

Room Ventilator and Air Purifier

Field of Invention

- 5 The present invention relates to a ventilation device for homes and residential, commercial or office units in single and multi-storied buildings.

Background of the invention

10 Modern buildings in tropical and sub-tropical climates are being increasingly built as sealed buildings, wherein windows are not designed to be opened frequently for ventilation and indoor ventilation is in the form of a centralized cooling and dehumidification including ventilation by air-conditioning (HVAC) systems. The HVAC systems carry high operational cost and most of them, especially decentralised split units do not bring in fresh air. Occupants residing within the building during prolonged
15 periods suffer from poor indoor air quality such as build-up of carbon dioxide, volatile organic compounds and allergens.

Additionally, due to pollution, forest fires and land clearing activities, outdoor air can become tainted with unhealthy amounts of smog, carbon dioxide, carbon monoxide, haze particulates, common ash, and other pollutants which in the long run are
20 detrimental to the health of occupants of a building. Occupants in buildings with windows which are designed to be opened to allow outside air into the building would not leave their windows open in fear of exposure to such pollutants and is so doing, suffer from poor indoor air quality. In spite of that, occupants who still do open their windows to allow outside air in also risk exposure to pests such as mosquitoes and
25 other flying insects. Hence, both kinds of occupants, those who close their windows to prevent polluted air from entering and those who open their windows to allow polluted air to enter are at risk. The danger culminates during a haze, as even closing the windows cannot render healthy indoor air quality conditions. The trade-off appears to be between having unpolluted indoor stale air or polluted outdoor air from outside. In
30 case the occupants close the windows, they might get both: unhealthy stale air as air pollutants from the haze may intrude into a building even when all windows are closed. Conventional air purifiers designed to purify indoor air are able to do so, but they are unable to produce fresh air.

In view of the foregoing, there is a need for a means to provide fresh air to building
35 occupants while avoiding exposure to outdoor air pollutants and pests.

Summary of the invention

The present invention relates to a ventilator for creating an exchange of air between a first area and a second area separated by a wall, comprising a housing forming a channel between the first area and second area to allow exchange of air between the first area and second area, a first opening disposed at side of the housing facing the first area to allow air to be drawn in from the first area, a second opening disposed at side of the housing facing the second area to allow air to be introduced to the second area, at least one mesh fitted within the housing to permit passage of air while inhibiting progress of particulate matter and/or insects, and a fan located within the housing for creating a flow of air from the first area to the second area. The second opening is sealable with a cover, whereby closing the cover on the second opening causes the fan to turn off.

Brief Description of the Drawings

The present invention will become more fully understood from the detailed description given herein below and accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, wherein:

Figure 1 shows a top isometric view of a room ventilator being a preferred embodiment of the present invention.

Figure 2 shows an exposed top isometric view of the ventilator shown in Figure 1.

Figure 3 shows a side cross-sectional view of the ventilator shown in Figure 1 which is installed at a wall.

Figure 4a shows direction of air travelling in a room with a ventilator drawing air in.

Figure 4b shows direction of air travelling in a room with a ventilator drawing air in and an exhaust drawing air out.

Figure 4c shows direction of air travelling in a room with a ventilator drawing air in and an exhaust drawing air out wherein the exhaust is in a location different from the location shown in Figure 4b.

Figure 5a shows a preferred ventilator control system.

Figure 5b shows an alternative ventilator control system.

Detailed Description of the Preferred Embodiment

Detailed description of preferred embodiment of the present invention is disclosed herein. It should be understood, however, that the embodiment is merely exemplary of

the present invention, which may be embodied in various forms. Therefore, the details disclosed herein are not to be interpreted as limiting, but merely as the basis for the

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claim and for teaching one skilled in the art of the invention. The numerical data or ranges used in the specification are not to be construed as limiting.

Figure 1 shows a front isometric view of a ventilator (10) being a preferred embodiment of the present invention, where the ventilator (10) comprises of a housing (11) fitted
10 through a wall or window of a building to enable exchange of air between a first area and a second area. The housing (11) forms a channel through which air may travel from the first area to the second area, or from the second area to the first area.

For the purposes of this disclosure, the first area is an outdoor area wherein fresh and preferably cooler night time air is to be drawn in, while the second area is an indoor
15 area where occupants reside and the harvested air is to be introduced. Preferably, ambient air in outdoor area is cooler than indoor air, in conditions such as during night-time or especially cool seasons or cooler places like near to mountain ridges or in highlands.

