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EXHAUST SYSTEM FOR ULTRA-CLEAN LAMINAR FLOW ENCLOSURES

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2 Sheets-Sheet 1

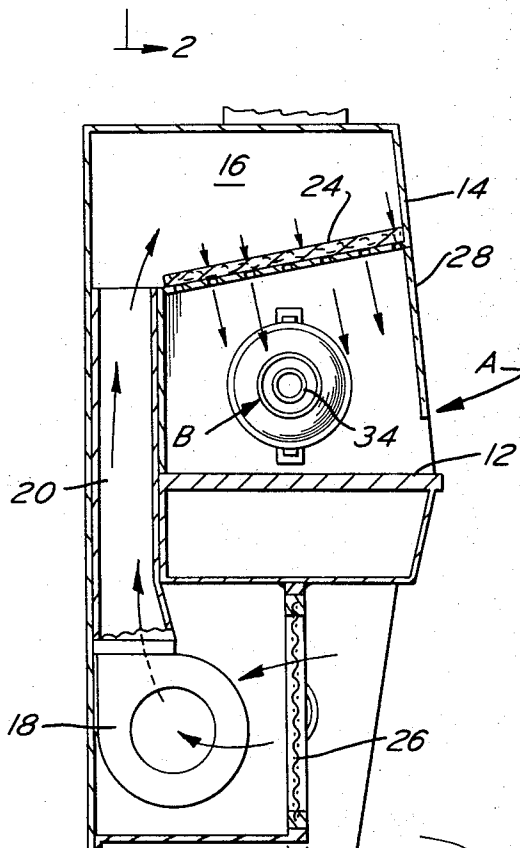
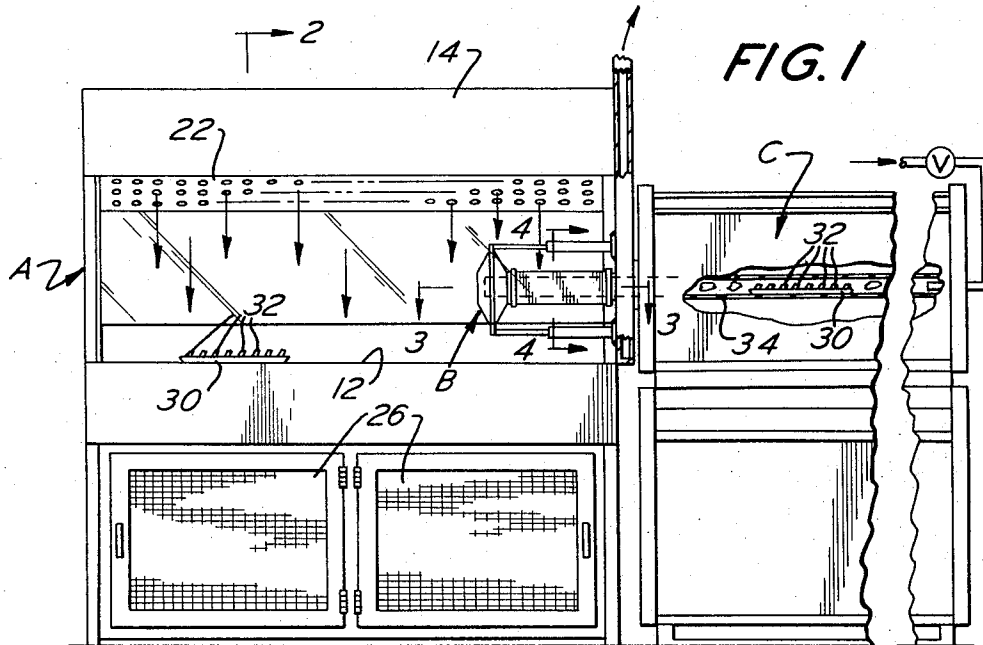


