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STERILE LAMINAR AIRFLOW DEVICE

Inventors: Rajesh Thakur, Palampur (IN); Anil Sood, Palampur (IN); Paramvir Singh Ahuja, Palampur (IN)

Assignee: Council of Scientific & Industrial Research (IN)

The device described in this patent is a compact, portable, lightweight, low power consuming, convenient, versatile and sterile laminar airflow device, useful in obtaining a workspace substantially devoid of airborne particulate contaminants. It consists of a body divided into an upper and lower chambers; the upper chamber housing one or more pre-filtration members, a motor driving a fan, and one or more filters located below the motor; and the lower chamber provided with a slideable front panel, a removable platform located at the lower portion of the chamber and a perforated plane placed on the removable platform.

39 Claims, 3 Drawing Sheets
STERILE LAMINAR AIRFLOW DEVICE

FIELD OF INVENTION

The present invention relates to a compact, portable, lightweight, low power consuming, convenient, versatile and sterile laminar airflow device, useful in obtaining a workspace substantially devoid of airborne particulate contaminants. More particularly, the present invention relates to an apparatus for obtaining a working platform devoid of both biological and a biological contaminants for tissue culture operations, watch and electronic device assembling, and initiation of aseptic cultures of micro-organisms from field samples ‘in situ’.

BACKGROUND OF THE INVENTION

In tissue culture and industries like the electronic industry, watch industry etc., the requirements for a clean area are near absolute and even a small leakage or mishandling can lead to disastrous results in the production line. Such is the essentiality of the clean area or clean bench that a substantial amount of money goes into the erection of these structures and the maintenance of the same. Maintaining these structures is also expensive, leading to an escalation in the ultimate cost of production.

UV cabinets, which are being used for this purpose, have the drawback of limited O₂ supply. This leads to restricted use. Also, it may endanger the safety of the user if the sprayed alcohol/rectified spirit inside the chamber does not dry up. Further, these are quite bulky and unsuitable for portability and do not offer flexibility in their usage, e.g. in the electronic industry, as the materials need to be placed well before use.

The horizontal and vertical sterile laminar air flow systems which are also presently being used have the disadvantage of being heavy, bulky, and expensive in terms of cost and maintenance, making them unsuitable for low end applications, where sterile environment is not required intensively, and more often a high infrastructure cost is not warranted, such as micro-electronics works, cottage tissue culture practices, demonstration and teaching in schools; for field activities such as collection of biological samples like microbes and plants from far off places. Field applicability is further limited by the inevitable high power inputs required. At times, it becomes the limiting factor in dissemination of technologies at the grass root levels where these could be more suitable.

It is well known that the hills, because of congenial environmental conditions are very rich in biodiversity that could be more suitable.

OBJECTS OF THE INVENTION

The main object of the present invention is to provide a compact, lightweight, versatile and convenient sterile airflow device.

Another object of the present invention is to provide a portable sterile laminar airflow cabinet with a working platform providing a sterile environment for carrying out aseptic operations.

Yet another object of the present invention is to provide a lightweight, portable, compact, low power consuming sterile laminar airflow cabinet that can be conveniently used in far flung remote areas for ‘in situ’ aseptic inoculation of biological samples such as plants and microbes for establishment of their cultures.

Still another object of the present invention is to provide a sterile airflow device suitable for integration with other devices that may at times require a sterile environment, such as the workbench of an enlarging device, thus increasing the versatility of applications.

One more object of the present invention is to provide a low cost sterile laminar airflow cabinet for demonstration and teaching purposes.

One another object of the present invention is to provide a low cost sterile laminar airflow cabinet for promotion of plant tissue culture as a cottage industry.

Another object of the present invention is to provide a portable, versatile, convenient sterile airflow device, that is small in size, requires less space and can therefore, be used for desktop sterile air applications.

SUMMARY OF THE INVENTION

The present invention relates to a compact, portable, lightweight, low power consuming, convenient, versatile and sterile laminar airflow device, useful in obtaining a workspace substantially devoid of airborne particulate contaminants.

DETAILED DESCRIPTION OF THE INVENTION

Accordingly, making reference to FIGS. I through III, the present invention provides a sterile laminar airflow device, useful in obtaining a workspace substantially devoid of airborne particulate contaminants, said device comprising a body (C) divided into an upper and lower chambers; the upper chamber housing one or more pre-filtration members (B), a motor (T) mounted with fan (S), one or more HEPA filters (U), which are mounted on a gasket (V); and the lower chamber provided with a front panel (M) and housing a removable platform (X) and a perforated plane (N).

In an embodiment of the present invention, the body is made up of materials selected from the group comprising of solid wood, laminated wood, stainless steel or any other metal sheets and a lightweight high-strength plastic.

In another embodiment of the present invention, the lightweight high-strength plastic is selected from the group comprising of Polycarbonate, fibre-glass and reinforced strengthened glass, acrylic polymethylacrylate, polystyrene, polyethylene, polypropylene and polymethyl pentene (TPX).

In still another embodiment of the present invention, the body has provisions for housing the dust filter, fan and HEPA filters.

In yet another embodiment of the present invention, the length to width ratio of the laminar airflow device is in the range of 3 to 2.

In one more embodiments of the present invention, a twin turbo fan ensures continuous downward movement of sterile air.

