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Childress et al.

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(54) **PORTABLE SANITIZING SYSTEMS AND METHODS**

(58) **Field of Classification Search**

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See application file for complete search history.

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 360 days.

This patent is subject to a terminal disclaimer.

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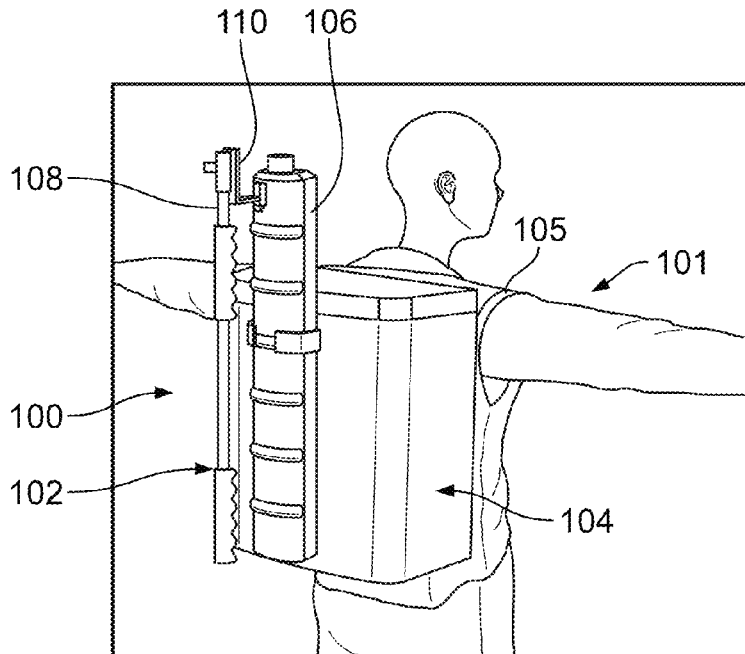
(51) **Int. Cl.**
A61L 2/10 (2006.01)

(52) **U.S. Cl.**
CPC **A61L 2/10** (2013.01); **A61L 2202/11** (2013.01); **A61L 2202/14** (2013.01); **A61L 2202/16** (2013.01); **A61L 2202/25** (2013.01)

(57) **ABSTRACT**

A portable sanitizing system and method includes a sanitizing head including an ultraviolet (UV) lamp. The UV lamp is configured to emit UV light having a wavelength between 200 nm-230 nm to disinfect a surface.

19 Claims, 12 Drawing Sheets



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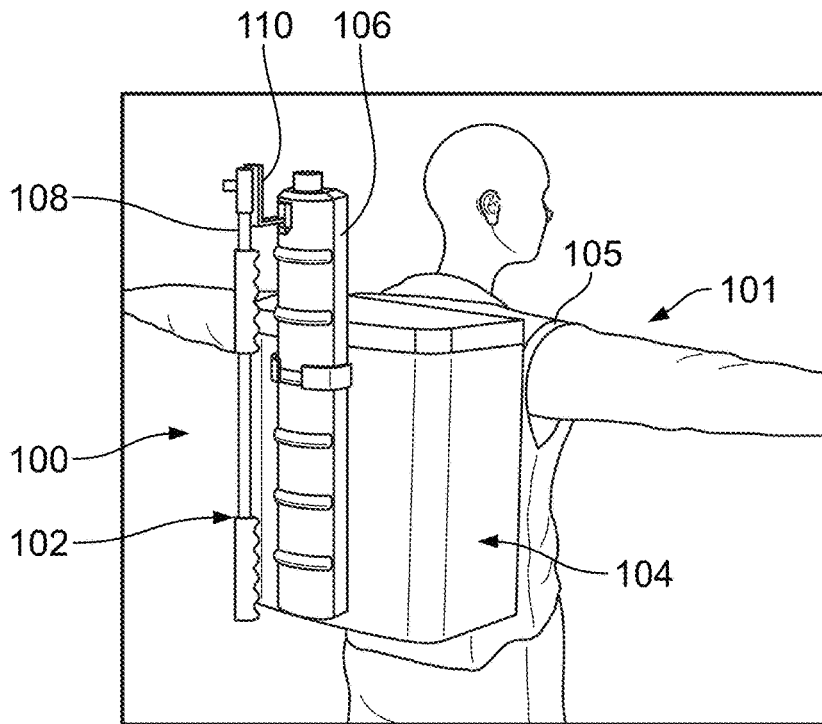


