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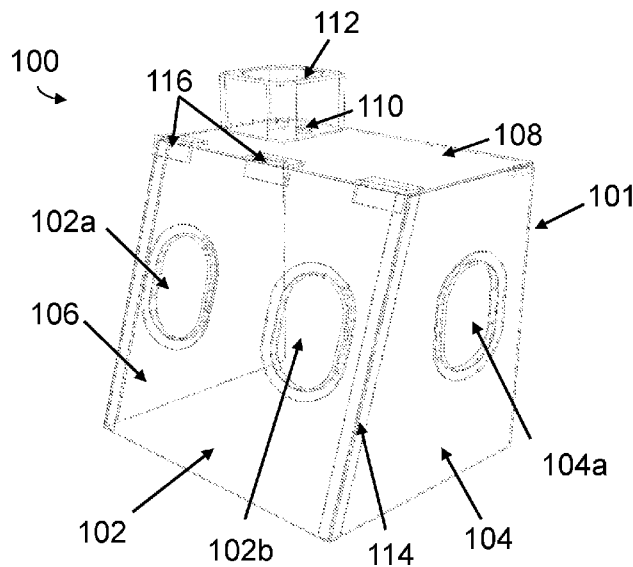


Figure 1

(57) **Abstract:** A treatment apparatus is described. In an embodiment, the treatment apparatus comprises: a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein; a fan adapted to connect to an air filter; and an exhaust opening provided in one of the plurality of panels, the exhaust opening being adapted to connect to the fan, wherein the fan is adapted to generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space. A method of deploying the treatment apparatus and a kit of parts arranged to be assembled for forming the treatment apparatus are also described.



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## A TREATMENT APPARATUS AND A METHOD OF DEPLOYING A TREATMENT APPARATUS

### Technical Field

5 The present disclosure relates broadly, but not exclusively, to a treatment apparatus serving as a protective equipment, and to a method of deploying the treatment apparatus.

### Background

10 Droplets generated by patients may carry pathogens and/or infectious particles which are harmful for healthcare workers providing treatments to these patients. These droplets may be generated by coughing, sneezing, and speaking of patients with contagious diseases, or may be generated from aerosols produced as a result of medical procedures, for example “Aerosol Generating Procedures” (AGPs), performed on these patients. The AGPs include a wide range of commonly performed procedures such as intubation, extubation, endoscopy, 15 cardiopulmonary resuscitation (CPR), laparoscopy and bronchoscopy, which are often unavoidable. These harmful droplets produced by the patients have the potential to hang around in the air for some time, or may stay on surfaces for prolonged periods. Healthcare workers who work in close proximity to these patients are therefore at high risk of being exposed to such droplets and/or aerosols generated by these patients.

20

One way to protect health workers from these harmful droplets and/or aerosols is for these health workers to don on personal protective equipment before coming into contact with these patients or performing the AGPs. However, in situations where these patients require immediate medical care, time for treating the patients is of the essence, and any time spent 25 in gowning up the personal protective equipment may take precious minutes away from the required emergency patient care and may adversely affect an outcome of such emergency situations.

It is therefore desirable to provide a treatment apparatus and a method of deploying a 30 treatment apparatus which address the aforementioned problems and/or provides a useful alternative. Further, other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

### 35 Summary

Aspects of the present application relate to a treatment apparatus and a method of

deploying a treatment apparatus.

In accordance with a first aspect, there is provided a treatment apparatus comprising: a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein; a fan adapted to connect to an air filter; and an exhaust opening provided in one of the plurality of panels, the exhaust opening being adapted to connect to the fan, wherein the fan is adapted to generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space.

By having the plurality of panels assembled to form a chamber to provide a confined space that at least partially enclosing a patient therein, droplets and/or aerosol produced by a patient can be contained to limit exposure of these droplets and/or aerosol to the external environment. The treatment apparatus therefore creates a physical barrier to protect healthcare providers providing aids to the patient from potential pathogens, germs and/or virus produced from the patient. Further, the exhaust opening provided is adapted to connect to the fan, where the fan is adapted to generate an air flow from the confined space to the external environment. In this way, the droplets and/or aerosol produced by the patient within the confined space can be filtered out before the air from the confined space is exhausted to the external environment, thereby minimising contamination of the external environment. Further, by generating this air flow, fresh air from the external environment can be drafted into the confined space to ventilate the confined space (note that the confined space is not air tight). This provides an oxygen-enhanced environment for the patient during performance of the procedure.

The fan may comprise an ultra violet C (UV-C) light column adapted to emit UV-C light to treat the air from the confined space. The UV-C light is effective in removing infectious particles or micro-organisms, thereby ensuring that the air exhausted from the confined space is pathogens, germs or virus free.

The treatment apparatus may comprise one or more ultra violet C (UV-C) light columns arranged within the confined space adapted to emit UV-C light towards at least a surface of one of the plurality of panels. The UV-C is effective in removing infectious particles or micro-organisms and thus keeping the patient safe within the confined space of the chamber.

The UV-C light may have a wavelength between 200 nm and 300 nm. The UV-C light of

this wavelength range is strongly absorbed by nucleic acids, thereby aiding disinfection of infectious particles or microorganisms within the chamber, or in the exhausted air from the confined space of the chamber.

5 The plurality of panels may comprise wall panels and a top panel securable to the wall panels when deployed, the top panel being arranged on top of the wall panels. Securing the wall panels to the top panel provide a rigid and sturdy structure of the chamber, and improve a stability of the treatment apparatus, particularly during the performance of a procedure on the patient.

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The treatment apparatus may comprise through holes in the wall panels, and the through holes being adapted to provide access to the confined space. The through holes provide access to the confined space so that health workers may perform a procedure on the patient.

15 The treatment apparatus may comprise snap-in flanges each provided to engage a perimeter of each of the through holes for securing to each of the through holes at least one of: a cover of the through hole and a user protection sleeve. The snap-in-flanges allow for customizability of an arm port covering (sleeves or diaphragm). Further, given the snap-in features, it means that the cover of the through hole or the user protection sleeve can be  
20 replaced easily. This allows for easy cleaning of the through hole covers or user protection sleeves if necessary.

The snap-in flanges may be made of polyoxymethylene.

25 Adjacent panels of the wall panels may be connected to each other via at least one living hinge.

The top panel may be connected to a top edge of one of the wall panels via at least one living hinge.

30

The at least one living hinge may be made of carbon reinforced nylon.

The top panel and the wall panels may be made of polycarbonate.

35 The wall panels may comprise a front panel and two side panels, and wherein the at least one through hole may comprise two through holes provided in the front panel.

The treatment apparatus may comprise a covering connected to the top panel, the covering may be adapted to cover at least an opposite side of the chamber to the front panel. The covering acts as a protective covering to reduce air from the confined space of the chamber from leaking out to the external environment and to prevent any droplets produced in a procedure to be exposed to the external environment.

The exhaust opening may be provided in the top panel.

10 The exhaust opening may be provided near or at a bottom of one of the wall panels.

The air filter may comprise a high efficiency particulate air (HEPA) filter.