FIG. 2

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FIG. 3

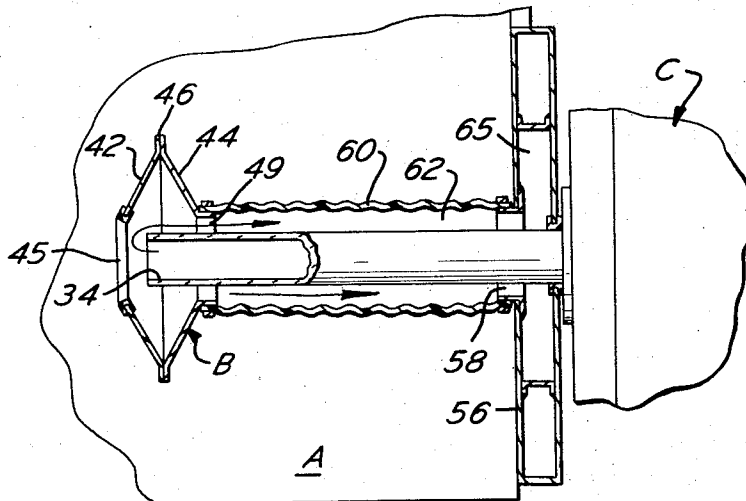


FIG. 4

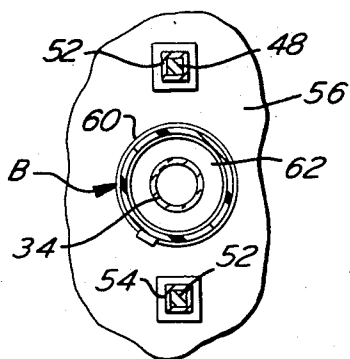


FIG. 5

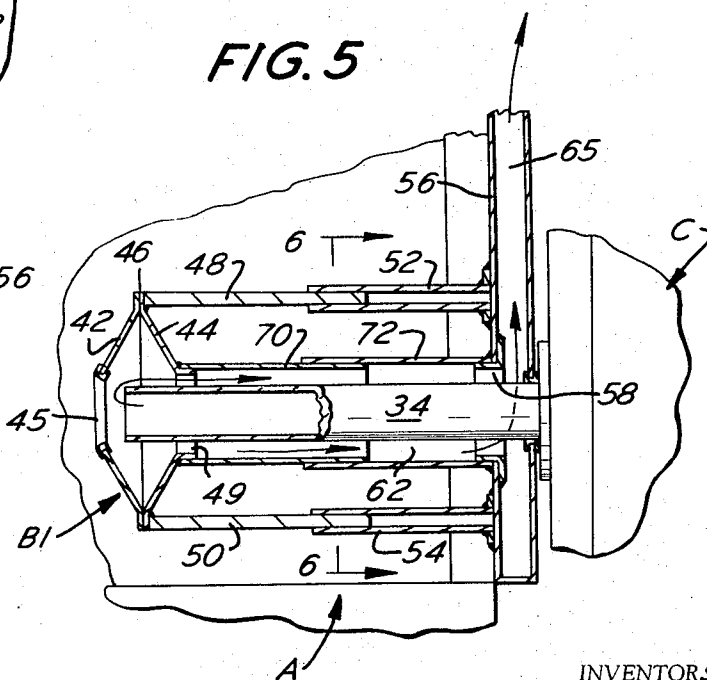
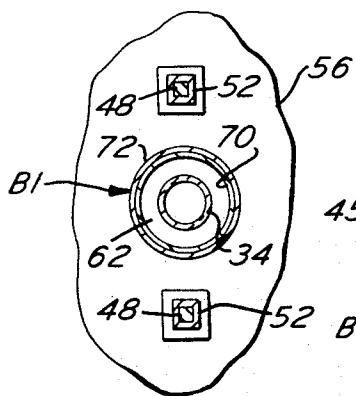


FIG. 6



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EXHAUST SYSTEM FOR ULTRA-CLEAN LAMINAR FLOW ENCLOSURES

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ABSTRACT OF THE DISCLOSURE

An exhaust system for an ultra-clean laminar flow enclosure comprising an outer shell member having an open end projecting within the enclosure and including an air foil surface transverse to the laminar air flow. Work is loaded from within the enclosure through the open end into an inner conduit which is annularly spaced within the outer shell, and a suction is applied to the annular zone so as to withdraw fumes from within the conduit without contaminating the enclosure or interfering with the laminar air flow therein.

