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(54) **AIR PURIFIER**

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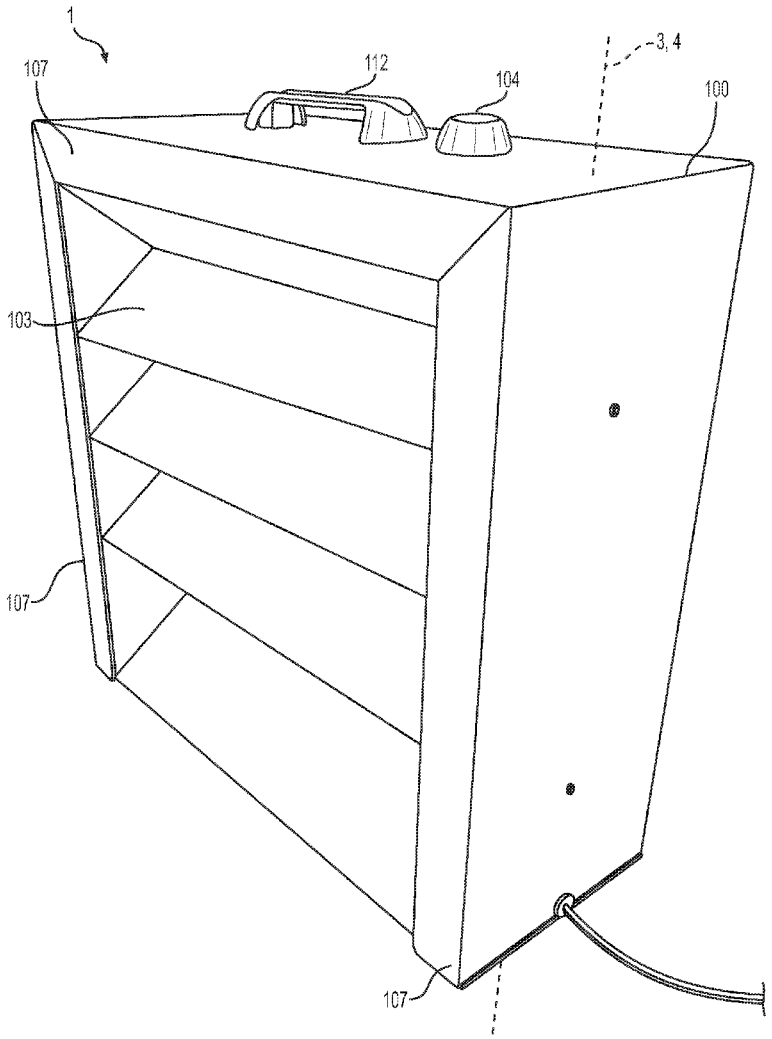
(57) **ABSTRACT**

A portable air filtration and purification system with a portable housing having three sides and an open area. The open area facilitates filter replacement. A pre-filter is positioned within the housing. A fan assembly having a fan housing and fan blades is also positioned within the housing and is adjacent the pre-filter. A post-filter is adjacent the fan assembly and is positioned within the housing such that the pre-filer and the post-filter sandwich the fan assembly. The pre-filter intercepts the air flow into the portable air filtration and purification system before the air flows through the fan. The post-filter intercepts the air after it flows through the fan.



