

Fan Unit Air Flow Control

Field of the Invention

- 5 The present invention relates to a fan unit air flow control and refers particularly, though not exclusively, to a fan unit air flow control for reducing noise from a fan unit in a clean room facility.

Background of the Invention

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- It is common for modern production and testing facilities to control the quantity of particles in the air that circulates within clean room facility in order to ensure the quality of the output of the clean room facility. Whether be it wafer dies, compact discs or memory disk drives, effective fan units are needed to not only keep the particle content within the clean room at acceptable levels, but also to circulate the air which workers breathe. As such, the fan units tend to be relatively powerful.

- However, such powerful fan units create excessive noise. Insulation material has been used to line the internal sides of the casing of the fan units to reduce the noise generated by the fan blowers. However, such an elementary method often does not reduce the noise to a satisfactory level for workers inside the clean room facility. The problem associated with the noise in a clean room facility is exacerbated in a confined space or enclosures such as, for example, a multi-storey wafer fabrication plant. Where there is low height clearance, the noise from fan units may be quite pronounced.

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Summary of the Invention

- In accordance with a preferred form there is provided a fan unit comprising:
- 30 a top having an inlet opening,
at least one side enclosing the fan unit,
an outlet opening,
a fan blower disposed on a blower mounting, the fan blower being for drawing air through the inlet opening and for discharging air through the outlet opening,
- 35 at least one pair of guides extending inwardly from a lower end of the at least one side towards the outlet opening, said at least one pair of guides and the blower mounting forming an air flow channel therebetween.

The air flow channel creating a constriction on air flow to raise air pressure within the air flow channel to thereby create substantially mono-directional air flow in the air flow channel and through the outlet opening, with reduced turbulence such that
 5 noise from said fan unit is minimised.

There may be provided two pairs of baffles disposed within the fan unit, the baffles being mutually perpendicular. The guide baffles may define the outlet opening. The guide baffles may be disposed at an angle of between 90° and 60° with the at least
 10 one side, preferably 90° . The guide baffles may be perforated. The perforation may be over all or a part only of the guide baffles, and the guide baffles may be covered by a cloth. Additionally or alternatively, the guide baffles may be curved or flat.

15 The outlet opening may be of a shape selected from: circular, triangular, square, rectangular, pentagonal, or octagonal.

There may be further included at least one pair of plates disposed within the fan unit extending between and being connected to each of the top and the at least
 20 one side, each of the at least one pair of plates defining an enclosed space behind it. There may be two pairs of plates, the plates being mutually perpendicular. At least one of the plates may be perforated. The perforations may be over all or part of the at least one of the plates. The plates may be curved or flat and the plates may be covered by a cloth. The enclosed space may be filled with a noise insulating
 25 material.

A noise insulating material may be used to line an internal surface of one or more of the at least one side, the top, the guide baffles, and the plates.

30 The blower mounting may have a noise insulating material attached to a surface thereof. The surface may be a lower surface. The blower mounting may be in the form of an inverted tray with depending side walls, the noise insulating material being located in the tray.

35 The top may have a central opening. The central opening may have an inlet cover, the inlet opening being in the inlet cover.

A filter may be located below the outlet opening.

The at least one side may be four mutually perpendicular sides, the sides also being perpendicular to the top.

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There is also provided a method to control the flow of air.

Brief Description of the Drawings

10 In order that the invention may be clearly understood and readily put into practical effect there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings in which:

15 Figure 1 is a exploded, front perspective view of a preferred form of the present invention integrated as part of a fan unit;

Figure 2 is a cross sectional elevational view of the form of Figure 1 when assembled;

Figure 3 is a full cross-sectional view along the lines and in the direction of arrows

20 A-A on Figure 2;

Figure 4 is a view corresponding to Figure 3 of an alternative embodiment;

Figure 5 shows the locations where the velocity of airflow was measured;

Figure 6 is a chart comparing the average velocity of airflow and the noise level with and without the preferred form of the present invention; and

25 Figure 7 shows a cross sectional elevational view of an alternative embodiment of the lower portion of Figure 1 when assembled.

Description of the Preferred Embodiments

30 In the following description, numerous specific details are set forth such as, for example, guides and baffles, in order to provide a thorough understanding of the invention. In other instances, well-known components such as, for example, the motors for the fan blower and ducts connected to the fan units, are not shown and/or described in order not to obscure the invention.

