



AN AIR FILTRATION SYSTEM

Field of Invention

The present invention relates generally to plant-based air filtration systems.

5

Background

Plants are known to support complex biological and bacterial processes within the plant and also within plant medium surrounding the plant roots. These processes have been harnessed for improving the air quality of confined spaces, for example within a house, by removal of volatile organic compounds (VOCs) therefrom. The plant medium, for example soil, may also contain micro-organisms capable of naturally degrading the VOCs. These VOCs includes but are not limited to pollutants such as benzene, toluene, TCE and α -pinene. Apparatuses have been built for containing specific species of plants for removal of specific VOCs from air being displaced therethrough. However, the effectiveness of such apparatuses may be impeded when used in an environment where dust and particle content in the air is high. For example, dust drawn into one such apparatus may attach itself to the plants, thereby hindering the pollutant removal effectiveness of the plants. Therefore, there is a need for an air filtration system for addressing the foregoing problem.

20

Summary

In accordance with a first aspect of the invention, there is disclosed a filtration system comprising a conduit having a first end and a second end forming extremities thereof. The filtration system further comprises a plant support structure and an actuator. The plant support structure is for supporting plants with the conduit being configurable with a container for containing water for submerging the second end of the conduit in the water. The plant support structure being spatially displaced away from the water. The actuator is for displacing air through the conduit towards the second end thereof. Air is displaced at least one of across the surface of and through water contained in the container during travel thereof towards the second end of the conduit for exit therefrom with dust contained in the air being substantially retained by the water as the air exits therefrom.

30



The plant support structure is disposed for enabling coinciding of the air travelling away from the water with the plants for substantially removing pollutants therefrom upon contact with the plants supported by the plant support structure.

- 5 In accordance with a second aspect of the invention, there is disclosed an air filtration system comprising a conduit having a first end and a second end forming extremities thereof. The air filtration system further comprises a plant support structure for supporting plants, a duct and an actuator. The conduit is configurable with a container for containing water for submerging the second end of the conduit in the water. The duct
- 10 extends from the conduit and form concentric the conduit with the duct inter-coupling the conduit and the plant support structure and spatially displacing the plant support structure away from the water. The conduit defines a first path extending from the first end to the second end thereof. The conduit and the duct are inter-configured to define a second path therebetween with the second path extending from the second end of the conduit towards
- 15 the plant support structure. The actuator is for displacing air along the first path towards the second end of the conduit with the air being displaced at least one of across the surface of and through water contained in the container during travel thereof towards the second end of the conduit for exit therefrom. Dust contained in the air being substantially retained by the water as the air exits therefrom. Air exiting the second end of the conduit
- 20 substantially travels along the second path towards the plant support structure for coinciding with the plants to thereby substantially removing pollutants therefrom upon contact therewith.

Brief Description of the Drawings

- 25 FIG. 1 illustrates a partial front sectional elevation an air filtration system comprising a plant support structure, a conduit and a duct according to an exemplary embodiment of the invention;

- FIG. 2 illustrates a partial front sectional elevation of the air filtration system of FIG. 1
- 30 with the conduit being received within a container having a base and a wall extending

therefrom, the wall of the container displacing the plant support structure and the conduit away from the base of the container;

5 FIG. 3 illustrates a partial front sectional elevation of the air filtration system of FIG. 1 with one extremity of each of the conduit and the duct being submerged in water contained in a container and with plants planted in growth medium being supported by the plant support structure;

10 FIG. 4 shows a system flow diagram of two filtration mechanism employed by the air filtration system of FIG. 1; and

FIG. 5 shows a process flow diagram of an air filtration method employable by the air filtration system of FIG. 1.

Detailed Description

An exemplary embodiment of the present invention, an air filtration system 20, is described hereinafter with reference to FIGS. 1 to 5. The air filtration system 20 comprises a plant support structure 22 and a conduit 24. Preferably, the plant support structure 22 is an annular structure defining a first opening 26 and a second opening 28. The plant support structure 22 is shaped and dimensioned for receiving plants 30 therewithin.

10 The plants 30 can be of a single or a combination of multiple plant species. Preferred species of the plants 30 comprises *Hemigraphis alternata*, *Hedera helix*, *Hoya carnosa*, *Asparagus densiflorus*, *Tradescantia pallid*, *Fittonia argyroneura*, *Ficus benamina* and *Polyscias fruticosa*.