In another embodiment of the present invention, the turbo fan is a heavy-duty axial fan.

In an embodiment of the present invention, the front panel is preferably of sliding type.

In another embodiment of the present invention, the front panel has upward and downward restricted movement.
In another embodiment of the present invention, the front panel can be held at any desired position.

In still another embodiment of the present invention, the perforated plate is made up of materials selected from the group comprising metal, synthetic material and wood.

In another embodiment of the present invention, the central part of the perforated platform is made removable by a slit and groove mechanism, enabling integration of the device with other devices that may at times require a sterile environment.

In an embodiment of the present invention, the HEPA-filter opening facing towards the lower chamber is covered with a plastic grill.

The present invention further provides a compact, portable, lightweight, low power consuming, convenient and versatile sterile laminar airflow device, useful in obtaining a workspace substantially devoid of airborne particulate contaminants, said device comprising a body (C) provided with mounts (O) and divided into upper & lower chambers; the upper chamber being provided with a removable panel (D) at the front for access to the internal components, housing a pre-filtration member (H) capable of retaining suspended particles in the air, a motor (T) with a twin turbo fan (S) compartmentalized by a partition (R) into a suction channel for pushing the air entrapped in the pre-filtration member (H) unidirectionally through the air tight exhaust channel and a HEPA filter (U), which is mounted on a leak-proof spongy rubber gasket (V), placed in the path of pressurized air, for further cleansing of the air of any possibly remaining particles, said device being provided with a platform with perforations.

In another embodiment of the present invention, the UV tube is fixed at a position below the upper chamber.

In yet another embodiment of the present invention, the device is provided with removable legs to have clearance under the chamber, facilitated by an appropriately placed handle (F) with provision for holding the whole panel at different heights, with the help of notches (G) along the side edges, which are obstructed by the ball, spring and screw system (I) fixed to the body wall, and fibrous mat packing provided in the horizontal slot (Y) to prevent free movement of air and dust particles.

In an embodiment of the present invention, the device is provided with handle (A) as a carrying device.

In another embodiment of the present invention, the device is provided with buckles (W) on the sides for attachment of shoulder straps.

In still another embodiment of the present invention, the front panel can be held at any desired position.

In yet another embodiment of the present invention, the HEPA-filter opening towards the lower chamber is covered with a plastic grill.

In yet another embodiment of the present invention, the front panel is preferably of sliding type.

In another embodiment of the present invention, the front panel has upward and downward restricted movement.

In yet another embodiment of the present invention, the device is provided with removable legs to have clearance under the chamber.

In one more embodiment of the present invention, the central part of the perforated platform is made removable by a slit and groove mechanism, enabling integration of the device with other devices that may at times require a sterile environment.
In another embodiment of the present invention, the entire device can be carried in a lightweight box. In yet another embodiment of the present invention, the device can be used as workbench of an enlarging device.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

In the drawings accompanying the specification,

FIG. 1 is a perspective view of the present device called ‘STERIFLOW’ embodying the present invention.

In the drawings accompanying the specification,

FIG. 2 is a perspective view of the vertical section taken on the line 2—2 of FIG. 1.

FIG. 3 is a front view of the vertical section taken on the line 2—2 of FIG. 1, indicating the direction of the airflow streamlines that would affect particulate trajectories in the ‘STERIFLOW’. Details of the individual parts of the device called ‘STERIFLOW’ are given below by way of illustration, however, this should not be construed to limit the invention in any manner:

A) Handle: Swing type handle, centrally located at the top of the body such that it does not obstruct the air inlet.

B) Pre-filter: A fibrous washable filter sheet with large pore size and folded setup for high surface area to volume filter to restrict the intake of suspended dust particles.

C) Body: A wooden cabinet 35x25x50 (cm): WxDxH and wall thickness 2 cm provided with rubberized mounts (G) of 2 cm height, and divided into upper & lower chambers; the upper chamber having internal dimensions 31x21x21 (cm): WxDxH, with a removable panel (D) at the front for access to the internal components, housing the filtration member (B) capable of retaining suspended particles in the air, a motor (T) with a twin turbo fan (S) compartmentalized by a partitions (R) into a suction channel for pushing the air entrapped in the pre-filtration member (B) unidirectionally through the air tight exhaust channel and the HEPA filter (U), which is mounted on a leak-proof spongy rubber gasket (V), placed in the path of pressurized air, for further cleansing of the air of any biological or a biological air borne particulate contaminants so as to ensure a continuous flow of sterile air into the lower chamber and on the removable solid platform (X) perforated plate (N); an air pressure measuring device (Z) in the upper chamber monitors and includes means to regulate inside pressure, and hence the air flow through the HEPA filter, by regulating the speed of fan motor (T), for example; a lower chamber of internal dimensions 35x21x23 (cm): WxDxH, with an assembly for UV tube (J) with germicidal properties, a solid perforated plate (X) and a perforated plate (N); switches with indicator lights (H) on one side surface for controlling the operations; a speed controller (E) for regulating fan or motor speed; a large, centrally located handle (A) at the top for ease of carrying by a single hand, (W) buckles for attaching standard shoulder straps; openable panels (L, P) on opposite sides with hinges joints (K) along the rear vertical axis, and a front panel (M) with height=27 cm so that at closed position it does not obstruct the removal of the front panel of the upper chamber, openable by upward sliding movement in a vertical plane along the vertical slot (Q) in the body, through a horizontal slot (Y) at the front of the body and above the lower chamber, facilitated by an appropriately placed handle (F) with provision for holding the whole panel at different heights, with the help of notches along the side edges (G), which are obstructed by the ball, spring & screw system (I) fixed to the body wall typically referred to as a “click-stop” system; fibrous mat packing fixed to the body, between the front panel of the lower chamber and the boundaries of the horizontal slot above the lower chamber for verti-cal-sidable front panel to prevent free movement of air.

