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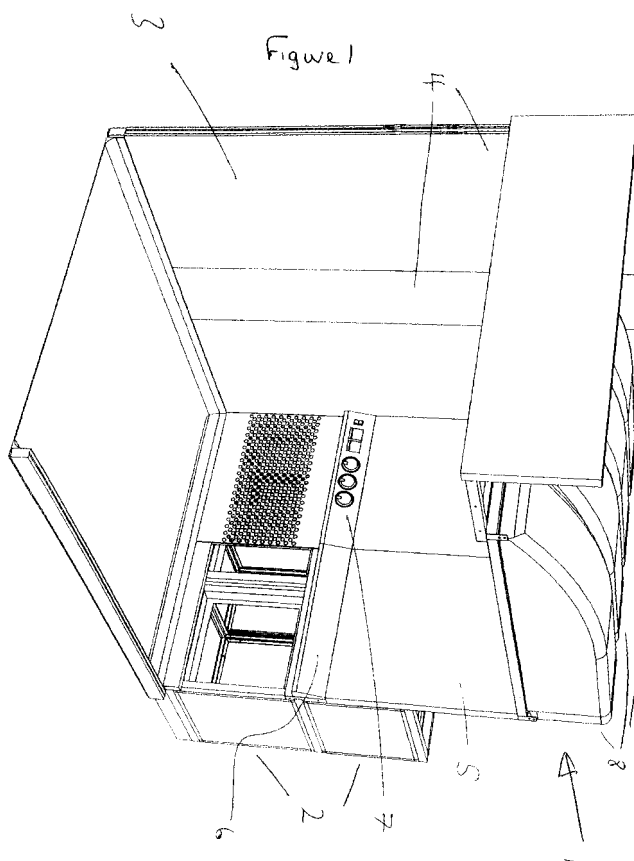
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(54) **Assembly**

(57) The present invention relates to a modular containment assembly of novel component parts which by virtue of its inherent versatility is straightforward and inexpensive to assemble whilst providing improved per-

formance and cleanliness thereby minimising the potential for product contamination. More particularly, the component parts are an operator booth and a modular structure comprising a plurality of unitary frameworks between which (in use) is induced an airflow.



EP 1 146 293 A2

Description

[0001] The present invention relates to a novel modular containment assembly comprising certain components, in particular to a down flow modular containment assembly, and to the components themselves.

[0002] In conventional containment assemblies for use in (for example) handling pharmaceuticals, the air quality in the operator booth may be controlled using forced ventilation. One category of forced ventilation is "down flow" in which surrounding air is drawn downwardly to entrain contaminants to a level below the handling area (eg to a level below the typical operators breathing zone). For down flow containment, exhaust is usually carried out at low level relative to the source of the contaminant.

[0003] Due to the demanding requirements of current Good Manufacturing Practices exercised within the pharmaceutical manufacturing industry and to the required containment performance and operator exposure levels, conventional down flow containment assemblies are in general complex unitary structures which are difficult and relatively expensive to assemble.

[0004] The present invention seeks to overcome certain of the disadvantages of the conventional assemblies by providing a simpler and more hygienic containment assembly without compromising the performance of the assembly (*ie* which meets the strict industrial operating parameters such as the the Good Manufacturing Practices of the pharmaceutical industry). In particular, the present invention provides a modular containment assembly of novel component parts which by virtue of its inherent versatility is straightforward and inexpensive to assemble whilst providing improved performance and cleanliness thereby minimising the potential for product contamination.

[0005] Thus viewed from one aspect the present invention provides a modular containment assembly comprising components between which (in use) is induced an airflow, said components being:

a modular structure comprising a plurality of unitary frameworks stacked to form a network of discrete housings;

an operator booth of box-like configuration having a rear wall positioned adjacent to the modular structure, wherein the modular structure is adapted at or near to its lower end to receive the airflow from the operator booth and at or near to its upper end to transmit the airflow to the operator booth, and the rear wall of the operator booth is adapted at or near to its lower end to transmit the airflow to the modular structure; and

means for inducing the airflow downwardly in the operator booth.

[0006] The versatility of the modular containment assembly of the invention is such that any of the individual

components may be readily assembled and supplied to a user with the intention of putting the invention into effect in combination with the other components which may already be available to the user.

[0007] Typically, the assembly of the invention is adapted so that air falls in an undisturbed, non-turbulent manner past the region of the operator booth in which the operator operates ("the operator breathing zone") at a predetermined velocity. Preferably the components of the assembly are adapted to attain perfect laminar flow (PLF) of air. Preferably the modular structure at or near to its upper end comprises PLF material (eg a PLF screen) through which the airflow passes to the operator booth.

[0008] A preferred embodiment of the modular containment assembly of the invention further comprises a plenum arrangement adjacent to an open ceiling of the operator booth, wherein the plenum arrangement is capable of transmitting the airflow from at or near to the upper end of the modular structure downwardly into the operator booth.

