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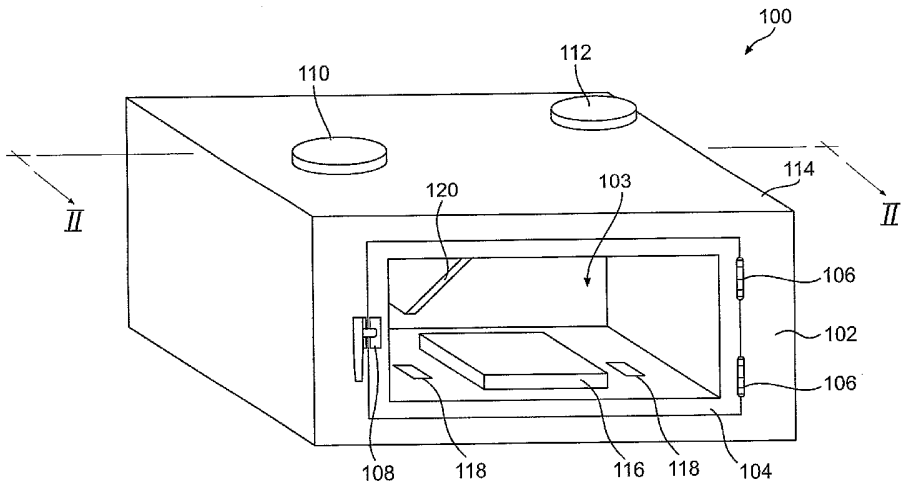
(54) **Title:** AIR-CONTROLLED CHAMBER WITH AN INTEGRATED ROBOTIC WORKSTATION



(57) **Abstract:** An air-controlled chamber (100) includes an inlet port (110) and an outlet port (112), each of which includes an air filter (111). Air, which is drawn into the chamber (100) via the inlet port (110), is directed by one or more baffles (120) to pass over an integrated robotic workstation (140) arranged in the chamber (100), and subsequently to the outlet port (112). Air is expelled from the chamber (100) after having been re-filtered at the outlet port (112).

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AIR-CONTROLLED CHAMBER WITH AN INTEGRATED ROBOTIC WORKSTATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 60/_____, filed on October 27, 2004.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to chambers in which chemical and/or biological analyses (hereinafter "analyses" or, in the singular, "analysis") occur. Historically, analyses that could present a danger to a technician, e.g., analyses that release toxins, pathogens, and/or microorganisms (e.g., yeasts) into the air, have been aided by laminar airflow. Specifically, such analyses have typically occurred in fume hoods or laminar flow hoods in which ambient air is drawn into an analysis region in the hood and is expelled via an outlet that usually leads to an exhaust pipe; the laminar airflow carries the toxins, pathogens and/or microorganisms away from the technician and toward the exhaust pipe. In addition, to protect the environment, air filters, e.g., High Efficiency Particulate Air ("HEPA") filters, have been provided adjacent the outlet so as to filter the air being expelled into the environment.

[0003] Some analyses, however, can be harmed by the laminar airflow. Specifically, if the ambient air carries something harmful (e.g., bacteria or other microbes) to an analysis, the analysis may be compromised. Further, if the analyses are to be conducted under specific temperature and/or pressure constraints, the ambient air drawn into the analysis region in which the analyses are occurring may negatively impact these constraints. To combat this problem, some fume hoods (e.g., the Purifier Delta Series Total Exhaust Safety Cabinet 3621404) have diluted the ambient air drawn into the fume hood with filtered air. However, although these fume hoods reduce the problems associated with completely unfiltered ambient air drawn in fume hoods, they do not eliminate the problem.

[0004] Furthermore, robotic workstations for sample handling in performing these analyses are typically not designed as closed units. In order to operate any analysis with sample handling robotic workstations in a closed or partially closed environment, it is necessary to provide a laminar flow hood to cover or partially cover the robotic workstation. This is inconvenient because a laminar flow hood needs to be readily available for attachment before the robotic workstation can be used for the analysis and also an optimal closed environment

may not be easily achieved by the use of the laminar flow hood (for example, the airflow inside the flow hood may need to be run for certain length of time, often twenty to thirty minutes, before the analysis can be performed).

SUMMARY OF THE INVENTION

[0005] An embodiment of the invention addresses an air-controlled chamber that includes, among other possible things: (a) an inlet port comprising one or more inlets, wherein the inlet port is provided with a first air filter, and wherein the first filter is configured to filter air drawn into the chamber via the inlet port; (b) an outlet port comprising one or more outlets, wherein the outlet port is provided with a second air filter, and wherein the second filter is configured to filter air expelled from the chamber via the outlet port; and (c) an integrated robotic workstation that is configured to automatically process samples. Substantially all of the air drawn into the chamber passes through the inlet port. Further, substantially all of the air expelled from the chamber passes through the outlet port.

[0006] In a further embodiment, the air-controlled chamber may include one or more pressure sensors positioned proximate the analysis region. Further, the pressure sensors may be configured to monitor the pressure of the air-stream.

[0007] In another further embodiment, each of the inlet and outlet ports may be provided with an air pump, a blower, or a motorized fan.

[0008] In another further embodiment, the air-controlled chamber may include a controller electrically connected to the one or more pressure sensors and to the air pumps, blowers, or a motorized fans of the inlet and outlet ports.

[0009] In another further embodiment, if the pressure monitored by the one or more pressure sensors falls below a threshold value, the controller may be configured to instruct the pump, blower, or motorized fan of the inlet port to increase the amount of air drawn into the chamber and/or to instruct the pump, blower, or motorized fan of the outlet port to decrease the amount of air expelled from the chamber.

[0010] In another further embodiment, if the pressure monitored by the pressure sensor rises above a threshold value, the controller may be configured to instruct the pump, blower, or motorized fan of the inlet port to decrease the amount of air drawn into the chamber and/or to instruct the pump, blower, or motorized fan of the outlet port to increase the amount of air expelled from the chamber.

[0011] In another further embodiment, the filters of the inlet and outlet ports may be HEPA filters.

[0012] In another further embodiment, the chamber may be portable.

[0013] In another further embodiment, the chamber may include one or more baffles arranged to direct the air from the inlet port through a work area of the chamber.

[0014] In another further embodiment, the robotic workstation may be configured to operate while the chamber is located outside of a fume or flow hood.