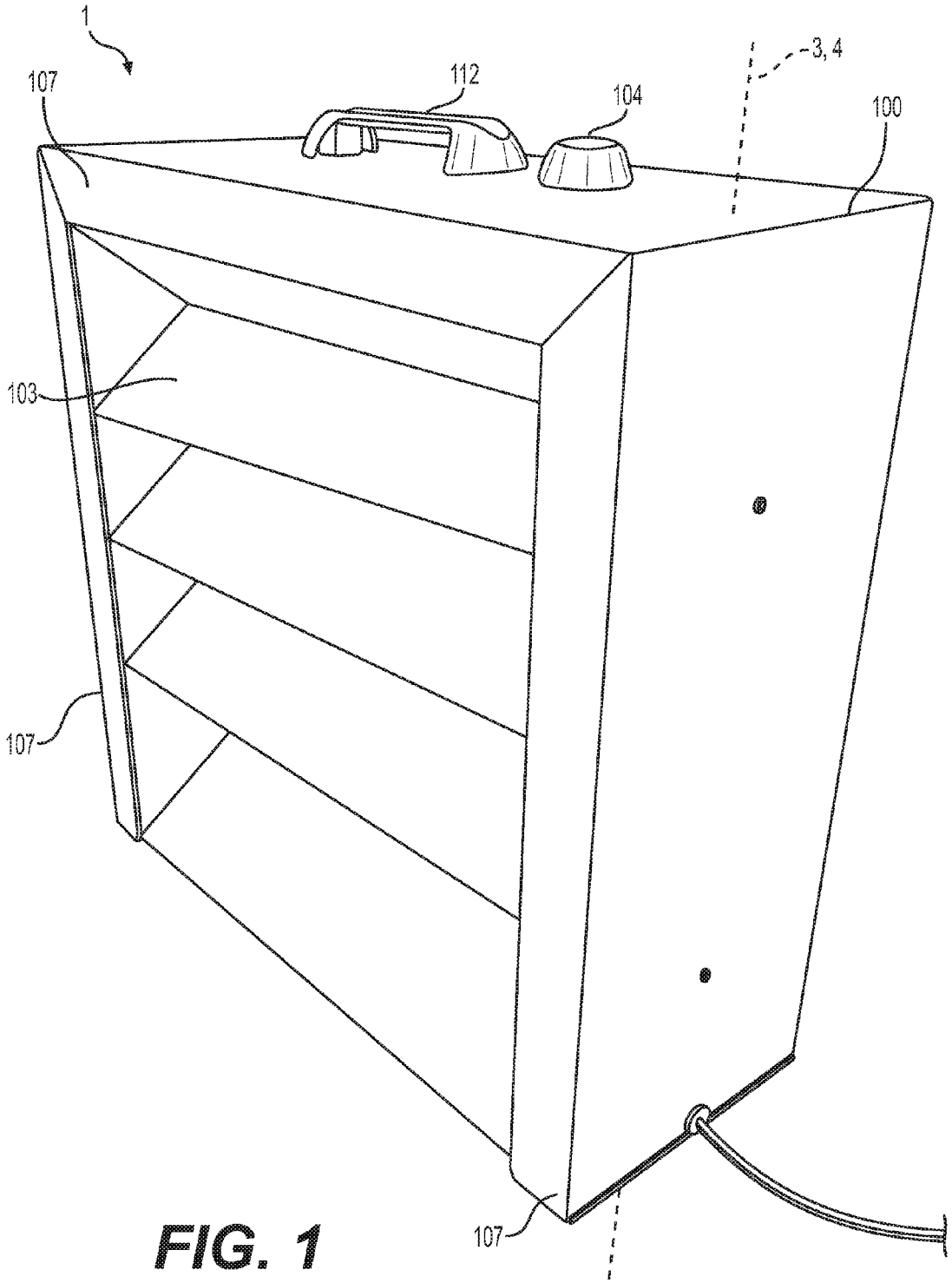


FIG. 1

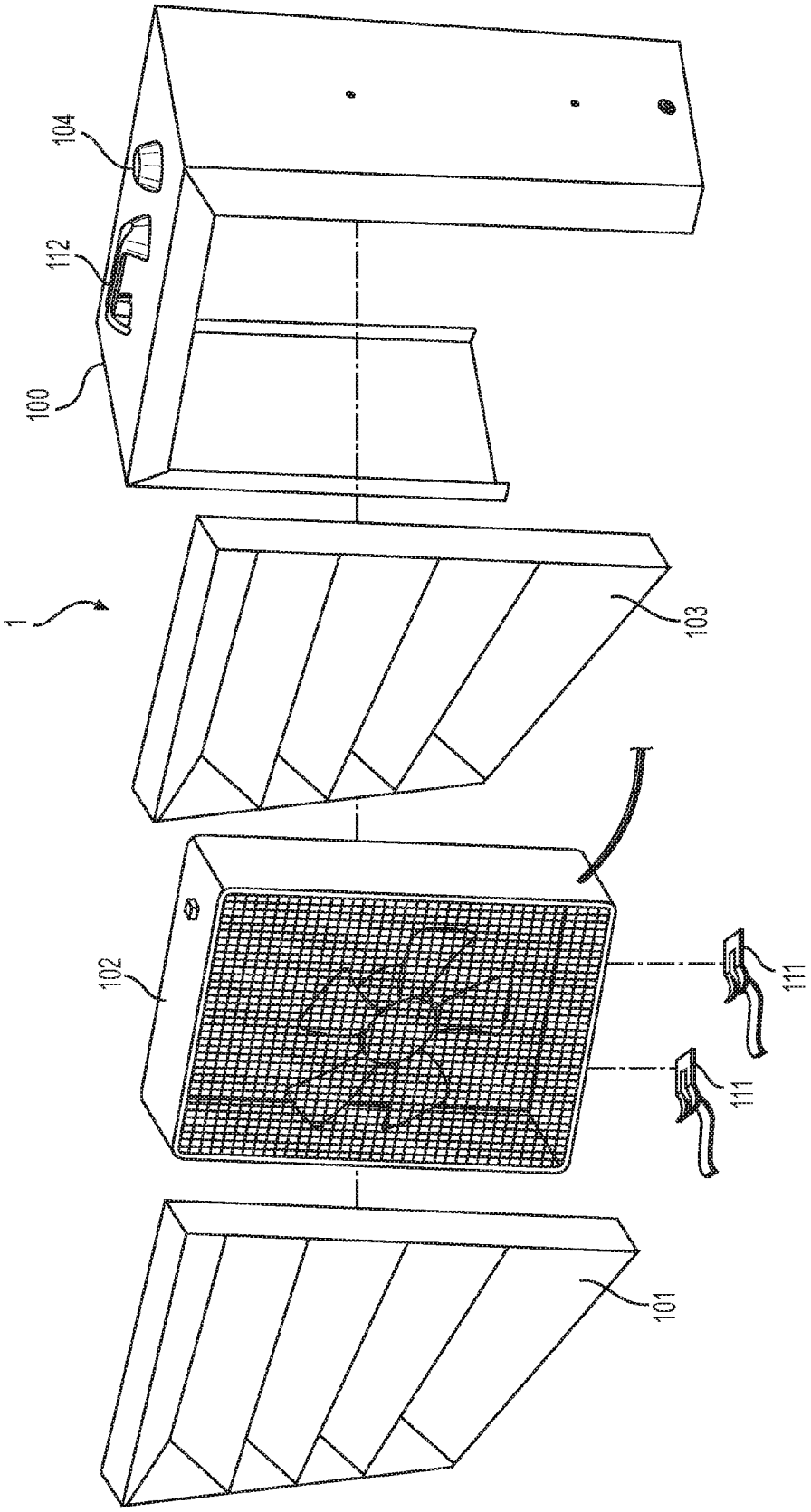


FIG. 2

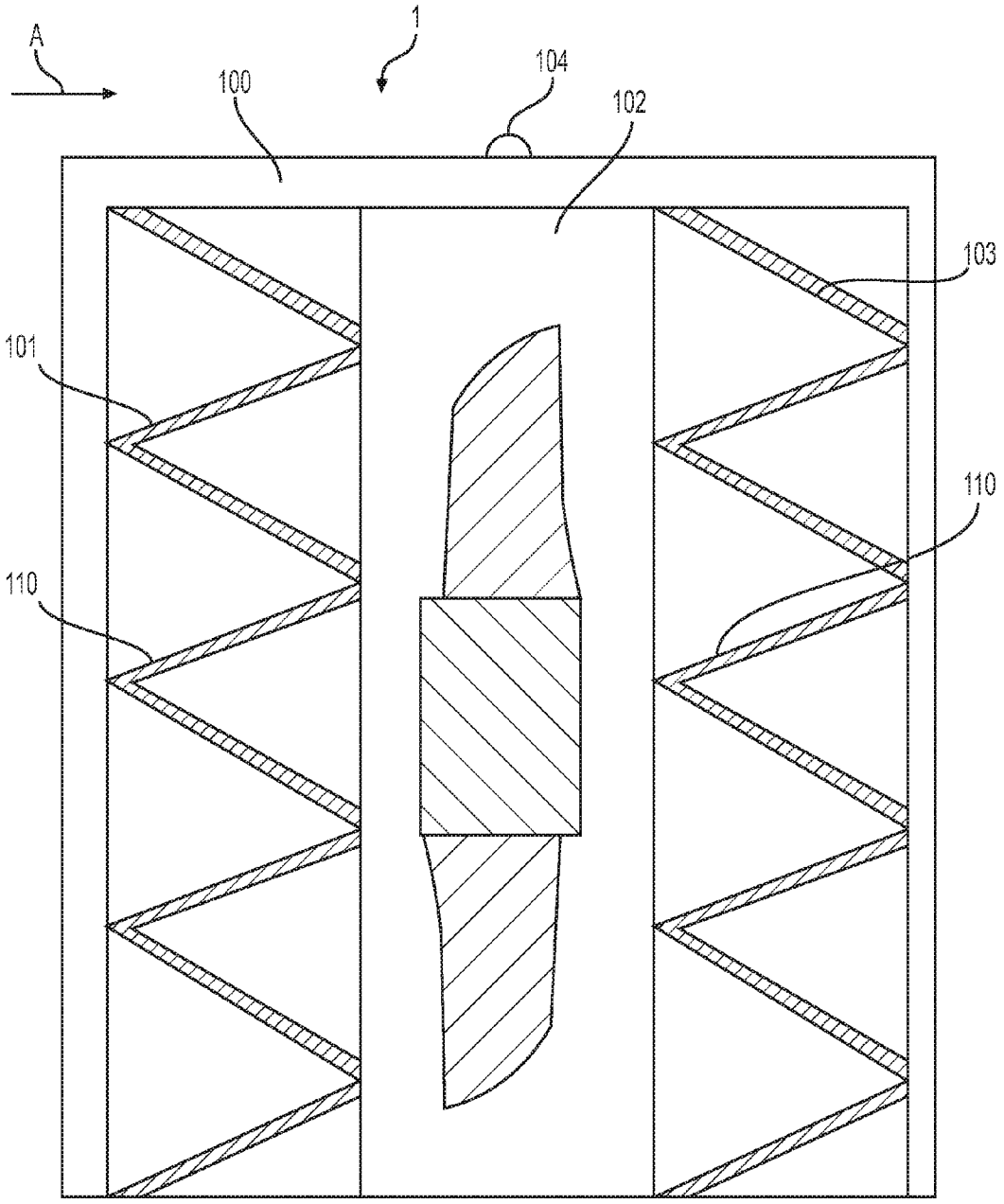


FIG. 3

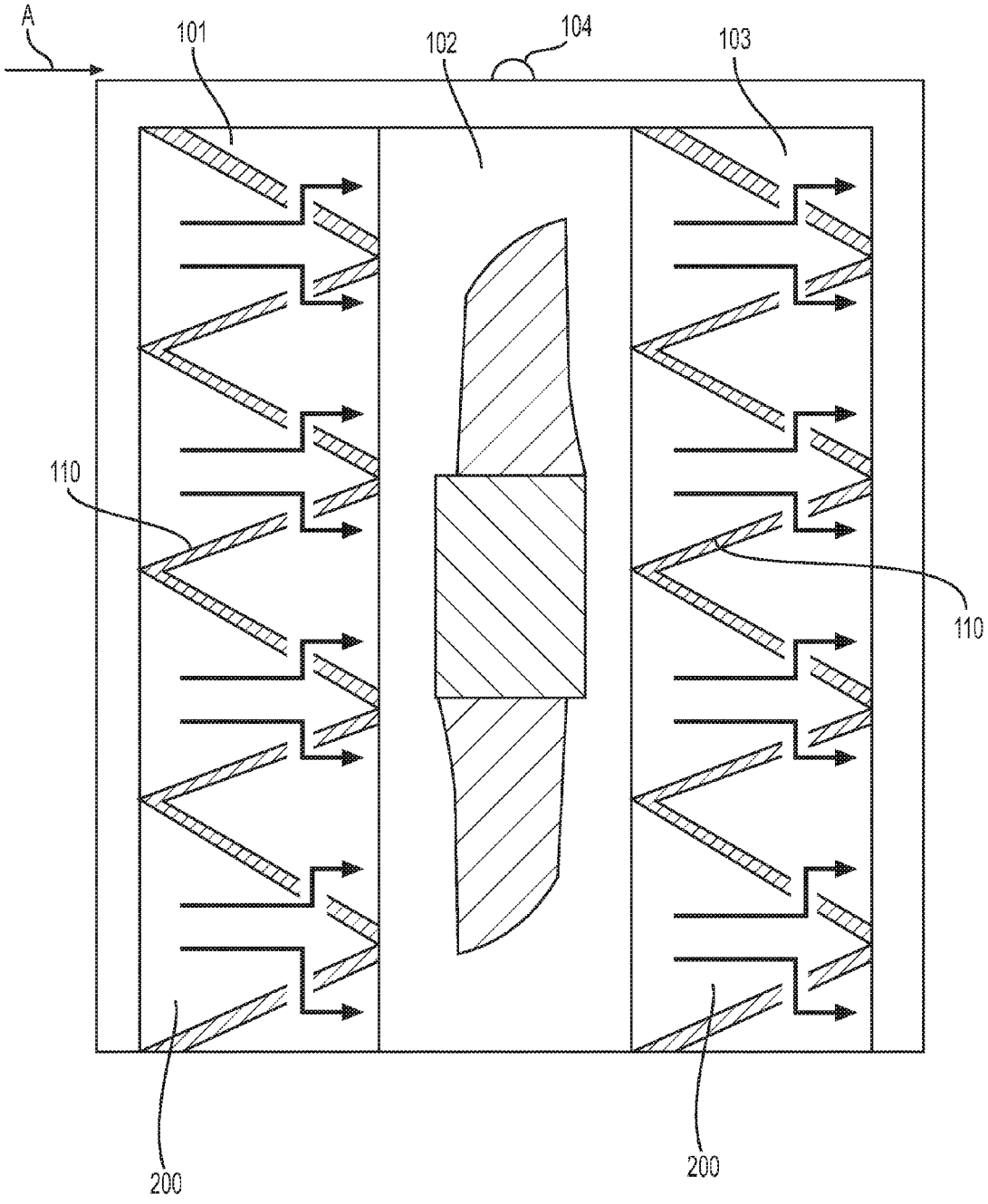


FIG. 4

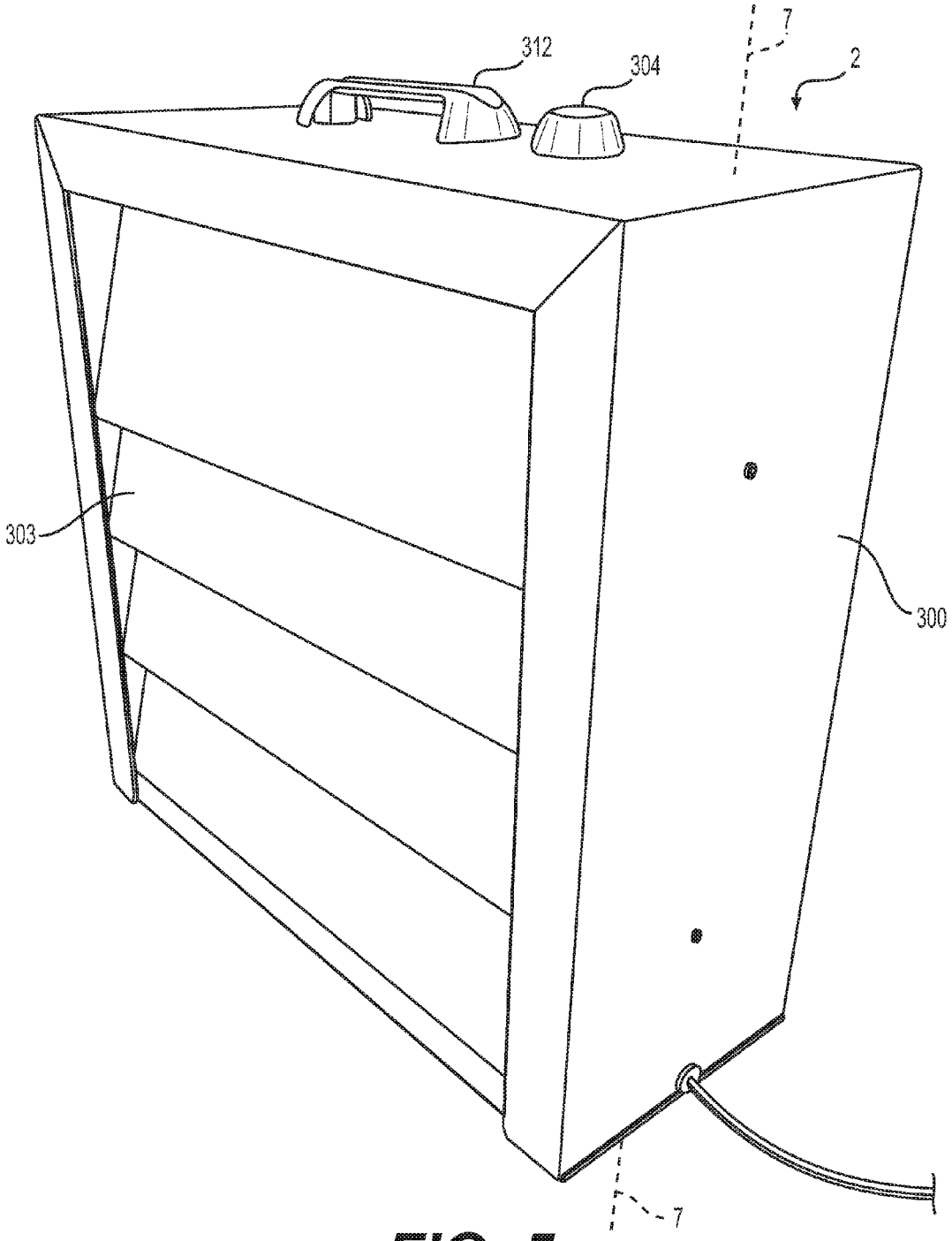


FIG. 5

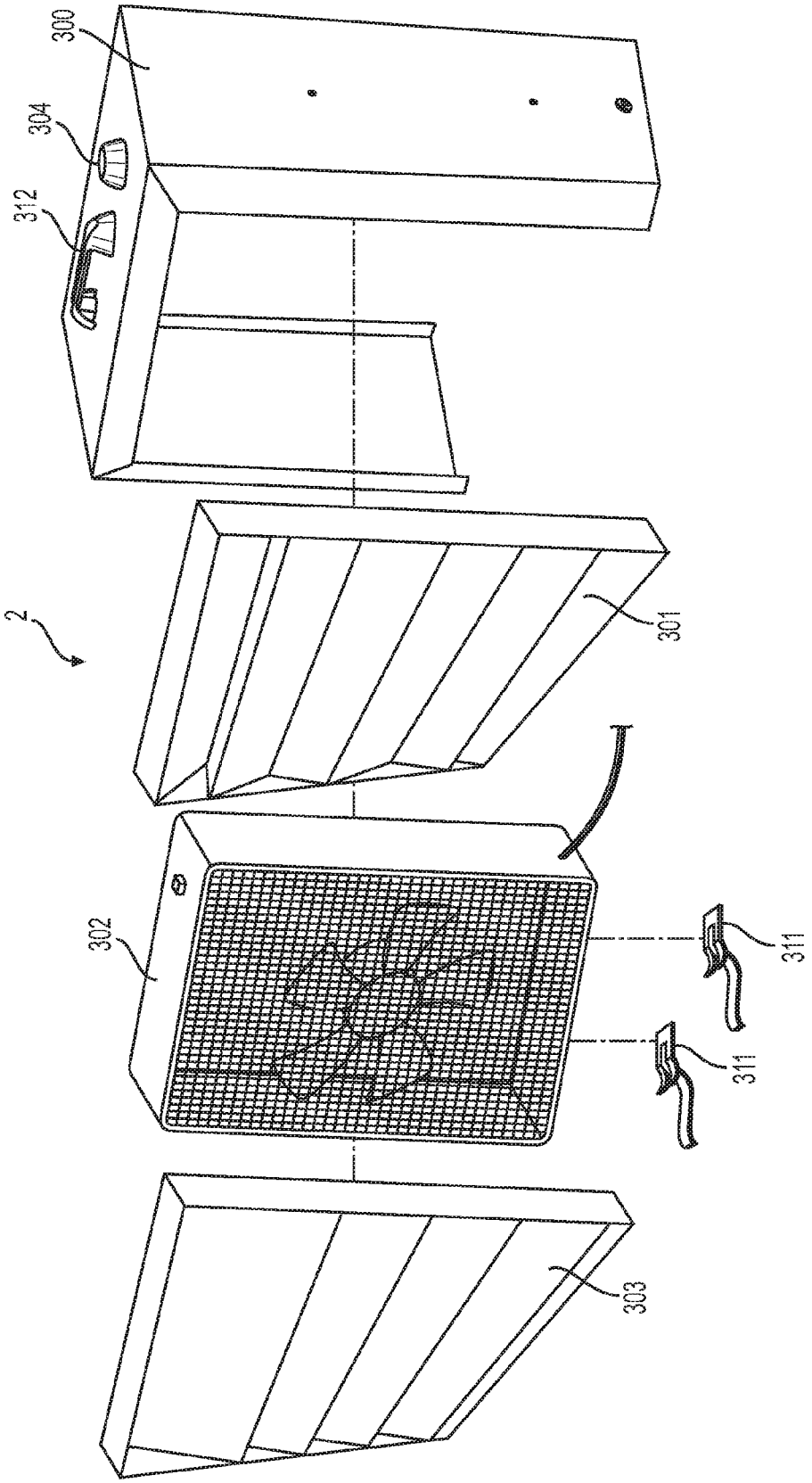


FIG. 6

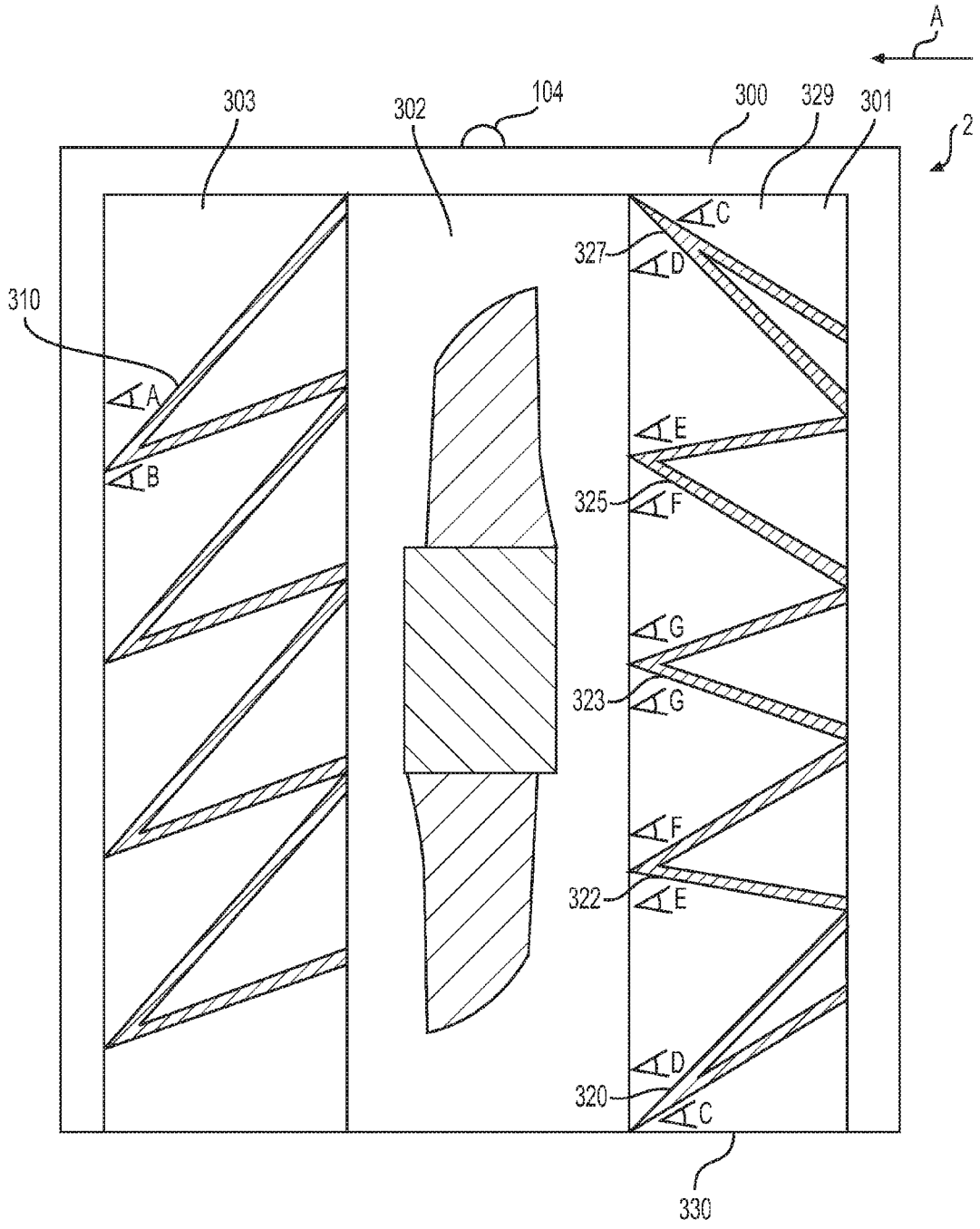

A
303
302
104
300
329
301
2
310
A
B
C
D
327
E
F
325
G
G
323
F
E
322
D
C
320
330

FIG. 7

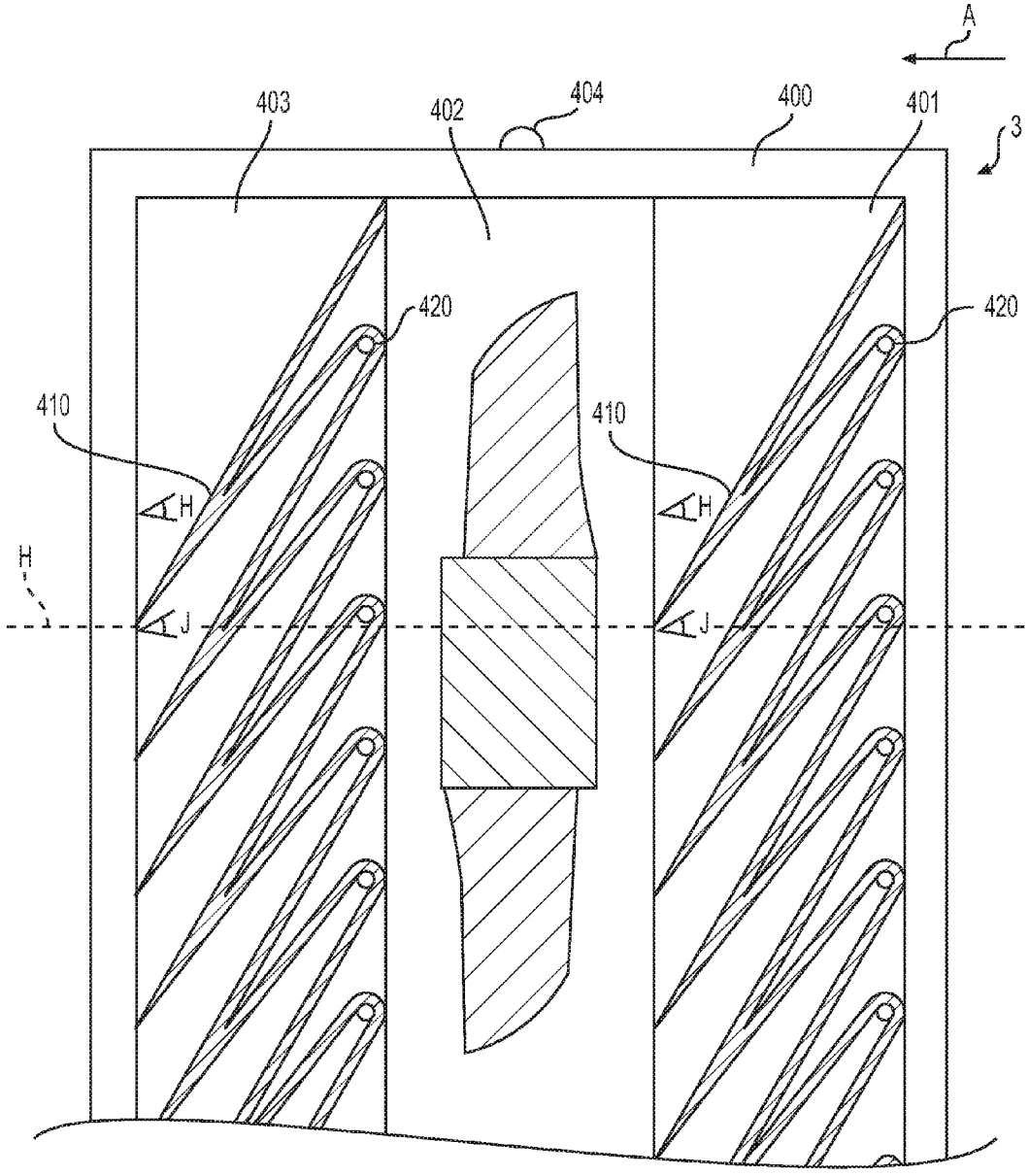


FIG. 8

AIR PURIFIER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application takes priority from U.S. Provisional Patent Application 62/261,415, filed Dec. 1, 2015, the entirety of which is incorporated by reference herein.

FIELD OF INVENTION

[0002] The invention relates in general to portable air filtration and purification units.