The housing (11) has a first opening (shown in later figures) at side of the housing
20 facing the first or outdoor area to allow air to be drawn in and a second opening facing the second or indoor area, which in this figure is sealed with a cover (12), to allow air to be introduced to indoor area whilst open. A handle (12a) connected to a latch (shown in Figure 2) allows the cover (12) to be opened. At least one side opening (13) is formed at side of the housing (11) to at least one mesh (shown in later figures) to be
25 fitted. The first opening located at the outside bottom portion of the ventilator allows outdoor air to be drawn in and supplied indoors at the second opening.

Figure 2 shows an exposed view of the ventilator (10), wherein parts of walls of the housing (11) are removed so that additional components may be seen. Preferably, the ventilator (10) measures at 28cm height by 28cm width by 30cm depth, wherein the
30 height is measured from upper wall to lower wall of the housing (11). The width is measured from left wall to right wall of the housing (11) and depth is front side to rear side of the housing (11), wherein the front side faces the indoor area and rear side faces the outdoor area. The housing (11) is preferably fabricated from plastics material such as polyethylene. However, other materials such as aluminium, stainless steel,
35 acrylonitrile butadiene styrene (ABS) or any lightweight, rigid materials with consistently low U-values (heat transmission rate) and low g-values (solar energy transmittance)

are envisioned to be equally suited for fabricating the housing (11) of the ventilator (10).

As it can be seen in Figure 2, the inlet first opening (14) is an opening made at the bottom part of the housing (11) facing the outdoor area. By placing the first opening (14) at bottom of the housing (11), ingress of foreign material such as rain droplets is minimized or almost nil. A sloping portion (15) made at rear or outside portion of the

housing (11) functions as a guard to allow rain droplets or other falling matter landing on the sloping portion (15) to be directed away from the inlet first opening (14). The sloping portion (15) is preferably angled at 60° from horizontal plane, however, the sloping portion (15) may be angled in a range of 60° to 80° from horizontal plane.

A mesh (18) is fitted in the housing (11) via the side opening (13) shown in Figure 1 and functions to permit air to flow through the ventilator while preventing particulate matter or insects from entering. For the purposes of this disclosure, the term mesh includes any type of barrier such as, but not limited to netting, screen, filter, or gauze which allows passage of air and prevents particulate matter or other foreign objects from entering. Preferably, the mesh (18) is bordered by a slidable frame which allows easy insertion and removal of the mesh or filters (18) through side opening (13). The mesh (18) may be a mosquito net or an air filter which stops particulate matter up to 10 microns in size (PM₁₀) and especially fine particulate matter up to 2.5 microns in size (PM_{2.5}) in outdoor air or an insect netting which prevents insects present outdoors from passing through the ventilator (10). Preferably, and especially in urban areas, the mesh (18) is not a mosquito net, but an air filter having a high-efficiency particulate arrestance (HEPA) F6 grade which is washable. Alternatively, the mesh (18) is an air filter of HEPA G3-H13 (minimum efficiency reporting value (MERV) 17 rating) grades. Filters with MERV 17 rating are able to capture over 95% of particulate matter which are 2.5 microns in size (PM_{2.5}). Generally, such filters are disposable, however, such filters are preferably washable. Such filters may be obtained from suppliers such as Filter-Mueller e. K..

Depending on the type of filter (washable or disposable), the filter may be washed or disposed as needed by removing the filter from the side opening (13) and replacing it as and when it is needed. While a single mesh (18) is shown in the figure, it would be appreciated by a person skilled in the art that more than one filter (18) may be installed, each with varying fineness of mesh size. For example, a mesh (18) being a mosquito netting having a mesh size of 1mm by 1mm may be used to prevent intrusion by pests such as mosquitos and flies, and another mesh (18) being an air filer and having a

grade of F6 may be used to filter out particulates such as particulate matter (PM₁₀) and fine particulate matter (PM_{2.5}), ordinary fly ash, dust and soot. Preferably, to ensure minimal intrusion of air pollutants, the indoor area to be ventilated is almost airtight and outdoor air is introduced into the room solely by the ventilator (10), whereby the dissipating air from indoor area to outdoor area is either performed by a ducted or non-ducted exhaust fan or existing air gaps.

A fan (20) located within the housing (11) is capable of drawing in air from outdoors and blowing it into the indoor area. Preferably, the fan (20) is an axial energy-efficient fan operating at the following parameters: 230V AC, 50/60Hz, 1700/1200RPM, 32W, 0.24A, 40Pa. Still preferably, the fan draws in air at a rate of 300liters/hour. In a preferred embodiment, the fan (20) is an axial energy-efficient fan with model no. W1G250-BB17-01 from ebm-papst. While the fan (20) is preferably configured to blow in a single direction, which is to bring outdoor air into the indoor area, the fan (20) may optionally be configured to blow in both directions, wherein outdoor air may be brought into an indoor area, and after a switching period of 50-80 seconds indoor air may be brought into the outdoor area. As the fan (20) is the only component which requires electrical power to operate, the fan (20) preferably draws power from the usual AC-driven electrical supply, or alternatively, is connected to a solar panel or any other DC source. Preferably, the fan (20) is disposed with a plurality of radial fins (20a) which dampen noise produced by the fan (20) when the fan (20) is in operation. While it can be seen that the mesh (18) is placed behind the fan (20), it is conceivable that the arrangement of the fan (20) and mesh (18) need not be so and the mesh (18) may be placed before the fan (20) or a fan (20) placed in between two meshes (18).