[0015] Another embodiment of the invention addresses an air-controlled chamber that includes, among other possible things: (a) an inlet port that includes one or more inlets, wherein the inlet port is provided with a first air filter, and wherein the first filter is configured to filter air drawn into the chamber via the inlet port; (b) an outlet port that includes one or more outlets, wherein the outlet port is provided with a second air filter, and wherein the second filter is configured to filter air expelled from the chamber via the outlet port; one or more baffles arranged proximate to the inlet port to direct air along an air-stream from the inlet port to the outlet port; (c) one or more pressure sensors positioned proximate an analysis region of the chamber; and (d) an integrated robotic workstation that is provided in the analysis region in the chamber. The integrated robotic workstation is configured to automatically process samples. Air flows through the chamber from the inlet port to the outlet port along the air-stream. The one or more pressure sensors are configured to monitor the pressure of the air-stream. Substantially all of the air drawn into the chamber passes through the inlet port and substantially all of the air expelled from the chamber passes through the outlet port.

[0016] In a further embodiment, each of the inlet and outlet ports may be provided with an air pump, a blower, or a motorized fan.

[0017] In another further embodiment, the chamber may also include a controller electrically connected to the one or more pressure sensors and to the air pumps, blowers, or motorized fans of the inlet and outlet ports.

[0018] In another further embodiment, if the pressure monitored by the pressure sensor falls below a threshold value, the controller may be configured to instruct the pump, blower, or motorized fan of the inlet port to increase the amount of air drawn into the chamber and/or to instruct the pump, blower, or motorized fan of the outlet port to decrease the amount of air expelled from the chamber.

[0019] In another further embodiment, if the pressure monitored by the pressure sensor rises above a threshold value, the controller may be configured to instruct the pump, blower, or motorized fan of the inlet port to decrease the amount of air drawn into the chamber and/or to instruct the pump, blower, or motorized fan of the outlet port to increase the amount of air expelled from the chamber.

[0020] In another further embodiment, the filters of the inlet and outlet ports may be HEPA filters.

[0021] In another further embodiment, the chamber may be portable.

[0022] In another further embodiment, the robotic workstation may be configured to operate while the chamber is located outside of a fume or flow hood.

[0023] Another embodiment of the invention addresses a method of processing a sample in a chamber that includes at least one inlet port and at least one outlet port. This method includes, among other possible steps: (a) drawing, via the inlet port, air into the chamber; (b) filtering substantially all of the air drawn into the chamber; (c) directing the air that was drawn into the chamber across a robotic workstation integrally provided in the chamber, (d) processing at least one sample provided on the robotic workstation; (e) re-filtering substantially all of the air that passed the robotic workstation; and (f) expelling, via the outlet port, the air that passed the robotic workstation and was subsequently re-filtered.

[0024] In a further embodiment of this method, the method may also include the step of monitoring the pressure of the air that passes the analysis region.

[0025] In another further embodiment of this method, the method may also include the step of increasing the pressure in the chamber if the pressure of the air in the analysis region of the chamber falls below a threshold value.

[0026] In another further embodiment of this method, the method may also include the step of decreasing the pressure in the chamber if the pressure of the air in the analysis region of the chamber rises above a threshold value.

[0027] In another further embodiment of this method, the filtering and re-filtering steps may be performed using HEPA filters.

[0028] In another further embodiment of this method, the step of processing at least one sample provided on the robotic workstation may include analyzing the at least one sample automatically using the robotic workstation.

[0029] These and other features, aspects, and advantages of the present invention will become more apparent from the following description, appended claims, and accompanying exemplary embodiments shown in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the description, serve to explain the principles of the invention.

[0031] Figure 1 is a perspective view of an embodiment of an air-controlled chamber according to the present invention;

[0032] Figure 2 is a cross-sectional view of the air-controlled chamber of Figure 1 taken along line II-II of Figure 1 and shows an air-stream flowing through the air-controlled chamber; and

[0033] Figure 3 is a schematic drawing showing the connectivity between a controller and the air-controlled chamber.

DETAILED DESCRIPTION

[0034] Reference will now be made in detail to presently preferred embodiments of the invention, which are illustrated in the drawings. An effort has been made to use the same reference numbers throughout the drawings to refer to the same or like parts.

[0035] Figure 1 is a perspective view of one embodiment of the air–controlled chamber provided by the present invention. It should be understood that Figure 1 is exemplary only. One skilled in the art would recognize various modifications and alternatives, all of which are considered a part of the present invention. In Figure 1, the air-controlled chamber 100 has one inlet port 110 and one outlet port 112. Of course, one skilled in the art would recognize that two or more inlet ports 110 and/or two or more outlet ports 112 could be also be used with the air-controlled chamber 100 in certain embodiments of the present invention.

[0036] The air controlled chamber 100 includes a chamber body 102 that defines and encloses a work area 103 (or analysis region) in which a robotic workstation (shown in Figure 2 as element 140) may be installed. The work area 103 may include a platform 116 that serves as an analysis region of the air-controlled chamber 100. Alternatively, or in addition thereto, a robotic workstation may be integrally built into the work area 103 of the air-controlled chamber 100. It should be understood that the work area 103 may be dimensioned based on the robotic workstation that is housed in the work area 103.

Alternatively, the platform 116 may be designed to be of sufficient size so that it can accommodate most of the analysis that is anticipated to be performed in the air-controlled chamber 100. Accordingly, as would be recognized by those skilled in the art, the air-controlled chamber 100 could be designed in various sizes and shapes to accommodate the various analyses that is anticipated to be performed in the air-controlled chamber 100.

[0037] In certain embodiments, in which the robotic workstations are built into the work area 103 of the air-controlled chamber, the size of the air-controlled chamber would be designed to optimally enclose the robotic workstation and to perform the analyses on the robotic workstation. Alternatively, in certain embodiments, the air-controlled chamber 100 may be designed so that different robotic workstations can be attached in the work area 103. Particular robotic workstations may be temporarily attached in the work area 103 so that a semi-permanent attachment is formed and the air-controlled chamber and the robotic workstation may be used transported and used together. However, the particular robotic workstation components may then be removed and components of another robotic workstation may then be attached so that the air-controlled chamber 100 has the flexibility to create one or more integral robotic workstations.

[0038] In certain embodiments, the work area 103 includes connections for power and/or fluids which can be used by the robotic workstations that are attached inside the work area 103. In this manner, external power and/or control signals or reagents (in fluid repositories such as bags or other containers) can be easily provided inside the air-controlled chamber 100 where they can be used by the robotic workstation in the work area 103 of the air-controlled chamber 100. This is achieved by providing appropriate tubing and cables that access the work area 103 so that the robotic workstation components can be connected to the appropriate cables and tubing as dictated by the particulars of the robotic workstation components and the particular sample handling and assay operations to be performed by the robotic workstation.

[0039] Access to the work area 103 may be provided by an access door 104 which is connected to the chamber body 102 by hinges 106 and is latched by a latch 108. One skilled in the art would recognize that access to the work area 103 could also be provided by various other closures including a sliding panel or windows that can be separately opened. In certain embodiments, the access door 104 may include a software controlled lock so that the access door may be automatically locked whenever the air-controlled chamber 100 is in operation.