BACKGROUND OF INVENTION

[0003] Chronic allergy and asthma sufferers appreciate the need for clean air and understand that many harmful particulates may be suspended in air. Pollen, pet dander, smoke, dust, mold, and viruses are examples of pollutants that cause symptoms of allergies and asthma that are found in air. To combat these and other pollutants companies and individuals in general have been seeking the aid of air filtration devices as stand-alone units or units that attach to HVAC systems. The problem with these units of the past is that, like HVAC, they focus on volume of air movement in cubic feet per minute (cfm), which does not allow the filtration portion of the device to properly or efficiently clean the air going through it. A slower, constant air movement across the filtration portion may significantly increase the efficiency of the device and drastically reduce the number of pollutants to which people are being exposed. There exists a need to develop an air filtration and purification unit that does not focus on volume of air movement but instead focusses on constant air movement and that would clean the air better than prior devices. The unit should be quiet, portable, light weight, and easy to maintain.

BRIEF SUMMARY OF INVENTION

[0004] A stand-alone, portable air filtration and purification unit that requires standard 110V electricity to operate and can easily be moved from room to room in a household, office, or industrial setting. The unit may include a sheet metal shroud which houses an internal fan and two M11 or better filters. One of the filters—a pre-filter—is positioned such that the air enters the pre-filter before the air passes through the fan. The second filter—a post filter—is positioned such that the air passes through the second filter after the air passes through the fan. A dial switch may be used for selecting the fan speed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a perspective view of the air filtration and purification unit according to an embodiment.

[0006] FIG. **2** is an exploded view of the air filtration and purification unit of FIG. **1**.

[0007] FIG. **3** is a cross-sectional view of the air filtration and purification unit of the FIG. **1** taken along line **3**,**4**-**3**,**4**.

[0008] FIG. **4** is a cross-sectional view of the air filtration and purification unit of FIG. **1** showing the path of the air through the unit taken along line **3**,**4**-**3**,**4**.

