



AIR SCRUBBING APPARATUS

FIELD OF INVENTION

- 5 The present invention relates to air and gas scrubbing and in particular to the treatment of air by passing a flow of the air through an atmosphere which includes a mist.

BACKGROUND

- 10 Air scrubbing devices which pass a flow of air through a mist, spray or atomised liquid are known.

European Patent 36339 describes a device having a reservoir containing an aqueous solution and an enclosure in which a mist of the solution is generated by a spinning rotor.

- 15 An atmosphere to be treated is forced through the mist in the enclosure.

- Another known air scrubbing device is an air revitaliser which uses a mist generator mounted over a reservoir bowl which is partially filled with a body of air-cleansing liquid. The mist generator is a motor-driven rotary disc that has an axially-located funnel fixed to its underside. The lower narrower end of the funnel is immersed in the liquid which is drawn up into the rotating funnel. The liquid is expelled radially outwardly from apertures in the upper flared end of the funnel at the under side of the rotating disc. The disc flings the liquid against the inside of the upper wall of the bowl from where the liquid trickles back down to the body of liquid. The rotating disc generates a fine mist. Vanes on the top side of the rotating disc circulate air from outside the revitaliser, drawing the air into a housing resting on the bowl, passing the air through the mist and back out to the atmosphere outside the revitaliser.
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- The liquid may be a solution incorporating additives for example plant extracts for enhancing the effectiveness of the scrubbing device. In particular the additives enhance the effectiveness of the scrubbing device to remove fungi, bacteria, viruses, dust particles, and the products of partial combustion, such as carbon monoxide, from treated air. The
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additives can also deodourise and/or add a fragrance to treated air. Preferably the additives are biodegradable, non-toxic to mammals, and are water soluble or are emulsified for ready miscibility with water.

5 The rotor is driven by an electric motor to rotate typically at about 3000 rpm (revolutions per minute). As noted above, rotation of the disc flings liquid at the walls of the bowl. Operation of the revitaliser generates a level of noise. This noise is due in part to the motor and disc rotation, to the movement of air through the revitaliser, and to the liquid impinging on the walls of the bowl. Because the revitaliser is typically used in indoor
10 spaces such as rooms in work spaces and in domestic homes, the noise level can be undesirable. It is preferred that operation of the revitaliser generate as little noise as possible, or at least generate noise that is not as obtrusive to occupants of a room or other space where the revitaliser is being used.

15 SUMMARY OF INVENTION

It is an object of the invention to provide a device that can scrub gas, using a mist generated by rotation of a rotor partially immersed in a liquid, while generating a level of noise that is less than that of such devices of the prior art.

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It is another object of the invention to provide a device that can scrub gas, using a mist generated by rotation of a rotor partially immersed in a liquid, while generating a noise that is less obtrusive than that of such devices of the prior art.

25 In broad terms the invention may be said to be an apparatus for treating an atmosphere, the apparatus including;

a container for holding a body of liquid and for housing a treatment space, the container having a wall which surrounds and extends upwardly from a space in which the body of liquid is to be held,

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a mist generator having a rotor adapted for partial immersion in liquid held in the container, the rotor being adapted for providing a mist at the treatment space, the mist being provided from liquid held in the container by rotation of the rotor, and

a circulator for circulating a portion of the atmosphere external to the container through the treatment space,
wherein the interior surface of the wall has a non-circular horizontal cross-sectional shape.

- 5 Preferably the interior surface of the wall has an otherwise substantially circular horizontal cross-sectional shape from which at least one protrusion extends radially inwardly.

Preferably the container has three of the protrusions.

- 10 The or each protrusion may include a vane.

The or each protrusion may include a flat section of the interior surface of the wall.

The or each protrusion may include a lobe.

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Preferably the wall extends upwardly to terminate at a junction with at an inward return.

Preferably different length portions of the junction are at different heights above the bottom of the container.

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Preferably the non-circular cross-sectional shape surrounds said space in which the body of liquid is to be held.

Alternatively or additionally, the non-circular cross-sectional shape surrounds the

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treatment space.

