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(54) **Title**: METHOD FOR PROTECTING AND UNPROTECTING THE FLUID PATH IN A CONTROLLED ENVIRONMENT ENCLOSURE

(57) **Abstract**: A controlled environment enclosure comprises a robotic arm manipulation system used to protect and unprotect a fluid path within the controlled environment enclosure. The apparatus allows the fluid path to be protected against dangerous decontamination vapors and chemicals before the controlled environment enclosure is decontaminated, the method not requiring the use of gloves or other means that degrade the integrity of the controlled environment enclosure. The apparatus similarly allows the fluid path to be unprotected for use without the use of gloves, the method not requiring the use of gloves or other means that degrade the integrity of the controlled environment enclosure when decontamination is completed. The apparatus and method allow for the protecting, unprotecting and decontaminating sequences to be automated.

METHOD FOR PROTECTING AND UNPROTECTING THE FLUID PATH IN A CONTROLLED ENVIRONMENT ENCLOSURE

TECHNICAL FIELD

This document relates generally to controlled environment enclosures and in particularly to a method for protecting and unprotecting the fluid path in a controlled environment enclosure.

BACKGROUND

Controlled environment enclosures are known in the art. Such enclosures are used, for example, for containment of hazardous materials. In other examples controlled environment enclosures are used to provide controlled environments with limited numbers of particulates.

In the art controlled environment enclosures are typically fitted with ports for transfer of materials in and out of the enclosure and the ports are fitted with gloves for manual manipulation of equipment, parts or materials inside the enclosure. Such gloves are subject to significant risk of puncture.

In some examples known in the art the controlled environment enclosure is also used to limit exposure to viable particulates. Such controlled environment enclosures may be required for aseptic processing of cell cultures and for the manufacture of pharmaceutical products, medical devices, food or food ingredients. In these cases it is a requirement that the controlled environment enclosure be decontaminated. This may be done thermally using steam or chemically using chemical agents. Suitable chemical agents known in the art include hydrogen peroxide, ozone, beta-propiolactone, aziridine, formaldehyde, chlorine dioxide, ethylene oxide, propylene oxide, and peracetic acid. In most cases the decontamination and sterilization operations has to be preceded by a cleaning process. Such cleaning processes have the function of removing major contamination by simple mechanical and chemical action.

In some examples in the prior art the controlled environment also contains automated equipment. Such automated equipment includes machines for filling of vials. The automated equipment located in the controlled environment is typically of such a size and complexity that it cannot be operated

fully automatically without human intervention. Such human intervention typically requires the use of gloves with the associated risk of puncture.

Fluid paths within the controlled environment enclosures may be made from flexible tubing materials and can therefore have significant gas permeability. Gases that naturally occur in air, such as oxygen and carbon dioxide, as well as chemical decontamination agents, are known to diffuse into these tubing materials. Accumulation of these agents in flexible tubing and subsequent delayed release can be a major contamination problem during operation. This applies in particular to products or solutions that are sensitive to exposure to alkylating agents, oxidizers, radicals or carbon dioxide. A typical example of human intervention involving the use of gloves is the installation of the fluid path or multiple fluid paths after the completion of decontamination.

In view of the above there remains a need for controlled environments that do not require human intervention via the use of gloves.

SUMMARY OF THE INVENTION

In one aspect of the invention there is provided a method for installing a fluid path within a controlled environment enclosure comprising, protecting the fluid path against an environment external to the fluid path; introducing the fluid path into the controlled environment enclosure; decontaminating the controlled environment enclosure; and mechanically unprotecting the fluid path within the controlled environment enclosure. The mechanically unprotecting can be by a robotic arm manipulation system. The decontaminating the controlled environment enclosure is automatically done after the introducing the fluid path into the controlled environment enclosure. The unprotecting is automatically done after the decontaminating the controlled environment enclosure.

In one aspect of the invention there is provided a method for transferring within a controlled environment enclosure a fluid along a fluid path to a destination within the controlled environment enclosure, comprising protecting the fluid path against an environment external to the fluid path; introducing the fluid path into the controlled environment enclosure; decontaminating the controlled environment enclosure; mechanically unprotecting the fluid path within the controlled environment enclosure; and transferring the fluid to the destination along the fluid path. The mechanically

unprotecting can be by a robotic arm manipulation system. The fluid path can comprise a pre-sterilized tube. The method can further comprise filtering the fluid in the fluid path and the filtering can be sterile filtering. The destination can be at least one of a culture of cells, a culture of tissue, an enzyme solution, a suspension of immobilized enzymes, a mix of active ingredients, and an excipient. The fluid can be an aseptic fluid. The controlled environment enclosure can be an isolator. The destination can be microwell plates or containers for pharmaceutical products.

In one aspect of the invention there is provided a method for uninstalling a fluid path from a controlled environment enclosure, comprising mechanically protecting the fluid path within the controlled environment enclosure; decontaminating the controlled environment enclosure; opening the controlled environment enclosure; and removing the fluid path from the controlled environment enclosure. The mechanically protecting can be by a robotic arm manipulation system. The decontaminating the controlled environment enclosure can be done automatically after the protecting the fluid path. The opening the controlled environment enclosure can be done automatically after the decontaminating the controlled environment enclosure.

In one aspect of the invention there is provided a method for decontaminating a controlled environment enclosure having a fluid path, the method comprising mechanically protecting by a robotic action the fluid path within the controlled environment enclosure; decontaminating the controlled environment enclosure; and opening and closing the controlled environment enclosure. The opening and closing the controlled environment enclosure can be done before or after the decontaminating the controlled environment enclosure. The mechanically protecting can be by a robotic arm manipulation system. The decontaminating the controlled environment enclosure can be done automatically after the mechanically protecting the fluid path.

In one aspect of the invention there is provided an apparatus for protection and unprotection of a fluid path within a controlled environment enclosure that includes a fluid path terminated by a fill needle with removable sheath, and a remotely operated manipulation system for protection and/or unprotection of the fluid path. The remotely operated manipulation system can include a robotic arm manipulation system. The apparatus can further include a

tamper-evident device positioned to reveal a breach of seal between the sheath and the fill needle. The apparatus can further include a removal station that includes a surface operative to interact with part of the sheath. The remotely operated manipulation system can include a robot end tool including at least one surface that is shaped to hold the fill needle. The fluid path can be a pre-sterilized unit.

In one aspect of the invention there is provided an apparatus for installing a fluid path within a controlled environment enclosure that includes means for conveying the fluid, and remotely operated means for protecting and/or unprotecting the means for conveying the fluid.

The inventors envision that compact and well-designed automated equipment can be operated inside closed controlled environments without the use of any gloves, eliminating thereby the risk of leaky gloves. The invention provides a method of installing a fluid path inside a controlled environment enclosure without the use of gloves. This requires the fluid path to be protected during the decontamination process and to be unprotected prior to the use of the fluid path. Furthermore the fluid path can be automatically closed after use.