This invention relates to an exhaust system for enclosures which have been rendered ultra-clean and contamination-free by the use of laminar flow sweeping principles. More particularly, the instant invention relates to an auxiliary suction or exhausting device which will draw off infiltrating contaminants, such as smoke, dust and fume particles, from ultra-clean laminar flow boxes and hoods without interfering with the directional laminar air flow.

In U.S. Patent No. 3,158,457 there is shown and described an ultra-clean enclosure which has been cleansed through the use of laminar air flow sweeping principles. That is, a laminar air flow system is one in which clean filtered air is directed into an operating chamber in a series of unidirectional parallel paths so as to continuously sweep over the working areas. By circulating a large volume of the already sub-micron filtered air in laminar paths through the working area, the ultra-clean air "sweeps" through the enclosure so that the latter essentially cleans itself.

The laminar unidirectional flow is created by pumping or forcing a relatively large volume of moving air by means of a blower or fan into a plenum where the air becomes relatively static. The static air exits from the plenum through a grid or screen having a plurality of regularly-sized and regularly-arranged apertures. When the air is squeezed through the rows and files of apertures, it is caused to be directed in a series of unidirectional laminar flow paths. A sub-micron particle filter is either arranged across the entire inlet to the plenum chamber or across the entire outlet so that all of the air passing into the working area will have passed through the filter. The air outlet from the working area of the hood or enclosure is preferably arranged normal to the laminar air flow in order to permit optimum sweeping out of the enclosure of whatever contaminant particles are entrained on objects or articles interposed in the air path. Thus, it is apparent that in order to obtain maximum benefit of the ultra-clean laminar air flow, one must maintain the air flow laminar and minimize any interference with the unidirectional currents which could create turbulence.

However, there are certain procedures in which it is desirable to perform additional operations upon articles while or immediately subsequent to their decontamination at the ultra-clean work station. For example, certain techniques require evaporation or deposition of coating materials upon the article after the article has already been sterilized. In other cases, the article or composition may be itself heated so as to evaporate contained solvents or to

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effect sublimation. In such cases, one may wish to avoid contamination of the environment and other articles within the work station by withdrawing the created impurities through the use of an exhaust or suction system.

However, it is easily perceived that the use of a random suctioning or total exhaust system would have series impact upon the laminar "sweep" of air within the ultra-clean work station or enclosure. Also, if an auxiliary highly directional vacuum device were used immediately adjacent the source to suck out fumes too great a suction might deteriorate the laminar flow environment by producing eddy currents. In addition, any bulky object, such as a suction pipe, which is placed within an aerodynamic stream has a tendency to destroy the aerodynamic laminar flow. It is therefore an object of this invention to provide an auxiliary exhaust system for laminar flow ultra-clean enclosures in which contaminating fumes can be removed without affecting the laminar flow.

Another object of this invention is to provide an auxiliary exhaust system for a laminar flow work station enclosure in which the articles may be maintained in a sterile sanitary environment preparatory to insertion within an interconnecting diffusion or evaporation chamber.

Yet a further object of this invention is to provide an auxiliary exhaust system for an ultra-clean laminar flow work station in which contamination fumes entering the station from a diffusion or evaporation operation may be immediately withdrawn without disturbing the adjacent environment.

Still another object of this invention is to provide an auxiliary exhaust system for a laminar flow work station wherein the orientation of the exhaust structure is aerodynamically configured.