The invention may further be said to consist in any alternative combination of parts or features mentioned herein or shown in the accompanying drawings. Known equivalents of these parts or features which are not expressly set out are nevertheless deemed to be
30 included.

BRIEF DESCRIPTION OF DRAWINGS

Preferred embodiments of the invention will now be described, by way of example only and without intending to be limiting, with reference to the drawings of which:

5 Figure 1 shows a schematic cross-sectional side view of a first embodiment of a gas scrubbing device according to the invention,

Figure 2 shows a cross-sectional plan view of the reservoir of the first embodiment of the scrubbing device as seen at line A-A of Figure 1,

10 Figure 3 shows a cross-sectional plan view of a second embodiment of a scrubbing device according to the invention,

Figure 4 shows a cross-sectional plan view of a third embodiment of a scrubbing device according to the invention, and

15 Figure 5 shows a cross-sectional plan view of a fourth embodiment of a scrubbing device according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 Referring to the drawings, it will be appreciated that a scrubber according to the invention may be implemented in various forms. As noted above, the embodiments are described by way of example only.

25 It is to be understood that references to vertical and horizontal directions, to upper and lower, and other similar references, are given only for the convenience of description. Such references are to be understood in the general context of the typical operational orientation of the device as shown in Figure 1, and are not to be construed as limiting the invention to any particular orientation. In particular, references to vertical and horizontal
30 are not to be understood as nominal references to approximate orientations and not to exact vertical or horizontal directions.

It is also to be understood that the Figures are not all at the same scale.

Figure 1 shows an air scrubbing device. It is to be understood that the device is equally suitable for scrubbing a gas or gasses in general, and is not limited to use only in air. A mist generator or atomiser is mounted over a reservoir 2 which is partially filled with a body of air-cleansing liquid 3. The mist generator has a rotor 4 which is fitted to a vertical shaft 5. The shaft is rotated by an electric motor 6. The rotor includes a horizontal rotor disc 7. On the underside of the rotor disc there is a funnel 8. The motor shaft 5, rotor disc 7 and funnel 8 are aligned on a common vertical axis.

The funnel has a hollow tapered lower end portion 9 which in use is partially immersed in the body of liquid in the reservoir and has an opening 10 at the lower distal end which allows entry of liquid into the hollow interior of the funnel. The funnel has a hollow upper flared end portion 11. The wall of the flared end portion is provided with vertically extending slots 12.

The rotor also includes a series of radially extending vanes 13 on the upper surface of the disc.

The reservoir 2 has substantially flat bottom portion 14 allowing the device to be supported in a stable state on a generally horizontal support surface, such as a table or shelf. Alternatively, the reservoir can be supported in an intermediate base member which rests on the horizontal support surface.

The side walls 15 of the reservoir extend upwardly from the flat bottom portion to an inward return 16 which terminates at the rim 17 of the reservoir.

The mist generator is mounted in a cover or lid 18 which rests on the top of the reservoir. The motor is fixed in the lid with the motor shaft protruding downward. The rotor, which is fixed to the shaft, is partly immersed in the body of liquid in the reservoir when the lid rests on the top of the reservoir.

The lid has an outer skin 19 and includes partitions 20 which divide the interior volume of the lid into an inlet chamber 21 and an outlet chamber 22, and which define channels which allow ambient air external to the scrubbing device to be drawn through the scrubber and returned to the external atmosphere as will be explained further below. An inlet
5 channel 23 connects the inlet chamber to a central zone 24 of the rotor vanes and an outlet channel 25 connects a circumferential and radially outer zone 26 of the rotor vanes to the outlet chamber. The outer skin of the lid is provided with apertures 27 which connect the outlet chamber to the atmosphere external to the scrubbing device. The lid partitions are shaped to effectively close off the top opening in the reservoir, other than at the inlet and
10 outlet channels described above.

The air scrubbing device as shown in Figure 1 is operated by partially filling the reservoir with a liquid. Typically the liquid is an aqueous solution including one or more additives to enhance the effectiveness of the scrubbing operation or the aesthetic appeal of the
15 device. There are many additives known to be suitable for use in such air scrubbing devices. Some of these have already been discussed above.

