

METHOD OF REDUCING NOISE LEVEL IN AN AIR PURIFIER

FIELD OF INVENTION

5 The present invention is generally related to an air purifying system and, more particularly is related to a High Efficiency Particulate Air (HEPA) air purifier system with large airflow capacity and method of reducing the noise level emitted by the high capacity mechanical ventilation fan therein.

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BACKGROUND

Scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Research
15 also indicates that people spend approximately 90 percent of their time indoors. Thus, for many people, the risks to health may be greater due to exposure to air pollution indoors than air pollution outdoors.

Examples of contaminants in indoor air that can affect one's breathing and overall health are:
20 dust mites, mold spores, tobacco smoke, pollen, bacteria, viruses, gas molecules such as auto exhaust fumes, and other pollutants. Unpleasant odors also contribute to poor indoor air quality. Odors are caused by gases such as formaldehyde (a caustic agent), ammonia (pet and body odors), acetaldehyde (tobacco odors), and off-gassing from paints, carpets, adhesives, and other pollutants that a human senses can detect. Cleaning sprays also emit fumes that are unpleasant
25 and unsafe to breathe. Personal discomfort including itchy and watery eyes and coughing is a visible sign that these contaminants are present. A combination of odor and contaminant control is important for healthier indoor air. As a result, air purifiers have grown in popularity as a means of reducing these contaminants and improving overall indoor room air quality. Conventional air purifiers trap airborne contaminants using either mechanical or electrostatic
30 technology. One example of a conventional air purifier is a HEPA air purifier.

HEPA air purifiers are air purifiers that utilize HEPA filters which have an efficiency for removing at least 99.97% of the particles of size 0.3 micron or larger from the air in a room. A HEPA filter comprises a sheet of a special paper filter, which is pleated with corrugated aluminum separators between the pleats. This forms the HEPA air filter element, which is then bonded into a rigid frame using a polyurethane compound.

One disadvantage of HEPA air purifiers, in particularly those with large airflow capacity of at least 1000 cubic feet per minute, is that the level of the noise emitted by the high capacity mechanical ventilation fan therein can reach as high as 80 to 90 dBA. Such noise level is not desirable as HEPA air purifiers are used commonly in places where silence is desired, for example in a library and a hospital.

Therefore, a need exists in the industry to address the aforementioned deficiencies and inadequacies of the HEPA air purifier.

SUMMARY

The aspects of the invention can also be viewed as providing method of reducing the noise level emitted by the High Efficiency Particulate Air (HEPA) air purifier system. In this regard, one
5 embodiment of such a method, among others, can be broadly summarized by the steps described hereinafter.

In accordance with a first aspect of the invention, there is provided an air purifier, comprising:

a housing divided into a lower compartment, a middle compartment, and an upper
10 compartment;

said lower compartment comprising:

an air inlet formed in said lower compartment for entry of air;

a first filter coupled to said air inlet for trapping airborne particles of at
least a predetermined size;

15 and

at least a lamp disposed within said lower compartment for killing micro-organisms in the air;

said middle compartment comprising:

an air-moving equipment mounted in said middle compartment for
20 creating a pressure difference between said upper compartment and said lower compartment;

said upper compartment comprising:

an air outlet formed in said upper compartment for letting air to exit
thereof;

25 a second filter disposed between said air outlet and said fan for filtering air particles of at least a predetermined size,

said second filter acts as a barrier between said air-moving equipment and said air outlet to reduce the noise level emitted from said air purifier by said air-moving equipment.

In accordance with a second aspect of the invention, there is provided a method of reducing the level of noise in an air purifier, comprising:

providing a housing divided into a lower compartment, a middle compartment,
and a upper compartment, said lower compartment comprising an air inlet formed in said
5 lower compartment for entry of air;

trapping air particles of at least a predetermined size using a first filter
coupled to the air inlet; and

killing micro-organisms in the air using at least one lamp disposed within
said lower compartment;

10 creating a pressure difference between said upper compartment and said
lower compartment using a air-moving equipment mounted in said middle
compartment;

providing an air outlet formed in said upper compartment for letting air to
exit therefrom; and

15 filtering air particles of at least a predetermined size using a second filter
disposed between said air outlet and said fan,

said second filter acting as a barrier between said air-moving equipment and said air
outlet to reduce the noise level emitted from said air purifier by said air-moving
equipment.

20 Other systems, methods, features, and advantages of the present invention will be or become
apparent to one with skill in the art upon examination of the following drawings and detailed
description.

BRIEF DESCRIPTION OF THE DRAWINGS

Various aspects of the invention can be understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon
5 clearly illustrating the principles of the embodiments of the present invention.