The closed fluid path can be re-opened and re-used at a later time. This can be useful for continuing the use of the fluid path after unplanned events that require breaking of the integrity of the enclosed controlled environment. Additionally the closing of the fluid path can be particularly useful in situations where the fluid path has been in use for transfer of hazardous substances. After closing of the fluid path, the enclosed environment can be cleaned and decontaminated; after which the fluid path can be removed.

Other features, elements, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are not necessarily drawn to scale, like numerals may describe similar components in different views. Like numerals having different letter suffixes may represent different instances of similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

FIG. 1 shows an apparatus for the protecting and unprotecting of a fluid path in a controlled environment enclosure.

FIG. 2 shows detail of an end piece of an apparatus for the protecting and unprotecting of a fluid path in a controlled environment enclosure

FIG. 3 shows detail of a robotic arm forming part of an apparatus for the protecting and unprotecting of a fluid path in a controlled environment enclosure

FIG. 4 is a flow chart for the typical prior art method.

FIG. 5 shows a method flow chart of an aspect of the invention

FIG. 6 shows a method flow chart of another aspect of the invention

FIG. 7 shows a method flow chart of another aspect of the invention

FIG. 8 shows a method flow chart of another aspect of the invention

DETAILED DESCRIPTION

FIG. 1 shows an embodiment of an apparatus for protecting and unprotecting of a fluid path **404** in a controlled environment enclosure **420**. The term "fluid" as used herein denotes any liquid, gas, liquid-gas mixtures and any mixture of solids in liquid that has fluid attributes, such as flowability or having appreciable fluidity at ambient temperature and pressure, including, without limitation, a dispersion of a solid or solids in a liquid, an emulsion, a slurry, a micro-emulsion, colloidal suspension, a suspension, a suspension of liposomes, a suspension of micelles or the like. The term "fluid path" as used herein denotes any single channel or multi channel tubing, rigid or flexible, for transporting a fluid.

A fluid path **404** starts at a container **401**. The term "container" as used herein denotes any vessel suitable to hold a fluid, including without limitation any vial, syringe, ampoule, carpule, bottle, flask, beaker, bag, well in micro-well plates, well in multi-well plates, or tube. The container **401** is fitted with an air filter **402**. The container **401** can be equipped with optional sensors (not shown) to measure volume, weight of fluid, or other parameters. In some embodiments there can be multiple containers connected in parallel or in series with one another. Along the fluid path **404** there can be optional measuring devices (not shown) that measure properties, including without limitation any one or more of pressure, flow, temperature, density and conductivity. The fluid path **404** can be

fitted with a filter element **403**. The filter element **403** can be selected to be suitable for sterile filtration of fluids.

The fluid path **404** enters the controlled environment enclosure **420** at opening **406**. In **FIG. 1** the fluid path **404** consists of flexible tubing **405**. Opening **406** is sealed. The sealing can be, for example, via the use of a suitable flange (not shown). The container **401** and air filter **402** can be located outside the controlled environment enclosure **420**, as shown in **FIG. 1**. In other embodiments of the invention the container **401** and air filter **402** can be located inside the controlled environment enclosure **420**.

Controlled environment enclosure **420** is equipped with an inlet filter **430**, an inlet valve **431**, a blower **432**, an outlet filter **433** and an outlet valve **434**. The characteristics of blower **432**, inlet filter **430** and outlet filter **433** are chosen to yield a controlled environment inside controlled environment enclosure **420**. As understood by those skilled in the art, various other filter and blower arrangements are possible to establish a controlled environment inside controlled environment enclosure **420**. A suitable controlled environment can be obtained, for example without limitation, by means of any one or more of turbulent airflow, horizontal unidirectional airflow and vertical unidirectional airflow.

The fluid from container **401** can be transferred through the fluid path **404** by a number of different mechanisms, including without limitation a peristaltic pump **410** as shown in **FIG. 1**, a difference in pressure between the container **401** and the controlled environment enclosure **420**, a difference in static height of the container **401** and the end of the fluid path **404**, a gear pump, a lobe pump, a membrane pump, a piston pump, or a syringe pump.

The flexible tubing **405** of the fluid path **404** can terminate with an end piece **414**. A suitable end piece can be, for example without limitation, a fill needle, a pipette dispensing system, a syringe dispensing system, a valve dispensing system, quick connectors, aseptic connectors, dispense tips and a needle for piercing of elastomers. In **FIG. 1** the end piece **414** is selected to be a fill needle.

The end piece **414** can be manipulated inside the controlled environment enclosure **420** by mechanical means, for example, a robotic arm manipulation system **415**. Suitable robotic arm manipulation systems for

mechanically manipulating end piece **414** include, but are not limited to, 6-axis robotic arms, Selective Compliant Articulated Robot Arm (SCARA) systems, r-theta robots, or combinations of linear actuators and rotary actuators.

Fluids are transferred along the fluid path **404** to a destination, which can be containers such as the tray with vials **411** located on pedestal **412** in **FIG. 1**. The fluid path **404** may be employed for a variety of purposes including without limitation the filling of empty containers, washing and rinsing of containers, adding fluid to containers with a freeze dried powder, adding fluids to containers containing excipients and/or active ingredients, adding medium to cells, tissue or microbes, inoculating cells or microbes, adding substrate to enzyme solutions or suspensions of immobilized enzymes, adding gases such as argon or nitrogen to create an inert head space in containers, adding gases such as nitrogen, air or carbon dioxide to cells and removing fluids out of containers by suction. The term "excipient" as used herein denotes an inert substance used as a diluent or vehicle for a drug.

Fluid path **404** may in some applications be required for aseptic transfer of fluids. In such a case fluid path **404** can be pre-sterilized before installation in the controlled environment enclosure **420**. The aseptic part of the fluid path **404** can start with container **401** or with filter **403**. Installation of the aseptic fluid path **404** requires sealing of the end piece **414**.

FIG. 4 is a flowchart showing the prior art method for installing a fluid path in a prior art controlled environment enclosure. The prior art method requires the steps in sequence of decontaminating **(100)** the prior art controlled environment enclosure; transferring **(110)** the fluid path into the prior art controlled environment enclosure; and installing **(120)** by hand the fluid path in the prior art controlled environment enclosure, before using **(130)** the fluid path for the purpose for which it is intended.