The second opening (16) is formed at front or indoor side of the housing (11) and allows air to be introduced into an indoor area. The second opening (16) may be sealed with a cover (12) pivotably connected to the ventilator (10) which prevents thermal leakage when the ventilator (10) is not in use. A latch (12b) helps secure the cover (12) to the housing (11) when the cover (12) is closed. An elastomeric seal (12c) prevents air from leaking either from indoor area to outdoor area or from outdoor area to indoor area when the cover (12) is closed which therefore prevents thermal leakage. Preferably, a normally closed contact switch (23) allows power to be supplied to the fan (20) when the cover (12) is open. When cover (12) is closed, this engages the contact switch (23) which causes circuit connected to the fan (20) to be open and cuts off the electrical supply to the fan (20) which then stops operating. When cover (12) is open, the contact switch (23) is disengaged and circuit is closed which allows power is

supplied to the fan (20) for the fan (20) to operate. Alternatively, a reed switch may be used in place of contact switch (23). Still further, other means known to a skilled person or a smart automated system to achieve this effect may be employed.

- 5 Conditions which call for the cover (12) to be closed to prevent thermal leakage would be in weather conditions where ambient air in an indoor area is at a thermally comfortable temperature, which in the tropically adapted thermal comfort bandings is generally at 26-28°C (depending on the humidity), and outdoor air is at a significantly higher or lower temperature, for example, being at usually not higher than tropical 34°C
10 (shaded heat peak temperature) or not lower than 24°C (lowest early morning temperature) whereby introduction of outside air would raise the temperature of

- ambient air during daytime, causing it to not be a thermally comfortable temperature. This consideration will be different depending on the exact location and given weather
15 condition.

- A dimmer switch (21) allows rotational speed of the fan (20) to be set. Preferably, the dimmer switch (21) has a dimmer knob which may be rotated to control rotational speed of the fan (20). Where higher air flow rate is desired, the dimmer switch (21) may be manipulated to cause the fan (20) to rotate at a higher speed, and where lower air
20 flow rate is, the dimmer switch (21) may be manipulated to cause the fan (20) to rotate at a lower speed.

- Figure 4 shows the ventilator (10) installed in a building wall (22) where the area at left of the wall (22) is the indoor area (B) and area at right of the wall (22) is the outdoor area (A). When the fan (20) is turned on, outdoor air is drawn into the housing (11)
25 through the first opening (14). The air then passes through the mesh (18) which allows air to pass while preventing particulate matter and/or insects from progressing further. Air then passes through the fan (20) and exits the ventilator (10) through the second opening (16), where it is then introduced to the indoor area.

- The mesh (18) is able to act as an insect trap by causing small winged insects such as mosquitoes and flies to be trapped at the mesh (18). This is observed to occur when
30 other openings to an indoor area are closed leaving only the ventilator (10) as the main passage through which such insects would seek to enter. Due to suction force created by the fan (20), such insects are trapped as they try to fly into indoor area through the ventilator (10) but are stopped by the mesh (10) and unable to escape as they have
35 been caught by suction caused by the fan (20).

The ventilator (10) may be additionally configured to also exhaust indoor air to outdoor area. This is achieved by reversing rotation of the fan (20), which in effect would draw

air from indoor area and through the second opening (16) and fan (20) past the mesh (18) and exiting through the first opening (14). In this manner, build-up of harmful gasses such as carbon dioxide can be exhausted from inside a building so that indoor
 5 air quality may be improved. The best effect, however, can be achieved through cross-ventilation via an exhaust fan operating from the other side of the room.

Figures 4a, 4b, and 4c show a plan view of a room (100) whereby a ventilator (10) has been installed. In Figure 4a, the room (100) is installed with a ventilator (10). Ventilation of the room is achieved by means of the ventilator (10) supplying air into the room
 10 (100) by bringing air from an outdoor area into the room (100). This creates a positive pressure in the room (100) and air inside the room (100) will seek a way to escape (100). Air may escape through openings such as through an open door (101), or if the door (101) is closed, then it will escape through the gap present between door (101)

15 and floor of the room (100). This creates an exchange of air wherein fresh air is brought in from outdoor area and into the room (100) while stale air in the room (100) is forced out through the door slot (101). Alternatively, the ventilator (10) may be configured to draw outdoor air into the room (100) for a predetermined duration, and once the duration is over, exhaust indoor air from the room (100) to outdoor area for
 20 another predetermined duration. This can be configured to occur alternately so that there is an automated supply of fresh air and exhaust of stale air to ensure good quality of indoor air.