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Figure 1 is an exploded, front, perspective view of a preferred embodiment the present invention integrated as part of a fan unit. The fan unit comprises four

mutually perpendicular side walls 22, and an annular top 17 having a central opening 10. Although the fan unit is shown as being square in shape, it may be of any suitable shape such as, for example, cylindrical, triangular, rectangular, pentagonal, octagonal, and so forth.

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The central opening 10 is shown as being square. It also may be of any suitable shape such as, for example, round, triangular, rectangular, pentagonal, octagonal, and so forth. Preferably, the shape of central opening 10 is similar to that of the fan unit.

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Located over and enclosing central opening 10 is air inlet cover 11. Cover 11 covers central opening 10 and is dimensionally larger than opening 10 such that it contacts top 17 around the periphery of opening 10. Cover 11 is securely, releasably and substantially sealingly attached to top 17. Cover 11 is also annular and has a central air inlet opening 18. Inlet opening 18 is shown as being round. It may be any suitable shape as is required or desired such as, for example, triangular, square, rectangular, pentagonal, octagonal, and so forth. There may be more than one inlet opening 18.

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A fan blower 12 is disposed on a fan blower mounting 14 that may have depending side walls 15. Alternatively, mounting 14 may be flat. Mounting 14 may also be invertable. Attached to the blower mounting 14 and extending upwardly therefrom are four rods 13 also releasably connected to the air inlet cover 11. Not shown, but required for the normal operation of the fan unit, is a motor for providing rotational movement for the fan blower 12. The mounting 14 may be dimensionally larger than the outlet opening 19 in the horizontal plane so that it extends beyond the periphery of outlet opening 19. The mounting 14 may also be dimensionally smaller than the outlet opening 19 in the horizontal plane. The dimensions of the mounting 14 may depend on the dimensions of the fan blower 12. The size of the fan blower 12 may depend on the performance requirements of a user. The mounting 14 need not be a custom-fitted blower mounting.

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In this way the blower 12 may be located inside the fan unit and may be on its mounting 14. The mounting 14 may be suspended from top 17 by the connection of the rods 13 to the inlet cover 11, and the inlet cover 11 may be supported by top 17. This may enable blower 12 to be easily removed through central opening 10 for

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servicing, maintenance, or replacement. The central opening should be sized accordingly.

By itself, the fan unit draws air externally through air inlet 18 as is shown by arrows 1 on Figure 2. The air is discharged through the outlet opening 19 as shown by arrows 2 on Figure 2. Located below the outlet opening 19 may be a filter 32 for removing large particles or contaminants. The outlet opening 19 is shown as being square. It may be any suitable or desired shape such as, for example, circular, triangular, rectangular, pentagonal, octagonal, and so forth. There may be more than one outlet opening 19. Filter 32 may be spaced from outlet opening 19, or may be immediately adjacent outlet opening 19.

Referring again to Figure 1, guide baffles 28 are placed in strategic locations within the fan unit to minimise noise from it, and may also be placed along the path of the airflow. Baffles 28 extend inwardly from a lower end of side 22. At least one pair of the guide baffles 28 is disposed on opposite sides of the outlet opening 19 and extend inwardly from side walls 22 to the outlet opening 19. The pair of baffles 28 are substantially identical, opposed, parallel, and co-planar. The guide baffles 28 are at an angle to the side walls of 90° to 60° , preferably 90° . Also, there are preferably two such pairs of guide baffles 28 all being mutually perpendicular to form, in effect, a floor of guide baffles 28 around outlet opening 19. Guide baffles 28 may also define the outlet opening 19. Guide baffles 28 may be flat, as shown, or may be curved. If curved, they may be curved downwardly toward outlet opening 19. This is illustrated in Figure 7.

Figure 3 is a full cross-sectional view along the lines A-A of Figure 2 highlighting the guides baffles 28. The guide baffles 28 are placed to receive the discharged air from the fan blower 12 (shown in the dotted circle) and to guide the flow of air 3 within the fan unit with minimal of turbulence towards, and through, the outlet opening 19.

At least one pair of plates 26 for further absorbing the sound generated from the moving air 3 generated by the fan blower 12 may also be provided.

Preferably there are two pairs of plates 26, mutually perpendicular to each other. The plates 26 extend between top 17 and sides 22 and are preferably at an angle of between 30° and 60° , preferably 45° , to the sides 22, and thus at an angle of

between 60° and 30°, preferably 45°, to top 17. Each plate 26 may be a sheet of metal, and may have a matrix of holes or perforations over all or part of its surface.