In an aspect of the invention there is provided a method for installing a fluid path **404** in the controlled environment enclosure **420**. Referring to the apparatus of **FIG.4** and the flow chart of **FIG.5**, the method comprises protecting **(301)** the fluid path **404** against an environment external to the fluid path **404**, introducing **(302)** the fluid path **404** into the controlled environment enclosure **420**, decontaminating **(303)** the controlled environment enclosure **420**, and mechanically unprotecting **(304)** the fluid path **404**. In its unprotected state

fluid path **404** can then be used for transporting **(305)** fluids to destination **411**, which fluids can be aseptic or sterile fluids. Such transporting **(305)** of fluids can comprise filtering the fluid in the fluid path **404** using filter element **403** and the filtering can be sterile filtering. The terms "sterile" and "aseptic" are used interchangeably in this specification. The term "decontamination" as used herein denotes a process for removing or inactivating contamination, including without limitation viruses, bacteria, spores, prions, molds, yeasts, proteins, pyrogens and endotoxins, to acceptable levels. "Decontamination" as used herein includes both sterilization (that is, the destruction of all microorganisms, including bacterial spores to a probability of surviving organisms of typically less than $1:10^6$) and disinfection (that is, the destruction and removal of specific types of micro-organisms).

In **FIG.2** a suitable arrangement for mechanically unprotecting **(304)** fluid path **404** is shown, comprising end piece **414** of fluid path **404** in the form of a fill needle, together with a fill needle sheath **503**. The fill needle **414** comprises fill needle tubing **501** and fill needle hub **502**. When the fluid path **404** is within controlled environment enclosure **420**, the fill needle sheath **503** can be stored in a sheath removal station **413** of the controlled environment enclosure **420** shown in **FIG.1**.

The fill needle hub **502** and the fill needle tubing **501** can be glued or welded together. In alternative embodiments the fill needle hub **502** and the fill needle tubing **501** can be made as one part out of solid material. The fill needle sheath **503** can be manufactured using materials with different thermal expansion coefficients to allow it to slide on and off the fill needle hub **502** after thermal expansion. Alternatively the needle sheath **503** can be designed to have a sliding fit on the fill needle hub **502** using porous PTFE or a steam permeable elastomeric material.

Protecting **(301)** the fluid path **404** comprises sealingly placing the fill needle sheath **503** over the fill needle **414** such that the fill needle sheath **503** seals with the needle hub **502**. The fill needle sheath **503** and needle hub **502** can be equipped with one or multiple of tamper evident features **504** that will provide evidence of breaking the seal between needle hub **502** and fill needle sheath 503. Possible tamper evident features **504** include but are not limited to heat shrink bands, tape seals, breakable ring, tear-off connectors and snap

connect tear-off connectors. Unprotecting (**304**) the fluid path **404** comprises removing the fill needle sheath **503** from the fill needle **414**, thereby exposing the fill needle **414** to an environment within the controlled environment enclosure **420**. When the fill needle **414** is in use within the controlled environment enclosure **420**, the fill needle sheath **503** is stored in the sheath removal station **413**.

The mechanically unprotecting (**304**) the fill needle **414** when it is within controlled environment enclosure **420** can comprise using a robotic arm manipulation system **415** shown in **FIG. 1**. **FIG. 3** illustrates part of the robotic arm manipulation system **415** of **FIG.1**, wherein a forearm **601** is connected to a wrist **602**, and the wrist **602** is connected to a tool flange **603**. The end tool **604**, shown in **FIG. 3** as being fork shaped, has a partially opened bore of such diameter that the end tool **604** can slide around a narrow tubular section of needle hub **502** and the end tool **604** can move upwards to establish a precise locating fit to needle hub **502**. For unprotecting (**304**) the fill needle **414** the end tool **604** moves the fill needle **414** with the fill needle sheath **503** and places the fill needle **414** with the fill needle sheath **503** in sheath removal station **413**.

In one embodiment of the apparatus and method, the sheath removal station **413** heats the fill needle sheath **503**, which thereby expands and releases its grip or seal to the needle hub **502**. Practitioners in the field will appreciate that there are many different ways by which the fill needle sheath **503** can be removed from the fill needle **414**. The end tool **604**, through the motion of the robotic arm manipulation system **415**, removes the fill needle **414** from the fill needle sheath **503**. The fill needle sheath **503** can remain in the sheath removal station **413** while the robotic arm manipulation system **415** moves the fill needle **414** to the destination. In one embodiment of the apparatus and method the destination shown is the tray with vials **411** located on the pedestal **412** in **FIG. 1**.

The end tool **604** and the needle hub **502** can have various different other shapes allowing the use of various other closure systems such as, for example without limitation, a plug, a cap with sliding fit o-ring seal with minimal occluded surface area, a cap with membrane peel-off seal, or a twist-off cap. As understood by those skilled in the art, some closure systems will be

more suitable than other closure system for use with particular sterilization methods.

Materials of lesser permeability can be used in the manufacture of the flexible tubing **405**, but this is not always an option. Tubing permeability can also be reduced by adding additional layers to the tubing. Example methods for establishing such additional layers around the flexible tubing **405** include, but are not limited to, heat shrinking with non-permeable polymer such as FEP, multilayer coextrusion with non-permeable polymers, creating a diffusion barrier by polymeric coating such as poly(p-xylylene), encasing with layers of tape, and the fitting of a sleeve.

In a further aspect of the invention there is provided a method for uninstalling a fluid path **404** from the controlled environment enclosure **420**. Referring to the apparatus of **FIG. 1** and the flow chart of **FIG. 6**. The method comprises mechanically protecting **(306)** the fluid path **404** within the controlled environment enclosure **420** once the use of fluid path **404** has been completed, decontaminating **(303)** the controlled environment enclosure **420**, and removing **(307)** the fluid path **404** from the controlled environment enclosure **420**. The mechanically protecting **(306)** the fill needle **414** can comprise using the robotic arm manipulation system **415** shown in **FIG. 1**.

The mechanically protecting **(306)** the fill needle **414** within controlled environment enclosure **420** can comprise using the robotic arm manipulation system **415** of **FIG. 1**. The end tool **604** (See **FIG. 3**) of robotic arm manipulation system **415** is used to move the fill needle **414** to and place it in the fill needle sheath **503**, which is housed in the sheath removal station **413**. The sheath removal station **413** heats the fill needle sheath **503** until the fill needle sheath **503** can slide over fill needle **414** to suitably seal to needle hub **502** after cooling, to thereby protect **(306)** the fill needle **414** within controlled environment enclosure **420**. The robotic arm manipulation system **415** can then further move the protected fluid path **404** as may be required.

In a further aspect of the invention the mechanically unprotecting **(304)** and the mechanically protecting **(306)** the fill needle **414** using the robotic arm manipulation system **415** can be done automatically. For example, a suitable controller **440** (**see FIG. 1**), communicating control instruction with the controlled environment enclosure **420** via a control line **450**, can be programmed

to automatically unprotect **(304)** the fill needle **414** using the robotic arm manipulation system **415** once the decontaminating **(303)** the controlled environment enclosure **420** has been completed. Such automation obviates human intervention in the step of mechanically unprotecting **(304)** the fill needle **414**. In an embodiment of the method, the step of decontaminating **(303)** the controlled environment enclosure **420** can also be managed by controller **440** This allows the remainder of the steps of installing the fill needle **414**, beyond the step of introducing **(302)** the fluid path **404** into the controlled environment enclosure **420**, to be automated using controller **440**, including the use of the fill needle for the purpose for which it is installed, and the mechanically protecting **(306)** the fill needle **414** after such use.