[0009] Preferably the plenum arrangement comprises one or more plenum chambers. The or each chamber may be generally adapted to minimise the plenum volume. Preferably the or each plenum chamber is adapted to contribute to perfect laminar flow (PLF).

[0010] The or each plenum chamber preferably comprises a metal (preferably steel) base frame coated on two sides with a material of a preset tension. The base frame provides a specific pressure drop which may contribute to the perfect laminar flow (PLF). The base frame conveniently has a ladder-like configuration. For example, the base frame comprises two elongate side members joined in parallel spaced apart relationship by a plurality of transverse members. On the lower face of the base frame there may be mounted PLF material (eg a PLF screen). Laminar flow light fittings may be mounted to the lower face of the frame (eg the side members) if desired.

[0011] A profiled canopy may be secured to the upper face of the base frame. Preferably the profiled canopy is capable of providing a smooth and interrupted airflow from the modular structure into the PLF material. For example, the profiled canopy may have a substantially vertical open end (eg a substantially square open end) through which may be transmitted airflow from the modular structure. The substantially vertical open end may be defined by two side walls joined in substantially parallel spaced apart relationship by an integral rear wall which curves inwardly away from the open end.

[0012] The substantially vertical open end may be fitted with a liquid seal. For this purpose the ends of the two side walls and integral rear wall may be provided with a securing flange.

[0013] The substantially vertical open end may fitted with a PLF panel to advantageously contribute to even distribution of air across the width and down the length of the plenum chamber.

[0014] The or each plenum chamber may consist of only one external seal and is advantageously constructed without external sealants thereby eliminating a source of possible contamination whilst maintaining the desired level of cleanliness.

[0015] Preferably the or each plenum chamber is detachably mounted to the ceiling of the operator booth (eg is a plug-in/plug-out arrangement) which advantageously makes it sufficiently versatile to be attached to any type of operator booth.

[0016] In a preferred embodiment of the modular containment assembly of the invention, the modular structure comprises an at least partially open front face at or near to its lower end and adjacent to the rear wall of the operator booth, wherein the rear wall of the operator booth at or near to its lower end comprises an elongate gap capable of transmitting airflow from the operator booth to and through the at least partially open front face of the modular structure. Preferably the at least partially open front face is adapted to mount a pre-filter (eg by incorporating a filter retainer panel).

[0017] Although the modular structure may be manufactured from any suitable metal (such as steel or aluminium), steel is generally preferred in terms of costs and flexibility to accommodate design change (eg future developments in filter design or other internal component design).

[0018] In a preferred embodiment of the modular containment assembly of the invention, each unitary framework is a metal (eg an aluminium or steel) frame construction. A frame construction advantageously minimises the potentially contaminated volume of the modular structure.

[0019] Each unitary framework provides a discrete housing which may be tailored to meet the requirements and conform to the size of a desired internal component. Examples of internal components may include part of the means for inducing the airflow such as *inter alia* one or more filters or a fan unit. For example, one or more filters may be housed in a lower discrete housing and a fan unit in an upper discrete housing of the modular structure.

[0020] If desired, one or more of the unitary frameworks may be panelled. Suitable panels include standard pressed or vacuum formed filter retainer panels. Such panels may be attached using a proprietary adhesive tape and adhesive liquid seal to eliminate any tendency for product entrapment whilst giving overall structural rigidity. The adhesive tape provides a seal for the panel and the liquid adhesive seal ensures a substantially leak-free join. Preferred are sheet metal (eg steel) panels which (when used with a compatible (eg steel) framework) may be secured in suitable manner (eg using adhesives, tapes or fasteners).

[0021] Preferably, each unitary framework comprises a plurality of struts (eg a plurality of horizontal struts and a plurality of vertical struts). Particularly preferably the struts are uniform thereby minimising the number of

parts which need to be specially manufactured. For example, the uniform struts may be of standard dimensions eg standard 500mm and/or 700mm lengths may be used to assemble the unitary framework allowing any operator booth of width up to 5 metres to be used. Preferably each strut of the unitary framework has a uniform drill pattern ensuring complete modularity.

[0022] Each strut of the unitary framework may be fabricated from metal (eg aluminium or steel) extrusions and joined in a conventional manner (eg permanently joined with an air tight corner piece). Preferably the internal joints between struts are flush and closed to eliminate entrapment areas. Each strut may comprise an internal elongate flange which provides a means for securing the unitary framework to an adjacent unitary framework (eg by providing a surface through which a fastener such as a bolt may pass) and to act as a seal zone between adjacent unitary frameworks.

[0023] Preferably one or more of the unitary frameworks is box-like (eg cuboidal or cubic). Adjacent unitary frameworks may be fastened together to form the modular structure using any conventional fastener eg bolts and may be of variable dimensions (eg variable height) as desired.

[0024] A unitary framework may be adapted to vertically mount a filter such as a pre-filter (eg by incorporating a filter retainer panel). Such a unitary framework would generally be positioned at or near to the lower end of the modular structure and may for example be the lowermost unitary framework of the modular structure.