D) Upper Front Panel: A wooden panel 6 mm in thickness, fixed in front position of the upper chamber with screws, and allowing access to the internal components for servicing.

E) Regulator: An electronic fan regulator with maximum capacity of 600 watts operable at 240V AC, 50 Hz electricity supply, to regulate the speed of the motor, turbo fan and hence, the speed of the sterile air flow.

H) Indicator Switches: Two indicator switches of 6 Amp capacity, operable at 250 V AC; placed on the side of the body (C) to facilitate the switching on and off the motor (T) and the germicidal UV lamp (J).

J) Germicidal UV Lamp: A ‘Sankyo Denki’, Japan brand, 31 cm long, 6 Watt shortwave UV tube placed at the rear side, below the upper chamber to evenly illuminate the lower chamber and any objects kept on the working platform (N).

M) Lower Front Panel: 4 mm thick rectangular UV stabilized transparent polycarbonate plate of dimensions 32x27 (cm): WxH, the left and right margins of which are notched (G) at regular intervals, which, when obstructed by the ball, spring & screw system (I), provide a mechanism of holding it at desired heights. The lower edge is partially trimmed in an oblique manner to avoid obstruction by the ball, spring screw system (I) during the initial insertion into the body (C). The shape and size are such that upon complete closure it does not obstruct with the removal of the upper front panel (D). A handle (F) fixed to the panel is a convenient means for gripping with hand, to facilitate its vertical movement.

N) Perforated Plate: A removable stainless steel perforated plate, with such shape that it fits well into the working platform (X). The perforations facilitate partial vertically downward flow of the sterile air. The perforated plate can be replaced by a solid plate made of laminated wood, glass, stainless steel or any other non-corrosive material as desired but not limited to them.

O) Rubberized legs: 2 cm tall rubberized legs that keep the working platform (X) raised above the surface, thus allowing air passage from beneath the working platform. It also dampens the vibrations in the body due to activity of the motor (T), resulting in a smoother operation.

S) Twin turbo fans: A pair of turbo fans are provided to minimize any recirculation of air due to leakage from the exhaust channel to the suction channel, and to maximize the unidirectional flow of air so as to build up higher pressures required to drive the air through the HEPA filter.
T) Motor: The fan motor has the following specifications: (i) Power: 200 Watts, (0.003 units/minute); (ii) Operation voltage: 230V AC, 50 Hz; (iii) Current: 0.95 Amp; (iv) Suction strength: 650 mm water column; and (v) Speed: 15500–16000 rpm.

U) HEPA filter: A setup of high surface area folded filter membrane with a cut off pore size of 0.2 microns located at the end of the exhaust channel in the upper chamber, upon passing through which the air pressurized by the motor and twin turbo fan generates a vertically downwards stream of sterile air into the lower chamber hence, creating a sterile environment above the working platform (X).

V) Spongy rubber strip: A strip of spongy rubber is sandwiched along the circumference of the HEPA module, between the HEPA module and the lower wall of the upper chamber of the body (C) to which the HEPA module is fixed, to avoid any air leakage from the upper chamber into the lower chamber except through the HEPA filter.

The working of the sterile air flow device STERIFLOW for obtaining a continuous flow of clean air at the perforated bench area is described below:

The STERIFLOW is switched on so that the air is sucked into the upper chamber because of the fan and is filtered through the pre-filter (B) which retains dust particles. Soon the pressure builds up within the upper chamber and the air is then forced through the HEPA filter which takes care of any remaining suspended particles, both biological and biological, so that clean air flows in a continuous stream across the filter and onto the working area which also gets cleared of any suspended particles after 10–12 minutes and can be used for sterile operations. In case of biological experiments, the use of UV light for at least 10 minutes is recommended to kill already existing contaminants. A spirit lamp or a gas burner to flame sterilize the mouths of the culture vessels before carrying out operations involving live biological material can also be used.

The following examples are given by way of illustration of the utility of the present invention (STERIFLOW) for raising aseptic cultures and should not be construed to limit the scope of the present invention.

**EXAMPLE-1**

In this example, pre-sterilized petriplates were first kept in the working platform along the arms of a cross stretching across the corners of the working platform for 10 minutes with UV light on and then, when still hot, sterilized liquid MS medium containing sucrose (30% w/v), vitamins and agar for solidification, was poured into them and allowed to solidify for 15 minutes. The petriplates were then sealed with paraffin (Methyl Sigma, USA) and incubated to check for any contamination for 3 weeks. No contamination in these petriplates confirmed the proper working of the present invention.