Other objects of this invention are to provide an improved device of the character described which is sturdy in construction, that is easily and economically produced, and which is highly efficient and effective in operation.

With the above and related objects in view, this invention consists of the details of construction and combination of parts as will be more fully understood from the following detailed description when read in conjunction with the accompanying drawing, in which:

FIGURE 1 is a front elevational view of a laminar flow, ultra-clean work enclosure having an auxiliary exhaust system embodying this invention.

FIGURE 2 is a sectional view taken along lines 2—2 of FIGURE 1.

FIGURE 3 is a sectional view taken along lines 3—3 of FIGURE 1.

FIGURE 4 is a sectional view taken along lines 4—4 of FIGURE 1.

FIGURE 5 is a front sectional view of a modified embodiment of the exhaust system.

FIGURE 6 is a sectional view taken along lines 6—6 of FIGURE 5.

Referring now in greater detail to the drawings in which similar reference characters refer to similar parts, we show an ultra-clean laminar flow work station in the form of a hood, generally designated as A, and an exhaust device, generally designated as B which is coupled intermediate the work station and a diffusion furnace C.

Referring to FIGURES 1 and 2, the ultra-clean enclosure A comprises a work bench 12 in which operations may be performed under extremely sanitary conditions. Immediately above the work bench area 12 is a canopy portion 14 which encloses a plenum chamber 16. Air is pumped or blown into the plenum 16 by a blower 18 through a passageway 20 formed in the rear of the enclosure. The canopy 14 supports a perforated screen 22 or honeycombed grid in a plane slightly canted from a horizontal. Above the screen 22 is a sub-micron filter 24

which prevents the passage of 99.97 percent of dust and other particles in excess of 0.3 micron diameter particle size. An example of such a high efficiency filter is shown and described in detail in U.S. Patent No. 3,025,964 and the performance of such filters is governed by Military Specification Standard No. MIL-STD-282. The grid 22 may be, for example, a perforated steel plate, such as a $\frac{1}{16}$ " round-staggered center with 22.67 percent pen area, defined in Edgcomb Steel Co. catalog of Philadelphia, Pa.

The air is drawn by the blower 18 through a pre-filter 26 at the lower portion of the bench A and forced into the plenum 16. The air in the plenum 16 is essentially static and the pressure within the chamber 16 is in the range of 0.2 inch static head. This air is squeezed through the filter 24 which extracts the dust particles and exits through the perforated plate 22 in a series of jets or laminates at a velocity of perhaps 120 feet per minute. The front of the canopy 14 may have a glass or other transparent shield 28 detachably connected to the frame and permitting the air to exit in a controlled sweep at the surface of the work bench 12.

In order to demonstrate the salient features of this invention and the objects which it achieves, we have elected to illustrate the use of the diffusion furnace C in combination with the laminar flow work station A. Although the diffusion furnace does not itself actually form part of the present invention, it is considered well to exhibit here the general problem presented by the diffusion furnace which this invention solves.

For example, in FIGURE 1, there is shown the diffusion furnace C which is coupled to the work station enclosure A whereby an operator would load a quartz boat 30 containing a plurality of semiconductor wafers or slices 32 into a ceramic or quartz tube 34 of the furnace from the left. As is well known from an examination of U.S. Patents No. 3,131,099 or No. 3,183,130, a diffusion furnace is generally an elongated heating chamber in which the semiconductor slices 32 are elevated to a temperature of perhaps 1300° C. and exposed to an environment of doping impurities by solid state diffusion. In the present example, the boat 30 of semiconductor dices 32 is inserted through the left-hand end of the tube 34 into the central hot zone of the furnace C. The wafers 32 may have had certain operations performed on the work bench 12, but are already sanitized and clean by virtue of the ultra-clean sweeping environment of the enclosure A under the hood 14. The doping impurities are introduced into the right-hand end of the tube 34, as shown in FIGURE 1, whereby the solid state vapors pass over the semiconductor wafers in the hot zone and thence through the left-hand end of the tube 34 to contaminate the ultra-clean environs under the hood 14.