[0025] A unitary framework may be adapted to horizontally mount a filter such as a HEPA filter. Such a unitary framework would generally be positioned above the lowermost unitary framework of the modular structure.

[0026] A unitary framework may be adapted to mount a fan unit. Such a unitary framework would generally be positioned at or near to the upper end of the modular structure and may for example be the uppermost unitary framework of the modular structure.

[0027] In a preferred embodiment of the modular containment assembly of the invention, the means for inducing the airflow comprises a fan unit driven by a flange mounted inverter controlled motor which ensures smooth drive via a flexible coupling. The fan motor unit is placed down flow from the filters ensuring that the unit is only exposed to clean filtered air. The fan unit may be seated on highly compressed anti-vibration mounts to ensure that no vibration is passed onto the adjacent parts of the booth.

[0028] Preferably, the operator booth incorporates a clean room partition system adapted to meet the requirements of the pharmaceutical industry. Preferably, the operator booth comprises individual panels capable of being locked together. This advantageously eliminates the need for fasteners and reduces assembly time. Preferably, the operator booth is adapted so that the number of panel joins are minimised (eg 5 or less)

and are hygienically sealed by a thin bead of silicone.

[0029] The panels of the operator booth may be adapted to provide exceptional noise damping and vibration isolation. The panels may provide increased rigidity to support an upper mounted plenum arrangement. The rear wall of the operator booth comprises a "service band" which may contain *inter alia* control buttons, the electrical and gauge piping, inverter and commissioning interface which permits entire commissioning from the interior of the booth. For example, the motor mounted inverter may be controlled via a link from the service band for ease of commissioning and set up. Preferably the service band has an aerofoil shaped exterior profile which improves dust capture in the work area by accelerating airflow over its surface.

[0030] Each component of the modular down flow booth of the invention is itself independently patentably significant.

[0031] Thus viewed from a further aspect the present invention provides a modular structure as hereinbefore defined.

[0032] The modular nature of the modular structure makes it easier and less costly to manufacture than a large, complex unitary structure (eg a sheet metal fabrication) fulfilling the same function. The modular structure is extremely rigid and provides a steady foundation for the attachment of an operator booth. A preassembled modular structure may be advantageously transported (eg using a fork-lift transporter) onto a site in ready-to-run condition so that only internal components (such as filters, electrical components and piping) need to be added. Alternatively it may be provided to the user in disassembled form for assembly on site. The modular structure has the added advantage that the volume within the network of housings which has the potential to be contaminated is minimised.

[0033] Viewed from a yet further aspect the present invention provides a plenum chamber as hereinbefore defined.

[0034] The invention will now be described in a non-limitative sense with reference to the accompanying Figures in which:

Figure 1 illustrates a modular containment assembly in accordance with an embodiment of the invention;

Figure 2 illustrates a modular containment assembly in accordance with an embodiment of the invention together with associated down flow (front perspective view);

Figure 3 illustrates a modular containment assembly in accordance with an embodiment of the invention together with associated down flow (side view);

Figure 4 illustrates a disassembled unitary framework of a modular structure in accordance with an embodiment of the invention;

Figure 5a and 5b illustrate an assembled unitary framework of a modular structure in accordance

with an embodiment of the invention in (a) unpanelled and (b) panelled form;

Figure 6 illustrates a perspective view of a disassembled plenum chamber of a plenum arrangement of the invention; and

Figure 7 illustrates an assembled unitary framework of a modular structure in accordance with an embodiment of the invention.

[0035] With reference to Figure 1, there is shown (in partially exposed view) an embodiment of the modular containment assembly of the invention designated generally by reference numeral 1. The assembly comprises a rear modular structure comprising a number of stacked unitary frameworks 2 each having a frame construction (discussed below). The exposed view of the interior of the operator booth 3 shows panels 4 which are locked together without the need for fasteners. The rear wall of the booth 5 incorporates a laminar flow service band 6 from which the operator can control the assembly using the control panel 7. In the ceiling region of the operator booth, there is mounted a plenum arrangement comprising a number of plenum chambers 8 (discussed below).

[0036] Figures 2 and 3 are intended to illustrate in detail the airflow in the embodiment described in Figure 1. In the operator booth, the airflow is directed downwardly to and through an elongate opening 20 in the lower part of the rear wall 21. In the lowermost discrete housing 2a of the modular structure, there is vertically mounted a FP95 pre-filter 31 through which air flows to a vertically adjacent discrete housing 2b which contains a horizontally mounted EU13 Gel Seal HEPAfilter 32. In the uppermost discrete housing 2c, there is provided a fan unit 33 which draws air into the plenum chamber 8 and through the laminar flow material downwardly into the operator booth.