FIG. 1

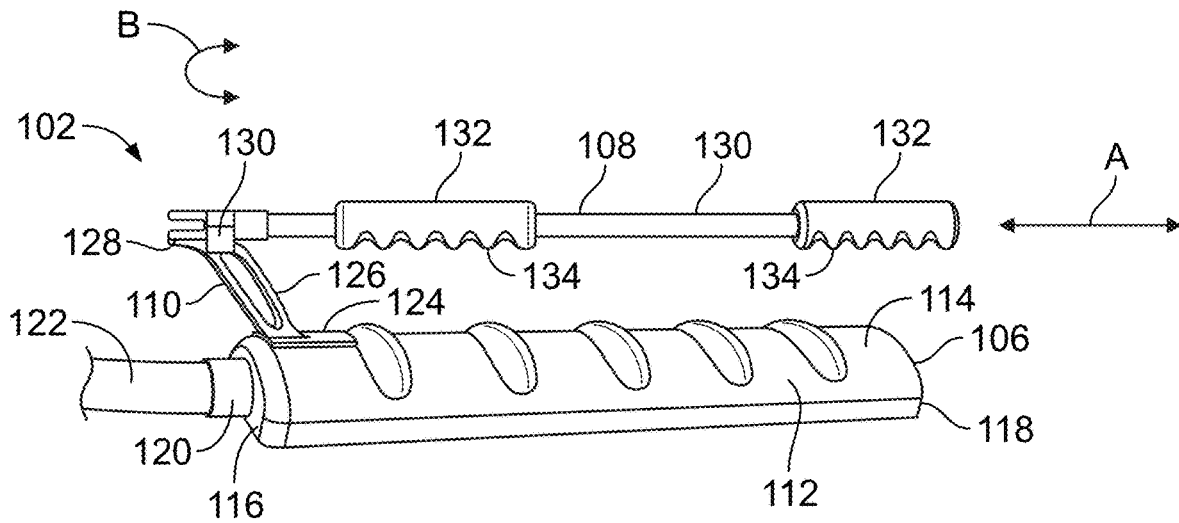


FIG. 2

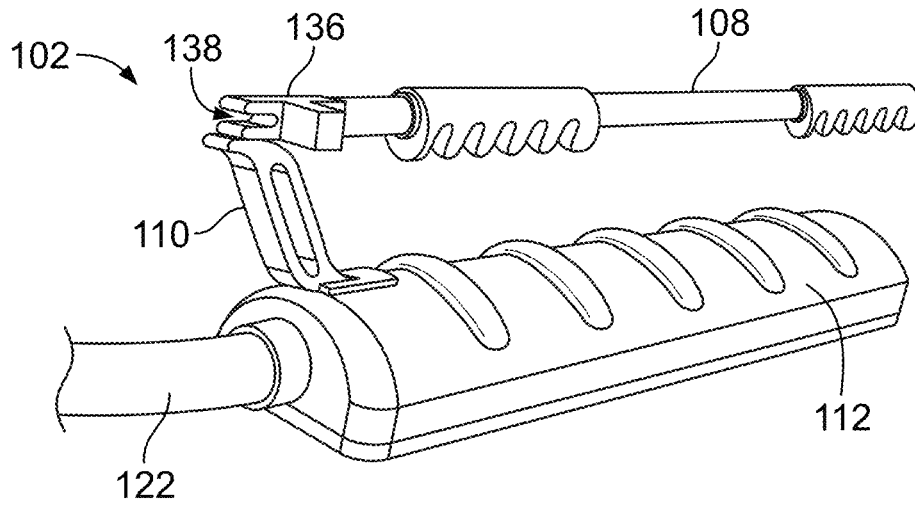


FIG. 3

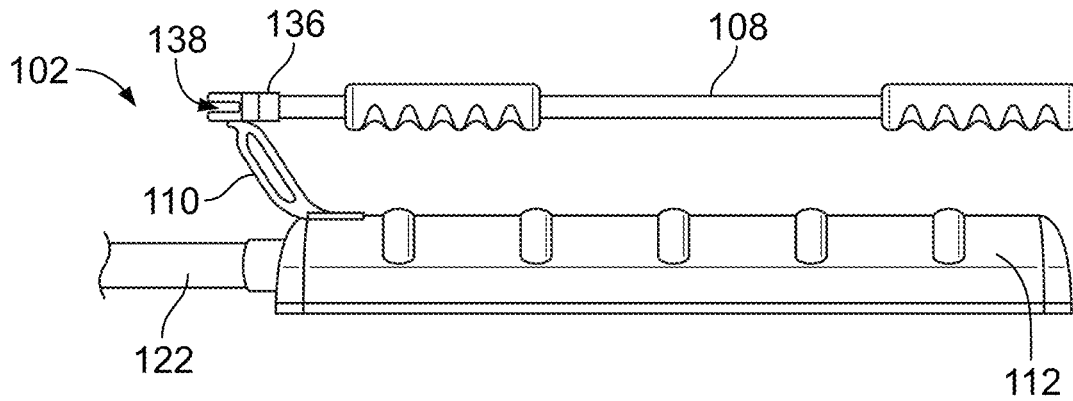