5 Sound insulation materials 6 and/or such as sponge, fibreglass, rockwool, linen cloth and so forth may be fixed on the plates 26 and/or the guide baffles 28 and/or top 17 on an internal surface facing the air streams 1, 2 and 3. The plates 26 are preferably disposed at the angles given above to absorb the noise generated from the air flow 3 from the fan blower 12 and/or to assist in controlling the air flow 3.

10 As stated above, each plate 26 may contain perforations. The size of the perforations may determine whether or not the air will slow when passing through the perforations. As plates 26 extend between top 17 and sides 22, a space 31 is created between each plate 26, the top 17 and the side 22. Due to space 31 behind plates 26, air pressure in space 31 will increase to be the same as that on
15 the perforations at the part of the airflow 3 with the highest velocity. This will force air out through perforations in plates 26 where the airflow 3 is not as fast. The space 31 may have insulation or other material in it to reduce noise caused by air turbulence. Plate 26 may also be wholly or in part perforated.

20 Sound insulation materials may be used to partially or completely fill the space 31. The sound insulation material may be one or more of: sponge, fibreglass, rockwool, linen cloth and so forth. If desired, a layer of protection may further be added on top of the insulation facing the air stream 3 to further strengthen the insulation material from relocation or disintegration over a period of time.

25 To further reduce noise level, insulation material 16 may also be fixed on a lower surface of the fan blower mounting 14 to further absorb noise generated by both the air flow 3 and the blower 12. The insulating material 16 may be on other surfaces of mounting 14. When mounting 14 is an inverted tray (as shown),
30 insulating material 16 may be located within tray 14. Preferably, mounting 14 has sides that extend vertically for a height equal to or greater than the thickness of insulating material 16.

35 One or more of the guide baffles 28 may be porous, if desired. The porosity may be achieved by using perforations over the area of the baffles 28. The perforations may be over all or part of their surfaces.

For baffles 28 and plates 26, if insulated, a cloth covering may be placed over all or some of the insulation material, or behind the perforations, to reduce the likelihood of dislodgement and contamination of the air. The perforations may assist in securing the insulation material to the baffles 28 and plates 26.

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Guide baffles 28 direct the flow of air 3 towards outlet opening 19, and may be flat or curved.

Side walls 22 may have insulation 36 over all or part of their internal surfaces. The insulating material 36 may be of a greater thickness than insulating materials 6 and/or 16. It may be sponge, fibreglass, rockwool, linen cloth and may have a cloth covering. Some or all of insulating materials 6, 16, 36 may have reinforcement frames, if required or desired.

As can be seen, due to blower mounting 14 extending beyond the periphery of outlet opening 19, the guide baffles 28 and blower mounting 14 between them create one or more air-flow channels 20 through which air is moved towards the outlet opening 19 and thus filter 32. Preferably, the air flow channels extend around the periphery of outlet opening 19.

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Outlet air flow 2 may pass through filter 32. This also applies to the embodiment as shown in Figure 7. The air-flow channels 20 create a constriction on air flow, and thus form a high pressure air zone. Air flows from high pressure to low pressure. This therefore forces all air to flow through channels 20 so that the air flow will be strongly mono-directional through outlet opening 19 as air will generally not flow from low pressure to high pressure. This significantly reduces turbulence in channels 20 and outlet opening 19. As such, noise is significantly reduced, and air-flow efficiency is increased.

Figure 6 is a chart comparing the average velocity of airflow and the noise level of a fan unit with and without the present invention. The average velocity of airflow is measured at 24 different points in the fan filter unit and illustrated in Figure 5 respectively. Referring to Figure 6, (a) is a conventional fan unit, whereas (b) and (c) are in accordance with the present invention. The average air velocity of both (b) and (c) is higher and quieter than (a). As such the pressure loss of the fan units (b) and (C) is less than (a). Therefore, energy savings over time can be achieved.

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Finally and most importantly, comparing the noise level in decibels from a fan unit with and without a preferred form of the present invention and is measured at a location 1.5 meter directly below the outlet of the unit. Measured 1.5 meter below a fan unit, an embodiment of the present invention may allow the fan unit to
5 operate with less noise than a prior art fan unit.

While the present invention has been described particularly with reference to Figures 1 to 7 with emphasis on a method and apparatus for minimising noise form a fan unit, it should be understood that the figures are for illustration only and
10 should not be taken to be a limitation on the invention. In addition, it is clear that the method and apparatus of the present invention have utility in many applications where air flow control is required. It is contemplated that many changes and modifications maybe made by one of the ordinary skill in the art without departing from the spirit and the scope of the invention as described.