[0037] The components of a unitary framework 2 of the modular structure of the invention are shown in disassembled view in Figure 4. In this particular case, the unitary framework 2 is adapted to vertically mount a pre-filter (see 2a in Figures 2 and 3). The unitary framework 2 comprises a plurality of uniform struts arranged vertically and horizontally to form a regular box-like framework. Each vertical and horizontal strut is a standard length R25-9 aluminium extrusion 40 and they are interconnected by means of air tight P25-3 corner parts 41 which eliminate the need for screw fixings. One pair of opposing vertical faces are panelled using a standard panel 42 of universal size. One of the second pair of opposing vertical faces is provided with a standard pressed or vacuum formed filter retainer panel 43 capable of retaining a pre-filter (not shown). Each strut is provided with a standard hole pitch 44 in an internal flange 45.

[0038] The fully assembled frame construction with struts and corner pieces is shown unpanelled in Figure 5a and panelled in Figure 5b. In order to fix a panel 42,

the satin aluminium finish of the struts 40 may be primed and an acrylic adhesive tape and a compatible adhesive seal applied. Panels 42 may be bonded into place whilst the seal is wet leaving no small internal gaps. The adhesive tape provides an instant bond while the liquid seal sets. This method of construction is quick, simple and lowers the skill level required for manufacture.

[0039] Figure 6 illustrates a disassembled view of a plenum chamber. A steel frame base 62 has a ladder like configuration coated on two sides with a material of a preset tension which provides a specific pressure drop contributing to perfect laminar flow (PLF). The base frame comprises two elongate side members 67 joined in parallel spaced apart relationship by a plurality of transverse members 68. Each side member 67 is adapted to fasten a light fitting at the position 65.

[0040] A profiled canopy 63 is bonded using a silicone bead seal to the upper face of the base frame to provide a smooth and interrupted airflow from the modular structure into a PLF material 64 mounted on the lower face of the base frame. The profiled canopy has a substantially vertical end 69 defined by two side walls 70 joined in substantially parallel spaced apart relationship by an integral rear wall 71 which curves inwardly away from the open end. Compressible foam seal 61 fits over a 25mm securing spigot 66 at the ends of the side walls and rear wall and pushes against a flat bulk head. The compression seal 61 represents the only external seal of the plenum chamber and is fitted with a PLF panel 80 to ensure even distribution of air across the width and down the length of the plenum chamber. The plenum chamber is a clean, sealed unit ensuring that air which has been filtered to 99.99995% is uncontaminated upon transmission to the operator booth.

[0041] Figure 7 illustrates a unitary framework 102 of an embodiment of the invention which is an alternative to that illustrated in Figures 4 and 5b. In this case, the unitary framework 102 comprises a plurality of unfirm steel struts arranged vertically and horizontally (for example 103 and 104) to form a regular box-like framework. Bonded to three faces of the unitary framework are steel panels 105a, 105b and 105c. The unpanelled front face 105d is capable of retaining a pre-filter (not shown). This unitary framework 102 advantageously has no gaps.

Claims

1. A modular containment assembly comprising components between which in use is induced an airflow, said components being:

a modular structure comprising a plurality of unitary frameworks stacked to form a network of discrete housings;
an operator booth of box-like configuration having a rear wall positioned adjacent to the mod-

ular structure, wherein the modular structure is adapted at or near to its lower end to receive the airflow from the operator booth and at or near to its upper end to transmit the airflow to the operator booth, and the rear wall of the operator booth is adapted at or near to its lower end to transmit the airflow to the modular structure; and

means for inducing the airflow downwardly in the operator booth.

2. A modular containment assembly as claimed in claim 1 further comprising:

a plenum arrangement adjacent to an open ceiling of the operator booth, wherein the plenum arrangement is capable of transmitting the airflow from at or near to the upper end of the modular structure downwardly into the operator booth.

3. A modular containment assembly as claimed in claim 2 wherein the plenum arrangement comprises one or more plenum chambers.

4. A modular containment assembly as claimed in claim 3 wherein the or each plenum chamber is adapted to contribute to perfect laminar flow (PLF).

5. A modular containment assembly as claimed in claim 3 or 4 wherein the or each plenum chamber comprises a base frame having a ladder-like configuration.

6. A modular containment assembly as claimed in claim 5 wherein the base frame comprises two elongate side members joined in parallel spaced apart relationship by a plurality of transverse members.

7. A modular containment assembly as claimed in claim 5 or 6 wherein on the lower face of the base frame is mounted PLF material.

8. A modular containment assembly as claimed in any of claims 5 to 8 wherein a profiled canopy is secured to the upper face of the base frame.

9. A modular containment assembly as claimed in claim 8 wherein the profiled canopy has a substantially vertical open end through which may be transmitted airflow from the modular structure.

10. A modular containment assembly as claimed in claim 9 wherein the substantially vertical open end is defined by two side walls joined in substantially parallel spaced apart relationship by an integral rear wall which curves inwardly away from the open end.

11. A modular containment assembly as claimed in claim 10 wherein the substantially vertical open end

is fitted with a panel of PLF material.

12. A modular containment assembly as claimed in any preceding claim wherein the modular structure comprises:

an at least partially open front face at or near to its lower end and adjacent to the rear wall of the operator booth, wherein the rear wall of the operator booth at or near to its lower end comprises an elongate gap capable of transmitting airflow from the operator booth to and through the at least partially open front face of the modular structure.