A controller 130, such as that disclosed in Figure 3, may be connected to the latch 108 to automatically lock the access door whenever the air-controlled chamber is in operation.

[0040] The inlet port 110 is shown on a top surface 114 of the air-controlled chamber 100. However, one skilled in the art would recognize that the inlet to the air-controlled chamber 100 could also be provided on the side or on the bottom surface of the air-controlled chamber 100. Likewise, while the outlet port 112 is shown on the top surface 114 of the air-controlled chamber 100, it could be positioned elsewhere on the air-controlled chamber 102 based on the position of the inlet port 110 and the direction of the laminar airflow desired. Furthermore, it should be recognized that substantially all the air drawn into the air-controlled chamber flows through the inlet port 110; of course, very minor (and non-impacting) quantities of air could conceivably enter through leakage or cracks or other defects in the structure of the air-controlled chamber 100. Arranged next to the inlet port 110 is a baffle 120 that circulates the air received through the inlet port 110 in an optimal flow pattern through the work area 103. Accordingly, the baffle 120 is designed based on the desired airflow through the work area 103. Suitable design of baffle 120 is required to ensure that the desired airflow within the work area is achieved.

[0041] Some of the baffle designs that may be used include a construction that directs the air from at least one inlet port 110 downward to one wall of the chamber 100. Upon reaching the bottom of the chamber 100, the airflow may be deflected along the work area 103 to the opposite wall where it may exit out of the chamber 100 via at least one outlet port 112.

[0042] Another application of baffle design would be a construction that directs the air from at least one inlet port 110 downward along one wall of the chamber 100. Upon reaching the bottom of the chamber 100, the airflow may be deflected along the work area 103 to the opposite wall where a second baffle (not shown) may direct the air along the far wall where the air may exit out of the chamber 100 via at least one outlet port 112.

[0043] In another embodiment, one or more baffles may have raised ridges that are parallel to the direction of airflow. The intent of this design is to reduce turbulence as the air that passes along the work area 103. In a further embodiment, ridges (not shown) may be provided in (or on) the walls (e.g., the wall where the air makes initial contact after entering the inlet port 110 and passing a first baffle) of the chamber 100; the ridges may extend parallel to the direction of airflow to reduce turbulence in the air stream as it moves along the work area 103.

[0044] As shown in Figure 2 (which is a sectional view along II-II in Figure 1), the baffle 120 directs the intake air (from the inlet port 110) to form a laminar air-stream through the working surfaces of the robotic workstation 140. After the interactions at the robotic workstation 140, the airflow is guided to the outlet port 112 through which it is expelled from the air-controlled chamber 100. The inlet port 110 includes an inlet air filter 111 which is selected based on the toxins, pathogens, and/or microorganisms that are to be eliminated. In certain embodiments, the inlet air filter 111 may be a HEPA filter that prevents most toxins, pathogens, and/or microorganisms from entering the work area 103 of the air-controlled chamber 100.

[0045] Furthermore, in certain embodiments, a pre-filter (not shown) may be provided before the inlet air filter 111 so that the larger particulates may be screened out by such a pre-filter before the inlet air is filtered by the inlet air filter 111. In this manner, a more sensitive or expensive inlet air filter 111, such as a HEPA filter, may be used for a longer time with the typically coarser or less expensive pre-filter being changed more frequently. In certain embodiments, the air-controlled chamber would need to be run for five to ten minutes to ensure that the particle count inside the work area 103 of the air-controlled chamber is sufficiently reduced so that sample handling and assay operations can be performed in the air-controlled chamber.

[0046] The inlet air filter 111 is selected based on the type of the particulates that need to be screened. For example, HEPA filters typically removes particles of 0.3 microns, which essentially includes all bacteria, spores, yeasts, molds, viruses, nucleic acids, and other similar items, with an efficiency of 99.97%. Further, some HEPA filters can also remove particles with good efficiency down to 0.01 microns. Specifically, some HEPA filters remove particles that are 0.3 microns at a 99.97% efficiency and remove particles that are larger or smaller than 0.3 microns at a higher efficiency (i.e., particles of 0.3 microns are the most difficult size to remove).

[0047] Likewise, an outlet air filter may be provided in the outlet port 112 so that the air that is expelled from the air-controlled chamber 100 does not contaminate the environment around the air-controlled chamber 100. As previously discussed, the type of air filter used in the outlet port 112 would also depend upon the particulates that need to be screened from being expelled with the air being expelled from air-controlled chamber 100.

[0048] In certain embodiments, the air controlled chamber 100 includes one or more pressure sensors 118 in the work area 103. As shown in the schematic diagram of Figure 3, the output from two pressure sensors 118A and 118B are connected to the controller 130. The controller 130 in turn is connected to a blower 122A in the inlet port 110 and a blower 122B in the outlet port 112 and can provide control signals that control the operation of these blowers 122A and 122B.

[0049] It should be noted that these blowers 122A and 122B are integrated into the inlet and outlet ports 110 and 112, respectively, and could be generically implemented using air pumps and/or motorized fans or other similar devices as would be well known to those skilled in the art. It should also be noted that there need be only one blower or fan in certain embodiments, although using a blower at both the inlet port and the outlet port provides for better control of the airflow within the work area 103 of the air-controlled chamber 100.

[0050] The controller 130 may be configured to maintain a desired absolute or relative pressure inside the work area 103. Controlling the pressure inside the work area 103 may be important for various reasons including preventing the return or backflow of any toxins (e.g., nucleic acids or other contaminants), pathogens, and/or microorganisms from the outlet port 112 back into the work area 103. Specifically, the controller 130 may use feedback or feed-forward control algorithms to control either or both of the blowers 122A and 122B to maintain the pressure inside the work area at a desired level as would be known to those skilled in the art.

[0051] For example, if the pressure inside the work area 103 is higher than desired, the controller 130 may increase the speed of the blower 122B in the outlet port 112 and if the pressure inside the work area 103 is lower than desired then the controller may lower the speed of the blower 122B. Alternatively, or in addition, the blower 122A in the inlet port may also be controlled to manage the pressure inside the air-controlled chamber 100. For example, the speed of the blower 122A may be increased to increase the pressure inside the air-controlled chamber 100 while the speed of the blower 122A may be decreased to decrease the pressure inside the air-controlled chamber.