FIG. 4

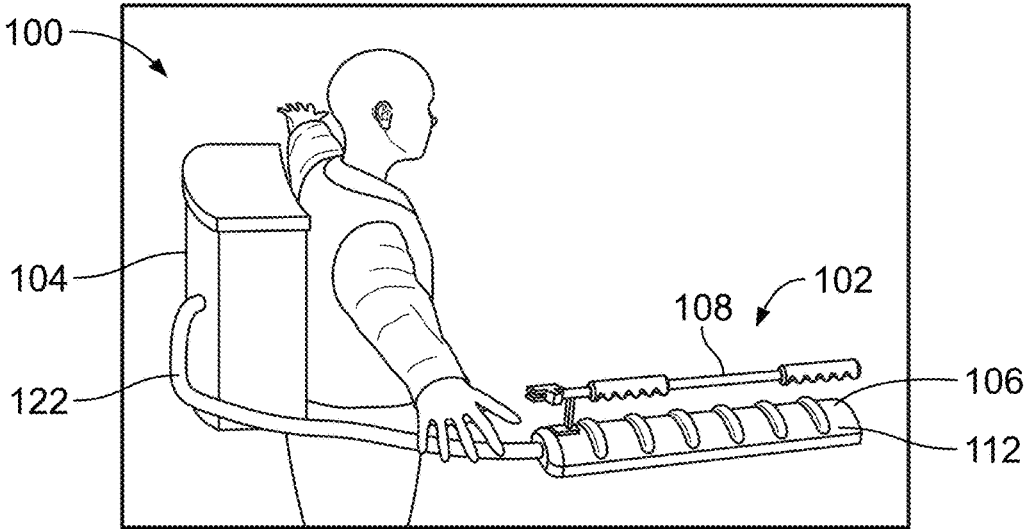


FIG. 5

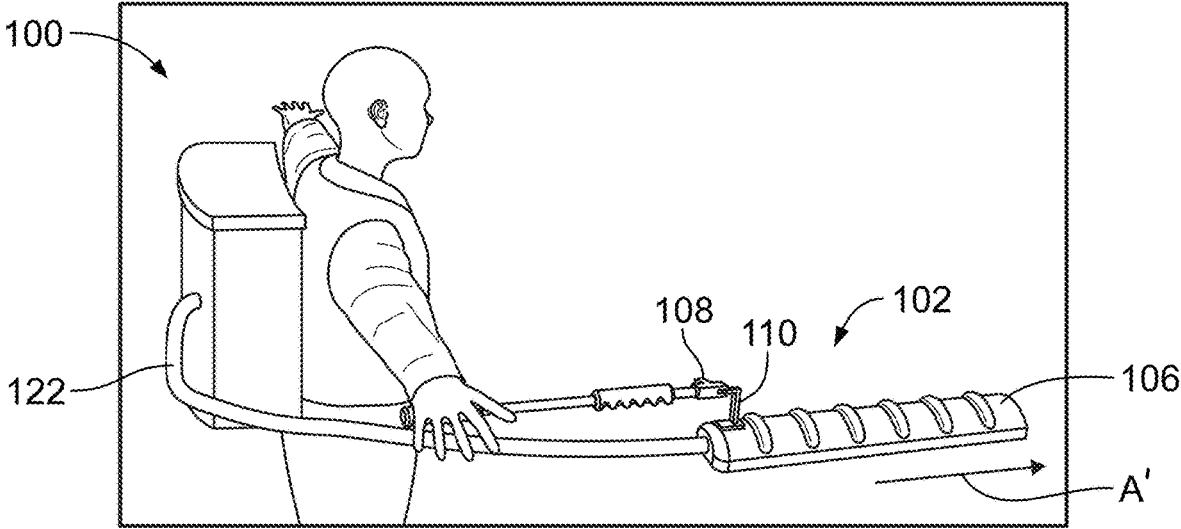


FIG. 6