13. A modular containment assembly as claimed in claim 12 wherein the at least partially open front face is adapted to mount a pre-filter.

14. A modular containment assembly as claimed in any preceding claim wherein each unitary framework is a metal frame construction.

15. A modular containment assembly as claimed in claim 14 wherein the metal is steel.

16. A modular containment assembly as claimed in any preceding claim wherein one or more of the unitary frameworks is panelled.

17. A modular containment assembly as claimed in claim 16 wherein the panels are steel panels.

18. A modular containment assembly as claimed in any preceding claim wherein each unitary framework comprises a plurality of struts.

19. A modular containment assembly as claimed in claim 18 wherein the struts are uniform.

20. A modular containment assembly as claimed in claim 18 or 19 wherein each strut of the unitary framework has a uniform drill pattern.

21. A modular containment assembly as claimed in any preceding claim wherein one or more of the unitary frameworks is box-like.

22. A modular containment assembly as claimed in any preceding claim wherein at least one unitary framework is adapted to vertically mount a filter.

23. A modular containment assembly as claimed in claim 22 wherein the at least one unitary framework is positioned at or near to the lower end of the modular structure.

24. A modular containment assembly as claimed in any preceding claim wherein at least one unitary framework is adapted to horizontally mount a filter.

25. A modular containment assembly as claimed in claim 24 wherein the at least one unitary framework is positioned above the lowermost unitary framework of the modular structure.

25. A modular containment assembly as claimed in any preceding claim wherein at least one unitary framework is adapted to mount a fan unit.

26. A modular containment assembly as claimed in claim 25 wherein the at least one unitary framework is positioned at or near to the upper end of the modular structure.

27. A modular containment assembly as claimed in any preceding claim wherein the means for inducing the airflow comprises a fan unit driven by a flange mounted inverter controlled motor.

28. A modular containment assembly as claimed in any preceding claim wherein the operator booth comprises individual panels capable of being locked together.