15 The conduit 24 has a first end 32 and a second end 34 with the conduit 24 being coupled to the second opening 28 of the plant support structure 22 for fluid communicating the plant support structure 22 with the conduit 24. Preferably, the plant support structure 22 and the conduit 24 are formed as a unitary structure. Alternatively, the plant support structure 22 and the conduit 24 are formed as two separate structures inter-coupled
20 subsequent to manufacture thereof.

The conduit 24 is configurable with a container 36 with the second end 34 of the conduit 24 extending into the container 36 when configured therewith. The container 36 is preferably for containing water and comprises a base 38 for resting the container 36 on a
25 surface when in use. The container 36 further comprises a wall 42 extending from the base 38. The conduit 24 is preferably cylindrically shaped. The second end 34 of the conduit 24 is substantially submerged when water is contained in the container 36. Alternatively, the conduit 24 is conically-shaped and dimensionally diverges from the first end 32 to the second end 34. The conically-shaped conduit 24 provides a stable base
30 wherefrom the plant support structure 22 is supportable.

Further alternatively, the container 36 is coupled to the plant support structure 22 with the wall 42 thereof spatially displacing the plant support structure 22, and consequently the second end 34 of the conduit 24, away from the base 38 of the container 36 as shown in FIG. 2.

5

Preferably, screw-threads are defined at a rim of the wall 42 of the container 36 where it terminates (not shown) for coupling with corresponding screw-threads defined on the plant support structure 22.

- 10 The conduit 24 defines a first pathway 44 extending from the first end 32 to the second end 34 thereof. A second pathway 46 is defined substantially between the conduit 24 and the wall 42 of the container 36 and extends from the second end 34 of the conduit 24 substantially towards the plant support structure 22. Preferably, the second pathway 46 terminates adjacent a gap 47b defined by and at the interface between the plant support structure 22 and the conduit 24.

- Alternatively, the second pathway 46 is defined between the conduit 24 and an elongated duct 47a disposed concentric the conduit 24 as shown in FIG. 3. The elongated duct 47a is preferably cylindrical. Preferably, the cylindrical duct 47a is coupled to the plant support structure 22 and extends therefrom towards the container 36. When in use, the elongated duct 47a interposes the plant support structure 22 and the container 36. Further, one extremity of the elongated duct 47a proximal the second end 34 of the conduit 24 abuts the base 38 of the container 36 for spatially displacing the second end 34 of the conduit 24 from the base 38 of the container 36. At least one opening (not shown) is defined by the elongated duct 47a at a portion thereof adjacent the second end 34 of the conduit 24 for passage of fluid therethrough.

- The conduit 24 defines at least one opening 48 adjacent the second end 34 thereof for fluid communicating the first pathway 44 with the second pathway 46 as shown in FIG. 2. Preferably, the at least one opening is disposed for partial submergence thereof in the water contained in the container 36 when in use. Further, the at least one opening 48 is

30

shaped and dimensioned to enable air passing therethrough from the first pathway 44 to create vortex at least along the surface of the water contained in the container 36 during travel of the air onto the second pathway 46. The vortex generated stirs the water for creating a whirlpool effect in the container 36 for better retention of dust carried in the air by the water. The plant support structure 22 defines at least one aperture adjacent where the plants 30 contained therewithin is disposed. Specifically, the second pathway 46 extends towards the at least one aperture of the plant support structure 22.

It is apparent to a person having ordinary skill in the art that the container 36 can form a constituent of the air filtration system 20 and be structurally coupled, fixably or removably, to the conduit 24. Preferably, the plant support structure 22 further comprises receptacles for receiving a growth medium 54, for example, soil. Preferably, the growth medium 54 is air permeable. The growth medium 54 receives roots of the plants 30 for support thereof. The at least one aperture is defined where the receptacles are disposed. Preferably, a wick extends substantially from the container 36 to the receptacles for transport of water contained in the container 36 to the growth medium 54, and consequently to the plants 30, via capillary effect. Preferably, each receptacle and the growth medium, plant contained therein and the wick extending thereto forms a module which is decouplable from the plant support structure 22 for replacement with another module containing a new plant. The modules defined by the receptacles mitigates mess within the air filtration system 20 and eases manipulation for effecting soil and plant replacements.