The rotor is rotated, for example at about 3,000 rpm, by powering the electric motor. Rotation of the funnel rotates the aqueous solution inside the funnel. The rotation of this
20 solution is assisted by the inclusion of vertical ribs (not shown) on the inside wall of the tapered funnel. The ribs improve the frictional coupling between the rotating funnel and the solution inside it. The solution in the funnel rises from the effect of centrifugal forces on the rotating solution. As the solution rises up the tapered funnel, the increasing diameter of the funnel increases the centrifugal effect. When the solution reaches the
25 slots 12 at the flared upper end of the funnel, the solution is flung outwardly through the slots. The rapidly spinning rotor thus generates a radial spray from the solution to form a fine mist or aerosol in the form of a cloud of liquid particles which occupies the volume of the reservoir 2 above the body of liquid 3. The radial spray is largely constrained by the rotor disc 7 from moving further upward, the liquid spray instead moving outwards
30 towards the side walls 15 of the reservoir 2. Excess solution not contributing to the mist reaches the wall of the reservoir and trickles back down into the body of liquid.

At the same time the rotating rotor vanes 13 causes a circulation of air by the centrifugal forces on air between and in the vicinity of the vanes. These centrifugal forces drive air outwardly from the central zone 24 of the vanes, to the circumferential and radially outer zone 26 of the vanes. The partial vacuum thus created at the central vane zone 24 draws air into the gap 28 between the rim 29 of the lid and the reservoir. Air drawn through the gap enters the inlet chamber 21 between the underside of the lid and the topside of the reservoir. This space communicates with the central zone 24 of the rotor vanes by inlet channel 23. Air driven outwardly by the spinning vanes mingles with the radial spray of liquid and circulates in a swirling motion through the mist, from where it moves up through outlet channel 25 to the outlet chamber 22, from where it returns, via the apertures 27 in the outer skin of the lid, to the ambient air external to the scrubbing device. This circulation of air is shown in Figure 1 by the solid headed arrows.

Thus it will be understood that air external to the device is circulated through the mist; the spinning rotor both generating the mist and circulating the air.

The horizontal cross section of the inner surface of the reservoir wall 15 surrounding the body of liquid 3 is provided with non-circularities which may be best appreciated from the horizontal cross-sectional view shown in Figure 2 as seen at line A-A of Figure 1.

The reservoir 2 also includes non-circularities in the horizontal cross-sectional shape of the interior surface of the walls 15 of the reservoir 2 and particularly of the walls which surround the body of liquid 3. In the first embodiment shown in Figure 1 and the cross-sectional plan view in Figure 2, the non-circularities are vanes 30.

Figures 3 and 4 show corresponding cross-sections of second and third embodiments in which the non-circularities are flat sections 31 of the wall. In Figure 3, the flat sections intersect the otherwise circular cross-section 32 (shown as a broken line) without substantial rounding or radiusing, whereas in Figure 4, there is a radiusing at these intersections. In another embodiment (not shown) the intersections are radiused to the extent that the protrusions have very little flat section.

Figure 5 shows a corresponding cross-section of a fourth embodiment in which the non-circularities are broad lobes 33 which project inwardly from the otherwise circular shape 32 (shown as a broken line) of the reservoir wall.

5 In the embodiments shown in the Figures the cross-sectional shape has three non-circularities, however it is to be understood that any suitable number of non-circularities may be used.

It will be readily appreciated that other shapes may be used to provide the non-circularities.
10 For example, a combination of the shapes shown can be used. In one arrangement (not shown), the reservoir includes vanes and broad lobes to provide the non-circularities in the walls around the body of liquid.

The use of the non-circularities lowers the obtrusiveness of the noise associated with
15 operation of the device. Although the noise contributors have not been rigorously studied, it is believed that contributors to the overall noise associated with operation of the device include the movement of the body of liquid in the reservoir, the hum from the motor, the whirr or wind noise from the spinning rotor vanes, the noise of the mist formation by the spinning rotor funnel and disc, and the splashing of the excess liquid against the reservoir
20 walls. It is believed that the splashing of the excess liquid against the reservoir walls is a major contributor to the overall noise associated with the operation of the device, and that the presence of non-circularities in the reservoir walls at the level where the spray impinges on the walls reduces this component of the noise.