29. A modular structure as defined in any of claims 4 to 28.

30. A plenum chamber as defined in any of claims 1 to 28.

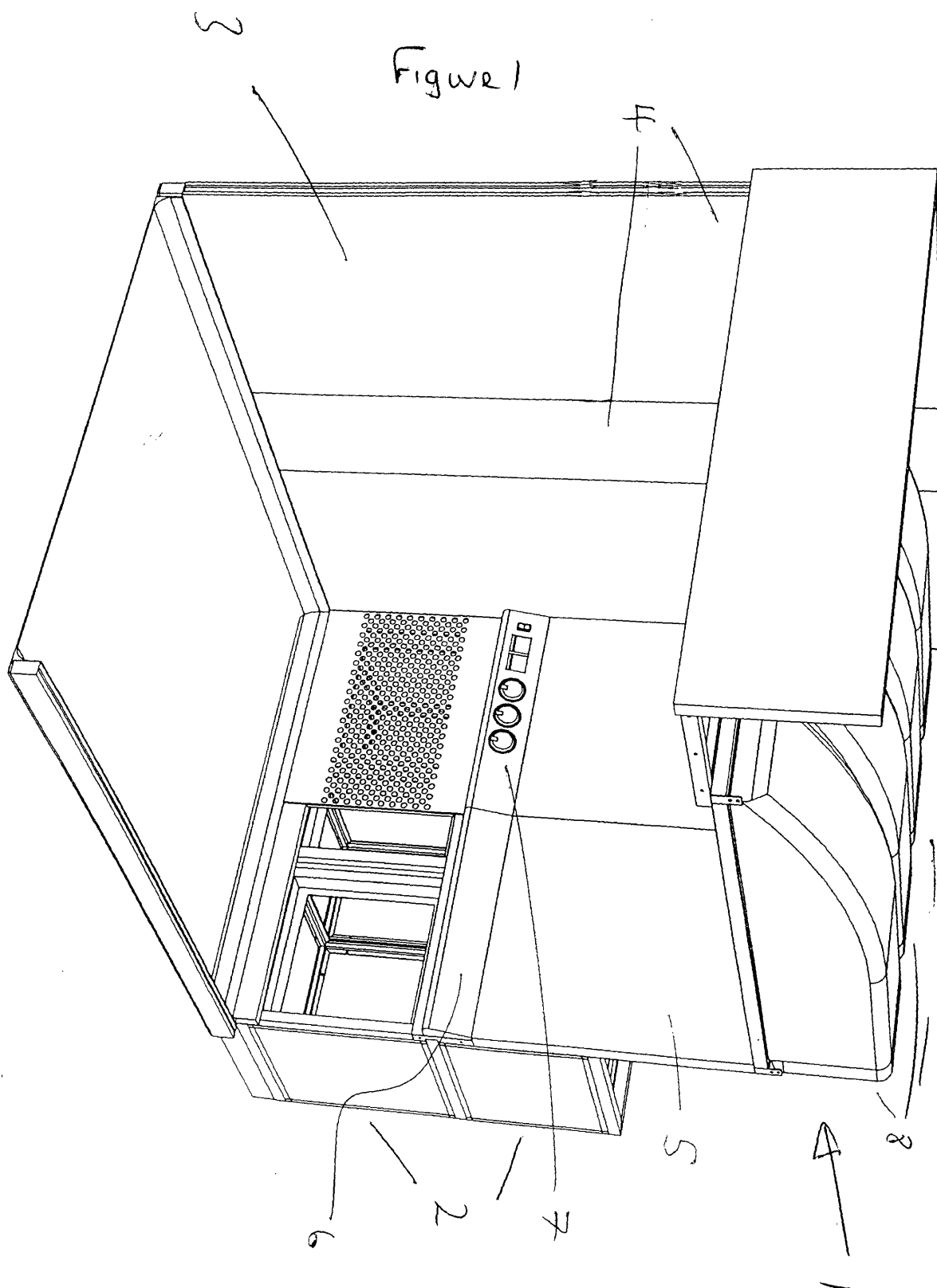


Figure 2