[0052] In certain embodiments, the controller 130 may be built into the air-controlled chamber with a user interface that allows a user to configure various parameters associated with the operation of the air-controlled chamber 100. For example, the desired pressure or temperature or even the type of sample handling or assay steps may be specified by a user by

using the user interface. In certain embodiments, the built-in controller 130 may be replaced by a standard personal computer ("PC") that is connected to the air-controlled chamber 100 using communication protocols that are well known to those skilled in the art (for example, by using a serial or parallel or parallel connection to the PC). Moreover, the PC may have custom software that is loaded for purposes of managing and/or controlling the operation of the air-controlled chamber 100.

[0053] As previously discussed, a variety of robotic workstations could be permanently or semi-permanently attached to the air-controlled chamber 100 in the work area 103 to form a closed environment robotic workstation 140 integrated with an air-controlled chamber 100. Typical sample preparation robotic workstations that apply reagents to a sample in an automated fashion are well known to those skilled in the art.

[0054] For example, the robotic workstation could include a robotic pipettor, analyte detector, and/or other sensitive equipment and/or assay chemistry that needs to be protected from the external environment. In addition, the robotic workstation may be designed to automatically perform an assay on the sample that is prepared in earlier stages of the robotic workstation. All of these sample preparation and assay stages of the robotic workstation may be integrated into the air-controlled chamber in certain embodiments of the present invention.

[0055] Furthermore, as previously discussed, the present invention also contemplates that robotic workstations could be semi-permanently attached within the work area of the air-controlled chamber so that a particular sequence of sample preparation and assay steps could be performed repetitively in the air-controlled chamber 100. However, the air-controlled chamber may be subsequently reconfigured by: (a) removing the existing robotic workstation components; and (b) attaching robotic workstation components for a different sample handling and/or assay operations to the air-control chamber 100 to create another integrated robotic workstation within the air-controlled chamber 100.

[0056] This closed environment robotic workstation integrated within the air-controlled chamber 100 has many advantages. It makes the integrated robotic workstation portable so that it can be easily transported for use. Moreover, the as the robotic workstation may be integrated into the chamber, the device may be used outside of a fume or flow hood. Further, the portable robotic workstation may be easily used in a wide variety of locations, as the environment outside the air-controlled chamber (including the integral robotic workstation) may protected from any contamination produced by the analyses performed by the integrated

robotic workstation. In other words, it may be possible for the closed environment robotic workstation to be used outside of a typical laboratory environment, as it does not substantially contaminate the surrounding area.

[0057] Types of Samples and Assays suitable for the Integrated Robotic Workstation with Air-Controlled Chamber

[0058] Any sample can be handled, manipulated, or analyzed in an automated fashion in an air-controlled chamber of the present invention. For instance, a sample may be a biological sample, a chemical sample, or a mineral, *e.g.*, an *in silico* sample.

[0059] A sample for analysis in the air-controlled chamber of the present invention also may be a solid or liquid food or a solid or liquid edible food substance (hereinafter collective a "food sample"). A food sample is usually of plant or animal origin, which contains or consists of essential body nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals, and which is ingested and assimilated by an organism to produce energy, stimulate growth, and maintain life. Accordingly, a food sample may be, or may include, meat, fish, seafood, game, or poultry or a piece, section, or cutting of a carcass from such foods. A food sample may be, or may include, a plant-based food substance, such as a vegetable, fruit, or grain. A food sample or substance thereof may be for human or animal consumption.

[0060] It may be desirable to analyze such a food sample in the present inventive chamber to determine the presence of a food pathogen. Four major bacterial pathogens of food, for instance, are *Salmonella*, *Campylobacter*, *E. coli* O157:H7, and *Listeria monocytogenes*. A food sample may also be tested for a toxin. A toxin usually refers to naturally produced substances that kill rapidly in small quantities, such as the bacterial proteins that cause tetanus and botulism. Ingestable toxins are also often referred to as poisons, especially when intentionally administered by a human. Examples of toxins include, but are not limited to Shiga-like toxin, endotoxin, and botulinum. Some common diseases are occasionally foodborne mainly through water, even though they are usually transmitted by other routes. These include infections caused by *Shigella*, Hepatitis A, and the parasites *Giardia lamblia* and *Cryptosporidium parvum*.

[0061] A food sample also can be tested for pesticides or medicines that may have been added to food, or for evidence of contact between the food sample and pests, especially flies, rodents and cockroaches. Similarly, meat and poultry samples in particular may also be

tested for the presence of prions that may cause variant Creutzfeldt-Jakob Disease or bovine spongiform encephalopathy.

[0062] All of such foodborne organisms, microorganisms, toxins, viruses, and chemicals exemplified herein may be targeted for detection in a solid or liquid food sample in the present air-controlled robotic workstation.

[0063] A sample of the present invention also may be a pharmaceutical. A pharmaceutical is a drug or medicine that is prepared or dispensed and used in medical treatment. A drug product, nasal solution, or inhalation product, for example, may be tested in the present chamber for contamination, such as by microorganism, chemical, or toxin, for instance. The United States Pharmacopeia recommends that certain categories of pharmaceuticals be routinely tested for total counts and specified indicator microbial contaminants. For example natural plant, animal and some mineral products can be tested for *Enterobacter cloacae*, *Salmonella*, oral liquids for *E. Coli*, topicals for *P. aeruginosa* and *S. Aureus*, and articles intended for rectal, urethral, or vaginal administration for yeasts and molds. For instance, Povidone Iodine products can be tested for *Pseudomonas cepacia* contamination (it is widely recognized that *Pseudomonas cepacia* is objectionable if found in a topical product or nasal solution in high numbers). Similarly, Metaproterenol Sulfate Inhalation Solution may be tested for *Pseudomonas gladioli/cepacia* contamination. Cosmetics also can be tested in the present chamber for microbial and chemical contamination.

[0064] A biological sample may be, for example, a sample from an individual. An individual may be a mammal, bird, reptile, fish, or plant. A biological sample from such an individual may be in the form of, but is not limited to, a fluid, liquid, tissue, or muscle extracted, obtained from, isolated from, or purified from the individual. In the case of a plant, a biological sample may be an explant, stem, root, leaf, petal, germ cell, or other cell.

[0065] In this regard, a biological sample also may be, for example, a culture or extraction of cells from an individual or plant or explant. A biological fluid or liquid from an individual, such as a human, may be, but not limited to, blood, lymphatic fluid, platelets, urine, sputum, mucus, amniotic fluid, or male or female reproductive fluids. A biological fluid or liquid may be a preparation of cells or a preparation of cell extracts.

[0066] A preparation of cells may be, for example, a preparation of any cell type from any tissue. For instance, a biological sample may contain, but is not limited to, cells obtained from any body organ, such as from, but not limited to, a brain, lungs, heart, liver, spleen,

kidney, stomach, gall bladder, pancreas, large intestine, small intestine, genitalia, appendix, bladder, or skin. Alternatively, a biological sample may itself be a tissue biopsy or section from any body organ, such as from, but not limited to, a brain, lung, gill, heart, liver, spleen, kidney, stomach, gall bladder, pancreas, large intestine, small intestine, genitalia, appendix, bladder, or skin. The body organ may be from a mammal, bird, reptile, or fish.