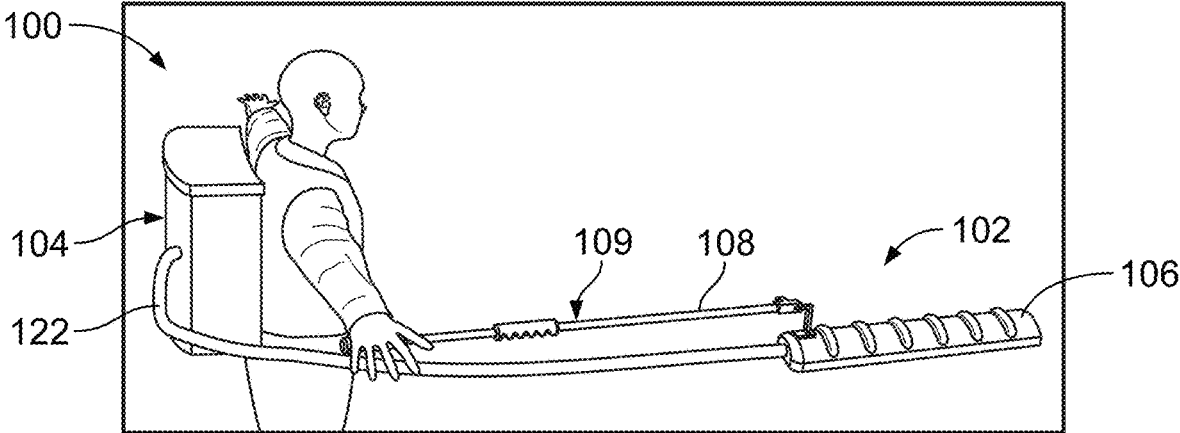


FIG. 7

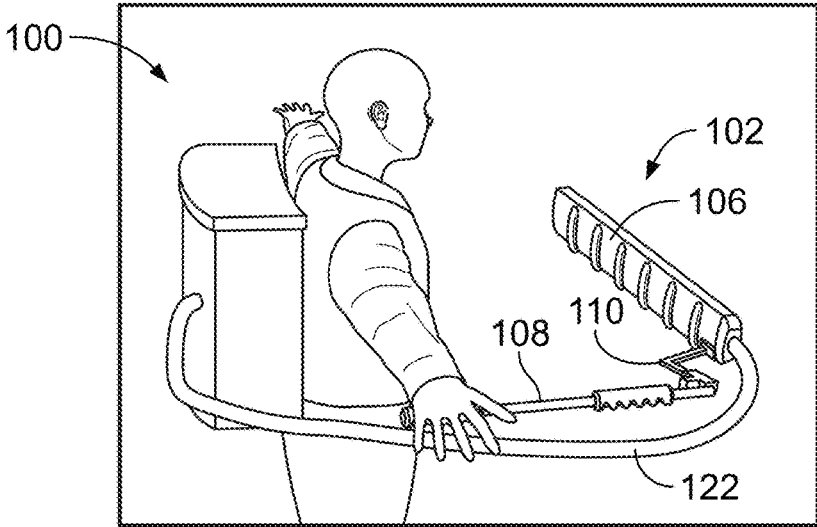


FIG. 8

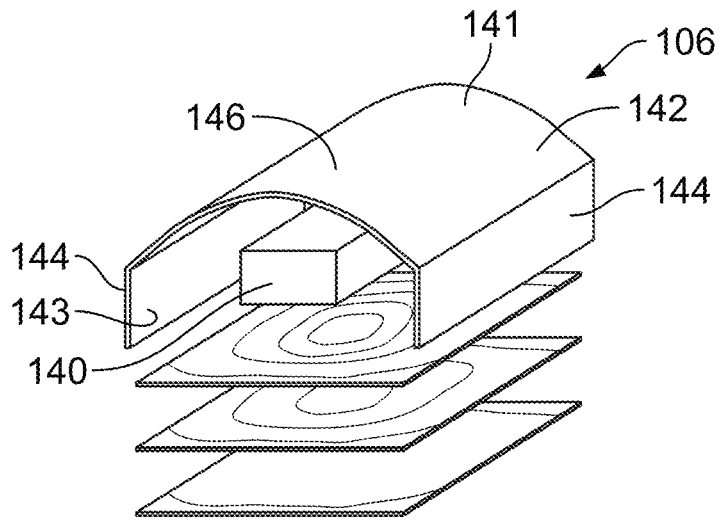


FIG. 9