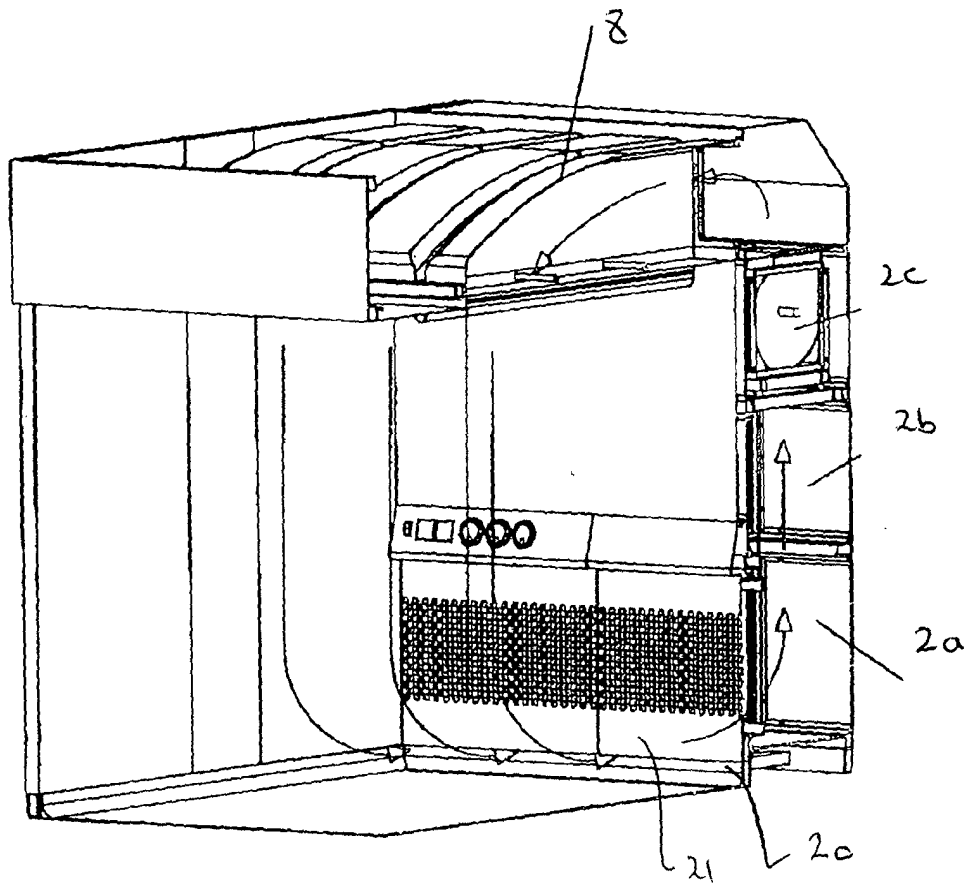


Figure 3

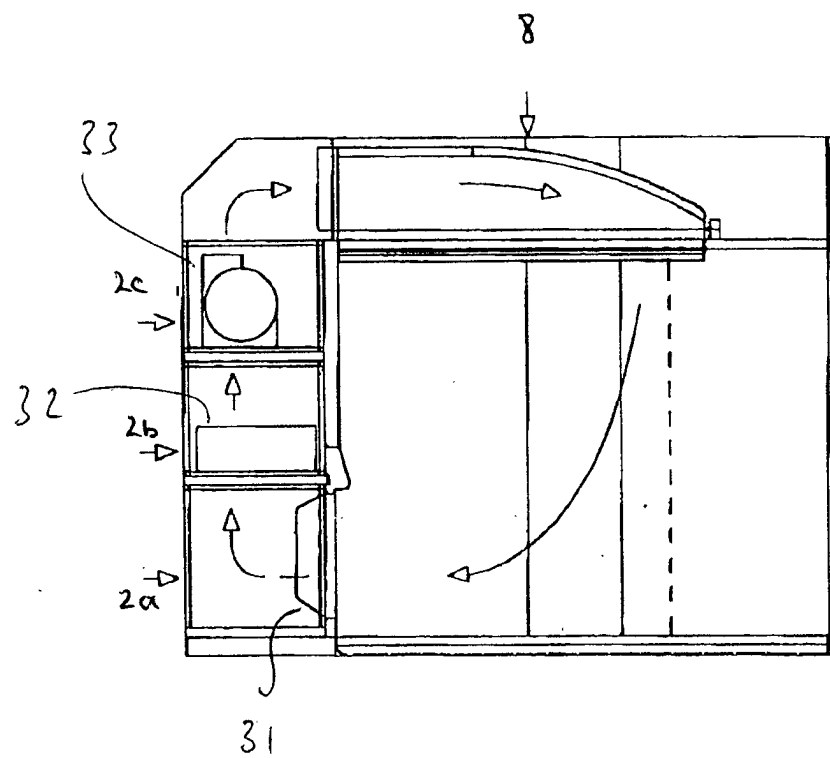


Figure 4

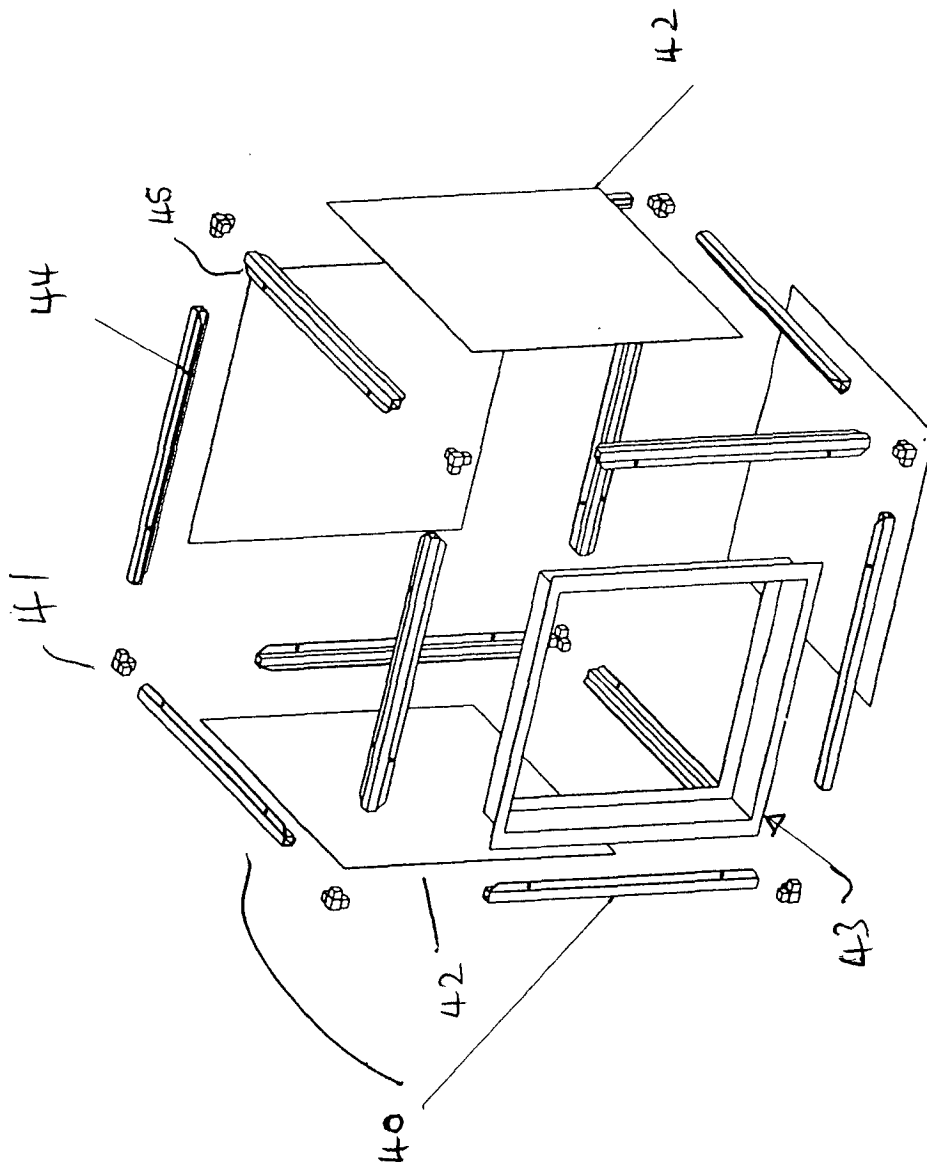
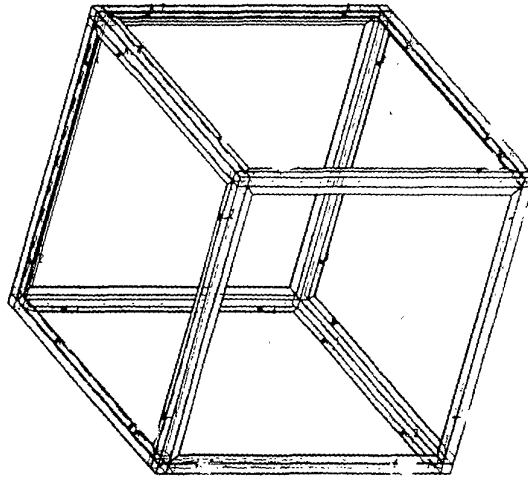