[0067] In the case of a plant, a plant tissue may be, for example, from a monocotyledenous plant, selected from the group consisting of turfgrass, wheat, maize, rice, oat, barley, orchid, iris, lily, onion, and sorghum. In another embodiment, the turfgrass may be selected from the group consisting of *Agrostis spp.* (bentgrass species including colonial bentgrass and creeping bentgrasses), *Poa pratensis* (kentucky bluegrass), *Lolium spp.* (ryegrass species including annual ryegrass and perennial ryegrass), *Festuca arundinacea* (tall fescue) *Festuca rubra commutata* (fine fescue), *Cynodon dactylon* (common bermudagrass), *Pennisetum clandestinum* (kikuyugrass), *Stenotaphrum secundatum* (st. augustinegrass), *Zoysia japonica* (zoysiagrass), and *Dichondra micrantha.*

[0068] The plant also may be a dicotyledenous plant, selected from the group consisting of cotton, tobacco, Arabidopsis, tomato, potato, sugar beet, broccoli, cassava, sweet potato, pepper, poinsettia, legumes, alfalfa, soybean, carrot, strawberry, lettuce, oak, maple, walnut, rose, mint, squash, daisy, geranium, and cactus.

[0069] A preparation of cells from a mammal, bird, reptile, fish, or plant may constitute a culture of a particular cell type. A cell type is a distinct morphological or functional form of cell. In mammals, a cell may be cell type from, but not limited to, a blastomere, an egg, a fibroblast, an oocytes, an osteoblast, an osteoclast, a sperm, or a zygote.

[0070] A preparation of cells may be obtained from, isolated from, or purified from a human. Such a cellular preparation may comprise blood and immune system cells, keratinizing epithelial cells, wet stratified barrier epithelial cells, exocrine secretory epithelial cells, hormone secreting cells, epithelial absorptive cells (such as from the gut, exocrine glands, or urogenital tract), metabolism and storage cells, barrier function cells (such as from the lung, gut, exocrine glands and urogenital tract), epithelial cells lining closed internal body cavities, ciliated cells with propulsive function, extracellular matrix secretion cells, contractile cells, sensory transducer cells, autonomic neuron cells, sense organ and peripheral neuron supporting cells, central nervous system neurons and glial cells, lens cells, pigment cells, germ cells, or nurse cells. A preparation may comprise an extract of any such cells.

[0071] A biological sample that may be handled, manipulated, or analyzed in an automated fashion in an air-controlled chamber of the present invention includes genetic material among others. Genetic material includes deoxyribonucleic acid ("DNA") and ribonucleic acid ("RNA"). The DNA may be, but is not limited to, nuclear DNA, genomic DNA, cDNA, heteronuclear DNA, cytoplasmic DNA, mitochondrial DNA, double-stranded DNA, or single-strand DNA. RNA may be, but is not limited to, messenger RNA ("mRNA"), transfer RNA ("tRNA"), ribosomal RNA ("rRNA"), or small nuclear RNA ("snRNA"). The RNA may be single- or double-stranded.

[0072] A biological sample may be, but is not limited to, a protein, polypeptide, or peptide, or a peptide-DNA hybrid molecule.

[0073] The automated machine (or robotic workstation) may be used to detect the presence of a microorganism (pathogenic or non-pathogenic) in a sample, such as in any biological sample described herein, *e.g.*, in blood or platelets. A pathogen (which may also be referred to as an "infectious agent" or a "contaminating organism") is a biological agent that can cause disease to its host or contaminate a solution or reagent or surface that is intended to be free of microorganisms. A pathogen is typically an agent that disrupts the normal physiology of a multicellular animal or plant. However, pathogens can infect unicellular organisms from all of the biological kingdoms. Examples of pathogens includes bacteria, viruses, subviral pathogens, protozoa, yeasts, mold, fungi, and parasites. Examples of bacteria (and the diseases they can cause), include, but are not limited to *Escherichia coli* (food poisoning), *Mycobacterium tuberculosis* (tuberculosis), Neisseria gonorrhoeae (gonorrhea), *Neisseria meningitidis* (meningitis), *Haemophilus influenzae* (meningitis), *Corynebacterium diphtheriae* (diphtheria), *Rickettsiae* (typhus, Rocky Mountain spotted fever), *Salmonella* (food poisoning), *Staphylococcus aureus* (Toxic Shock Syndrome), *Streptococcus pneumoniae* (pneumonia), *Streptococcus* (strep throat), *Streptococcus pyogenes* (strep throat), *Treponema pallidum* (syphillis), and *Yersinia pestis* (plague).

[0074] Examples of viruses (and the diseases or disorders they can cause), include, but are not limited to, variola (smallpox), poliovirus (poliomyelitis), varicella (chicken pox), cytomegalovirus (blindness), hantaviruses (including the Sin Nombre virus, which causes HPS), hepatitis A, B, C, D and E (Liver disease/failure), herpes simplex virus (contagious herpes rash), Human Immunodeficiency Virus/HIV (AIDS), Molluscum contagiosum (rash-like skin growths), papillomavirus (warts), coronavirus (one variety causes Severe Acute

Respiratory Syndrome), TMV (Tobacco Mosaic Virus), hypovirus CHV1 (fungi virus), lambda phage (bacteria virus), and Thermoproteus tenax virus (TTV1) (*Archea* virus).

[0075] Examples of subviral pathogens includes, but is not limited to, prions and viroids.

[0076] Examples of protozoa includes but is not limited to opportunistic pneumonia, such as *Pneumocystis carinii* and *Pneumocystis jerovici*.

[0077] Examples of yeast and fungal pathogens that attack mammals including humans include, but are not limited to, *Candida albicans* (thrush), *Cryptococcus neoformans* (pneumonia), *Cryptococcus neoformans* (pneumonia), *Aspergillis niger* (pneumonia) and *Histoplasma capsulatum* (pneumonia).

[0078] Fungal pathogens that attack plants include, but are not limited to, *Cryphonectria parasitica* (Chestnut blight), *Claviceps purpurea* (Ergot), *Monilinia fructicola* (Brown rot), *Phymatotrichopsis omnivora* (Texas Root Rot), *Cordyceps* (Vegetable Caterpillar), and *Erysiphe graminis* (Powdery mildew).

[0079] Fusarium fungi are known to infect humans and animals and include species such as *Fusarium arthrosporoides*, *Fusarium avenaceum*, *Fusarium culmorum*, and *Fusarium equiseti*. Similarly, mycoses are particularly severe in the case of immunodeficient patients, such as those suffering from AIDS.