**EXAMPLE-2**

The STERIFLOW as shown in FIG. 1 was used for raising the aseptic cultures of the nodal explants of a bamboo (Dendrocalamus hamiltonii). The nodal explants after surface sterilization with 0.04% solution of HgCl2 (w/v) containing a drop of liquid detergent were transferred on to a modified Murashige and Skoog (1962) medium containing a cytokinin, benzyl adenine and an auxin, 2,4- dichlorophenoxy acetic acid (2,4-D; 1.0 mg/1 each). There was no contamination because of any bacteria or fungi after three weeks of incubation period, confirming that the STERIFLOW is working in the desirable manner.

Main Advantages of the Present Invention are:

The present invention is a low power consuming, portable, versatile, convenient device capable of providing continuous flow of clean air on a working platform making it suitable for all industries requiring clean areas at the working benches.

It provides a lightweight, portable, compact, low energy consuming sterile laminar air flow cabinet that can be conveniently used in far flung remote areas for 'in situ' aseptic inoculation of biological samples such as plants and microbes for establishment of cultures.

Provision of a large handle for carrying and buckles for attaching flexible shoulder belts, in addition to the small compact size and light weight, make the device truly portable.

It is a low cost sterile laminar air flow cabinet for promotion of plant tissue culture as a cottage industry, demonstration and education in schools and colleges, and for industries with low end cost requirement such as the watch industry and the micro-electronics industry.

It being small in size, requires less space and can therefore, be used for desktop sterile air applications.

The working platform being partially removable, the device can be integrated with other devices that may at times require sterile environment, such as the workbench of an image enlarging device, thus increasing the versatility of applications.

Provision for opening or closing the front and the side panels, make manipulation inside the sterile zone within the lower chamber possible from any direction as per convenience.

Maintenance is negligible as except for the HEPA filters, the rest of the items are available easily in the market.

What is claimed is:

1. A sterile laminar airflow device useful in obtaining a workspace substantially devoid of airborne particulate contaminants, said device comprising a hollow body divided into an upper chamber and a lower chamber separated from the upper chamber by a filter; the upper chamber having at least one pre-filtration member mounted thereon, a motor mounted inside the upper chamber between a top face and the filter, a fan driven by the motor for creating a flow of air going into the upper chamber through the pre-filtration member and out of the upper chamber into the lower chamber through the filter; and the lower chamber provided with a selectively operable front panel having adjustment members to secure the lower front panel in a variety of positions allowing selective adjustment of a width of an aperture of the lower chamber, whereby the aperture provides access to the lower chamber, a removable platform located on a base face of the lower chamber and a perforated plane located on the removable platform inside the lower chamber, wherein the air flow exits the lower chamber through the perforated plane.

2. A device as claimed in claim 1, further comprising removable legs or mounts (O) for providing clearance from any surface on which the device is placed.

3. A device as claimed in claim 1, wherein the fan is compartmentalized by a partition which creates a closed path between the pre-filtration member and the fan whereby a suction channel is formed through the pre-filtration and the filter for pushing the flow of air unidirectionally into the lower chamber.

4. A device as claimed in claim 1, further comprising one or more switches on at least one outer surface of the body for
controlling operations; a speed controller for regulating fan or motor speed; an illuminating device; and a UV source with germicidal properties being provided in the lower chamber.

5. A device as claimed in claim 1, further comprising panels arranged on sides of the body, swingably mounted on hinge joints arranged along a rear vertical axis, a handle, attached to the front panel, positioned so that at a completely closed position the handle does not obstruct removal of a removable panel of the upper chamber, a vertical groove, and a horizontal slot enabling movement of the front panel toward the upper chamber, and wherein the adjustment members include notches on at least one side of the front panel and a spring and screw mechanism along an inner surface of the vertical groove cooperating with said notches to hold the front panel in different positions.

6. A device as claimed in claim 1, wherein a large centrally located handle is mounted on an outer top portion of the upper chamber for moving the device.

7. A device as claimed in claim 4, wherein the UV source is a UV tube.

8. A device as claimed in claim 4, wherein the illuminating device is selected from the group consisting of a tube, bulb and halogen lamp.

9. A device as claimed in claim 1, wherein the body is formed of materials selected from the group consisting of solid wood, laminated wood, stainless steel, carbon steel, and plastic.

10. A device as claimed in claim 9, wherein the plastic is selected from the group consisting of Polycarbonate, fibre-glass and reinforced strengthened glass, acryl, polymethylacrylate, polystyrene, polylactylene, polypropylene and poly(epsilon-caprolactone) (TPX).

11. A device as claimed in claim 1, wherein a ratio defined by the distance between the top face and the base face, over the distance between opposing first and second side faces which connect with ends of the top face and extend perpendicular to the top face and the front panel, is approximately 3:2.

12. A device as claimed in claim 1, wherein the body is provided with removable legs to provide clearance for exiting air from the lower chamber.