Figures 4b and 4c show the same room (100), but with an exhaust (102) fitted at a side of the room (100) across the ventilator (10) or at same side as the ventilator (10). Now,
 25 air is allowed to escape through the exhaust (102). The exhaust (102) is preferably an exhaust second opening with a fan, however, it is conceivable that the exhaust (102) may be a second ventilator (10) with a reverse flow to draw air from the room (100) out to the outdoor area as opposed to bringing outdoor air into the room (100). Additionally, to prevent thermal leakage and pest intrusion, if the exhaust (102) is a simple exhaust
 30 fan, it may be fitted with a netting to prevent pest intrusion, and also a self-closing exhaust grill which opens when the exhaust fan is operating and closed when the exhaust fan stops operating.

It would be appreciated by a person having ordinary skill in the art that the above configurations are merely exemplary and other configurations known to a person
 35 having ordinary skill in the art may be employed.

Figure 5a shows a preferred embodiment of a control system for controlling operation of a ventilator. A switch (300) is connected to the fan (20), wherein the switch (300)

controls the speed of the fan (20). Preferably, the switch (300) is a dimmer type switch wherein fan speed is adjusted by rotating a dimmer knob of the switch (300). Optionally, the switch (300) may be integrated with a timer control the operation
5 duration of the fan (20) so as to only turn on at certain times. An example would be to set the fan (20) to function only at night before or sometimes after midnight until after dawn, where outdoor air temperature has dropped to a lower level than the indoor temperature. By drawing in outdoor air to cool the indoor area, devices interactively operated with the ventilator such as air conditioners would consume less power as by
10 far less energy is required to provide a refrigeration effect to cool air in the room during most tropical nights and during / after heavy downpour.

In another embodiment, shown in Figure 5b, a thermostat (301) is connected to an air conditioner (200) while a ventilator (10) is in operation. The thermostat (301) detects temperature of indoor air and turns off the air conditioner (200) fully when a
15 predetermined lower temperature is reached and turns the air conditioner (200) back

on when a predetermined upper temperature is reached. This will help reduce electrical consumption since the air conditioner (200) is only turned on when the individualised allowable highest temperature could not be achieved by the ventilator (10) harvesting
20 outdoor air. Once the temperature harvested from outside is in line with the occupants' satisfaction, the air conditioner virtually is silent. As a 1 horsepower air conditioner consumes approximately 1 kW, up to 1/20 of the electricity is required to maintain the desired temperature as the fan consumes approximately 30 W as the ventilator (10) continues to supply fresh air as needed while the air conditioner remains dormant until
25 the temperature gain in the indoor area exceeds the individualised limit. Conceivably, this is achievable at night time conditions when outdoor air is cooler than indoor air.

Claims

1. A ventilator (10) for creating an exchange of air between a first area (A) and a second area (B) separated by a wall (22), comprising:

5 a housing (11) forming a channel between the first area and second area to allow exchange of air between the first area and second area;

a first opening (14) disposed at side of the housing (11) facing the first area to allow air to be drawn in from the first area;

10 a second opening (12) disposed at side of the housing (11) facing the second area to allow air to be introduced to the second area;

at least one mesh (18) fitted within the housing (11) to permit passage of air while inhibiting progress of particulate matter and/or insects; and

a fan (20) located within the housing (11) for creating a flow of air from the first area to the second area;

15 wherein

the second opening (12) is sealable with a cover (12), whereby closing the cover (12) on the second opening (12) causes the fan (20) to turn off.
2. The ventilator (10) as claimed in claim 1, wherein the ventilator (10) further comprises a contact switch (23) engagable by the cover (12) to cause the fan (20) to turn off.

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3. The ventilator (10) as claimed in claim 1, wherein the first opening (14) is placed at bottom of side of the housing (11) facing the first area.
4. The ventilator (10) as claimed in claim 1, further comprising a sloping portion (15) to direct matter falling onto the sloping portion (15) away from the first opening (14).

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5. The ventilator (10) as claimed in claim 1, wherein the mesh (18) is an air filter.
6. The ventilator (10) as claimed in claim 1, wherein the mesh (18) is an insect netting.
7. The ventilator (10) as claimed in claim 1, wherein the fan (20) is configurable to rotate at a reversed direction to create a flow of air from the second area to the first area.

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