[0080] Examples of parasites include, but are not limited to, *Giardia lamblia*, roundworms, scabies, and tapeworms.

[0081] The automated machine (or robotic workstation) that is housed in the air-controlled chamber may be used to detect any one of such pathogens. It can be used to detect common bacterial pathogens, such as *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus faecalis*, *Staphylococcus saprophyticus*, *Streptococcus pyogenes*, *Haemophilus influenzae* and *Moraxella catarrhalis*. The apparatus may also detect commonly encountered and clinically relevant bacterial antibiotic resistance genes directly from clinical specimens or, alternatively, from a bacterial colony.

[0082] A pathogen may be detected using, for example, antibodies, enzymatic assays, colorimetric assays, or DNA or RNA based detection methods. In the case of the latter, a biological sample may be tested to determine whether it contains any bacterial nucleic acids. For instance, the biological sample may be exposed to a labeled or detectable probe or primer

that are hybridizable to a target of a bacterial-specific DNA or RNA sequence. Such a method can be employed using Northern blot analysis or PCR, for instance.

[0083] In this regard, an assay such as the Procleix® assay and systems use nucleic acid testing technology to detect viral RNA and DNA in donated blood and plasma during the very early stages of infection, when those infectious agents are present but cannot be detected by immunodiagnostic tests. For instance, this assay can be used to detect human immunodeficiency virus and hepatitis B and C, and West Nile virus.

[0084] As previously discussed, HEPA filters can be used to prevent entry of contaminant pathogens into a biological sample housed in the present air-controlled chamber and/or to prevent escape of a disease pathogen from a biological sample into the environment outside of the chamber.

[0085] Although the aforementioned describes embodiments of the invention, the invention is not so restricted. It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed preferred embodiments of the present invention without departing from the scope or spirit of the invention. Accordingly, it should be understood that the apparatus and method described herein are illustrative only and are not limiting upon the scope of the invention, which is indicated by the following claims.

What is claimed is:

1. An air-controlled chamber comprising:

an inlet port (110) comprising one or more inlets, wherein the inlet port (110) is provided with a first air filter (111), and wherein the first filter (111) is configured to filter air drawn into the chamber (100) via the inlet port (110); and

an outlet port (112) comprising one or more outlets, wherein the outlet port (112) is provided with a second air filter (111), and wherein the second filter (111) is configured to filter air expelled from the chamber (100) via the outlet port (112);

an integrated robotic workstation (140) that is provided in an analysis region (103) in the chamber (100),

wherein the integrated robotic workstation (140) is configured to automatically process samples,

wherein substantially all of the air drawn into the chamber (100) passes through the inlet port (110), and

wherein substantially all of the air expelled from the chamber (100) passes through the outlet port (112).

2. The air-controlled chamber according to claim 1, further comprising:

one or more pressure sensors (118) positioned proximate the analysis region (103),

wherein the one or more pressure sensors (118) are configured to monitor the pressure of an air-stream through the chamber (100).

3. The air-controlled chamber according to claim 2, wherein each of the inlet and outlet ports (110, 112) is provided with one of an air pump, a blower, or a motorized fan (122A, 122B).

4. The air-controlled chamber according to claim 3, further comprising:

a controller (130) electrically connected to the one or more pressure sensors (118) and to the air pumps, blowers, or motorized fans (122A, 122B) of the inlet and outlet ports (110, 112).

5. The air-controlled chamber according to claim 4, wherein if the pressure monitored by the one or more pressure sensors (118) falls below a threshold value, the controller (130) is configured to instruct the air pump, blower, or motorized fan (122A) of the inlet port (110) to increase the amount of air drawn into the chamber (100) and/or to instruct the air pump, blower, or motorized fan (122B) of the outlet port (112) to decrease the amount of air expelled from the chamber (100).

6. The air-controlled chamber according to claim 4, wherein if the pressure monitored by the one or more pressure sensors (118) rises above a threshold value, the controller (130) is configured to instruct the air pump, blower, or motorized fan (122A) of the inlet port (110) to decrease the amount of air drawn into the chamber (100) and/or to instruct the air pump, blower, or motorized fan (122B) of the outlet port (112) to increase the amount of air expelled from the chamber (100).

7. The air-controlled chamber according to claim 1, wherein the filters (111) of the inlet and outlet ports (110, 112) are HEPA filters.

8. The air-controlled chamber according to claim 1, wherein the chamber (100) is portable.

9. The air-controlled chamber according to claim 1, wherein the chamber (100) further comprises one or more baffles (120) arranged along an air-stream from the inlet port (110) to the outlet port (112).

10. The air-controlled chamber according to claim 1, wherein the robotic workstation (140) is configured to operate while the chamber (100) is located outside of a fume or flow hood.

11. An air-controlled chamber comprising:

an inlet port (110) comprising one or more inlets, wherein the inlet port (110) is provided with a first air filter (111), and wherein the first filter (111) is configured to filter air drawn into the chamber (100) via the inlet port (110);

an outlet port (112) comprising one or more outlets, wherein the outlet port (112) is provided with a second air filter (111), and wherein the second filter (111) is configured to filter air expelled from the chamber (100) via the outlet port (112);

one or more baffles (120) arranged proximate to the inlet port (110) to direct air along an air-stream from the inlet port (110) to the outlet port (112);

one or more pressure sensors (118) positioned proximate an analysis region (103) of the chamber (100); and

an integrated robotic workstation (140) that is provided in the analysis region (103) in the chamber (100),

wherein the integrated robotic workstation (140) is configured to automatically process samples,

wherein air flows through the chamber (100) from the inlet port (110) to the outlet port (112) along the air-stream,

wherein the one or more pressure sensors (118) are configured to monitor the pressure of the air-stream,

wherein substantially all of the air drawn into the chamber (100) passes through the inlet port (110), and

wherein substantially all of the air expelled from the chamber (100) passes through the outlet port (112).

12. The air-controlled chamber according to claim 11, wherein each of the inlet and outlet ports (110, 112) is provided with one of an air pump, a blower, or a motorized fan (122A, 122B).

13. The air-controlled chamber according to claim 12, further comprising:

a controller (130) electrically connected to the one or more pressure sensors (118) and to the air pumps, blowers, or a motorized fans (122A, 122B) of the inlet and outlet ports (110, 112).

14. The air-controlled chamber according to claim 13, wherein if the pressure monitored by the one or more pressure sensors (118) falls below a threshold value, the controller (130) is configured to instruct the air pump, blower, or a motorized fan (122A) of the inlet port (110) to increase the amount of air drawn into the chamber (100) and/or to instruct the air pump, blower, or a motorized fan (122B) of the outlet port (112) to decrease the amount of air expelled from the chamber (100).