13. A device as claimed in claim 1, wherein the fan is a heavy-duty axial fan.

14. A portable, sterile laminar airflow device, that can be carried by a user, useful in obtaining a workspace substantially devoid of airborne particulate contaminants, said device comprising a body provided with mounts and divided into upper and lower chambers; the upper chamber having a removable panel at a front of the body for gaining access inside the upper chamber, said upper chamber further having a pre-filtration member capable of retaining suspended particles in the air, a motor driving a twin turbo fan for creating a flow of air, the motor being compartmentalized by a partition which creates a closed path between the pre-filtration member and the fan wherein a suction channel is created for pushing the flow of air through the pre-filtration member, then unidirectionally through an exit of the partition, and through a HEPA filter separating the upper and lower chambers, the HEPA filter being mounted on a leak proof sponge rubber gasket and placed in the path of the flow of air, whereby the flow of air must pass through the HEPA filter to enter the lower chamber for further cleansing of the flow of air of all of any biological or a biological airborne particulate contaminants to ensure the flow of air into the lower chamber is sterile; the lower chamber having a removable solid platform, located on a base face of the lower chamber opposite the HEPA filter, a perforated plane mounted on the platform inside the lower chamber between the platform and the HEPA filter; the device further comprising a speed controller for regulating fan speed; a handle centrally located at a top of the body for ease of carrying; a UV source with germicidal properties mounted inside the lower chamber; openable side panels arranged on two opposing sides of the lower chamber and swingably mounted about hinge joints mounted on a rear panel of the lower chamber orthogonal to the side panels, and an openable lower front panel, orthogonal to the side panels and opposite the rear panel, slideable, within a plurality of grooves in the lower chamber, toward the upper chamber, through a horizontal slot in the lower chamber, allowing access to the lower chamber, the lower front panel including a handle, for sliding the lower front panel, and a plurality of notches, located on opposing side ends of the lower front panel which cooperate with a bull, spring and screw system fixed to the body for selectively releasably securing the front panel in various different positions to adjust a dimension of an opening of the lower chamber; the device further comprising a fibrous mat packing provided in the horizontal slot to prevent free movement of air and dust particles.

15. A device as claimed in claim 14, wherein the device is provided with an illumination device.

16. A device as claimed in claim 15, wherein the illumination device is selected from the group consisting of a tube, bulb and halogen lamp.

17. A device as claimed in claim 14, wherein the lower front and side panels are formed of shatter resistant UV stabilized material.

18. A device as claimed in claim 14, wherein the lower front panel is arranged for upward and downward movement.

19. A device as claimed in claim 14, wherein the body is provided with removable legs to provide clearance for exiting air from the lower chamber.

20. A device as claimed in claim 14, further comprising an air pressure measuring device installed in the upper chamber for monitoring an inside air pressure, the air pressure measuring device including means for regulating the inside pressure, thereby regulating the air flow through the HEPA filter.

21. A device as claimed in claim 14, further comprising a plurality of switches for controlling the flow of air and light intensities.

22. A device as claimed in claim 22, wherein the switches are selected from the group consisting of an ON-OFF click switch, sliding switch, and dimmer switch with rotary motion.

23. A device as claimed in claim 14, wherein the device is provided with a perforated platform arranged at a base of the body.

24. A device as claimed in claim 14, wherein the device is made up of materials selected from the group consisting of steel, wood, non-corrosive polystyrene material, non-corrosive polyplast material and non-corrosive metallic material.

25. A device as claimed in claim 14, wherein the central part of the perforated platform is made movable by a slit and groove mechanism, enabling integration of the device with other devices that may at times require sterile environment.

26. A device as claimed in claim 14, wherein a base of the lower chamber is perforated and with or without provision for removing a central part of the base.
28. A device as claimed in claim 14, wherein the prefiltration member is covered with a perforated plate.

29. A device as claimed in claim 28, wherein the perforated plate is formed of a non-corrosive material selected from the group consisting of metal, synthetic material and wood.

30. A device as claimed in claim 14, wherein the HEPA filter is covered with a plastic grill.

31. A device as claimed in claim 14, further comprising a box for housing and carrying the device.

32. A device as claimed in claim 14, wherein the device can be operated on a battery.

33. A device as claimed in claim 14, wherein the device can be used as a workbench of an enlarging device.

34. The device as claimed in claim 14, further comprising a plurality of buckles attached to the device to secure a strap for carrying the device.

35. The device as claimed in claim 1, further comprising a plurality of buckles attached to the device to secure a strap for carrying the device.

36. A portable laminar air flow device for creating a workspace substantially free of airborne contaminants comprising:

- an upper chamber having an upper interior space and a removable upper front panel for accessing the upper interior space;
- a motor, mounted within the upper interior space on an interior wall;
- a fan, mounted on the motor, to create a flow of air; and
- a prefiltration member sealably mounted to the upper chamber for allowing the flow of air to enter the upper chamber through the prefiltration member;
- a lower chamber, having a lower interior space, connected to an open bottom face of the upper chamber;
- a filter, sealably mounted to the open bottom face, for allowing the flow of air to enter the lower chamber through the filter; and,
- a lower front panel, selectively slideably mounted on a front face of the lower chamber substantially orthogonal to the open bottom face, having adjustment members to secure the lower front panel in a variety of positions allowing selective adjustment of a width of an aperture of the front face, whereby the aperture provides access to the lower interior space and allows the flow of air to exit the lower chamber therethrough.

37. The device according to claim 36, further comprising at least one side panel, hingedly mounted on at least one side face of the lower chamber substantially orthogonal to the front face to provide access to the lower interior space.

38. The device according to claim 36, further comprising a carrying handle mounted to the upper chamber for carrying the device.

39. The device according to claim 36, further comprising a plurality of buckles attached to the device to secure a strap for carrying the device.