The air filter may comprise an ultra low penetration air (ULPA) filter.

15

The treatment apparatus may comprise fastening means connected to a bottom side of one of the wall panels for securing a position of the treatment apparatus. The fastening means allow the treatment apparatus to be secured to a structure on which the patient is placed (e.g. a bed frame, an operating table or a stretcher etc.) to provide stability of the treatment apparatus and to ensure that the treatment apparatus is not displaced during performance of a procedure on the patient.

20

The fan may include a variable speed centrifugal fan.

25 In accordance with a second aspect, there is provided a kit of parts arranged to be assembled for forming any one of the preceding treatment apparatus. The kit of parts may include the plurality of panels arranged to form the chamber, wherein the plurality of panels are substantially flat and are arranged to be flat-packed together. The ability for the plurality of panels to be flat-packed improves a portability of the treatment apparatus, and enables the panels to be easily transported, stored or to be disinfected.

30

In accordance with a third aspect of the present invention, there is provided a method of deploying a treatment apparatus, the treatment apparatus comprising a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein, a fan adapted to connect to an air filter, and an exhaust opening provided in one of the plurality of panels adapted to connect to the fan, the fan being adapted to

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generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space, the method comprising: assembling the plurality of panels to form the chamber; connecting the fan to the exhaust opening; and using the fan for generating the  
5 air flow from the confined space, via the air filter, to the external environment to draft the air from the external environment into the confined space to ventilate the confined space.

The method may comprise decontaminating interior surfaces of the chamber before and after each use of the treatment apparatus. This improves a hygiene of the treatment  
10 apparatus, particularly, if the treatment apparatus is to be reused on a next patient.

The method may comprise using the fan to provide at least 15 or more air exchanges between the confined space and the external environment.

15 In accordance with a fourth aspect, a treatment apparatus for at least partially enclosing a patient therein during treatment is described. The treatment apparatus comprising: flat-packable wall panels deployable to form a chamber for providing a confined space for at least partially enclosing the patient therein; a top panel securable to the wall panels when deployed; an exhaust opening provided in one of: the top panel and the wall panels for  
20 allowing air from the confined space to flow to an external environment; and through holes provided in the wall panels adapted to provide access to the confined space.

The treatment apparatus may comprise snap-in flanges each provided to engage a perimeter of each of the through holes for securing to each of the through holes at least one  
25 of: a cover of the through hole and a user protection sleeve.

The treatment apparatus may comprise a fan adapted to connect to an air filter, wherein the exhaust opening may be adapted to connect to the fan, and the fan may be adapted to generate an air flow from the confined space, via the air filter, to the external environment  
30 for drafting air from the external environment into the confined space to ventilate the confined space.

The fan may include a portable vacuum pump system for field deployment.

35 In accordance with a fifth aspect, there is provided a treatment apparatus comprising: a plurality of panels assembled to form a chamber to provide a confined space for at least

partially enclosing a patient therein; a vacuum pump adapted to connect to an air filter; and an exhaust opening provided in one of the plurality of panels, the exhaust opening being adapted to connect to the vacuum pump, wherein the vacuum pump is adapted to generate an air flow from the confined space, via the air filter, to an external environment for drafting  
5 air from the external environment into the confined space to ventilate the confined space.

It should be appreciated that features relating to one aspect may be applicable to the other aspects. Embodiments therefore provide a treatment apparatus that creates a physical barrier to protect healthcare providers providing aids to the patient from potential pathogens,  
10 germs and/or virus produced from the patient. Further, an exhaust opening is provided in the treatment apparatus. The exhaust opening is adapted to connect to a fan in connection to an air filter, and the fan is adapted to generate an air flow from the confined space to the external environment for drafting air from the external environment into the confined space to ventilate the confined space. In this way, the droplets and/or aerosol produced by the  
15 patient within the confined space can be filtered out before the air from the confined space is exhausted to the external environment, thereby minimising contamination of the external environment. Further, by generating this air flow between the confined space and the external environment, fresh air from the external environment can be drafted into the confined space to ventilate the confined space (note that the confined space is not air tight).  
20 This provides an oxygen-enhanced environment for the patient during performance of the procedure. The aforementioned set-up therefore enables air exchanges between the confined space and the external environment which help to remove droplets and/or aerosols within the confined space, while providing an oxygen-enhanced environment for the patient.

### 25 **Brief Description of Drawings**

Embodiments of the disclosure will now be described, by way of example only, with reference to the following drawings, in which:

Figure 1 shows a treatment apparatus in a deployed state according to an embodiment, the  
30 treatment apparatus as shown includes a plurality of panels assembled to form a chamber and a fan or a vacuum pump connected to an exhaust opening of the treatment apparatus;

Figure 2 shows the plurality of panels of the treatment apparatus of Figure 1 in a storage or flat-packed state;

35 Figure 3 shows the treatment apparatus of Figure 1 together with removable snap-in flanges

which can be fitted onto through holes of the plurality of panels according to an embodiment;

Figure 4 shows an integrated locking feature of the treatment apparatus according to an embodiment, where during deployment, the plurality of panels are unfolded to form the chamber with a top panel of the plurality of panels being connected to side panels of the plurality of panels using a peg-in-hole type of locking feature;

Figure 5 shows the fan unit or the vacuum pump being connected to the exhaust opening of the treatment apparatus of Figure 1 according to an embodiment; and

Figure 6 shows various dimensions of the treatment apparatus of Figure 1 according to an embodiment, where the dimensions as shown are measured in millimetres.

### **Description**

The following description is merely exemplary in nature and is not intended to limit the disclosure or the application and uses of the disclosure. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following description.

Exemplary embodiments relate to a treatment apparatus and a method for deploying a treatment apparatus.

In the present embodiment, there is provided a treatment apparatus serving as a protective equipment for healthcare workers when they treat patients with contagious diseases. In particular, the treatment apparatus comprises a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein. An exhaust opening is provided in one of the plurality of panels, and is adapted to connect to a fan. The fan is adapted to connect to an air filter, and is configured to generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space. This air flow created by the fan drafts air into the confined space based on the Bernoulli's principle. It should be noted that the chamber is not air-tight and therefore air from the external environment can enter the chamber (e.g. from through holes formed in the panels and/or gaps in the chamber) to create an oxygen-enhanced environment for the patient during performance of the procedure. It should be appreciated that the physical principle of the air flow is such that a partial vacuum needs not be created within the confined space to draft

air from the external environment into the confined space. Rather, the generated air flow from the confined space, via the air filter, to the external environment drafts air from the external environment to the confined space due to the principle of mass continuity (or conservation of mass). A circulation of air is therefore generated by the treatment apparatus  
5 of the present invention, where air from the confined space is being purified by the air filter and exhausted out to the external environment, while fresh air from the external environment enters into the confined space of the chamber to provide an oxygen-enhanced environment for the patient.