Figure 5

(a)



(b)

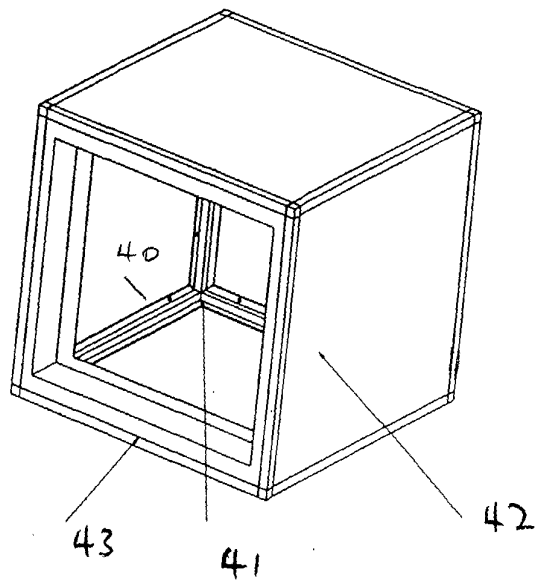


Figure 6

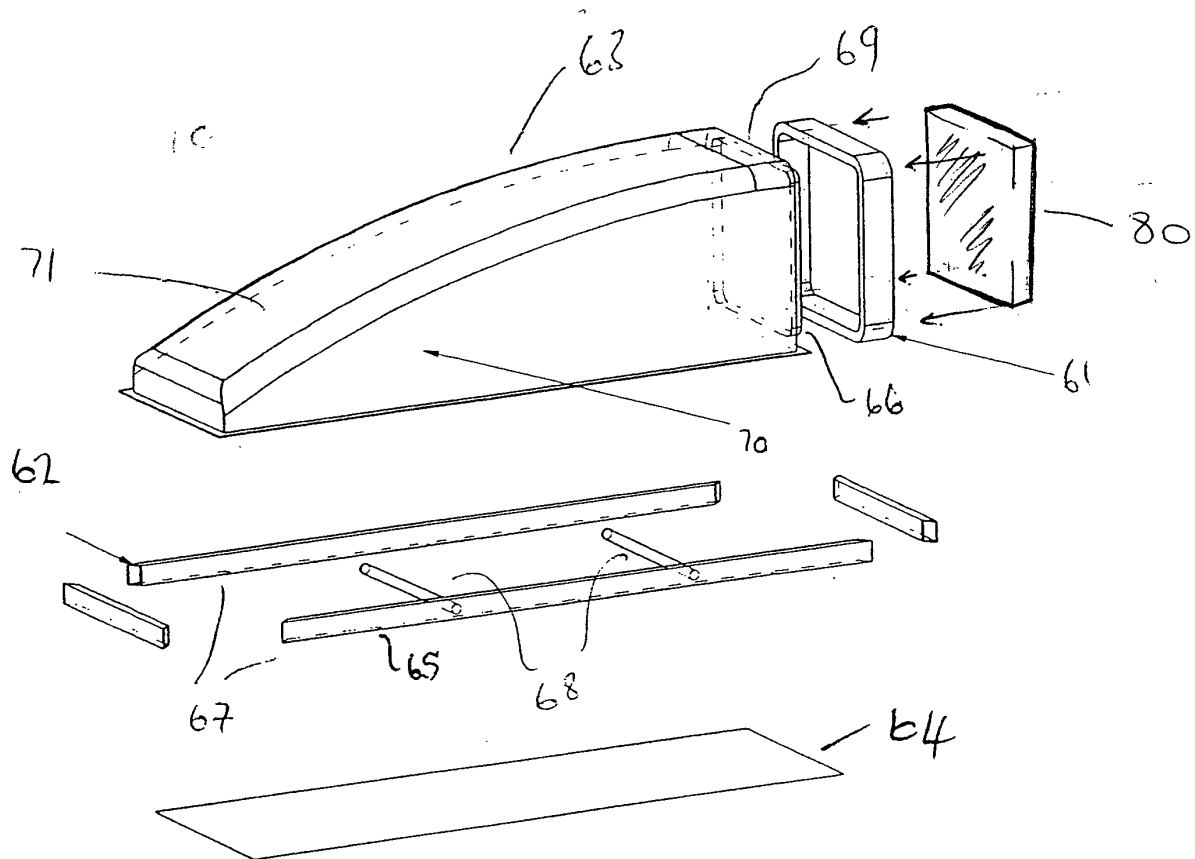


Figure 7