Figure 1a, Figure 1b and Figure 1c are schematic diagrams of a side view, a front view and a top view respectively, of an air purifier in accordance with an embodiment of the invention;

10 Figure 1d shows the direction of the airflow inside an air purifier in accordance with an embodiment of the invention;

Figure 2 is a perspective view of a High Efficiency Particulate Air (HEPA) filter in accordance with an embodiment of the invention;

15 FIG 3 is an enlarged view of a portion of a column in a High Efficiency Particulate Air (HEPA) filter in accordance with an embodiment of the invention

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DETAILED DESCRIPTION

Figure 1a, Figure 1b and figure 1c show the side view, front view and top view, respectively, of a HEPA air purifier in accordance with an embodiment of the invention. The HEPA air purifier is divided into three compartments: a lower compartment 102, a middle compartment 104 and an upper compartment 106. The lower compartment 102 of the air purifier comprises a pre-filter 108, a carbon filter 110, an air inlet 112 and a pair of ultra violet lamps 114. The middle compartment 104 of the air purifier comprises a high capacity mechanical ventilation fan 120 and a control panel (not shown in figure). The interior wall of the middle compartment 104 is covered by a noise absorbing foam 118. The noise absorbing foam 118 is stabilized to the interior wall by a perforated metal sheet 119. The upper compartment 106 of the air purifier comprises a HEPA filter 116 and an air outlet 122. The air purifier is powered by a power source (not shown in figure).

Figure 1d shows the direction of the airflow depicted by arrows 124, 126 and 128 through the HEPA air purifier. The direction of the airflow in the lower compartment 102 is illustrated by arrows 124. First the air enters the HEPA air purifier through the air inlet 112. Thereafter, the air passes through the pre-filter 108. Dust particles and air born pathogens of at least 3 μ m in size are trapped by the pre-filter 108. Other types of filter which may be used include simple flat paper filter or cloth. A carbon filter 110 may be aligned next to the pre-filter 108 for removing odor in the air. The size of the carbon filter 110 is half that of the pre-filter 108, which enables only half of the volume of air to flow through the carbon filter 110. This facilitates a slower airflow through the inlet as the layout causes a significant reduction of resistance in both filters, thus, increasing the volume of airflow of the air purification system. The air subsequently passes through in the vicinity of a pair of ultra violet (UV) lamps 114. The lamps 114 are placed for optimum Ultra violet Germicidal Irradiation (UVGI) elimination field. UVGI is ultra violet radiation in the range 225 to 302 nm that is lethal to microorganisms. At least a UV tube may be placed for optimum Ultra violet Germicidal Irradiation (UVGI) elimination field.

The chamber internal surface comprises reflective material to permit a multiplication of the UVGI field by spectral reflection. The UV tubes 114 are U-bended to allow for greater exposure. By having UV tube made of high silica glass, ozone (O₃) will not be emitted. Ozone emission is not desired because at a certain concentration, it is harmful to the health of human being. The ultra violet light emitted from the ultra violet lamps 114 damages microorganisms' deoxyribonucleic acid (DNA), thus rendering the microorganisms incapable of reproducing. At higher doses, ultra violet light can destroy molecular bonds, causing microorganisms literally to fall apart. The air subsequently enters the middle compartment 104. The direction of airflow in the middle compartment 104 is illustrated by arrows 126. The high capacity mechanical ventilation fan 120 spins so as to create a lower pressure in the middle compartment 104 as compared to the pressure in the lower compartment 102. Beside a high capacity mechanical ventilation fan, a blower may be used. This causes the air to move up into the middle compartment 104. The air subsequently enters the upper compartment 106. The direction of the airflow in the upper compartment 106 is illustrated by arrows 126. The HEPA filter 116 filters particles of size greater than 0.3 micron. The HEPA filter 116 also acts as a damper to the sound created by the high capacity mechanical ventilation fan 120 and attenuates the high-frequency noise generated by the fan up to 16 dBA from 71 dBA to 55 dBA. The noise is not able to exit from the air inlet as the pre-filter and the carbon filter acts as a damper to the sound created by the high capacity mechanical ventilation fan. Beside HEPA filter, Ultra Low Particulate Air (ULPA) filter may be used. After passing through the HEPA filter 116, the air flows out of the air purifier from the air outlet 122 as shown by arrows 128.

Figure 2 shows the perspective view of the HEPA filter 200. The air 201 enters the HEPA filter from the bottom. The HEPA filter comprises a plurality of column 202 which is enclosed by the sealant 203 and the frame 204. Each column comprises filter material 206 pleated with separators 205 between the pleats.

Figure 3 shows the enlarged view of a portion of the column 302 in the HEPA filter. The filter material 306 is pleated with separators 305 between the pleats. The pleated filter material 306 is made of high-density paper which is formed from sub-micron glass fibres. The filter material

306 is pleated to provide high ratio of media area to face area. The separator 305 is made from aluminum which is pleated to allow airflow with minimum resistance.