The air filtration system 20 further comprises an actuator 60 for displacing air through the conduit 24. Preferably, the actuator 60 is disposed adjacent the first end 32 of the conduit 24 for displacement of air along the first pathway 44 towards the second end 34 of the conduit 24. When the displaced air coincides with the water contained in the container 36, dust contained in the air is substantially retained thereby. As the air exits from the water and transits onto the second pathway 46, the air will be substantially filtered of dust. The second pathway 46 then directs the air substantially towards the at least one aperture and across the growth medium 54 received in the receptacles. As the air

- passages across the growth medium 54, finer particles remaining in the air, if any, will be substantially retained by the growth medium 54 functioning as a filter. Further, air passaging across the growth medium 54 will also come into contact with the roots of the plants 30. This enables the roots of the plants 30 to remove any pollutants present in the air. Exposed portions of the plants 30, for example the leaves and stems thereof, also further aids in the further removal of pollutants from the air as it exhaust from the growth medium 54. These pollutants include, but are not limited to, volatile organic compounds, particulate matters, ozone, radon, lead and biological contaminants. Preferably, the plant support structure defines an outlet, for example the gap 47b, wherefrom filtered air exhausts. The outlet is defined and disposed to substantially reduce mixing of the filtered air with air being drawn into the first end 32 of the conduit 24 to substantially prevent the already filtered air from being re-filtered by the air filtration system 20 immediately after being exhausted therefrom.
- Alternatively, the air filtration system 20 comprises an air stone (not shown) coupled to the at least one opening at the second end 34 of the conduit 24. This enables air displaced along the first pathway 44 to be dispersed through the water for subsequent percolation out of the water and onto the second pathway 46.
- The actuator 60 is preferably an electric fan or the like apparatus for effecting air displacement. The facilitation of airflow along the first pathway 44 and the second pathway 46 improve filtration of air by the air filtration system 20. The air filtration system 20 further comprises illumination means 66 for providing illumination to the plants 30 to aid plant growth. The illumination means 66 comprises at least one of light emitting diodes (LEDs), incandescent lamps and gas discharge lamps.

Functionally, the air filtration system 20 provides two filtration mechanisms 100 for air filtration according to an air filtration method 200. The two filtration mechanisms comprise a particle removal mechanism 102 for the removal of particles, for example dust, from the air. The particle removal mechanism 102 comprises the water contained in the container 36 for removing dust and the like particle from air passaging therethrough,

and the growth medium 54 which functions to substantially remove remaining particles still carried in the air, specifically finer particles. The two filtration mechanisms 100 further comprise a pollutant removal mechanism 104 for removal of pollutant from air. The pollutant removal mechanism 104 comprises the growth medium 54, the roots of the plants received in the growth medium 54 and exposed portions of the plants 30.

For clarity, the air filtration method 200 comprises a particle removal step 202 wherein air from the atmosphere is displaced through the particle removal mechanism 102. The particle removal step comprises a step 204 of displacing the air through water contained in the container 36 and a step 206 of displacing the air across the growth medium 54. The air filtration method 200 further comprises a pollutant removal step 208 wherein the air is displaced through the pollutant removal mechanism 104. The pollutant removal step 208 comprises the step 206 of displacing the air through the growth medium 54, a step 210 of displacing the air across the roots of the plants 30 and a step 212 of displacing the air across exposed portions of the plants 30, before exhausting the filtered air into the atmosphere.

In the foregoing manner, an air filtration system and an air filtration method are described according to an exemplary embodiment of the present invention. Although only exemplary embodiments of the present invention are disclosed, it will be apparent to a person skilled in the art in view of this disclosure that numerous changes and/or modifications can be made without departing from the scope and spirit of the present invention.

Claims

1. A filtration system comprising:

a conduit having a first end and a second end forming extremities thereof;

- 5 a plant support structure for supporting plants, the conduit being configurable with a container for containing water for submerging the second end of the conduit in the water, the plant support structure being spatially displaced away from the water; and

- 10 an actuator for displacing air through the conduit towards the second end thereof, air being displaced at least one of across the surface of and through water contained in the container during travel thereof towards the second end of the conduit for exit therefrom, dust contained in the air being substantially retained by the water as the air exits therefrom,

- 15 wherein the plant support structure is disposed for enabling coinciding of the air travelling away from the water with the plants for substantially removing pollutants therefrom upon contact with the plants supported by the plant support structure.

2. The system as in claim 1, the plant support structure further for containing a growth medium wherethrough roots of the plants extend, the plant support structure and the conduit being shaped and interconfigured for guiding the air exiting from the water substantially towards the growth medium.
- 20

3. The system as in claim 2, the plant support structure comprising at least one receptacle for receiving the growth medium and at least a portion of the plants therewithin.

- 25 4. The system as in claim 3, the at least one receptacle defining at least one aperture for passage of air therethrough and towards the growth medium.

5. The system as in claim 1, the air exits from the water and enters a passageway defined substantially between the conduit and the container.