[0009] FIG. **5** is a perspective view of the air filtration and purification unit according to a second embodiment.

[0010] FIG. **6** is an exploded view of the air filtration and purification unit of FIG. **5**.

[0011] FIG. **7** is a cross-sectional view of the air filtration and purification unit of FIG. **5** taken along line **7**-**7**.

[0012] FIG. **8** is a cross-sectional view of the air filtration and purification unit according to a third embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Embodiments will now be described in detail with respect to an apparatus and method for assessing skilled professional qualities reflecting the inventors' present preferred embodiments and the best means for practicing the invention. Those skilled in the art will recognize that the embodiments described herein are subject to modification and alteration without departing from the teaching herein. Therefore, the present discussion should not be considered limiting but an exemplification of the features of the invention.

[0014] In the illustrated embodiment in FIGS. **1**-**2**, an air filtration and purification unit **1** is shown. The air filtration and purification unit **1** has a shroud or housing **100**, a pre-filter **101**, a box fan assembly **102**, and a post-filter **103**. The pre-filter and post filters **101**, **103** sandwich the fan assembly **102**, and are held in place by clips, clamps, or crimping **111**. In the illustrated embodiment, filters **101**, **103** are identical.

[0015] The shroud **100** surrounds the pre-filter **101**, the fan assembly **102**, and the post-filter **103** on at least three sides and further includes lips **107** on all three sides which act as stops so the filter does not fall out of place. At least one side may be open to allow for easy replacement of filters **101**, **103**. The shroud **100** may be made from metals such as stainless steel, galvanized steel, aluminum, plastics, such as polycarbonate, or any appropriate materials known in the art, whether now known or later developed. On the exterior of the shroud **100**, located on top of the unit is a fan speed selection switch **104** which may have high, medium, low, and off positions. Also on top of the shroud **100** is a handle **112** for easy movement and portability of the air purification and filtration system. It is understood that the thickness of the filters will alter the dimensions of the shroud **100** and does not limit the invention, i.e. 20×20×2 inch filters, 20×20×4 inch filters. It is understood that an X-pattern grid filter holder may also be used herein with the invention.

[0016] FIG. **3** shows a cross-sectional view of an air filtration and purification unit **1**. Air will flow in direction A. The filters **101**, **103** may be made from fibrous material, paper, or other known or yet to be known materials in the art. The filters **101**, **103** are pleated with individual pleats **110**. These pleats **110** are folded such that they create a 45 degree isosceles triangular pattern in a uniform pattern. A standard efficient filter is made from a MERV rated material as is known in the art, and then is folded a pre-set number of times (creating pleats) for a given standard dimension, thereby having a set surface area and length of material used that is known in the art that will create a MERV rated filter. The pleated design of the filters **101**, **103** have less pleats **110** than a standard efficient filter and therein use less surface area, but still are efficient to be rated to a Minimum Efficiency Reporting Value (MERV) rating of 11 or better, which goes against the logic that the more pleats (or surface area) the better the filtration of the created filter.

[0017] FIG. **4** shows the flow of air **200** through the air filtration and purification unit **1**. The air flows through the pre-filter **101**, then through the fan assembly **102**, and

thereafter through the post filter **103**. By placing the pleats **110** at angles with respect to one another, the air flow **200** splits to create a Venturi effect at this first constriction. The fan assembly **102** controls the speed of the air flow **200**, and at slower fan blade speeds, the filters **101**, **103** can clean without harming the filters **101**, **103**. The filters **101**,**103** are placed at opposite ends of the fan assembly **102**. The split air flow **200** has the added advantage of reducing the noise of the air flow **200** through the filtration and purification system. In the addition, the filters **101**,**103** may by pleated in a variety of ways and will be further discussed below, and the number of pleats may be varied to slow the air flow **200**.

[0018] By using the post filter **103** after the air passes through the fan **102**, the air is defused and again goes through a Venturi effect as it passes through the post filter **103**, which cleans as much as 40% more than using the pre-filter **101** only. As a result, the filters **101**, **103** last much longer and clean better.

[0019] Current air handling and heating, ventilation, and air conditioning (HVAC) systems are designed for high air speed and air volume (i.e between 2.5 m/s to 30 m/s dependent upon the size of the system). The use of the pre-filter **101** and the post-filter **103** in such HVAC systems would create too much drag or resistance to the air flow, and such systems would not operate correctly. Accordingly, the fan assembly **102** should be selected so that it has a lower, slower air speed and volume (e.g., 0.2 m/s to 0.666 m/s), which allows the system to clean the air more thoroughly and more efficiently, and preserves and prolongs the life of the filters **101**, **103**. Slower air speed/volume fans are also generally less expensive and quieter, so their use in this application may well impart an economic advantage to this air filtration and purification system, as well as a quieter, more pleasant environment. Moreover, slower speed fans **102** are typically smaller and weigh less than high speed, high volume fans, making the portable air filtration and purification system easier to move and position. Indeed, testing has shown that use of the fan **102** to cause the air to slow down and circulate within the unit **1** allows for more particulates in the air to be captured, such that the air **200** ultimately exiting the post-filter **103** is substantially cleaner as compared to the air exiting prior art filtration systems.

[0020] It is foreseen that the filters **101**, **103** may be replaced with standard high efficiency pleated filters with a MERV rating of 8 or better as known in the art and this would be within the scope of the invention. It is also foreseen that they may be any combination of the filters disclosed herein and standard high efficiency pleated filters may be used.

[0021] In the illustrated embodiment in FIGS. **5-7**, an air filtration and purification unit **2** is shown. The air filtration and purification unit **2** has a shroud or housing **300**, a pre-filter **301**, a box fan assembly **302**, and a post-filter **303**. The air filtration and purification unit **2** is substantially similar to the air filtration and purification unit **1**, with the exception of the filters **301**, **303** utilized in the embodiment. The pre-filter and post filters **301**, **303** sandwich the fan assembly **302**.

[0022] The pre-filter **301** may be made from fibrous material, paper, or other known or yet to be known materials in the art. The pre-filter **301** may be dimensioned to be 20×30×2 inches or a standard filter size known in the art. The pre-filter **301** has five individual pleats **320**, **322**, **323**, **325**, **327** (FIG. **7**) with the pleats facing towards the fan in the direction of the air A. The outer pleats **320**, **327** are angled from a top **329** to a bottom **330** of the shroud **300** at an angle C with respect to the horizontal between 50 and 60 degrees, preferably at 55 degrees and then folded back at an angle D with respect to the horizontal between 55 and 65 degrees, preferably at 59.7 degrees. The inner pleats **322**, **325** adjacent the outer pleats **320**, **327** are angled from the outer pleats **320**, **327** at an angle E with respect to the horizontal between 35 to 45 degrees, preferably at 40.6 degrees and then folded back at an angle F with respect to the horizontal between 45 and 55 degrees, preferably at 48.8 degrees. The center pleat **323** is angled from the inner pleats **322**, **325** at an angle G with respect to the horizontal between 25 and 30 degrees, preferably at 28.6 degrees. The non-uniform folding pleated design of the pre-filter **301** and post-filter **303** in unison outperform current known in the art standard uniform pleating designs having multitudes of pleats in the same dimension. The pleated design of the pre-filter **301** filters uses less material (in comparison to a same dimensioned standard pleated filter) due to the nature of the curves and also filters in the 0.3 μm range to be rated to a MERV rating of 11 or better. The pre filter **301** is better rated than currently known in the art standard pleated using material with a MERV rating of 13-15 that have more uniform horizontal pleats or folds (not shown) and use a greater surface area having the same dimensions, i.e. 20×20×2 inches.