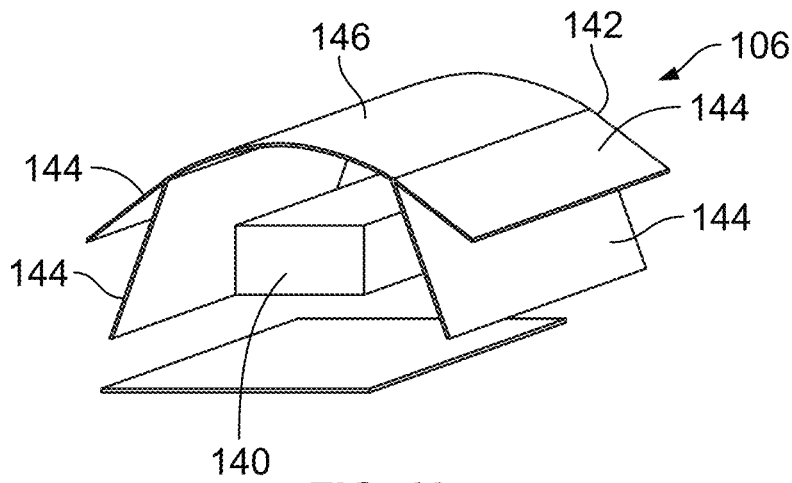


FIG. 10

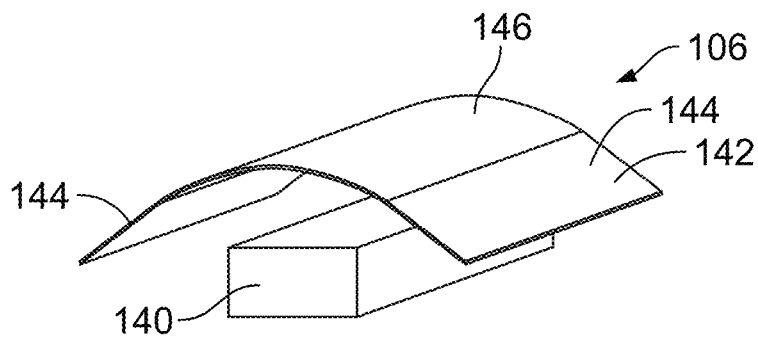


FIG. 11

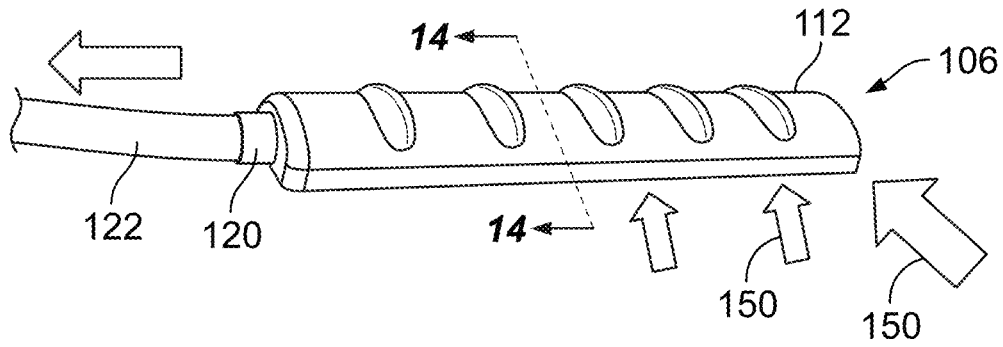


