6. The total heat exchanger according to claim 5, wherein the heat exchanging elements guide an air flow passing through the air supply duct and an air flow passing through the air discharge duct such that the air flows pass through the heat exchanging elements in a zig-zag manner.

7. The total heat exchanger according to claim 1, further comprising:

an air-discharge-side bypass passage branched from the air discharge duct, and adapted to guide the indoor air to be directly discharged to the outdoors by a forcible suction force of the air discharge fan, without passing through the heat exchanging element.

8. The total heat exchanger according to claim 1, further comprising:

an air-supply-side bypass passage branched from the air supply duct, and adapted to guide the outdoor air to be directly discharged to the indoor space by a forcible suction force of the air supply fan, without passing through the heat exchanging element.

9. The total heat exchanger according to claim 1, further comprising:

a filter unit arranged in the air supply duct, and adapted to remove foreign matter contained in the outdoor air.

10. The total heat exchanger according to claim 1, wherein the air supply fan includes a rotating shaft extending perpendicularly to a discharge direction of the outdoor air discharged to the indoor space.

11. The total heat exchanger according to claim 10, wherein the at least one air supply fan comprises a plurality of air supply fans,

further comprising:

a dual-axial motor for simultaneously driving the air supply fans.

12. The total heat exchanger according to claim 1, wherein the air discharge fan includes a rotating shaft extending perpendicularly to a discharge direction of the indoor air discharged to the outdoors.

13. The total heat exchanger according to claim 12, wherein the at least one air discharge fan comprises a plurality of air discharge fans,

further comprising:

a dual-axial motor for simultaneously driving the air discharge fans.

14. The total heat exchanger according to claim 1, further comprising:

an air supply chamber for storing air discharged by the air supply fan; and

an air discharge chamber for storing air discharged by the air discharge fan.

15. A ventilation system comprising:

an air supply duct for guiding outdoor air to an indoor space;

an air discharge duct for guiding indoor air to the outdoors;

an air supply fan arranged at one side of the air supply duct, the air supply fan sucking the outdoor air, and supplying the sucked air to the indoor space;

an air discharge fan arranged at one side of the air discharge duct, the air discharge fan sucking the indoor air, and discharging the sucked air to the outdoors;

a heat exchanging element arranged at a region where the indoor air and the outdoor air cross each other, the heat exchanging element heat-exchanging the indoor air with the outdoor air;

a first extension duct including a first diffuser for diffusing the outdoor air supplied from the air supply duct into the indoor space; and

a second extension duct including a second diffuser spaced apart from the first diffuser by a predetermined distance,

wherein the heat exchanging element has a shape causing the indoor air and the outdoor air to flow through the heat exchanging element while forming an acute angle with respect to each other.

16. The ventilation system according to claim 15, wherein the first extension duct further includes a lower extension duct for connecting the air supply duct to the indoor space, and an upper extension duct for connecting the air supply duct to the outdoors.

17. The ventilation system according to claim 15, wherein the second extension duct further includes a lower extension duct for connecting the air discharge duct to the indoor space, and an upper extension duct for connecting the air discharge duct to the outdoors.

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