10 Figure 1 shows a treatment apparatus 100 in a deployed state according to an embodiment. As shown in Figure 1, the treatment apparatus 100 includes a plurality of panels assembled to form a chamber 101. The plurality of panels includes three wall panels 102, 104 and 106 forming the walls of the chamber 101, and a top panel 108 connected to top edges of the three wall panels 102, 104, 106. In the present embodiment, a first and second through  
15 holes 102a, 102b are provided in a front panel 102 of the wall panels, while a third through hole 104a is provided in a side panel 104 of the wall panels. These through holes (102a, 102b, 104a) are adapted to provide accessibility to the confined space within the chamber 101. Also shown in Figure 1 is an exhaust opening 110. The exhaust opening 110 is a through hole through the top panel 108 and provides a passage for air to flow from the  
20 confined space and the external environment (i.e. environment outside of the confined space of the chamber 101). The exhaust opening 110 provides a connection to a fan (or a vacuum pump) 112. The exhaust opening 110 may be adapted to connect to the fan 112 using a port. It should be appreciated that the connection of the exhaust opening 110 to the fan 112 should be air-tight to ensure good suction strength of the fan 112 is maintained.  
25 It should also be appreciated that term “fan” should be understood as any form of mechanism which allows air to be drawn out of the confined space to the external environment. In an embodiment, the fan includes a variable speed centrifugal fan. The fan may therefore be adapted to transport a gas load from the confined space via the exhaust opening to the external environment through an outlet of the fan. In the present embodiment,  
30 the fan 112 is connected to an air filter (not shown) for filtering the air exhausted from the confined space to the external environment. The air filter may be connected between the exhaust opening and the fan, or at the outlet of the fan. By drawing or pumping air out from the confined space to the external environment, air is drafted from the external environment to the confined space to ventilate the confined space. This creates a continuous air flow  
35 from the external environment into the confined space of the chamber 101, and then out through the exhaust opening 110, via the air filter, to the external environment. In the

present embodiment, the air flow created is a laminar air flow. This laminar air flow allows for pathogen-carrying droplet and aerosol laden air within the chamber 101 to be filtered out. This movement of air from the confined space of the chamber 101 to the external environment is advantageous as this reduces the amount of unfiltered air leak occurring from the non-sealable edges of the chamber 101. The laminar air flow created minimises flow turbulence within the chamber 101 of the treatment apparatus 100, thereby preventing possible accumulation or trapping of pathogen-carrying droplets and/or aerosols at corners of the chamber 101.

10 The present embodiment with the exhaust opening 110 may also be fitted in rooms or facilities having integrated air suction/pumps at, for example, the ceilings or walls of the rooms or facilities. In the present embodiment, a velocity of the air flow is greater than 0.45 m/s. In some embodiments, the velocity of the air flow is in a range between 0.25 m/s to 0.32 m/s. In an embodiment, a pressure difference  $\Delta P$  created between the confined space and the external environment is in the range of 0.3 to 0.8 Nm<sup>-2</sup>.

In the present embodiment, the air filter is arranged between the fan 112 and the exhaust opening 110. The air filter includes a High Efficiency Particulate Air (HEPA) filter which is capable of filtering sub-micron size particles including any infectious particles emitted by the patient. The air exhausted from the chamber 101 through the exhaust opening 110 via the air filter to the external environment is therefore treated/filtered before being discharged into the external environment. In an embodiment, the fan 112 comprises an air filter. In some embodiments, the air filter may be a separate component to the fan 112. In these cases, the exhaust opening 110 may be connected, via the air filter, to the fan 112. In an embodiment, the air filter may be connected to the outlet of the fan so that the fan 112 is operationally connected between the exhaust opening and the air filter.

In the present embodiment, the treatment apparatus 100 is also known as "DART" (Droplet and Aerosol Reducing Tent) and is useful in creating a confined space that contains the droplets and/or aerosol and limits environmental contamination. The DART not only creates a physical barrier between the droplets and/or aerosol and the healthcare providers, but also allows the relatively the fine droplets in the air and/or aerosol within the confined space of the chamber 101 to be suctioned out prior to lifting of the chamber 101. Further, as explained above, the suction of air from the confined space through the exhaust opening 110 causes air to be drafted into the confined space from the external environment, thereby providing the patient with an oxygen-enhanced environment.

In the present embodiment, the top panel 108 and the wall panels 102, 104, 106 are made of polycarbonate. The high material strength and light weight of polycarbonate makes the panels 102, 104, 106, 108 portable. The surfaces of polycarbonate can also be transparent to aid visibility of the patient through the panels 102, 104, 106, 108, and can be easily disinfected. The cost of polycarbonate is also relatively low so that these panels 102, 104, 106, 108 can be replaced or disposed if necessary. It should be appreciated that other materials for forming these panels 102, 104, 106, 108 are possible as long as these panels are disposable or amenable to standard methods of disinfection. Also it should be recognised that these panels should be light weight to allow for manoeuvrability and/or portability, and should be transparent to allow for visibility and access to the patient.

As shown in Figure 1, these panels 102, 104, 106, 108 are each connected to at least one adjacent panel. The front panel 102 is connected to the side panels 104, 106 on opposite sides of the front panel 102, while the front panel 102 is connected to the top panel 108 on a third side between the two opposite sides. The plurality of panels 102, 104, 106, 108 are connected to one another via at least one living hinge 114. In the present embodiment, each living hinge is made of carbon reinforced nylon. Further, as shown in Figure 1, to reinforce the strength of the living hinge or the connection between adjacent panels, additional hinges 116 may be used. It should be appreciated that in alternative embodiments, other form of hinges can be used as long as the panels are connected to one another in such a manner that they can be form the chamber 101 in the deployed state as shown in Figure 1.

Figure 2 shows the plurality of panels 102, 104, 106 and 108 of the treatment apparatus 100 of Figure 1 in a storage or flat-packed state. The plurality of panels 102, 104, 106, 108 connected in the manner as described above allows the panels 102, 104, 106, 108 to be folded on top of one another in a flat-packed or storage state 200. At the same time, the plurality of panels 102, 104, 106, 108 can be unpacked and deployed to form the chamber 101 as shown in Figure 1. Flat-packing of the panels 102, 104, 106, 108 allows for easier transportation, storage, and disinfection of these panels. This is advantageous particularly because rapid deployment of these panels 102, 104, 106, 108 to form a physical barrier saves precious time in emergency situations while continuing to provide adequate protection for these healthcare workers. The panels which are made of polycarbonate are robust enough with rigid sides to provide a stable physical barrier while care is provided to the patient. The panels are also light enough for healthcare workers to manage easily. As discussed above, the plurality of panels 102, 104, 106, 108 should be made of material

which is light and rigid, and easy to clean or disinfect.