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The Claims

1. A fan unit comprising: a top having an inlet opening, at least one side for enclosing the fan unit, at least one pair of guide baffles extending inwardly from a lower end of the at least one side and defining an outlet opening, a fan blower disposed on a mounting, the mounting extending beyond a periphery of the outlet opening, the fan blower being for drawing air through the inlet opening and for discharging air through the outlet opening, said at least one pair of guide baffles and the mounting forming an air flow channel therebetween, the air flow channel creating a constriction on air flow for forming a high pressure air zone within the air flow channel for forcing all air to flow in the air flow channel and to thereby create substantially mono-directional air flow in the air flow channel and through the outlet opening with reduced turbulence such that noise from said fan unit is minimized.
2. A fan unit as claimed in claim 1, wherein the mounting is a blower mounting.
3. A fan unit as claimed in claim 1 or claim 2, wherein there are provided two pairs of guide baffles disposed within the fan unit, the guide baffles being mutually perpendicular.
4. A fan unit as claimed in claim 1 or claim 2, wherein the guide baffles are disposed at an angle of between 90 degrees and 60 degrees with the at least one side.
5. A fan unit as claimed in claim 4, wherein the angle is 90 degrees.
6. A fan unit as claimed in any one of claims 1 to 5, wherein the guide baffles are perforated.
7. A fan unit as claimed in claim 6, wherein the perforations are over only a part of the guide baffles.
8. A fan unit as claimed in claim 6, wherein the perforations are over all of each of the guide baffles.
9. A fan unit as claimed in any one of claims 6 to 8, wherein the perforations are covered by a cloth.

10. A fan unit as claimed in any one of claims 1 to 9, wherein the outlet opening is a shape selected from the group consisting of: circular, triangular, square, rectangular, pentagonal, and octagonal.
11. A fan unit as claimed in any one of claims 1 to 10, wherein the guide baffles are curved.
12. A fan unit as claimed in any one of claims 1 to 11 further comprising at least one pair of plates disposed within the fan unit and extending between the top and the at least one side, each of the at least one pair of plates defining an enclosed space between each of the at least one pair of plates, the top and the at least one side.
13. A fan unit as claimed in claim 12, wherein the plates are at an angle to the top of between 30 degrees and 60 degrees.
14. A fan unit as claimed in claim 13, wherein the angle is 45 degrees.
15. A fan unit as claimed in claim 12, wherein there are two pairs of plates, the plates being mutually perpendicular.
16. A fan unit as claimed in any one of claims 12 to 15, wherein at least one pair of the plates is perforated.
17. A fan unit as claimed in claim 16, wherein the perforations are over all of the at least one pair of plates.
18. A fan unit as claimed in claim 16, wherein the perforations are over a part only of the at least one pair of plates.
19. A fan unit as claimed claim 16 or claim 17, wherein the perforations are covered by a cloth.

20. A fan unit as claimed in any one of claims 12 to 19, wherein the plates are curved.
21. A fan unit as claimed in any one of claims 12 to 20, wherein the enclosed space is at least partially filled with a noise insulating material.
22. A fan unit as claimed in any one of claims 12 to 21, wherein a noise insulating material is used to line an internal surface of one or more selected from the group consisting of: the at least one side, the top, the guide baffles, and the plates.
23. A fan unit as claimed in any one of claims 1 to 22, wherein the blower mounting has a noise insulating material attached to a surface thereof.
24. A fan unit as claimed in claim 23, wherein the blower mounting is in the form of an internal tray with depending side walls, the noise insulating material being located in the tray.
25. A fan unit as claimed in any one of claims 1 to 24, wherein the top has a central opening, the central opening having an inlet cover, the inlet opening being in the inlet cover.
26. A fan unit as claimed in any one of claims 1 to 25, further including a filter located below the outlet opening.
27. A fan unit as claimed in any one of claims 1 to 26, wherein the at least one side comprises four mutually perpendicular side walls, the side walls also being perpendicular to the top.
28. A fan unit as claimed in any one of claims 1 to 27, wherein baffles employed in the fan unit are selected from the group consisting of: diffusion baffles and guide baffles.

List of Reference Numerals

	1.	Incoming air flow
	2.	Outlet air flow
5	3.	Internal air flow
	6.	Insulating material
	10.	Central opening
	11.	Air inlet cover
	12.	Blower
10	13.	Rods
	14.	Blower mounting
	15.	Sides of 14
	16.	Insulating material
	17.	Top
15	18.	Air inlet opening
	19.	air outlet opening
	20.	Air flow channels
	22.	Side walls
	26.	Plates
20	28.	Guide baffles
	31.	Space behind 26
	32.	Filter
	36.	Insulating material