* * * * *
Portable Laminar Air Flow Cabinet (STERIFLOW™)

Rajesh Thakur, Anil Sood* and P S Ahuja
Biotechnology Division, Institute of Himalayan Bioresource Technology,
PO Box 6, Palampur, Himachal Pradesh 176 061

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The development of a portable laminar air flow cabinet christened as STERIFLOW™ was prompted by the need to perform aseptic manipulations in places other than established laboratories, where conventional laminar air flow hoods are not available. STERIFLOW™ is based on the principle of a regular Laminar Air Flow, whereby an electrically operated propeller fan sucks air through a prefilter and drives it through a HEPA filter to generate a continuous stream of sterile air in the working zone. The Laminar is equipped with a UV lamp for ensuring initial disinfection of the working space. Besides being affordable, its small size and light weight allows it to be taken along on biological sample collection tours. Moreover, a removable base enables its use along with instruments like, a dissection microscope for manipulation and preparation of biological samples under aseptic conditions. Its performance was compared with that of a standard Laminar Flow Hood and the results were found to be comparable. Due to a combination of cost-effectiveness and portability, STERIFLOW™ has many potential applications.

Keywords: Portable laminar air flow, Aseptic environment, Steriflow

Introduction

Laminar air flow instruments used in 1950s were elaborate structures having a series of appliances connected to each other for providing purified air in the work chamber. With time, various refinements and modifications were incorporated in the apparatus to improve its efficiency and versatility. All these instruments are, however, designed to provide a large aseptic workbench for industrial applications. These horizontal and vertical sterile laminar air flow systems have the disadvantages of being heavy, bulky, and expensive in terms of cost and maintenance, and hence unsuitable for low end applications, where sterile environment is not required intensively, and more often a high infrastructural cost is unaffordable.

Establishment of aseptic cultures of the rare biological specimens from remote areas has always been a problem for biologists. By the time they return back to their laboratories after collecting the plant/microbial samples from far off places, the materials had already undergone tremendous amount of stress both due to environmental variations and due to contaminating microorganisms. This results in poor survival of in vitro cultures, causing frustration to the person who spent time and efforts in its collection. Commercial micropropagation has also remained restricted, since the cost of standard laminar flow in the Indian market is at least Rs 30,000 to 40,000 which becomes the limiting factor for many small entrepreneurs who wish to set up their own production centers at domestic levels.

It was thus realised that development of a portable model of the instrument would enable both the scientists and small scale entrepreneurs to take advantage of the affordability, portability, and ease of operation of the new instrument. Further, biotechnology has been included as a part of the revised curriculum of the CBSE, and STERIFLOW™ can fill the gap as a handy teaching aid in the school laboratories for the students at a fraction of the usual cost. The development process went through designing, fabrication and testing of various models before specific design parameters were standardized.

* Author for correspondence
E-mail address: kukisood@yahoo.co.in

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Design of the Apparatus.

The entire volume is divided into three chambers. These are: suction zone with a prefilter at its inlet, a compression zone with a propeller fan at its interface with the suction zone, and the working zone with a HEPA filter at its interface with the compression zone (Figure 1). The propeller fan generates a stream of air that is sucked through the prefilter, and then driven through the HEPA filter to generate an aseptic environment in the working zone.

Key Features/Specifications

- **Working space**: H x W x D = 27cm x 32cm x 23cm
- **Working surface**: Glossy stainless steel
- **Ext. Dimensions**: H x W x D = 55cm x 36cm x 25 cm
- **Weight**: 14.5 kg
- **Prefilter efficiency**: 99 per cent down to 5μ
- **HEPA filter efficiency**: 99.97 per cent down to 0.3μ
- **Body**: Medium density fibre body with sunmica finish (interior and exterior) - Acrylic doors on front and sides, front door height adjustable.
- **Portability**: Handle and shoulder strap
- **UV Lamp**: 9W germicidal UV-lamp
- **Power supply**: 50 Hz 220V AC Voltage
- **Power consumption**: 200W
- **Operation**: Noiseless and efficient blowers with a speed regulator

Specifications are subject to change as and when required, in order to incorporate improvements in the stated instrument.

Maintenance is negligible, except for care to keep it covered when not in use to protect from dust.

Details of the Individual Parts of the **STERIFLOW™** (Figure 1)

(A) **Handle** — Swing type handle, centrally located at the top of the body such that it does not come into the way of the air inlet.

(B) **Prefilter** — A fibrous washable filter sheet with large pore size and folded set up for high surface area to filter restrict the intake of suspended dust particles. Its filtration efficiency is 99 per cent down to 5μ.

(C) **Body** — A wooden cabinet made of medium density fibre body with sunmica finish (interior and exterior) with outer dimensions 36 x 25 x 55 cm: W x D x H and wall thickness 2 cm divided into upper and lower chambers. The internal dimensions of the upper chamber are: 32 x 23 x 21 cm: W x D x H. It has a removable panel (D) at the front for access to the internal components, a filtration member (B) at the top, a motor (T) with a propeller fan (S), HEPA filter (U) at the bottom, a partition (R) that compartmentalizes it into a suction channel through the prefilter (B) and the exhaust channel through the HEPA filter (U). The internal dimensions of the lower chamber are 32 x 23 x 27 cm: W x D x H. It has transparent panels (L,P) on sides with hinge joints (K) along the rear vertical axis, and a front panel (M) which can be opened by sliding movement in vertical plane along the vertical groove (Q) in the body, through a horizontal slot (Y) at the front, above the lower chamber. Fibrous mat packing fixed to the edges of the slot (Y) prevents free movement of unfiltered air from outside. Provision for opening or closing the front and the side panels, make manipulations inside the sterile zone within the lower chamber possible from any direction as per convenience.