[0023] It is foreseen that the pre-filter **301** may be utilized to test different filtrations efficiencies by observing the filtration efficiency of a single pleat design at the above noted angle ranges through the air filtration and purification unit **2**. This efficiency can then be compared to a standard pleated filter having the same dimensional size. It is foreseen that the pre-filter **301** may be oriented on either side of the fan or utilized as both the pre-filter **301** and the post-filter **303**.

[0024] The post-filter **303**, likewise may be made from fibrous material, paper, or other known or yet to be known materials in the art. The post-filter **303** may be dimensioned to be 20×20×2 inches or any standard filter size known in the art. The post-filter **303** has several individual pleats **310** pointed in the direction of the airflow A, and each pleat **310** is angled downwardly with respect to a horizontal, at an angle A between 25 to 35 degrees (FIG. **7**) preferably at 29.7 degrees and then folded over itself at an angle B between 10 to 20 degrees with respect to the horizontal, preferably at 14.2 degrees. The pleated design of the post-filter **303** filters uses less material and therefore less surface area (in comparison to a same dimensioned standard pleated filter) due to the natural of the downward curves and also filters in the 0.3 μm range to be rated to a MERV rating of 11 or better. The post filter **303** is better rated than currently known in the art standard pleated filters using materials with a MERV rating of 13-15 that have more uniform horizontal pleats (not shown) and use a greater surface area. The non-uniform angular design may not be made using standard pleating machinery. The post-filter **303** may be oriented on either side of the fan or utilized as both the pre-filter **301** and the post-filter **303**.

[0025] FIG. **8** shows a cross-sectional view of another embodiment of an air filtration and purification unit **3**. The filters **401**, **403** may be made from fibrous material, paper,

or other known or yet to be known materials in the art. The filters **401**, **403** may be dimensioned to be 20×20×2 inches or a standard filter size known in the art. The pre-filter **401** and the post filter **403** are identical in the illustrated embodiment. The filters **401**, **403** have several individual pleats **410** oriented in the direction of air A, and each pleat **410** is angled downwardly with respect to a horizontal H, at an angle H between 55 to 65 degrees, preferably at 60 degrees and then folded over itself at an angle J between 50 to 55 degrees with respect to the horizontal H, preferably at 52 degrees. From there the material is wrapped about rod or conduit **420** that is held in place by a bearing (not shown).

[0026] The pleated design of the filters **401**, **403** were tested at several downwardly sloping angles that approached 90 degrees or vertical (which will not allow any air through), and these angles H, J were determined to filter out the most microbial particles at the 0.3 μm range, thereby making a MERV 15 though utilizing material with MERV rating of 11. One result of such a test given by Assuredbio is given below.

TABLE 1

Test Results for Standard Filter MERV rating 11

Species indentification	Spore/m^3 of Air Inside	Spore/m^3 of Air Outside	(%) of Detected Species
Acremonium strictum	ND	ND	0.00
Alternaria alternata	2,065	2,503	12.52
Aspergillus niger/awamori/foetidus/phoenicis	ND	ND	0.00
Aspergillus flavus/oryzae	ND	ND	0.00
Aspergillus fumigatus, Neosartorya fischeri	ND	3,517	0.00
Aspergillus ochraceus/ostianus	ND	ND	0.00
Aspergillus penicillioides	ND	ND	0.00
Aspergillus restrictus/caesillus/conicus	51	51	0.31
Aspergillus sclerotiorum	ND	ND	0.00
Aspergillus sydowii	ND	ND	0.00
Aspergillus unguis	ND	ND	0.00
Aspergillus ustus	ND	ND	0.00
Aspergillus versicolor	ND	ND	0.00
Aureobasidium pullulans	ND	183	0.00
Chaetomium globosum	ND	ND	0.00
Cladosporium cladosporioides svar. 1	85	40	0.52
Cladosporium cladosporioides svar. 2	ND	ND	0.00
Cladosporium herbarum	13,759	8,342	83.42
Cladosporium sphaerosperrnum	157	ND	0.95
Eurotium (Aspergillus) amstelodami/ chevalleri/herbariorum/rubrum/repens	ND	ND	0.00
Epicoccum nigrum	ND	ND	50.00
Mucor amphibiorum/circinelloides/hiematis/ indicus/mucedo/racemosus/ramoissimus and *Rhizopus azygosporus/homothalicus/ microsporus/oligoporus/oryzae*	ND	ND	0.00
Paecilomyces variotii	ND	ND	0.00
Penicillium crustosum/camemberti/commune/ echinulatum/solitum	ND	ND	0.00
Penicillium brevicompactum | stoloniferum	ND	ND	0.00
Penicillium chrysogenum	ND	ND	0.00
Penicillium corylophilum	ND	ND	0.00
Penicillium purpurogenum	ND	ND	0.00
Penicillium variabile	ND	ND	0.00
Penicillium glabrum/lividum/purpurescens/ spinulosum/thomii	ND	ND	0.00
Rhizopus stolonifer	ND	ND	0.00
Scopulariopsis brevicaulis | fusca	216	198	1.31
Scopulariopsis chartarum	7	7	0.04
Stachybotrys chartarum	153	ND	0.93
Trichoderma viride/atroviride/koningii	ND	ND	0.00
Wallemia sebi	ND	154	0.00
Total Spores	16,493	14,841	

TABLE 2

Test Results for Filter 401/403

Species indentification	Spore/m^3 of Air Inside	Spore/m^3 of Air Outside	(%) of Detected Species
Acremonium strictum	ND	ND	0.00
Alternaria alternata	ND	ND	0.00
Aspergillus niger/awamori/foetidus/phoenicis	ND	ND	0.00
Aspergillus flavus/oryzae	ND	ND	0.00
Aspergillus fumigatus, Neosartorya fischeri	ND	ND	0.00
Aspergillus ochraceus/ostianus	ND	ND	0.00
Aspergillus penicillioides	ND	ND	0.00

TABLE 2-continued

Test Results for Filter 401/403			
Species indentification	Spore/m^3 of Air Inside	Spore/m^3 of Air Outside	(%) of Detected Species
Aspergillus restrictus/caesillus/conicus	ND	ND	0.00
Aspergillus sclerotiorum	ND	ND	0.00
Aspergillus sydowii	ND	ND	0.00
Aspergillus unguis	ND	ND	0.00
Aspergillus ustus	ND	ND	0.00
Aspergillus versicolor	ND	ND	0.00
Aureobasidium pullulans	ND	ND	0.00
Chaetomium globosum	ND	ND	0.00
Cladosporium cladosporioides svar. 1	7	9	50.00
Cladosporium cladosporioides svar. 2	ND	ND	0.00
Cladosporium herbarum	ND	ND	0.00
Cladosporium sphaerosperrnum	ND	ND	0.00
Eurotium (Aspergillus) amstelodami/ chevalleri/herbariorum/rubrum/repens	ND	ND	0.00
Epicoccum nigrum	7	ND	50.00
Mucor amphibiorum/circinelloides/hiematis/ indicus/mucedo/racemosus/ramoissimus and *Rhizopus azygosporus/homothalicus/ microsporus/oligoporus/oryzae*	ND	ND	0.00
Paecilomyces variotii	ND	ND	0.00
Penicillium crustosum/camemberti/commune/ echinulatum/solitum	ND	ND	0.00
Penicillium brevicompactum | stoloniferum	ND	ND	0.00
Penicillium chrysogenum	ND	ND	0.00
Penicillium corylophilum	ND	ND	0.00
Penicillium purpurogenum	ND	ND	0.00
Penicillium variabile	ND	ND	0.00
Penicillium glabrum/lividum/purpurescens/ spinulosum/thomii	ND	ND	0.00
Rhizopus stolonifer	ND	ND	0.00
Scopulariopsis brevicaulis | fusca	ND	ND	0.00
Scopulariopsis chartarum	ND	ND	0.00
Stachybotrys chartarum	ND	ND	0.00
Trichoderma viride/atroviride/koningii	ND	ND	0.00
Wallemia sebi	ND	154	0.00
Total Spores	13	164	