15. The air-controlled chamber according to claim 13, wherein if the pressure monitored by the one or more pressure sensors (118) rises above a threshold value, the controller (130) is configured to instruct the air pump, blower, or a motorized fan (122A) of the inlet port (110) to decrease the amount of air drawn into the chamber (100) and/or to instruct the air pump, blower, or a motorized fan (122B) of the outlet port (112) to increase the amount of air expelled from the chamber (100).

16. The air-controlled chamber according to claim 11, wherein the filters (111) of the inlet and outlet ports (110, 112) are HEPA filters.

17. The air-controlled chamber according to claim 11, wherein the chamber (100) is portable.

18. The air-controlled chamber according to claim 11, wherein the robotic workstation (140) is configured to operate while the chamber (100) is located outside of a fume or flow hood.

19. A method of processing a sample in a chamber comprising at least one inlet port and at least one outlet port, the method comprising the steps of:

drawing, via the inlet port, air into the chamber;

filtering substantially all of the air drawn into the chamber;

directing the air that was drawn into the chamber across a robotic workstation integrally provided in the chamber,

processing at least one sample provided on the robotic workstation;

re-filtering substantially all of the air that passed the robotic workstation; and

expelling, via the outlet port, the air that passed the robotic workstation and was subsequently re-filtered.

20. The method according to claim 19, further comprising the step of:

monitoring the pressure of the air the passes the robotic workstation.

21. The method according to claim 20, further comprising the step of:

increasing the pressure in the chamber if the pressure of the air that passes the robotic workstation falls below a threshold value.

22. The method according to claim 20, further comprising the step of:

decreasing the pressure in the chamber if the pressure of the air that passes the robotic workstation rises above a threshold value.

23. The method according to claim 19, wherein the filtering and re-filtering steps are performed using HEPA filters.

24. The method according to claim 19, wherein the step of processing at least one sample provided on the robotic workstation comprises:

analyzing the at least one sample automatically using the robotic workstation.