(D) **Upper Front Panel** — A removable wooden panel, approximately 6 mm in thickness, fixed in front of the upper chamber with screws, allows access to the internal components for servicing.

(E) **Regulator** — An electronic fan regulator that operates at 240V AC 50 Hz electricity supply, to regulate the speed of the motor, turbo fan and hence the speed of the air flow.

(F) **Notches** — The front transparent polycarbonate sheet has notches at regular intervals to facilitate holding the sheet at desired heights.

(G) **Indicator Switches** — Two indicator switches, operable at 250 V AC, placed on the side of the body (C) to facilitate the switching on and off the motor (T) and the germicidal UV lamp (J).

(H) **Ball, Spring and Screw System** — Provided in the lower front panel to hold the transparent sheet at desired heights.
(A) Handle; (B) Prefilter; (C) Body; (D) Upper Front Panel; (E) Regulator; (G) Notches; (H) Indicator Switches; (I) Ball, spring and screw system; (J) Germicidal UV Lamp; (K) Hinge; (L) Lower right side Panel; (M) Lower Front Panel; (N) Stainless steel plate; (O) Rubberized legs; (P) Lower left side panel; (Q) Vertical groove; (R) Partition wall; (S) Propeller fan; (T) The fan motor; (U) HEPA filter module; (V) Spongy rubber strip; (W) Buckle; (X) Removable basal plate; (Y) Horizontal slot; (Z) Rotating door lock.

Figure 1 — Clockwise – Picture; Isometric view – whole; Isometric view – Vertical cut section – Air currents – schematic diagram; Isometric view – front upper panel removed.
(J) Germicidal UV Lamp — A Sankyo Denki, Japan brand 21 cm long, 9 W short-wave germicidal UV lamp placed at the rear side, below the roof of lower chamber to evenly illuminate the working area and any objects kept on the working platform (N).

(K) Hinge — Provided to facilitate opening and closing of side panels.

(L) and (P) Lower Side Panels — Transparent openable panels on the sides provide access to the working platform when required.

(M) Lower Front Panel — A 4 mm thick rectangular UV stabilized transparent polycarbonate plate of dimensions 32 x 27 cm: W x H, the left and right margins of which are notched (G) at regular intervals, which when obstructed by the ball, spring and screw system (I) provide a mechanism of holding it at desired heights. The lower edge is partially trimmed at both ends in an oblique manner to avoid obstruction by the ball, spring screw system (I) during its initial insertion into the vertical groove (Q). Its shape and size are such that upon complete closure it does not obstruct the removal of the upper front panel (D). It has a handle (F) fixed to it as a site for gripping with hand, to facilitate its vertical movement.

(N) Stainless Steel Plate — A removable stainless steel plate, with such shape that it fits well into the working platform (X). It may have perforations to facilitate partial vertically downwards flow of the sterile air.

(O) Rubberized Leg — 2 cm tall rubberized legs that keep the working platform (X) raised above the surface. It dampens the vibrations in the body due to activity of the motor (T), resulting in a smoother operation.

(Q) Vertical Groove — Provided on the sides in which the front transparent panel's movement is materialized.

(R) Partition Wall — Partitions the upper chamber internally into an upper partition forming the suction channel through the prefilter(B), and a lower partition housing HEPA filter unit.

(S) Propeller Fan — This fan sucks air through the prefilter (B) and drives it through the HEPA filter (U) to generate a continuous stream of sterile air in the lower chamber.

(T) The Fan Motor has the following specifications:

(i) Power : 200 W, (0.003 units/min)
(ii) Operation voltage : 230V AC, 50 Hz
(iii) Current : 0.95 A
(iv) Suction strength : 650 mm water column
(v) Speed : 15500 ~ 16000 rpm

Motors of other configurations and specifications can also be used, with design modified suitably to ensure forced movement of air in order to generate a stream of sterile air upon the working platform at sufficient velocity.

(U) HEPA Filter Module — A set up of folded filter membrane for high surface area, with a cut off pore size of 0.2 μ located at the end of the exhaust channel in the upper chamber. It retains all the potent biological contaminants such as, bacterial and fungal spores, when the air pressurized by the propeller fan passes through it. This generates a vertically downwards uniform stream of sterile air into the lower chamber, thereby creating a sterile environment above the working platform (X).

(V) Spongy Rubber Strip — A strip of spongy rubber is sandwiched along the circumference of the HEPA module, between the HEPA module and the lower wall of the upper chamber of the body (C) to which the HEPA module is fixed, to avoid any air leakage from the upper chamber into the lower chamber except through the HEPA filter.

(W) Buckle — Site for attachment of shoulder strap, which enables convenient portability of the instrument.

(X) Removable Basal Plate — Its removal allows placement of an instrument such as a dissection microscope for carrying out aseptic dissection works.

(Y) Horizontal Slot — This facilitates movement of the lower front panel in a desired orientation.