Figure 3 shows the treatment apparatus 100 of Figure 1 together with removable snap-in flanges 302a, 302b, 304a which can be fitted onto through holes of the plurality of panels according to an embodiment. As shown in Figure 3, the removable snap-in flanges 302a, 302b, 304a are each provided to engage a perimeter of each of the through holes 102a, 102b, 104a for securing to each of the through holes 102a, 102b, 104a at least one of: a cover for the through hole and a user protection sleeve. The snap-in-flanges 302a, 302b, 304a allow for customizability of arm port covering (sleeves or diaphragm). The snap-in-flanges 302a, 302b, 304a also allow the cover or the user protection sleeve to be removable and to be replaced if necessary. This eases cleaning of these covers or protection sleeves, and alleviates concerns about their contamination. Further, the through holes and the removable snap-in flanges can also be customized to allow for different preferences, usability, and availability. The snap-in flanges should be flexible enough to be fitted into the through holes with relative ease, and should be strong enough for regular cleaning or disinfection. In the present embodiment, each snap-in flange is made of polyoxymethylene.

Figure 4 shows an integrated locking feature of the treatment apparatus 100 according to an embodiment. During deployment of the treatment apparatus 100, the plurality of panels 102, 104, 106, 108 are unfolded to form the chamber 101 with the top panel 108 being connected to the side panels 104, 106 using a peg-in-hole type of locking feature 402. For clarity, Figure 4 is a blown-up schematic which is showing only one of these locking features 402 at one side of the top panel 108, although it should be appreciated that an equivalent locking feature 402 can be formed at an opposite side of the top panel 108 to secure the top panel 108 to the other side panel 104. As shown in Figure 4, the peg-in-hole type of locking feature 402 includes a peg 404 attached to the side panel 106 and a complementary hole 406 which is fixedly connected to a side of a bottom surface of the top panel 108. When the plurality of panels 102, 104, 106, 108 are deployed, the peg 404 is fitted into the complementary hole 406 so that the top panel 108 is secured to the side panel 106. It should be appreciated that other types of fitting joint/arrangement can be made as long as the top panel 108 can be removably secured to the side panels 104, 106 when the treatment apparatus 100 is deployed. Also shown in Figure 4, the top panel 108 is connected to a top edge of one of the wall panels 106 via at least one living hinge 114. During deployment of the treatment apparatus 100, the top panel 108 can be flipped downwards so that the complementary holes 406 at the sides of the bottom surface of the top panel 108 can be engaged with the pegs 404 attached to the side panels 104, 106.

Figure 5 shows the fan unit 112 (or a vacuum pump) being connected to the exhaust opening 110 at the top panel 108 of the treatment apparatus of Figure 1 according to an embodiment. In the present embodiment, the fan 112 comprises at least one ultra violet C (UV-C) light column (not shown) arranged within an air column of the fan 112 and is adapted to emit UV light to treat exhaust air within the air column. The UV light may have a wavelength between about 200 nm and 300 nm, which is strongly absorbed by nucleic acids for disinfection of infectious particles or microorganisms. It should be appreciated that the UV-C light column is an optional feature. The fan 112 may be a portable fan (or a portable vacuum pump system) which can be deployed in an external setting (e.g. for field deployment). In this external setting, the fan 112 may allow at least 15 air exchanges per hour. In another embodiment, the fan 112 may be an indoor fan system (or an indoor vacuum pump system) that is suitable for an indoor setting (e.g. integrated fan system in a hospital or clinic). Similar frequency for air exchanges (i.e. 15 or more air exchanges per hour) can be used in the indoor setting. This frequency is advantageous for the present COVID-19 pandemic.

In an embodiment, an additional through hole or opening 502 can be provided in the top panel 108. This through hole or opening 502 can provide additional access to the confined space of the chamber 101.

Figure 6 shows various dimensions of the treatment apparatus of Figure 1 according to an embodiment, where the dimensions as shown are measured in millimetres. The dimensions of the treatment apparatus may be customised to suit the size of the patient (e.g. different sizes for children and adults).

A method of deploying the treatment apparatus 100 of Figure 1 is described. The method comprises: assembling the plurality of panels 102, 104, 106, 108 to form the chamber 101; connecting the fan 112 to the exhaust opening 110; and using the fan 112 for generating the air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space. It would be appreciated by the skilled person in the art that when the treatment apparatus 100 is deployed, it can be placed in an area over the head of a patient and up to the shoulders of the patient. With the chamber 101 having three wall panels 102, 104, 106, the remaining body of the patient can be protruded out from the open side of the chamber 101. The patient is therefore partially enclosed in the confined space of the chamber 101. In an embodiment

where a covering attached to the top panel 108 is provided, the covering can be used to lay over a portion of the remaining body of the patient on the open side of the chamber 101 (i.e. opposite side to the front panel 102), thereby creating a more confined environment within the chamber 101.

5

In the present embodiment, the plurality of panels 102, 104, 106, 108 may be stored in the flat-packed or storage state 200 as shown in Figure 2 initially. To deploy the treatment apparatus 100, the plurality of panels 102, 104, 106, 108 are unfolded from the flat-packed state 200. Pegs 404 on each of the side panels 104, 106 are then fitted into the  
10 complementary holes 406 located at the sides of the top panel 108 (or located at a bottom surface at the sides of the top panel 108) to secure the side panels 104, 106 to the top panel 108 to assemble the plurality of panels 102, 104, 106, 108 to form the chamber 101. A fan 112 adapted to connect to an air filter can then be connected to the exhaust opening 110 at the top panel 108. The fan 112 can then be turned on to generate the air flow from the  
15 confined space, via the air filter, to the external environment for drafting air from the external environment into the confined space to ventilate the confined space.

In the present embodiment, the method of deploying the treatment apparatus 100 includes providing a number of snap-in flanges each provided to engage the perimeter of each of  
20 the through holes for securing to each of the through holes at least one of: a cover of the through hole and a user protection sleeve. This is an optional step and it should be appreciated that in some embodiments, snap-in flanges and/or covers or user protection sleeve may not be required.

In an embodiment, the method comprises decontaminating interior surfaces of the chamber 101 before and after each use of the treatment apparatus 100. The work surfaces and interior walls of the chamber 101 can be disinfected with any suitable means that will kill  
25 any infectious particles or microorganisms within the confined space of the chamber 101. For example, surface decontamination can include steam sterilization or a wipe-down of the work surfaces, the sides, back and interior of the panels. In an embodiment, a solution of HOCl / bleach or 70% alcohol which is effective against micro-organisms can be used. In  
30 some cases, a second wiping with sterile water is needed if a corrosive disinfectant, such as bleach, is used. The sterilization process, such as wipe down sequence, number of times of wipe down and/or concentrations of detergents used can be customized depending on  
35 the size of infectious particles on the surface of the panel.

In an embodiment, the method comprises maintaining use of the fan 112 during a procedure or after the procedure on the patient is completed. This can be achieved by leaving the fan 112 to run for an extensive period of time or to use the fan 112 to provide a few rounds of air exchanges between the confined space in the chamber 101 and the external environment. This helps to ensure that the atmosphere inside the chamber 101 is purged to reduce the air bioburden before the fan 112 is switched off or removed.

In one embodiment, the method comprises of covering the confined space of the chamber 101 using a covering (e.g. a drape or a hood) connected to the top panel 108 when the patient is partially enclosed therein.