Other advantages of installing the HEPA filter above the high capacity mechanical ventilation fan are that beside acting as both a filter and a sound damper, the installed HEPA filter is also cost effective and does not take up any additional space.

It should be emphasized that the above-described embodiments of the present invention, particularly, any "preferred" embodiments, are merely possible examples of implementation, merely set forth for a clear understanding of the principles of the invention. Many variations and modifications may be made to the above-described embodiments of the invention.

CLAIMS:

1. An air purifier, comprising:

a housing divided into a lower compartment, a middle compartment, and an upper
5 compartment;

said lower compartment comprising:

an air inlet formed in said lower compartment for entry of air;

a first filter coupled to said air inlet for trapping airborne particles of at
least a predetermined size;

10 and

at least a lamp disposed within said lower compartment for killing micro-
organisms in the air;

said middle compartment comprising:

an air-moving equipment mounted in said middle compartment for
15 creating a pressure difference between said upper compartment and said lower
compartment;

said upper compartment comprising:

an air outlet formed in said upper compartment for letting air to exit
thereof;

20 a second filter disposed between said air outlet and said fan for filtering
air particles of at least a predetermined size,

said second filter acts as a barrier between said air-moving equipment and said air
outlet to reduce the noise level emitted from said air purifier by said air-moving
equipment.

- 25 2. The air purifier according to claim 1, wherein the predetermined size of said particles
trapped by first filter is at least 3 μm .

- 30 3. The air purifier according to claim 1 or 2, wherein the predetermined size of said
particles trapped by second filter is at least 0.3 μm .

4. The air purifier according to claim 1, 2 or 3, wherein said first filter is made of a layer of material capable of trapping said particles of size of at least 3 μm .
- 5 5. The air purifier according to anyone of the preceding claims, wherein carbon filter is aligned next to said first filter for removing odor in the air.
6. The air purifier according to anyone of the preceding claims, wherein said air-moving equipment is a high capacity mechanical ventilation fan.
- 10 7. The air purifier according to anyone of the preceding claims, wherein said second filter is a particulate air filter.
8. The air purifier according to claim 7, wherein said particulate air filter is pleated.
- 15 9. The air purifier according to anyone of the preceding claims, wherein said middle compartment further comprises a control panel for controlling various functions of the air purifier.
10. The air purifier according to anyone of the preceding claims, wherein said lamp is an ultra violet lamp.
- 20 11. The air purifier according to anyone of the preceding claims, wherein said micro-organisms in the air is killed by ultra violet germicidal irradiation.
- 25 12. The air purifier according to anyone of the preceding claims, wherein interior wall of said second compartment is covered by a noise absorption foam and said noise absorption foam is stabilized to the interior wall by perforated metal sheet.
13. A method of reducing the level of noise in an air purifier, comprising:

providing a housing divided into a lower compartment, a middle compartment, and a upper compartment, said lower compartment comprising an air inlet formed in said lower compartment for entry of air;

trapping air particles of at least a predetermined size using a first filter coupled to the air inlet; and

killing micro-organisms in the air using at least a lamp disposed within said lower compartment;

creating a pressure difference between said upper compartment and said lower compartment using a air-moving equipment mounted in said middle compartment;

providing an air outlet formed in said upper compartment for letting air to exit therefrom; and

filtering air particles of at least a predetermined size using a second filter disposed between said air outlet and said fan,

said second filter acting as a barrier between said air-moving equipment and said air outlet to reduce the noise level emitted from said air purifier by said air-moving equipment.

14. The method according to according to claim 13, wherein the predetermined size of said particles trapped by first filter is at least 3 μm .

15. The method according to claim 13 or 14, wherein the predetermined size of said particles trapped by said second filter is at least 0.3 μm .

16. The method according to claim 13, 14 or 15, wherein said first filter is made of a layer of material capable of trapping said particles of size of at least 3 μm .

17. The method according to anyone of claims 13 to 16, wherein carbon filter is aligned next to said first filter for removing odor in the air.

18. The method according to anyone of claims 13 to 17, wherein said air-moving equipment is a high capacity mechanical ventilation fan.

19. The method according to anyone of the claims 13 to 18, wherein said second filter is a particulate air filter.

20. The method according to claim 19, wherein said particulate air filter is pleated.

21. The method according to anyone of the claims 13 to 20, wherein said middle compartment further comprises a control panel for controlling various functions of the air purifier.

22. The method according to anyone of the claims 13 to 21, wherein said lamp is an ultra violet lamp.

23. The method according to anyone of the claims 13 to 22, wherein said microorganisms in the air is killed by ultra violet germicidal irradiation.

24. The method according to anyone of claims 13 to 23, wherein interior wall of said second compartment is covered by a noise absorption foam and said noise absorption foam is stabilized to the interior wall by perforated metal sheet.