(Z) Rotating Door Lock — This is a rotating lock for the side doors placed on the inside of the door, with a knob on the outside. Turning the knob turns the lock plate and engages it into the cavity in the vertical pillar, and prevents opening of the door.

Materials and Methods

The working of the present invention for obtaining a continuous flow of clean air at the perforated bench area is discussed subsequently: The STERIFLOW™ is switched on so that the air is sucked into the upper chamber because of the fan and is filtered through the filter B retaining the dust particles. Soon the pressure builds up within the upper chamber and the air is then forced through the HEPA
filter which takes care of the remaining suspended particles, both biological and abiological. Clean air flows as continuous and uniform stream upon the working area, which also gets cleared of any suspended particles and after 10-12 min, the same can be used for sterile operations. In the case of biological operations, the prior use of UV light for at least 10-15 min is recommended to kill already existing contaminants. A spirit lamp or a gas burner should be used to flame sterilize the mouths of the culture vessels before carrying out operations involving live biological material.

**Experiment 1 — Testing for Sterility Exposing Nutrient Medium Alone**

The UV light in the STERIFLOW™ was turned on for 15 min, and thereafter, its blower was kept running for another 10 min. Then pre-sterilized petri-plates were first kept in the working platform for 10 min, along the arms of a cross-stretching across the corners of the working platform and then, still hot, yet to solidify sterilized liquid MS medium containing sucrose (3.0 per cent w/v), vitamins and agar (0.8 per cent w/v) for solidification, was poured into them and allowed to solidify for 15 min. The petri-plates were then covered and sealed with parafilm M (M/s Sigma, USA) and incubated to check for any contamination for 3 weeks.

**Experiment 2 — Testing for Sterility During Inoculation Process**

STERIFLOW™ was used for raising aseptic cultures of the nodal explants of a bamboo plant, Dendrocalamus hamiltonii. The nodal explants after surface sterilization with 0.04 per cent solution of HgCl$_2$ (w/v) containing a drop of liquid detergent and subsequent rinsing with sterile water. These were then transferred to agar (0.8 per cent w/v) solidified nutrient medium in jam bottles and incubated in growth room maintained at 25 ± 2°C and with a 12 h photoperiod.

**Results and Discussions**

No contamination in the petri-plates in Experiment-1 confirmed the proper working of STERIFLOW™. Moreover, in Experiment-2, there was no contamination of cultures because of any bacteria or fungi even after three weeks of incubation period, affirming that the STERIFLOW™ is working in the desired manner and can be used for carrying out highly sensitive, aseptic activities such as, plant tissue culture.

Following are some of the potential uses of this instrument:

(a) **Promotion of Micropropagation as Cottage Industry** — The instrument is small and does not require dedicated space for keeping. Being cheap, it is much more affordable.

(b) **Collection of Biological Samples** — It can be taken along for an on-site establishment of aseptic cultures during collection of rare biological samples from places away from laboratory.

(c) **Educational Aid** — Being small and cheap, it can be widely used as an aid for demonstration of plant tissue culture technology in schools and colleges.

(d) **Microbiological Works** — Microbiology work mostly involves use of small culture vessels and this instrument may serve as just sufficient means for such work, instead of procuring standard laminar flow hood.

(e) **Use with Bioreactor Systems** — It is not practical to carry components of bioreactor system to the laminar flow for conducting aseptic activities such as, addition of the inoculum or aseptic connection or disconnection of tubings. STERIFLOW™ can be helpful for carrying out such activities, by generating a localized aseptic environment.

(f) **Integration with Other Devices** — The working platform being partially removable, the system can be integrated with other devices that may at times require sterile environment such as, a dissection microscope, thus increasing the versatility of applications.

**Guidelines for Proper Functioning of STERIFLOW™**

(i) Keep the STERIFLOW™ preferably in a clean enclosed area without direct stream of air.

(ii) Use UV light for at least 15 min before use.

(iii) Clean the prefilter periodically for efficient functioning.

(iv) Operate with absolutely clean hands and with a face mask and head gear.

**General Information**

- Its patent has been filed in India, USA, PCT, Britain, Australia, Brazil, Malaysia, New Zealand, Singapore, Zambia (US No. 60/273653, Filing date 05.03.2001).
- This multipurpose instrument costs just Rs 10,000, whereas other low-end Laminar Flow
Hoods would cost at least Rs 30,000 to 40,000 in the Indian market and upper end models, over Rs 1.0 lakh.

• Ms Rescholar Equipments Pvt Ltd, 85, HSIDC, Industrial Estate, Ambala Cantt 136 006, Haryana, India. (Tel. 0171-699883, Fax. 0171-699169, E-mail: rescholar@glide.net.in) had been licensed for its commercial production.

• Many trade inquiries have been received both from India and abroad.

Conclusions

The laminar air flow instrument developed by the authors, offers to the user at low initial costs, portability, freedom from arranging for a dedicated space for the laminar flow, without compromising on the functionality as a laminar flow. This instrument provides a special opportunity for the authorities in schools and colleges to arrange for demonstration of tissue culture technology to their students at affordable costs. It also provides the scientists/researchers an efficient means for on-site collection of biological specimens in remote places in the form of aseptic cultures. Thus the instrument will find great utility in diverse applications, where there is a need for an environment which is sterile and dirt-free.

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