In a further aspect of the invention there is provided a method for decontaminating the controlled environment enclosure **420** having a fluid path **404**. The method comprises mechanically protecting **(306)** the fluid path **404** within the controlled environment enclosure by sealingly placing the fill needle sheath **503** over the fill needle **414** such that the fill needle sheath **503** seals with the needle hub **502**; decontaminating **(303)** the controlled environment enclosure **420**; and opening **(308)** and closing **(309)** the controlled environment enclosure **420**. The opening **(308)** and closing **(309)** the controlled environment enclosure **420** can either be done after the decontaminating **(303)** the controlled environment enclosure **420**, as may be the case when the fluid or the materials at the destination **411** are dangerous. This is shown in **FIG.7**. Alternatively, the opening **(308)** and closing **(309)** the controlled environment enclosure **420** can either be done before the decontaminating **(303)** the controlled environment enclosure **420**. This is shown in **FIG.8**, as may be the case when the external environment holds potential of contaminating the fluid or the materials at the destination **411**. The mechanically protecting **(306)** the fill needle **414** can comprise using the robotic arm manipulation system **415** shown in **FIG. 1**, as already described.

The protecting **(306)** the fill needle **414** using the robotic arm manipulation system **415** can be done automatically via controller **440** (see Fig.14). Controller **440** can be programmed for automatically mechanically protecting **(306)** the fill needle **414** using the robotic arm manipulation system **415**, prior to opening **(308)** and closing **(309)** the controlled environment

enclosure **420**. The opening **(308)** and closing **(309)** the controlled environment enclosure **420** can likewise be automated via controller **440**.

ADDITIONAL NOTES

The above detailed description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show, by way of illustration, specific embodiments in which the invention can be practiced. These embodiments are also referred to herein as "examples." All publications, patents, and patent documents referred to in this document are incorporated by reference herein in their entirety, as though individually incorporated by reference. In the event of inconsistent usages between this document and those documents so incorporated by reference, the usage in the incorporated reference(s) should be considered supplementary to that of this document; for irreconcilable inconsistencies, the usage in this document controls.

In this document, the terms "a" or "an" are used, as is common in patent documents, to include one or more than one, independent of any other instances or usages of "at least one" or "one or more." In this document, the term "or" is used to refer to a nonexclusive or, such that "A or B" includes "A but not B," "B but not A," and "A and B," unless otherwise indicated. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Also, in the following claims, the terms "including" and "comprising" are open-ended, that is, a system, device, article, or process that includes elements in addition to those listed after such a term in a claim are still deemed to fall within the scope of that claim. Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

Method examples described herein can be machine or computer-implemented at least in part. Some examples can include a tangible computer-readable medium or machine-readable medium encoded with instructions operable to configure an electronic device to perform methods as described in the above examples. An implementation of such methods can include code, such as microcode, assembly language code, a higher-level language code, or the like. Such code can include computer readable instructions for performing various

methods. The code can form portions of computer program products. Further, the code can be tangibly stored on one or more volatile or non-volatile computer-readable media during execution or at other times. These computer-readable media can include, but are not limited to, hard disks, removable magnetic disks, removable optical disks (e.g., compact disks and digital video disks), magnetic cassettes, memory cards or sticks, random access memories (RAM's), read only memories (ROM's), and the like.

The above description is intended to be illustrative, and not restrictive. For example, the above-described examples (or one or more aspects thereof) may be used in combination with each other. Other embodiments can be used, such as by one of ordinary skill in the art upon reviewing the above description. The Abstract is provided to comply with 37 C.F.R. §1.72(b), to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. Also, in the above Detailed Description, various features may be grouped together to streamline the disclosure. This should not be interpreted as intending that an unclaimed disclosed feature is essential to any claim. Rather, inventive subject matter may lie in less than all features of a particular disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment. The scope of the invention should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

What is claimed is:

1. A method for installing a fluid path within a controlled environment enclosure comprising,

    a. protecting the fluid path against an environment external to the fluid path;

    b. introducing the protected fluid path into the controlled environment enclosure;

    c. decontaminating the controlled environment enclosure after introducing the protected fluid path; and

    d. mechanically unprotecting the fluid path within the controlled environment enclosure after decontaminating.

2. The method of claim 1, wherein the mechanically protecting is by a robotic arm manipulation system.

3. The method of claim 1, wherein the decontaminating the controlled environment enclosure is automatically done after the introducing the fluid path into the controlled environment enclosure.

4. The method of claim 1, wherein the unprotecting is automatically done after the decontaminating the controlled environment enclosure.

5. A method for transferring within a controlled environment enclosure a fluid along a fluid path to a destination within the controlled environment enclosure, comprising

    a. protecting the fluid path against an environment external to the fluid path;

b. introducing the protected fluid path into the controlled environment enclosure;

c. decontaminating the controlled environment enclosure after introducing the protected fluid path;

d. mechanically unprotecting the fluid path within the controlled environment enclosure after decontaminating; and

e. transferring the fluid to the destination along the fluid path after mechanically unprotecting.

6. The method of claim 5, wherein the mechanically protecting is by a robotic arm manipulation system.

7. The method of claim 5, wherein the fluid path comprises a pre-sterilized tube.

8. The method of claim 5, further comprising filtering the fluid in the fluid path.

9. The method of claim 8, wherein the filtering is sterile filtering.

10. The method of claim 5, wherein the destination includes at least one of a culture of cells, a culture of tissue, an enzyme solution, a suspension of immobilized enzymes, a mix of active ingredients, and an excipient.

11. The method of claim 5, wherein the fluid is an aseptic fluid.

12. The method of claim 5, wherein the controlled environment enclosure is an isolator.

13. The method of claim 5, wherein the destination comprises at least one of microwell plates and containers for pharmaceutical products.

14. A method for uninstalling a fluid path from a controlled environment enclosure, comprising

    a. mechanically protecting the fluid path within the controlled environment enclosure;

    b. decontaminating the controlled environment enclosure after protecting the fluid path;

    c. opening the controlled environment enclosure after decontaminating ; and

    d. removing the fluid path from the controlled environment enclosure after opening the controlled environment.

15. The method of claim 14, wherein the mechanically protecting is by a robotic arm manipulation system.

16. The method of claim 14, wherein the decontaminating the controlled environment enclosure is done automatically after the protecting the fluid path.

17. The method of claim 14, wherein the opening the controlled environment enclosure is done automatically after the decontaminating the controlled environment enclosure.

18. A method for decontaminating a controlled environment enclosure having a fluid path, the method comprising

    a. mechanically protecting the fluid path within the controlled environment enclosure;

    b. decontaminating the controlled environment enclosure; and

c. opening and closing the controlled environment enclosure.