Alternative embodiments of the invention include: (i) placement and number of through holes provided in the panels can be configured depending on accessibility and needs (e.g. through holes provided in the top panel 108 or another side panel 106 of the chamber 101); (ii) the exhaust opening being provided near a bottom of a side panel for connection to a fan adapted to connect to an air filter; (iii) the air filter is a ULPA (Ultra Low Penetration Air) filter; (iv) a number of through holes are provided in the top panel and is adapted to provide accessibility to the confined space; (v) a covering (e.g. a patient drape or hood) connected to the top panel, the covering may be adapted to cover at least an opposite side of the chamber to the front panel for enclosing the confined space; (vi) the plurality of panels 102, 104, 106, 108 are made of polyvinyl chloride (PVC) or acrylic; (vii) two wall panels (instead of the three wall panels shown in Figure 1) to form a chamber with a triangular footprint; (viii) the panels 102, 104, 106, 108 are individual modules which are separated and only assembled together when deployed, e.g. via living hinges that are provided as removable strips that can be slid into grooves provided at the edges of the panels to connect the panels 102, 104, 106, 108, (ix) one or more ultra violet C (UV-C) light columns are arranged within the confined space and is adapted to emit UV light towards a surface of the panel to sterilize it, (x) the plurality of panels 102, 104, 106, 108 are assembled together to create gaps there between which provide accessibility to the confined space (e.g. in place of, or in addition to, through holes which are formed in the panels as shown in Figure 1); (xi) the snap-in flanges 302a, 302b, 304a being optional and may not be provided; (xii) any coverings or protection sleeves provided at the through holes 102a, 102b, 304a being optional; (xiii) fastening means connected to a bottom side of one of the wall panels for securing a position of the treatment apparatus, (xiv) a cap for fitting into the exhaust opening 110; (xv) using a vacuum pump in place of the fan 112.

In relation to point (ii) of the alternative embodiments, vapours within the confined space of the treatment chamber can sometimes be dense and can prevent infectious particles or micro-organisms from rising up. By providing an exhaust opening near the bottom of a side panel for connection to a fan that is connected to an air filter in these cases, the infectious particles or micro-organisms which are mostly located near the bottom of the treatment chamber can be more effectively suctioned out through the exhaust opening by using the fan. In an embodiment, the exhaust opening is provided at a range of 1.0 to 6.0 cm from a bottom end of the side panel.

In relation to point (iii) of the alternative embodiments, the UCLA filter has a filtration rate of 99.999% at 0.12 microns. ULPA filters effectively capture and filter surgical smoke to remove odour, particulates, and other potentially hazardous by products of electro-surgery procedures. Coupling this feature of low particle penetration with sterilisation of air e.g. with UV-C, this ensure that contaminated air from the confined space of the chamber 101 is effectively treated before being admitted to the external environment. This is particularly important for facilities which have no airlock and thereby allow air to be recirculated back by the AHU (air handling unit) for air conditioning.

In relation to point (viii) of the alternative embodiments, having the panels as individual modules improve the ease of replacing each of these panels. This also aids in the disposal of individual panel or the sterilization of each of these panels.

In relation to point (ix) of the alternative embodiments, the UV-C light may have a wavelength between about 200 nm and 300 nm which are strongly absorbed by nucleic acids for disinfection of infectious particles or microorganisms. Infectious particles emitted from the patient would come into contact with the surfaces of the panels and there is a need for constant sterilization. The UV-C is effective in removing infectious particles or micro-organisms and thus keeping the patient safe within the confined space of the treatment chamber. The combination of both filtration of at least at 0.3 um and UV-C will provide an adequate level of safety for healthcare workers performing e.g. AGPs on a patient, particularly if the facility has 60% return air mixture.

In relation to point (xiv) of the alternative embodiments, a cap which can be fitted into the exhaust opening is provided. The cap can be used to seal the exhaust opening. In an embodiment where the fan and/or the air filter is not made available, the cap can be fitted to the exhaust opening to minimize air flowing from the confined space to the external

environment.

- In relation to point (xv), in an embodiment where a vacuum pump is used, an air flow generated by the vacuum pump may create a pressure difference between the external environment and the confined space. Particularly, a lower pressure is created in the confined space in relation to the external environment as air is being drawn from the confined space, via the air filter, to the external environment. In turn, this relatively lower pressure creates a flow of air from the external environment to ventilate the chamber.
- 10 Although only certain embodiments of the present invention have been described in detail, many variations are possible in accordance with the appended claims. For example, features described in relation to one embodiment may be incorporated into one or more embodiments and *vice versa*.

## Claims

1. A treatment apparatus comprising:
  - a plurality of panels assembled to form a chamber to provide a confined
  - 5 space for at least partially enclosing a patient therein;
  - a fan adapted to connect to an air filter; and
  - an exhaust opening provided in one of the plurality of panels, the exhaust opening being adapted to connect to the fan,
  - wherein the fan is adapted to generate an air flow from the confined space,
  - 10 via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space.
2. The treatment apparatus of claim 1, wherein the fan comprises an ultra violet C (UV-C) light column adapted to emit UV-C light to treat the air from the confined space.
- 15 3. The treatment apparatus of claim 1 or 2, further comprising one or more ultra violet C (UV-C) light columns arranged within the confined space adapted to emit UV-C light towards at least a surface of one of the plurality of panels.
- 20 4. The treatment apparatus of claim 2 or claim 3, wherein the UV-C light has a wavelength between 200 nm and 300 nm.
5. The treatment apparatus of any one of claims 1 to 4, wherein the plurality of panels comprises wall panels and a top panel securable to the wall panels when deployed,
- 25 the top panel being arranged on top of the wall panels.
6. The treatment apparatus of claim 5, further comprising through holes in the wall panels, and the through holes being adapted to provide access to the confined space.
- 30 7. The treatment apparatus of claim 6, further comprising snap-in flanges each provided to engage a perimeter of each of the through holes for securing to each of the through holes at least one of: a cover of the through hole and a user protection sleeve.
- 35 8. The treatment apparatus of claim 7, wherein the snap-in flanges are made of

polyoxymethylene.

- 5
9. The treatment apparatus of any one of claims 5 to 8, wherein adjacent panels of the wall panels are connected to each other via at least one living hinge.
10. The treatment apparatus of any one of claims 5 to 9, wherein the top panel is connected to a top edge of one of the wall panels via at least one living hinge.
- 10 11. The treatment apparatus of claim 9 or claim 10, wherein the at least one living hinge is made of carbon reinforced nylon.
12. The treatment apparatus of any one of claims 5 to 11, wherein the top panel and the wall panels are made of polycarbonate.
- 15 13. The treatment apparatus of any one of claims 6 to 8, wherein the wall panels comprise a front panel and two side panels, and wherein the at least one through hole comprises two through holes provided in the front panel.
- 20 14. The treatment apparatus of claim 13, further comprising a covering connected to the top panel, the covering being adapted to cover at least an opposite side of the chamber to the front panel.
- 25 15. The treatment apparatus of any one of claims 5 to 14, wherein the exhaust opening is provided in the top panel.
- 30 16. The treatment apparatus of any one of claims 5 to 14, wherein the exhaust opening is provided near a bottom of one of the wall panels.
17. The treatment apparatus of any one of claims 1 to 16, wherein the air filter comprises a high efficiency particulate air filter.
18. The treatment apparatus of any one of claims 1 to 16, wherein the air filter comprises an ultra low penetration air filter.
- 35 19. The treatment apparatus of any one of claims 1 to 18, further comprising fastening means connected to a bottom side of one of the wall panels for securing a position of the treatment apparatus.