These contaminating vapors must be removed before they come into contact with clean wafers 32 and the sterile area of the work bench 12. The removal must be effected without creating eddies in the laminar flow by either harsh suctioning or violent exhaust systems nor by interference with the aerodynamic laminar flow by non-aerodynamic surfaces.

Accordingly, and as shown in FIGURES 3 and 4, the exhaust system B comprises a pair of hollow truncated conical shells 42 and 44 having their bases cojoined by a flange 46. Bar members 48 and 50 affixed at diametrically-opposed portions of the flange 46 are slidably received within complementary brackets 52 and 54 respectively which project into the work area from the right-hand wall 56 of the enclosure A. A cylindrical bellows 60, of a diameter larger than furnace tube 34, is secured at one end about port 58 in wall 56 through which the tube 34 extends into the clean area. The left-hand end of the expandable bellows 60 is clamped about the throat 49 of conical shell 46. Appropriate longitudinal manipulation of the bar arms 48 and 50 permits the mouth 45 of shell 42 to be spaced slightly distal to the left-hand end of tube

34 whereby the tube end is encapsulated. The annular space 62 between the tube 34 and bellows 60 communicates with a vacuum chamber 65 which is formed adjacent the wall 56 of the enclosure A. The chamber 65 may be coupled to a small fan (not shown) at the discharge end thereof or directly connected to the room or building exhaust.

In either event, the fumes or vapors emitted from the left-hand end of tube 34 will be gently drawn into the annular space 62 without passing beyond the mouth 45 into the work area. The gentle suction created within the opposed conical shells 42 and 44 does not intrude on the laminar air flow within the hood. Furthermore, the aerodynamic conic shell and cylindrical bellows sections permit smooth "air foil" directional flow thereabout without disturbing the laminar flow.

In FIGURES 5 and 6, we show a modified embodiment B1 of the exhaust system in which longitudinally rigid cylindrical shell 70 is secured about the throat 49 of conical member 44 and telescopes within a complementary cylindrical shell 72 extending interiorly within the clean hood from port 58. The telescoping cylindrical shells 70 and 72 allow the same smooth air foil design while at the same time permitting adjustment of the hollow conic sections about the distal end of tube 34.

Although this invention has been described in considerable detail, such description is intended as being illustrative rather than limiting since the invention may be variously embodied, and the scope of the invention is to be determined as claimed.

What is claimed is:

1. An exhaust system for an ultra-clean laminar flow enclosure comprising an outer shell member having an open end projecting within the enclosure and including arcuate exterior surfaces transversely interposed in air foil disposition with respect to the laminar flow of air, a work-supporting inner shell member annularly spaced within said outer shell member, and suction means coupled with the annular space between said shell members whereby fumes emitted within the interior of said inner shell member will be withdrawn without contaminating the enclosure or interfering with the laminar flow.

2. The invention of claim 1 wherein said outer shell member comprises a pair of truncated hollow cones having the bases thereof adjoined, an expandable cylindrical member having one end coupled about an orifice at the truncated portion of one of said cones and the other end about a port in a side of the enclosure.

3. The invention of claim 2 wherein said expandable cylindrical member comprises a bellows.

4. The invention of claim 2 wherein said expandable cylindrical member comprises a pair of telescoping tubular sections.

5. The invention of claim 2 including a chamber exterior to said enclosure communicating with the interior of said cylindrical member, and blower means drawing air from said chamber.

6. The invention of claim 5 wherein said inner shell member constitutes a tube from a diffusion furnace having the distal end terminating intermediate the apices of said cones whereby the annular space between said outer shell member and said tube defines a passageway for withdrawal of diffusion impurities.

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