19. The method of claim 18, wherein the mechanically protecting is by a robotic arm manipulation system.

20. The method of claim 18, wherein the opening and closing the controlled environment enclosure is done after the decontaminating the controlled environment enclosure.

21. The method of claim 18, wherein the decontaminating the controlled environment enclosure is done automatically after the mechanically protecting the fluid path.

22. The method of claim 1 further including the step of inspecting a tamper-evident feature on a needle hub and needle sheath prior to the step of decontaminating the fluid path to verify that the hub and sheath have remained sealed since before the step of decontaminating.

23. An apparatus for protection and unprotection of a fluid path within a controlled environment enclosure, comprising:

a. a fluid path terminated by a fill needle with removable sheath, and

b. a remotely operated manipulation system for protection and/or unprotection of the fluid path.

24. The apparatus of claim 23 wherein the remotely operated manipulation system includes a robotic arm manipulation system.

25. The apparatus of claim 23 further including a tamper-evident device positioned to reveal a breach of seal between the sheath and the fill needle.

26. The apparatus of claim 23 further including a removal station that includes a surface operative to interact with part of the sheath.

27. The apparatus of claim 23 wherein the remotely operated manipulation system includes a robot end tool including at least one surface that is shaped to hold the fill needle.

28. The apparatus of claim 23 wherein the fluid path is a pre-sterilized unit.

29. An apparatus for installing a fluid path within a controlled environment enclosure, comprising:

a. means for conveying the fluid, and

b. remotely operated means for protecting and/or unprotecting the means for conveying the fluid.