20. The treatment apparatus of any one of claims 1 to 19, wherein the fan includes a variable speed centrifugal fan.
21. A kit of parts arranged to be assembled for forming the treatment apparatus of any one of claims 1 to 20, the kit of parts include the plurality of panels arranged to form the chamber, the plurality of panels being substantially flat and are arranged to be flat-packed together.
22. A method of deploying a treatment apparatus, the treatment apparatus comprising a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein, a fan adapted to connect to an air filter, and an exhaust opening provided in one of the plurality of panels adapted to connect to the fan, the fan being adapted to generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space, the method comprising:
- assembling the plurality of panels to form the chamber;
  - connecting the fan to the exhaust opening; and
  - using the fan for generating the air flow from the confined space, via the air filter, to the external environment to draft the air from the external environment into the confined space to ventilate the confined space.
23. The method of claim 22, further comprising decontaminating interior surfaces of the chamber before and after each use of the treatment apparatus.
24. The method of claim 22 or claim 23, further comprising using the fan to provide at least 15 or more air exchanges between the confined space and the external environment.
25. A treatment apparatus for at least partially enclosing a patient therein during treatment, the treatment apparatus comprising:
- flat-packable wall panels deployable to form a chamber for providing a confined space for at least partially enclosing the patient therein;
  - a top panel securable to the wall panels when deployed;
  - an exhaust opening provided in one of: the top panel and the wall panels for allowing air from the confined space to flow to an external environment; and

through holes provided in the wall panels adapted to provide access to the confined space.

- 5 26. The treatment apparatus of claim 25, further comprising snap-in flanges each provided to engage a perimeter of each of the through holes for securing to each of the through holes at least one of: a cover of the through hole and a user protection sleeve.
- 10 27. The treatment apparatus of claim 25 or claim 26, further comprising a fan adapted to connect to an air filter, wherein the exhaust opening is adapted to connect to the fan, and the fan is adapted to generate an air flow from the confined space, via the air filter, to the external environment for drafting air from the external environment into the confined space to ventilate the confined space.
- 15 28. The treatment apparatus of claim 27, wherein the fan includes a portable vacuum pump system for field deployment.
- 20 29. A treatment apparatus comprising:  
a plurality of panels assembled to form a chamber to provide a confined space for at least partially enclosing a patient therein;  
a vacuum pump adapted to connect to an air filter; and  
an exhaust opening provided in one of the plurality of panels, the exhaust opening being adapted to connect to the vacuum pump,  
25 wherein the vacuum pump is adapted to generate an air flow from the confined space, via the air filter, to an external environment for drafting air from the external environment into the confined space to ventilate the confined space.