FIG. 12

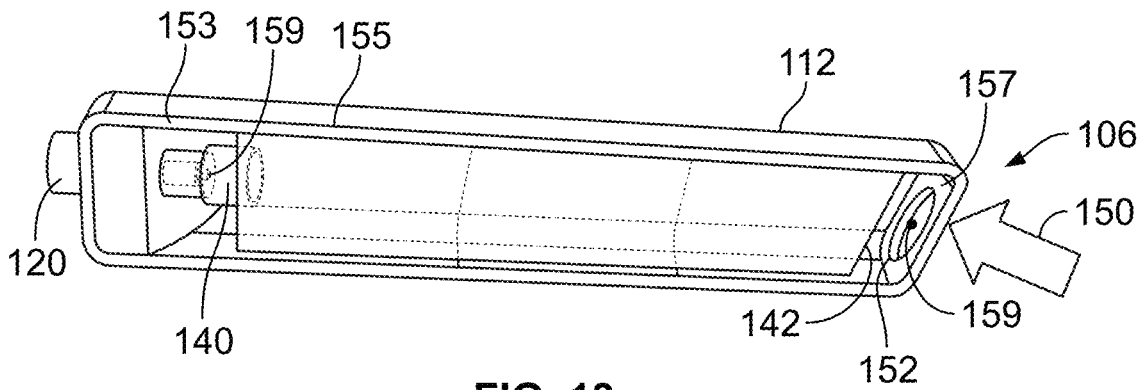


FIG. 13

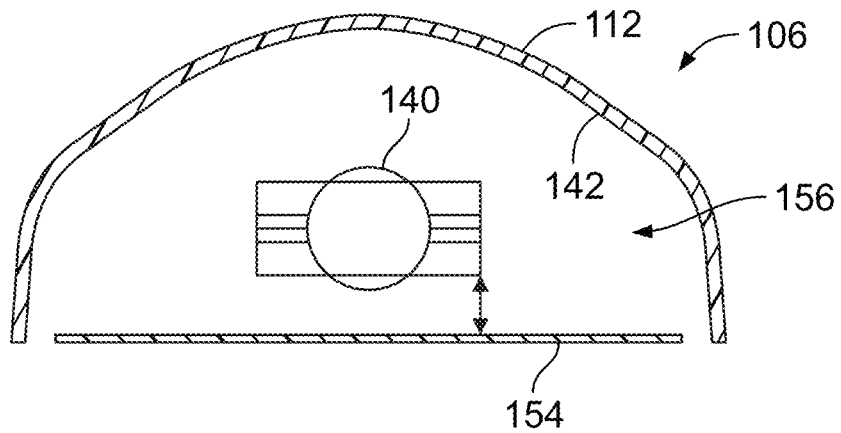


FIG. 14