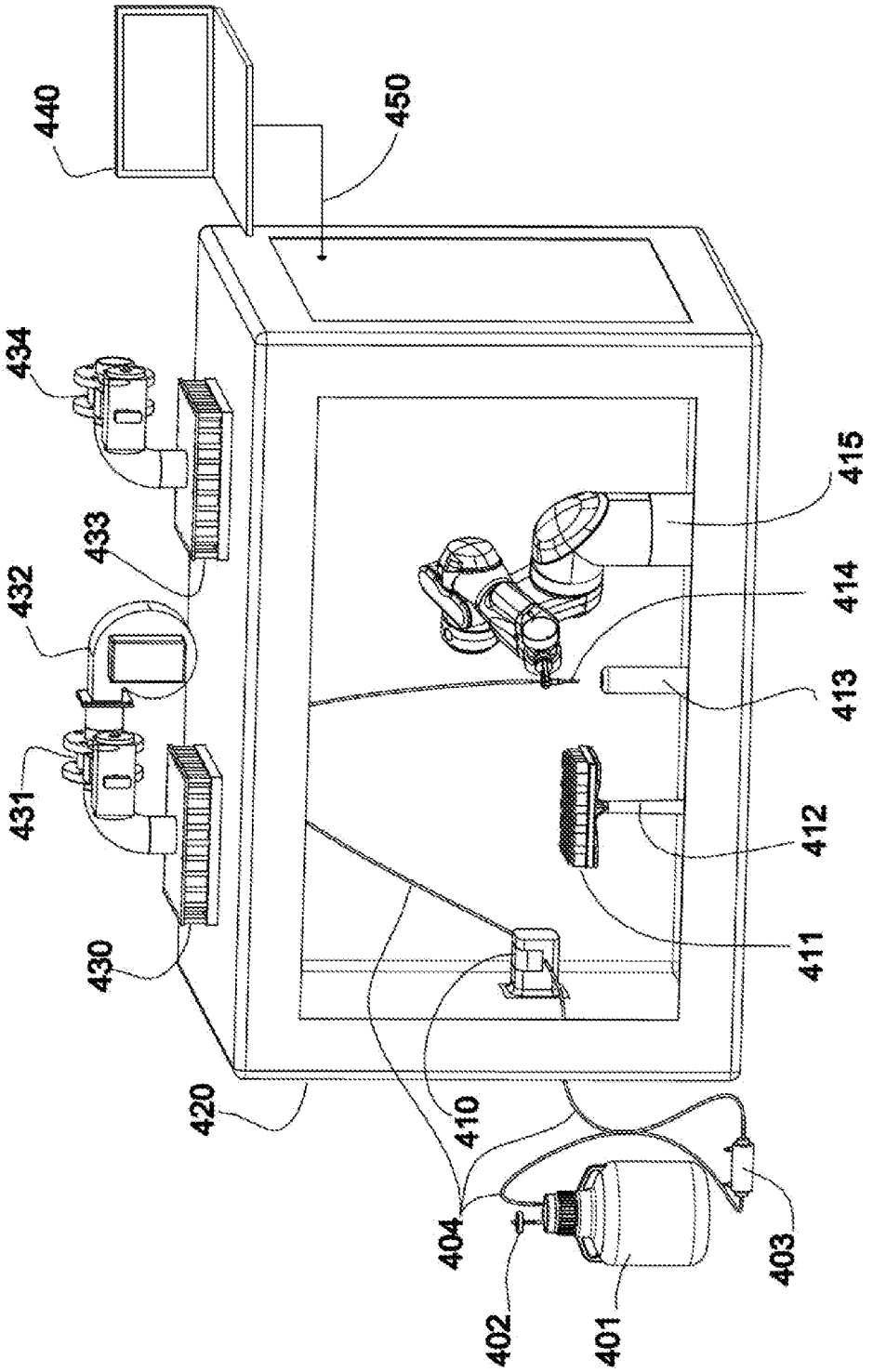

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Fig. 1

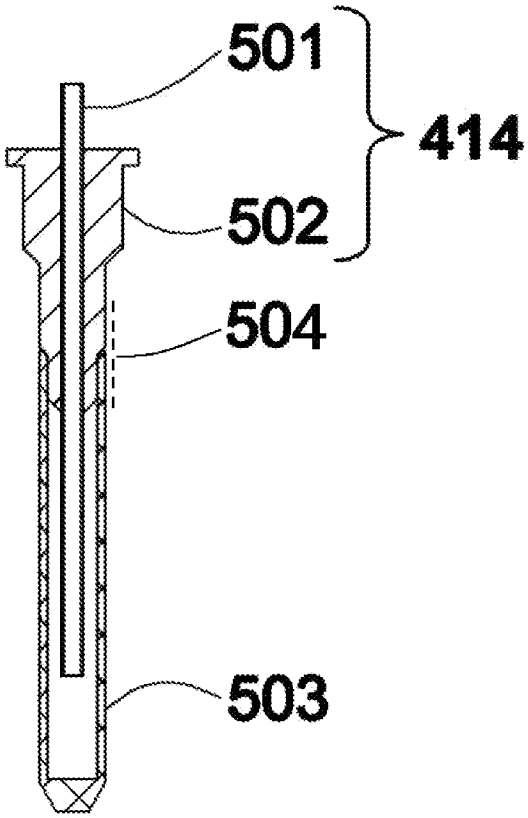


FIG.2

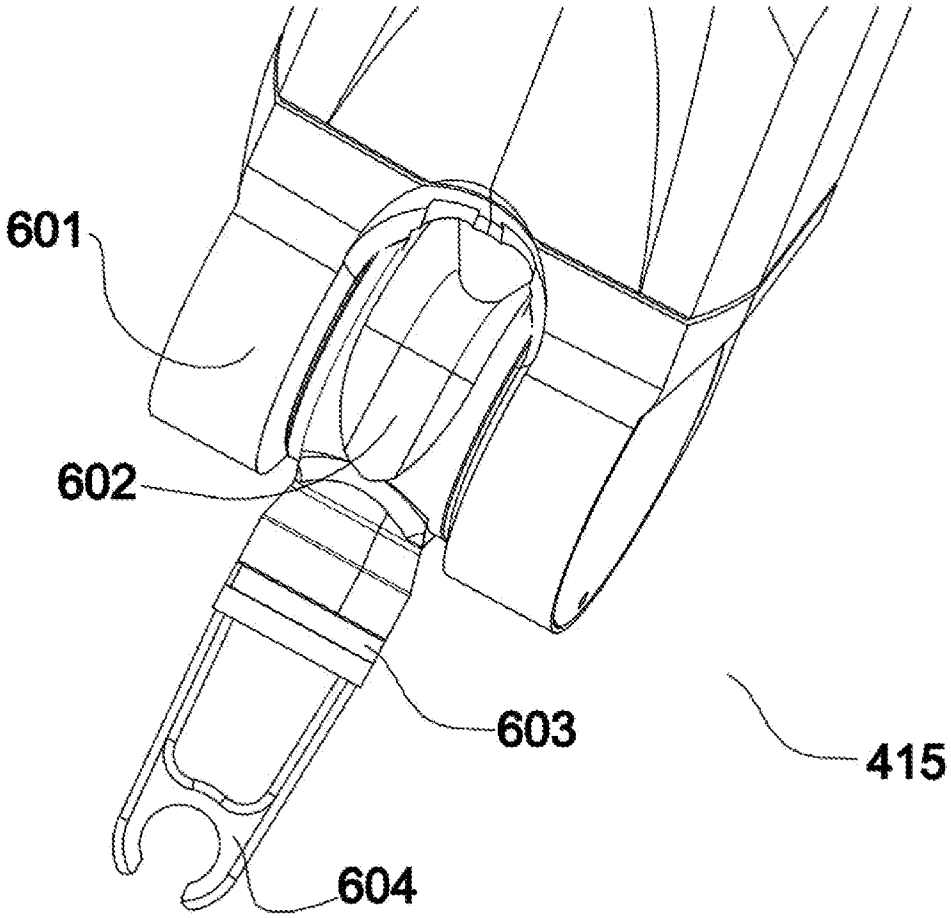
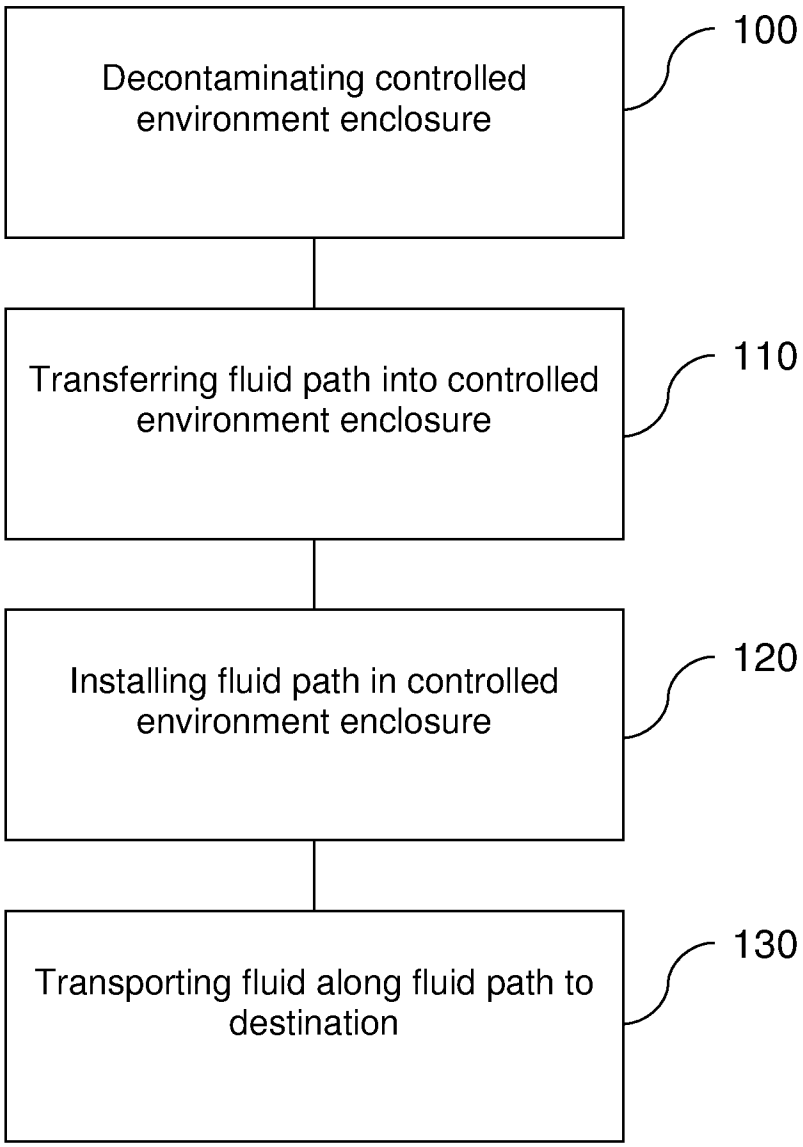