[0027] The standard filter with a MERV rating of 11, there were 16,493 spores/m^3 detected inside and 14,841 spores/m^3 detected outside, whereas with the non-uniform angled downward pleat design filters **401**, **403**, 13 spores spores/m^3 were detected inside and 164 spores/m^3 were detected outside. The results being a magnitude difference between the two filters tested, each being the same dimension and using the same MERV 11 rated material.

[0028] The filters **401**, **403** use less material (in comparison to a same dimensioned standard pleated filter) due to the natural of the downward curves and also filter in the 0.3 μm range. In a 20×20×2 inch filter size, 92 inches of material is used for a conventional known in the art pleated filter and in the filters **401**, **403** at those dimensions, 82 inches of material is utilized. The filter **401**, **403** is better rated than currently known in the art standard pleated designs made of the same material that have more uniform horizontal pleats (not shown) and use a greater surface area. It is foreseen that the air filtration and purification system **3** may be utilize any versions of filters previously discussed or a standard conventional filter.

[0029] The portable air filtration and purification system disclosed herein may be used in areas where it is most needed or desired. It thoroughly cleans the air in the area in which it is placed, is easy to move, economical, is quiet, and prolongs the life of the filters. It may also be used with or in addition to current HVAC systems wherein each filter may be placed at beginning and ends of ventilation systems. It is also understood that the filters discussed herein may be utilized outside the air filtration and purification unit, in the realms of automotive engines, includes cars, boats, aircraft, as well as ventilation systems and human made environments (satellites, space shuttles, etc.).

[0030] Thus, the present inventions have been described in detail with the understanding that the present detailed description is subject to modification and alterations without departing from the teaching herein. Therefore, the present invention should not be limited to the precise details presented herein but should encompass the subject matter of the claims and their equivalents, which follow.

1. A portable air filtration and purification system comprising:

a portable housing having three sides and an open area, the open area configured to facilitate filter replacement;

a pre-filter positioned within the housing;

a fan assembly having a fan housing and fan blades, the fan assembly positioned within the housing and being adjacent the pre-filter; and

a post-filter adjacent the fan assembly and positioned within the housing such that the pre-filer and the post-filter sandwich the fan assembly;

wherein:

the pre-filter intercepts the air flow into the portable air filtration and purification system before the air flows through the fan, and

the post-filter intercepts the air after it flows through the fan.

2. The system of claim **1**, wherein the filters are pleated filters with a Minimum Efficiency Reporting Value (MERV) rating of 8 or better.

3. The system of claim **1**, wherein the pre-filter has at least two pleats, the at least two pleats being positioned 45 degree angles apart from one another.

4. The system of claim **1**, wherein the post-filter has at least two pleats, the at least two pleats being positioned 45 degree angles apart from one another.

5. The system of claim **3**, wherein the at least two pleats are positioned at unequal angles with respect to one another.

6. The system of claim **4**, wherein the pre-filters are positioned at unequal angles with respect to one another.

7. The system of claim **1**, wherein the fan assembly rotates the fan blades at a speed between 0.2 m/s to 0.666 m/s.

8. The system of claim **7**, further comprising a switch that sets the rotation of the fan blades.

9. The system of claim **1**, wherein the pre-filter has at least two pleats, the at least two pleats each have an initial angle angled downwardly between 25 to 35 degrees and then folded over itself at a second angle between 10 to 20 degrees.

10. The system of claim **1**, wherein the pre-filter has at least two pleats, the at least two pleats each have an initial angle angled downward between 55 to 65 degrees and then folded over itself at a second angle between 50 to 55 degrees.

11. The system of claim **1**, wherein the post-filter has at least two pleats, wherein the at least two pleats each have an initial angle between 25 to 35 degrees and then folded over itself at a second angle between 10 to 20 degrees.

12. The system of claim **1**, wherein the post-filter has at least two pleats, the at least two pleats each have an initial angle angled downward between 55 to 65 degrees and then folded over itself at a second angle between 50 to 55 degrees.

13. The system of claim **1**, wherein the pre-filter includes a central pleat, an inner pleat, and an outer pleat, wherein the outer pleat has a first angle between 55 and 65 degrees and then folded back at a second angle between 50 and 60 degrees, the inner pleat being adjacent the outer pleats has a third angle between 35 to 45 degrees and then folded back at a fourth angle between 45 and 55 degrees, and the center pleat is angled from the inner pleat at an angle between 25 and 30 degrees.

14. The system of claim **1**, wherein the post-filter includes a central pleat, an inner pleat, and an outer pleat, wherein the outer pleat has a first angle between 55 and 65 degrees and then folded back at a second angle between 50 and 60 degrees, the inner pleat being adjacent the outer pleats has a third angle between 35 to 45 degrees and then folded back at a fourth angle between 45 and 55 degrees, and the center pleat is angled from the inner pleat at an angle between 25 and 30 degrees.

15. The system of claim **1**, wherein the pre-filter and the post-filter are identical.

16. The system of claim **1**, wherein the pre-filter has at least two pleats, each pleat being adjacent a rod.

17. The system of claim **1**, wherein the post-filter has at least two pleats, each pleat being adjacent a rod.

18. A portable air filtration and purification system comprising:

a first filter having at least two pleats, the at least two pleats each have an initial angle angled downward between 55 to 65 degrees and then folded over itself at a second angle between 50 to 55 degrees;

a fan; and

a second filter adjacent the fan;

wherein, the first filter and the second filter sandwich the fan.

19. A portable air filtration and purification system comprising:

a portable housing;

a pre-filter positioned within the housing and having a first set of pleats;

a fan assembly having a fan housing and fan blades, the fan assembly positioned within the housing and being adjacent the pre-filter; and

a post-filter adjacent the fan assembly and positioned within the housing such that the pre-filer and the post-filter sandwich the fan assembly, the post-filter having a second set of pleats;

wherein:

the pre-filter intercepts the air flow into the portable air filtration and purification system before the air flows through the fan, and

the post-filter intercepts the air after it flows through the fan;

wherein, in an operating position, the pre-filter and the post filter is each positioned within the housing such that an outermost portion of a plurality of pleats within the first set of pleats and the second set of pleats faces a surface on which the portable housing is situated.

20. The portable air filtration and purification system of claim **19**, wherein said surface is parallel to the ground.

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