6. The system as in claim 3, the plant support structure being shaped for disposing the growth medium between the plants and the passageway.
7. The system as in claim 1, the plant support structure having an annular shape defining an opening coupled to the conduit.
- 5 8. The system as in claim 1, the conduit defining an outlet at the second end thereof, the outlet being disposed for being partially submerged in the water contained in the container when in use, and the outlet being shaped and dimensioned for generating a vortex at least along the surface of the water for creating a whirlpool effect in the container.
- 10 9. The system as in claim 1, the actuator being disposed one of between the first end and the second end of the conduit and substantially adjacent the first end of the conduit.
10. The system as in claim 9, further comprising illumination means.
11. The system as in claim 10, the illumination means comprising at least one of light
15 emitting diodes, incandescent lamps and gas discharge lamps.
12. The system as in claim 1, the conduit being a substantially cylindrical tube with the first end and the second end forming extremities thereof.
13. The system as in claim 1, the conduit being substantially conical and diverging from the first end towards the second end.
- 20 14. The system as in claim 12, the conduit defining at least one aperture adjacent the second end.
15. The system as in claim 1, further comprising at least one wick extending between the water in the container and the plants for delivering water from the container to the plants by capillary effect.

16. The system as in claim 1, the actuator being an electric fan.
17. The system as in claim 1, further comprising an air-stone coupled to the second end of the conduit for fluid communication therewith, the air stone being disposed between the conduit and the container, air passaging through the conduit being discharge therefrom via the air stone.
18. The system as in claim 1, the plants being of at least one plant species.
19. The system as in claim 18, the plants comprising at least one of *Hemigraphis alternata*, *Hedera helix*, *Hoya carnosa*, *Asparagus densiflorus*, *Tradescantia pallid*, *Fittonia argyroneura*, *Ficus benjamina* and *Polyscias fruticosa*.
20. A filtration system comprising:
 - a conduit having a first end and a second end forming extremities thereof;
 - a plant support structure for supporting plants, the conduit being configurable with a container for containing water for submerging the second end of the conduit in the water;
 - a duct extending from the conduit and form concentric the conduit, the duct for inter-coupling the conduit and the plant support structure and for spatially displacing the plant support structure away from the water, the conduit defining a first path extending from the first end to the second end thereof, the conduit and the duct defining a second path therebetween with the second path extending from the second end of the conduit towards the plant support structure; and
 - an actuator for displacing air along the first path towards the second end of the conduit, air being displaced at least one of across the surface of and through water contained in the container during travel thereof towards the second end of the conduit for exit therefrom, dust contained in the air being substantially retained by the water as the air exits therefrom,
 - wherein air exiting the second end of the conduit substantially travels along the second path towards the plant support structure for coinciding with the

plants to thereby substantially removing pollutants therefrom upon contact therewith.

21. The system as in claim 20, the plant support structure further for containing a growth medium wherethrough roots of the plants extend, the plant support structure and the conduit being shaped and interconfigured for guiding the air exiting from the water substantially towards the growth medium.
21. The system as in claim 21, the plant support structure comprising at least one receptacle for receiving the growth medium and at least a portion of the plants therewithin, the at least one receptacle defining at least one aperture for passage of air therethrough and towards the growth medium.
23. The system as in claim 22, the plant support structure being shaped for disposing the growth medium between the plants and the second path.
24. The system as in claim 20, the plant support structure having an annular shape defining an opening coupled to the conduit.
26. The system as in claim 20, the conduit defining an outlet at the second end thereof, the outlet being disposed for being partially submerged in the water contained in the container when in use, and the outlet being shaped and dimensioned for generating a vortex at least along the surface of the water for creating a whirlpool effect in the container.
26. The system as in claim 20, the actuator being disposed one of between the first end and the second end of the conduit and substantially adjacent the first end of the conduit.
27. The system as in claim 26, further comprising at least one of light emitting diodes, incandescent lamps and gas discharge lamps.
28. The system as in claim 20, the conduit being a substantially cylindrical tube with the first end and the second end forming extremities thereof.

29. The system as in claim 28, the conduit defining at least one aperture adjacent the second end.
30. The system as in claim 20, further comprising at least one wick extending between the water in the container and the plants for delivering water from the container to the plants by capillary effect.
31. The system as in claim 20, the plants being of at least one plant species.
32. The system as in claim 31, the plants comprising at least one of *Hemigraphis alternata*, *Hedera helix*, *Hoya carnosa*, *Asparagus densiflorus*, *Tradescantia pallida*, *Fittonia argyroneura*, *Ficus benjamina* and *Polyscias fructicosa*.