FIG. 3



PRIOR ART

FIG. 4

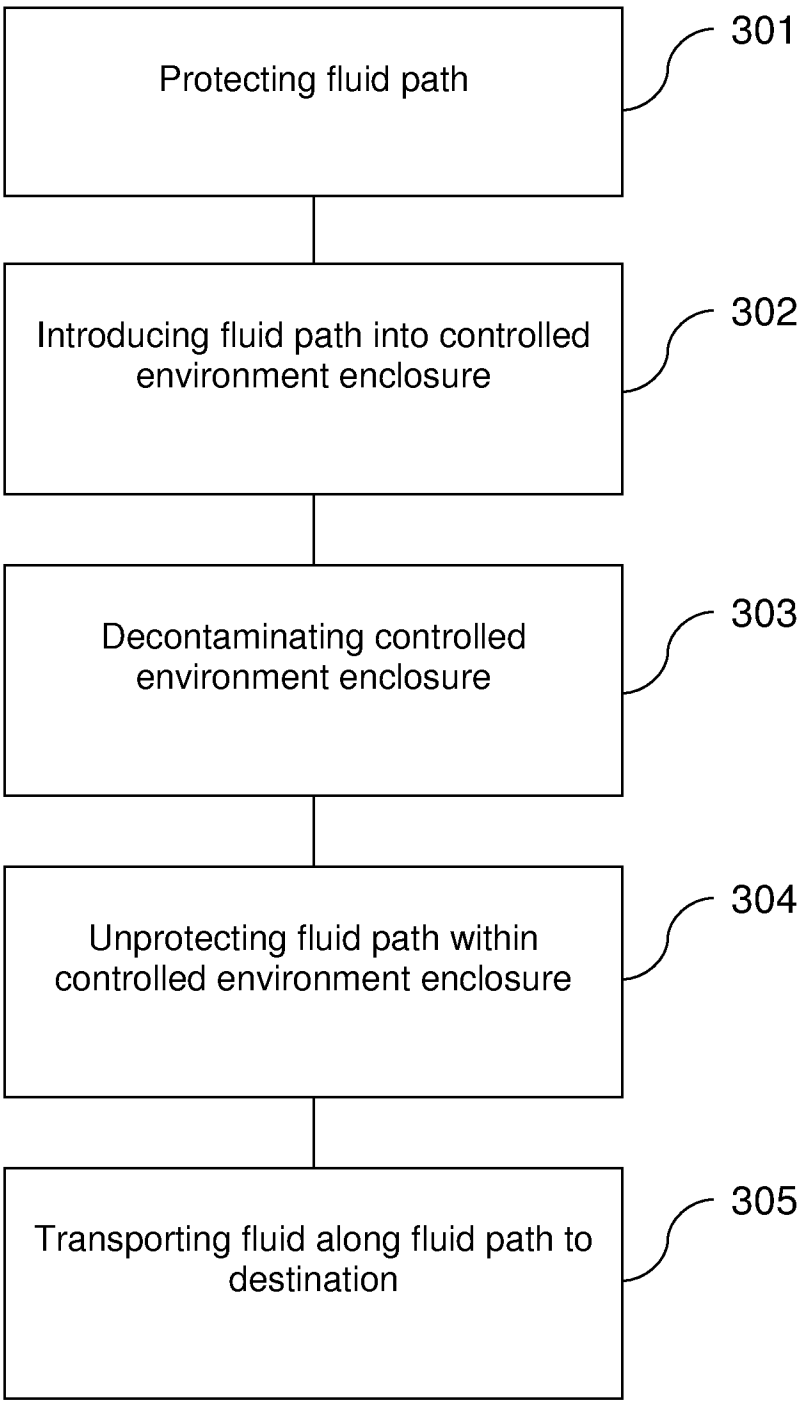

Protecting fluid path
301
Introducing fluid path into controlled environment enclosure
302
Decontaminating controlled environment enclosure
303
Unprotecting fluid path within controlled environment enclosure
304
Transporting fluid along fluid path to destination
305

FIG. 5

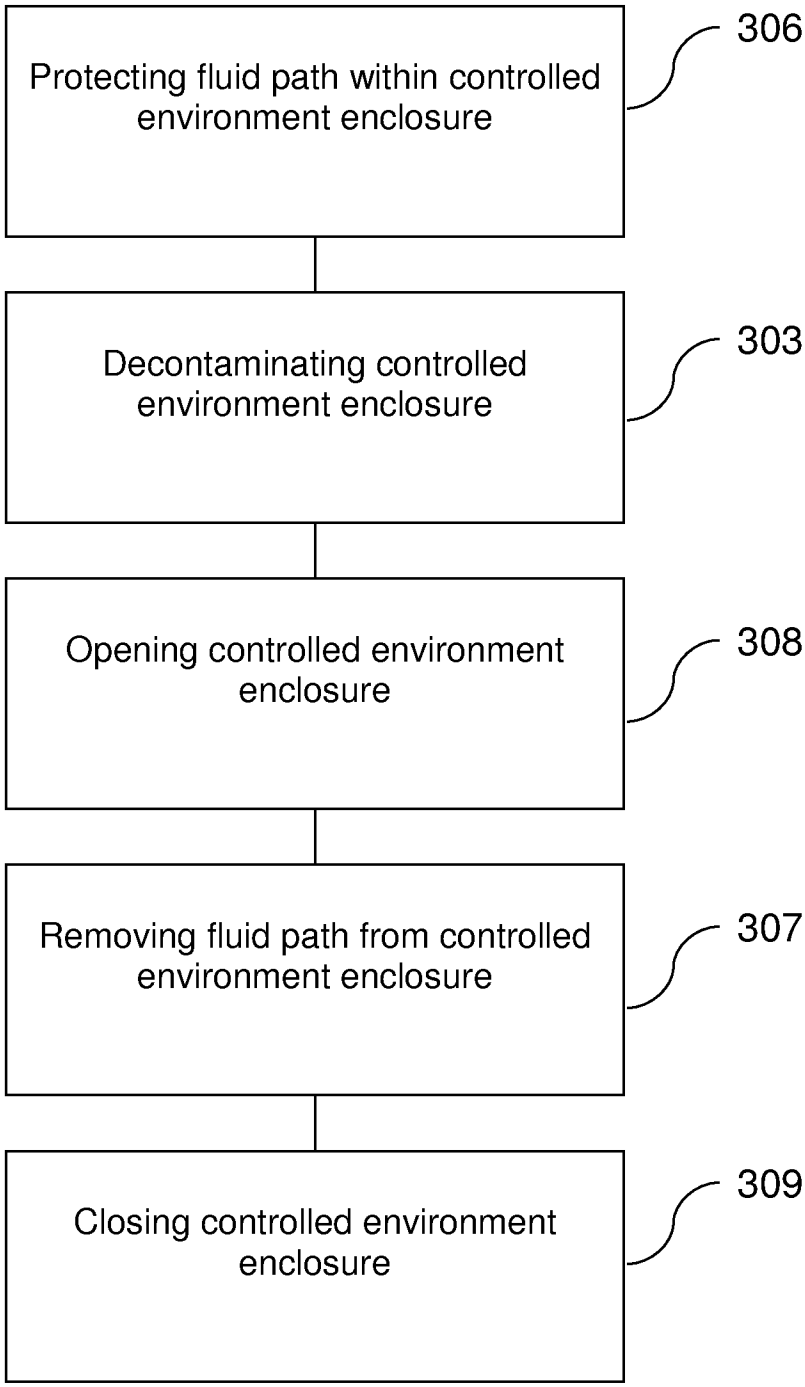

Protecting fluid path within controlled environment enclosure
306
Decontaminating controlled environment enclosure
303
Opening controlled environment enclosure
308
Removing fluid path from controlled environment enclosure
307
Closing controlled environment enclosure
309