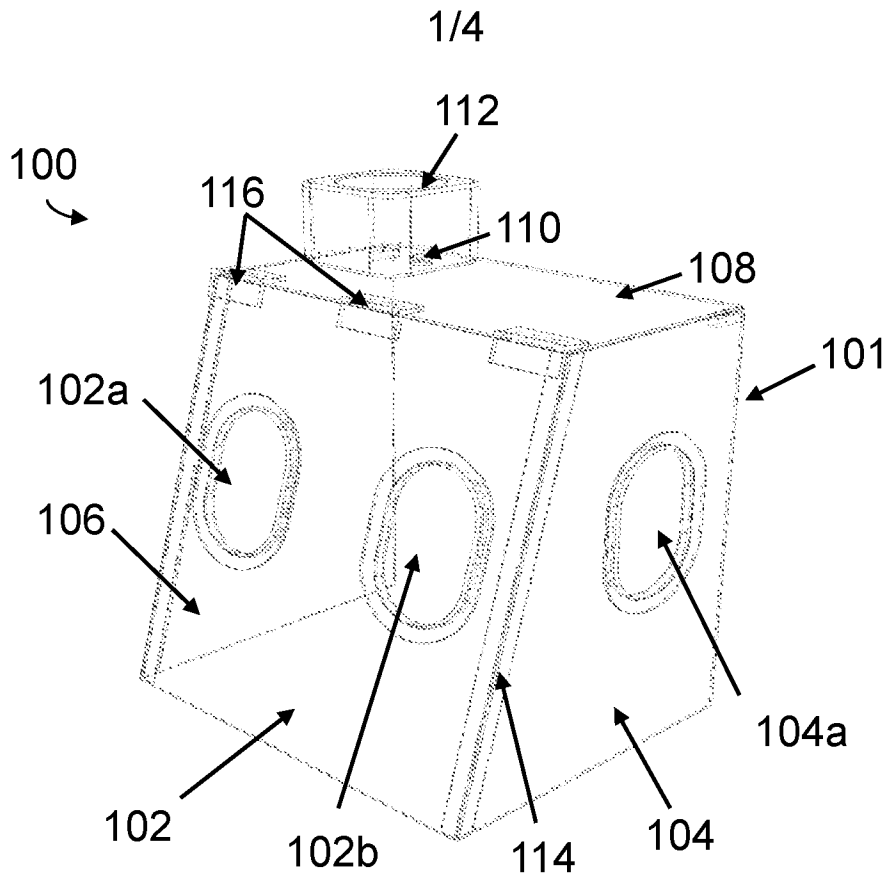


Figure 1

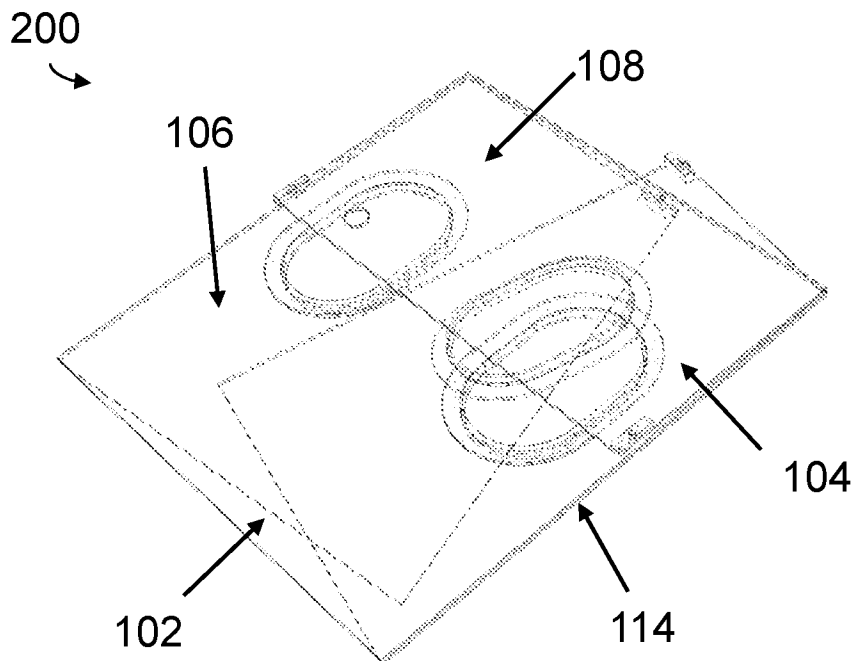
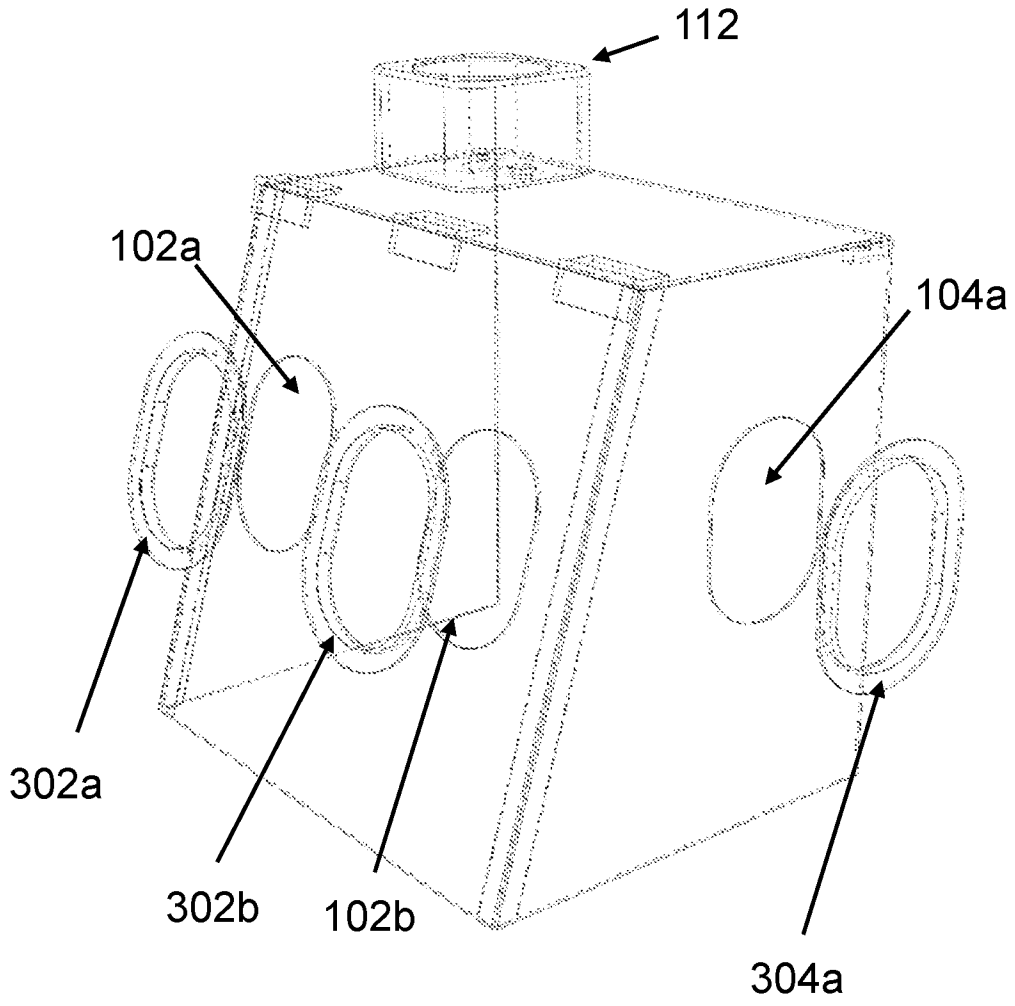


Figure 2



**Figure 3**

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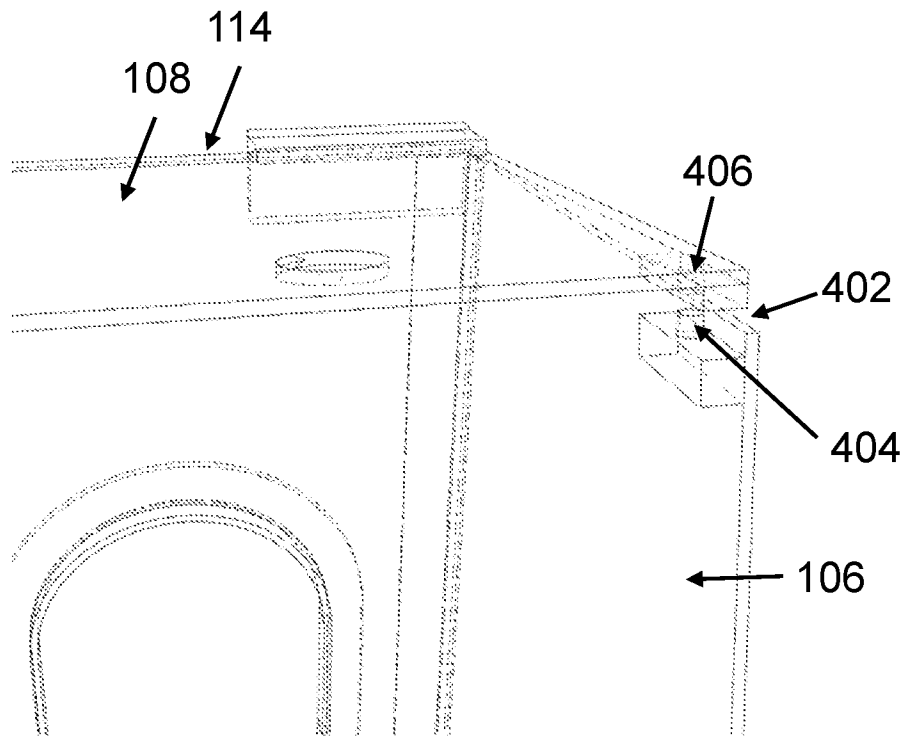