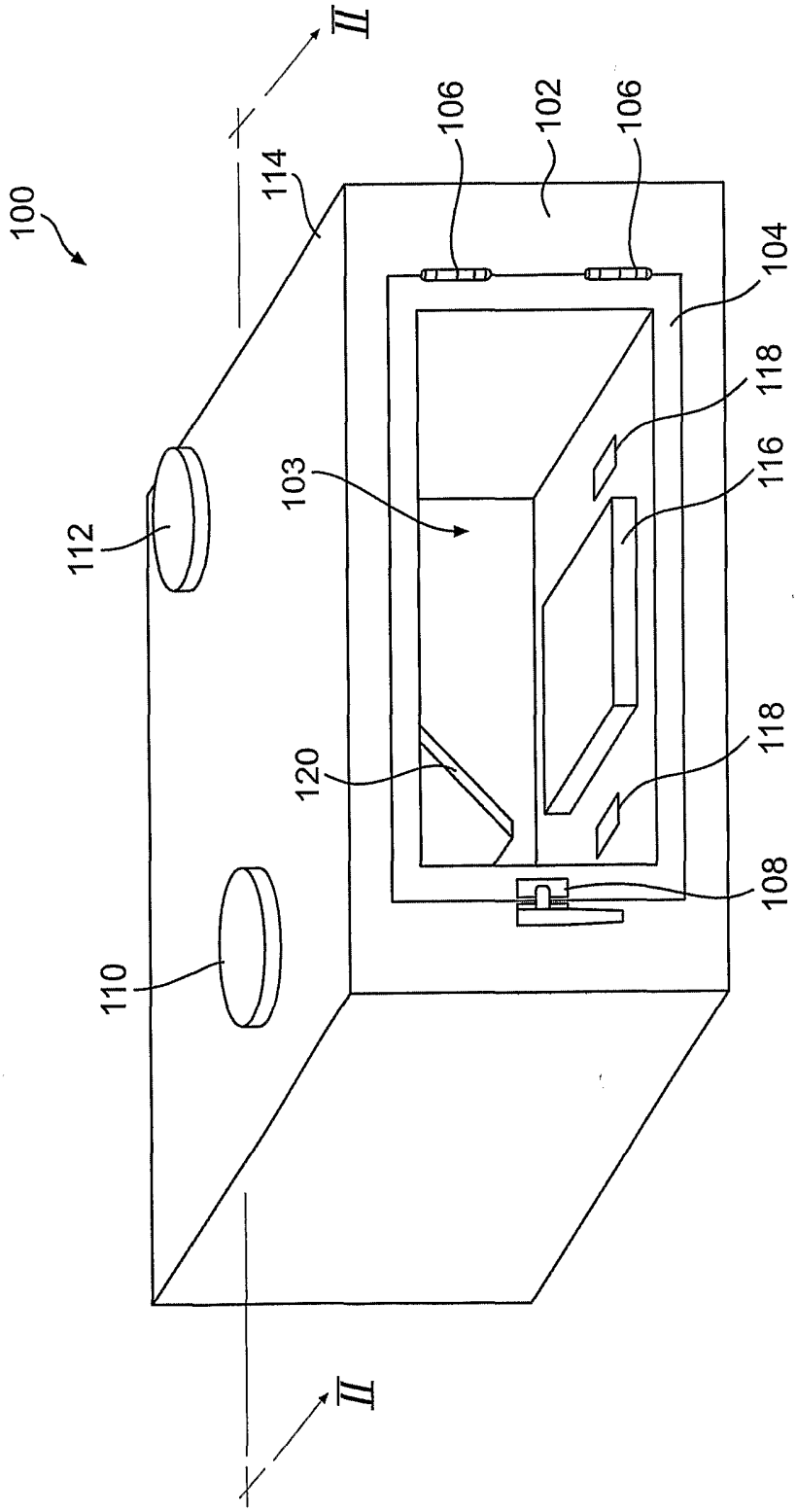

FIG. 1

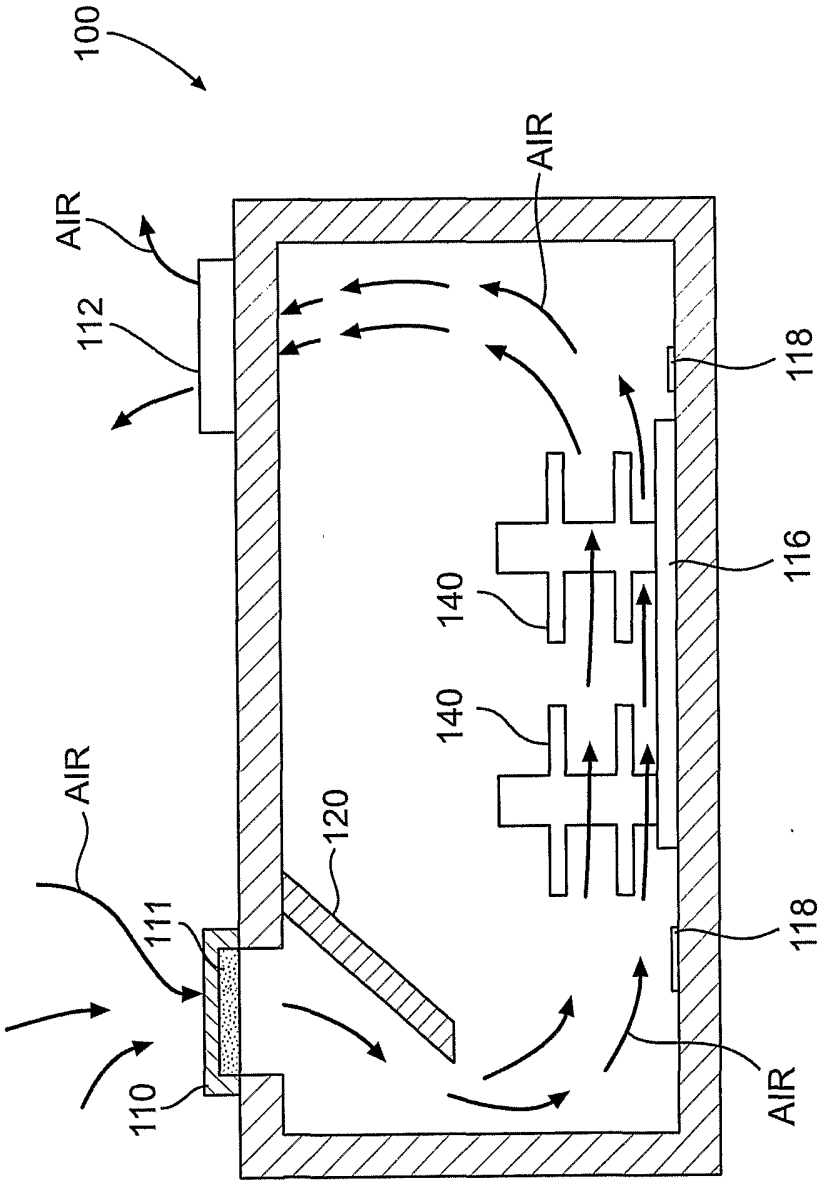

FIG. 2

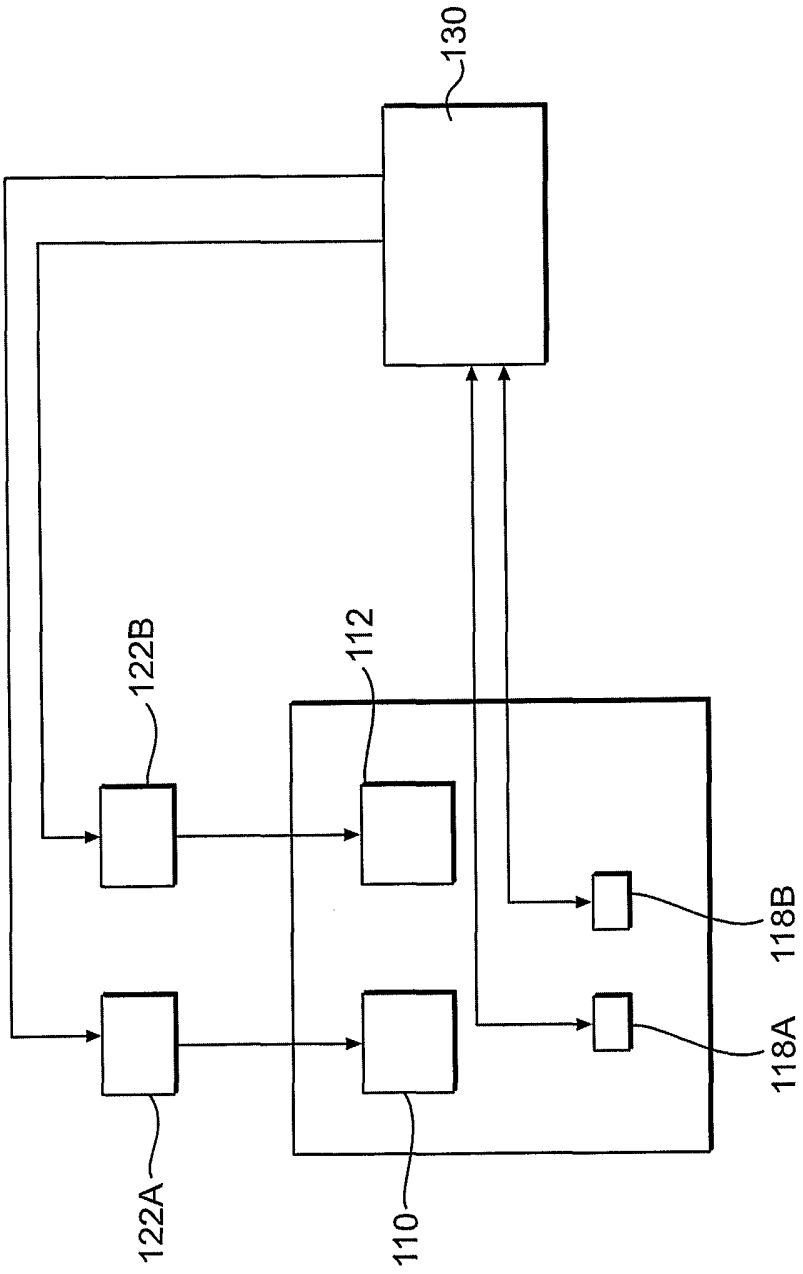

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/36020

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : **B01D 46/10; F24F 13/00**
US CL : 55/385.2, 454/187, 230, 233
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 55/385.2, 454/187, 230, 233

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,530,272 A (STOKES) 23 July 1985 (23.07.1985), Abstract, 10, 11, 13A, 13B, 15A, 15B, 24 & 25 in Fig. 1, col. 2, lines 13-66.	1-24
Y	US 4,726,824 A (STATEN) 23 February 1988 (23.02.1988) 16, 21, 31 & 32 in Fig. 1, col. 2, lines 42-66, col. 3, lines 9-22.	1-24
Y	US 5,290,330 A (TEPPER et al) 01 March 1994 (01.03.1994), col. 4, lines 25-36.	1-24

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 January 2005 (28.01.2005)	15 FEB 2005
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Minh-Chau T. Pham Telephone No. (703) 308-0661

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