25 Upon initial operation the body of liquid in the reservoir can be quite still, with only the within and closely adjacent the funnel circulating under the influence of the spinning rotor. However, in prior art devices having circular reservoirs, it has been observed that after a time most of the body of liquid begins to rotate. As this rotation increases, the body of fluid becomes unstable and sloshes around in the reservoir, slopping up and down the sides
30 of the reservoir as it does so. This creates an increase in the level or obtrusiveness of the noise generated by the device. It has been found that the use of non-circularities in the

reservoir walls at the level of the body of liquid helps to stabilise the body of liquid and reduce this component of the noise.

5 The non-circularities may also contribute to the reduction in noise by strengthening the reservoir walls, by increasing the rigidity of the walls. The relatively sharp corner at the junction between the walls 15 of the reservoir and the inward return 16 at the top of the walls may also help to contribute to the reduction in the noise. This contribution may be further increased by arranging for different portions of the length of this junction or corner to have different heights above the bottom of the reservoir. In one arrangement (not
10 shown) this junction follows a sinusoid-like wave around the reservoir.

It is believed that these measures may help to dampen the resonances in the reservoir and/or in the body of liquid and in the reservoir, and thereby help to lower the obtrusiveness of the noise associated with operation of the device.

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The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated within the scope hereof as defined in the accompanying claims.

List of feature labelled in the Figures

2. reservoir
3. body of liquid
- 5 4. rotor
5. shaft
6. motor
7. rotor disc
8. funnel
- 10 9. lower funnel end portion
10. opening
11. upper flared end portion
12. slots
13. rotor vanes
- 15 14. flat reservoir bottom
15. reservoir side walls
16. inward return
17. reservoir rim
18. lid
- 20 19. outer lid skin
20. partitions
21. inlet chamber
22. outlet chamber
23. inlet channel
- 25 24. central vane zone
25. outlet channel
26. outer vane zone
27. lid apertures
28. gap
- 30 29. rim
30. reservoir vanes
31. flat sections

32. circular cross-section

33. lobes

CLAIMS

1. An apparatus for treating an atmosphere, the apparatus including;
 - a container (2) for holding a body of liquid (3) and for housing a treatment space,
 - 5 the container having a wall (15) which surrounds and extends upwardly from a space in which the body of liquid is to be held,
 - a mist generator having a rotor (4) adapted for partial immersion in liquid held in the container, the rotor being adapted for providing a mist at the treatment space, the mist being provided from liquid held in the container by rotation of the rotor, and
 - 10 a circulator (13) for circulating a portion of the atmosphere external to the container through the treatment space,
 - wherein the interior surface of the wall has a non-circular horizontal cross-sectional shape (30).
- 15 2. An apparatus as claimed in claim 1, wherein the interior surface of the wall has an otherwise substantially circular horizontal cross-sectional shape (32) from which at least one protrusion extends radially inwardly.
3. An apparatus as claimed in claim 2, wherein the container has three of said
 - 20 protrusions.
4. An apparatus as claimed in claim 2 or claim 3, wherein the or each protrusion includes a vane (30).
- 25 5. An apparatus as claimed in claim 2,3 or 4, wherein the or each protrusion includes a flat section (31) of the interior surface of the wall.
6. An apparatus as claimed in any one of claims 2 to 5, wherein the or each protrusion includes a lobe (33).
- 30 7. An apparatus as claimed in any one of the preceding claims, wherein the wall extends upwardly to a junction with an inward return (16).

8. An apparatus as claimed in claim 7, wherein different length portions of the junction are at different heights above the bottom of the container.

9. An apparatus as claimed in any one of the preceding claims, wherein the non-circular cross-sectional shape surrounds said space in which the body of liquid is to be held.

10. An apparatus as claimed in any one of the preceding claims, wherein the non-circular cross-sectional shape surrounds the treatment space.