Figure 4

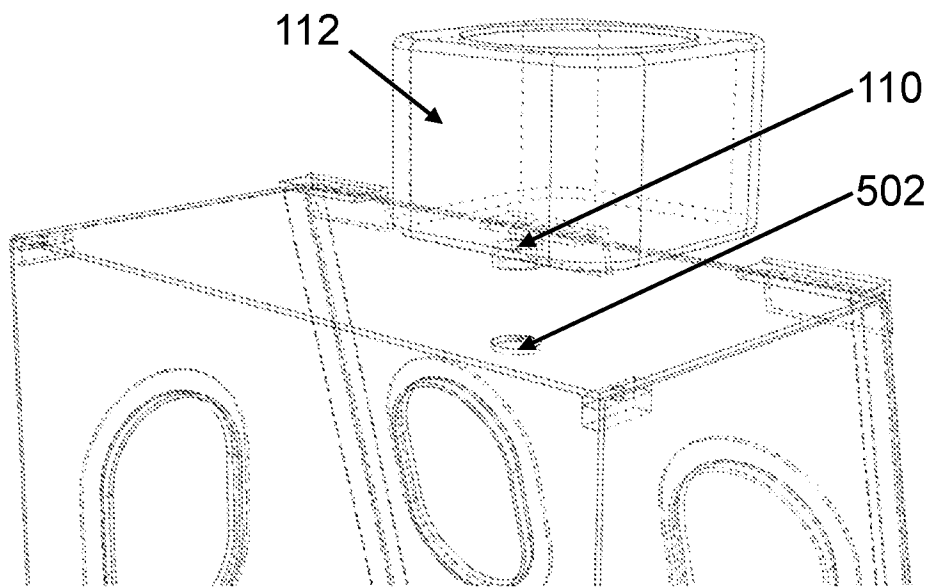


Figure 5

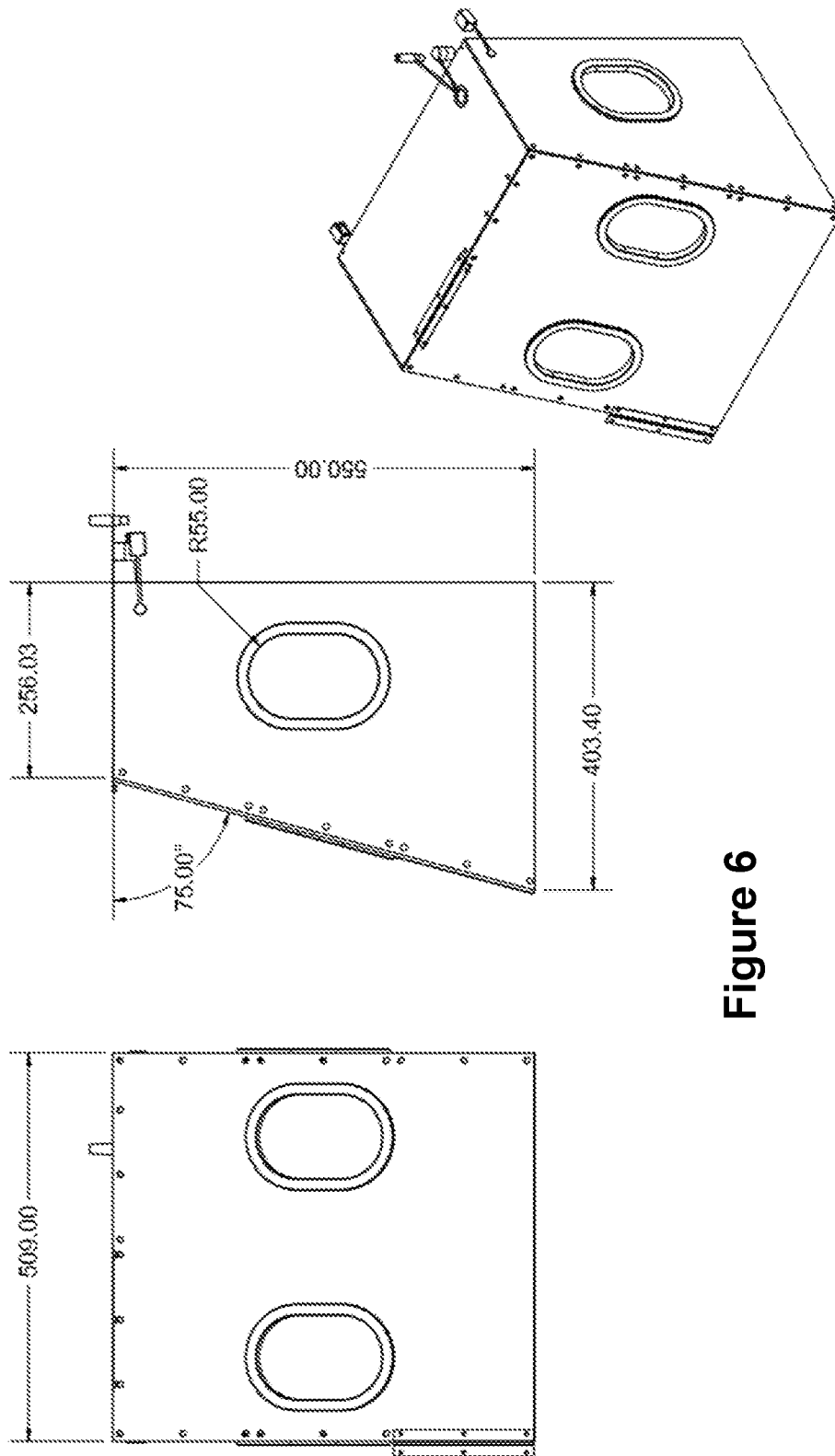



Figure 6

<b>INTERNATIONAL SEARCH REPORT</b>		International application No. <b>PCT/SG2021/050274</b>
<b>A. CLASSIFICATION OF SUBJECT MATTER</b> <b>A61B 90/00 (2016.01) A61G 10/00 (2006.01)</b> According to International Patent Classification (IPC)		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) A61B, A61G 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) FAMPAT: Chamber, panel, confined space, flat-packed, enclosure, fan, vacuum, filter, exhaust, aerosol, droplet, ambient, infectious and related terms		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5728041 A (FOWLER JR J. M.) 17 March 1998 Whole document, in particular Figures 1-6	1-24, 29
A	US 2008/0041399 A1 (KRIEK H. R.) 21 February 2008 Whole document	25-28
A	WO 2018/014003 A1 (SURGIBOX INC.) 18 January 2018 Whole document	-
P,X	CN 111437134 A (SHENZHEN MATERNITY & CHILD HEALTHCARE HOSPITAL) 24 July 2020 Whole document of the original non-English language document (a machine translation is enclosed <b>only</b> for your reference)	1, 21, 22, 25, 29
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input checked="" type="checkbox"/> 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 "D" document cited by the applicant in the international application "E" earlier application or patent but 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 01/07/2021 (day/month/year)		Date of mailing of the international search report 06/07/2021 (day/month/year)
Name and mailing address of the ISA/SG		Authorized officer
 <b>Intellectual Property Office of Singapore</b> 1 Paya Lebar Link, #11-03 PLQ 1, Paya Lebar Quarter Singapore 408533		<u>Cheng Chang</u> (Dr)
Email: pct@ipos.gov.sg		IPOS Customer Service Tel. No.: (+65) 6339 8616

<b>INTERNATIONAL SEARCH REPORT</b> Information on patent family members		International application No. <b>PCT/SG2021/050274</b>	
<i>Note: This Annex lists known patent family members relating to the patent documents cited in this International Search Report. This Authority is in no way liable for these particulars which are merely given for the purpose of information.</i>			
<b>Patent document cited in search report</b>	<b>Publication date</b>	<b>Patent family member(s)</b>	<b>Publication date</b>
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CN 111437134 A	24/07/2020	NONE	