FIG. 6

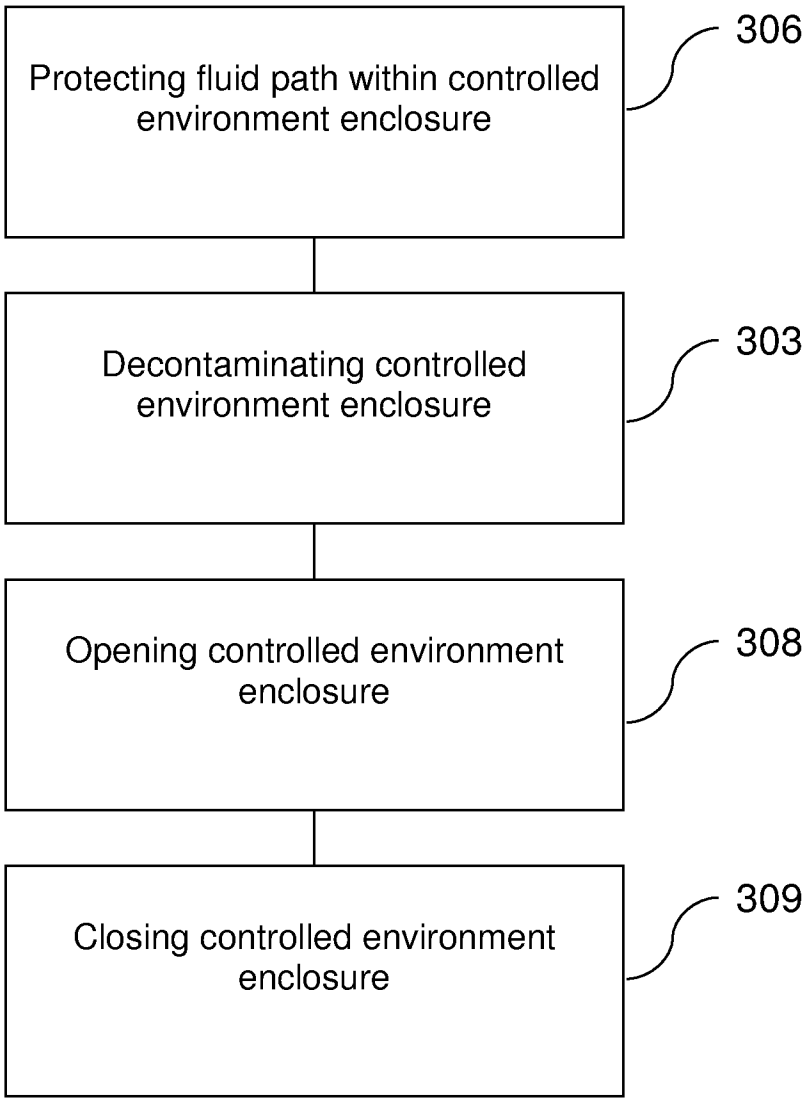

Protecting fluid path within controlled environment enclosure
306
Decontaminating controlled environment enclosure
303
Opening controlled environment enclosure
308
Closing controlled environment enclosure
309

FIG. 7

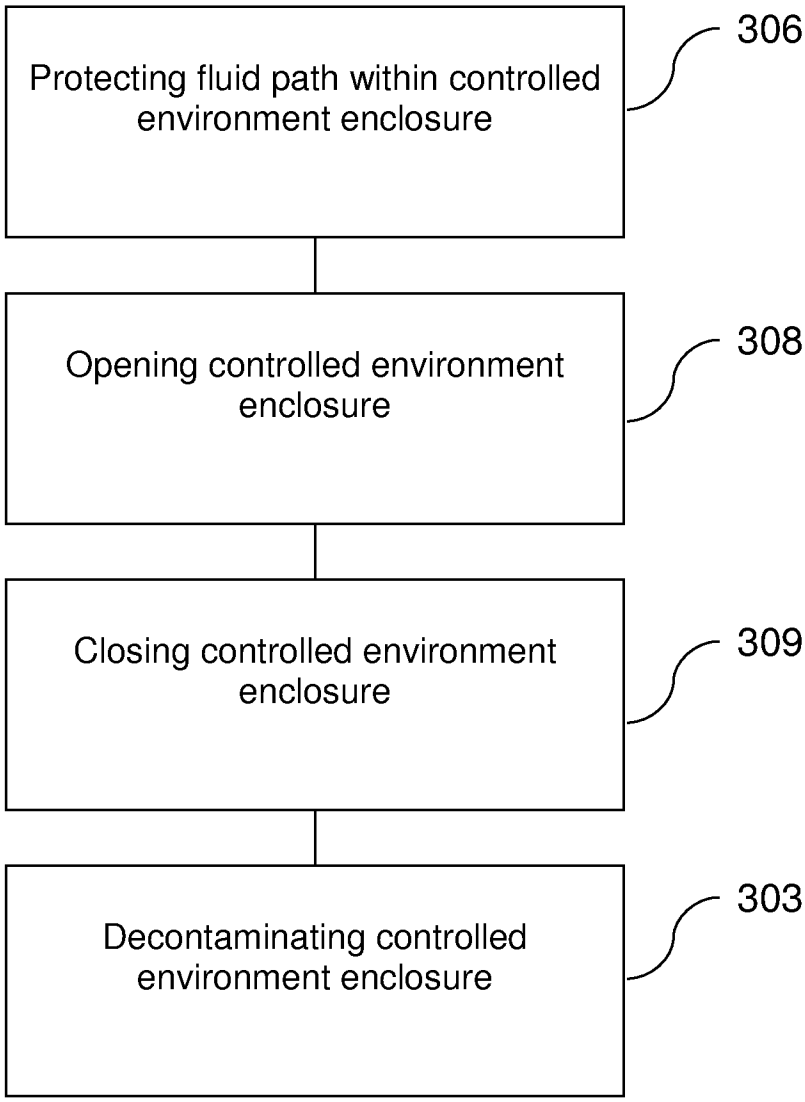

Protecting fluid path within controlled environment enclosure
306
Opening controlled environment enclosure
308
Closing controlled environment enclosure
309
Decontaminating controlled environment enclosure
303

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 2012/047765

A. CLASSIFICATION OF SUBJECT MATTER

B01L 1/00 *(2006.01)*
B25J 21/00 *(2006.01)*
A61L 2/00 *(2006.01)*

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)

B01L 1/00, 1/02, 1/04, 3/00, B25J 21/00, A61L 2/00, A61M 5/32

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)

PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 1996/033806 A1 (SYSTEMIX) 31.10.1996, p. 31-33, 36, 40, fig. 3	1-21, 23-24, 27-28
Y	US 4976699 A (STEVEN K. GOLD) 11.12.1990, abstract, col. 1, lines 5-11, fig. 1-2	1-21, 23-24, 27- 29
Y	US 2009/0298129 A1 (SIMON JONATHON SPENCE et al.) 03.12.2009, par. [0008]-[0012], [0017], [0101], [0231], [0232]	2, 4, 6, 11, 13, 15, 19, 23-24, 27-29

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"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
31 October 2012 (31.10.2012)	22 November 2012 (22.11.2012)
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