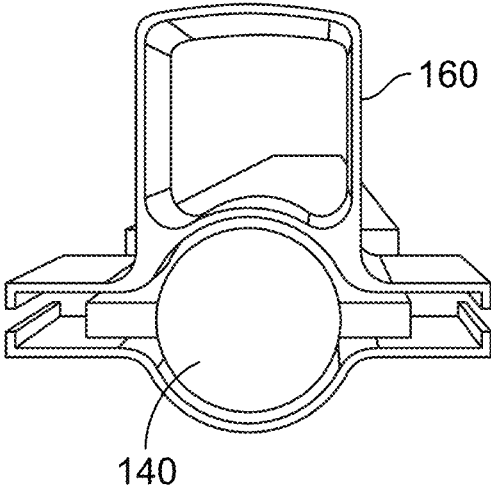


FIG. 15

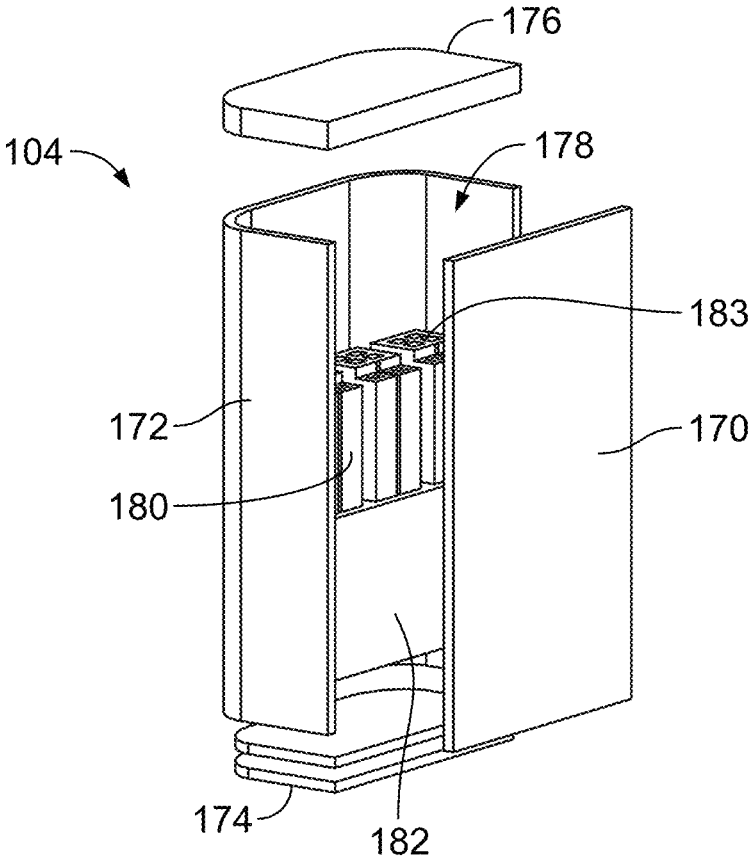


FIG. 16

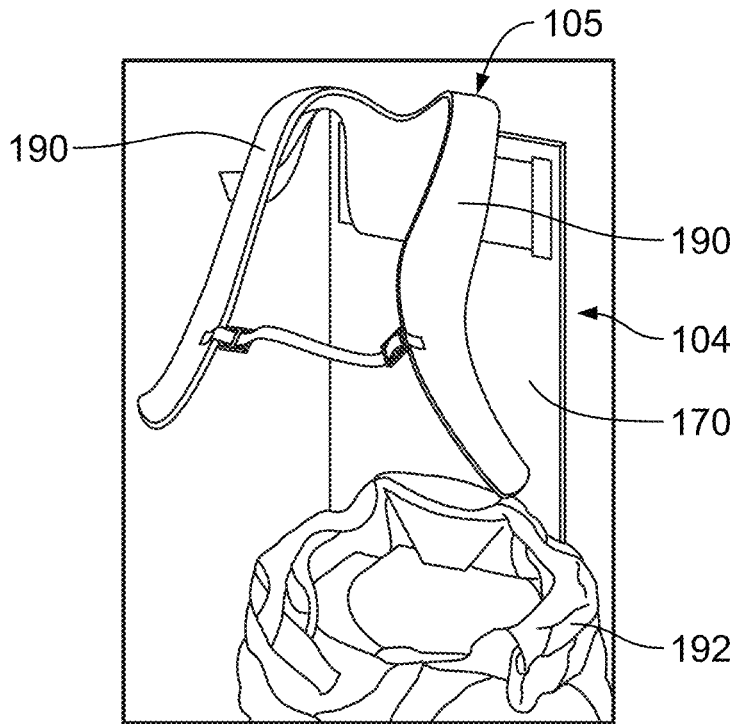


FIG. 17

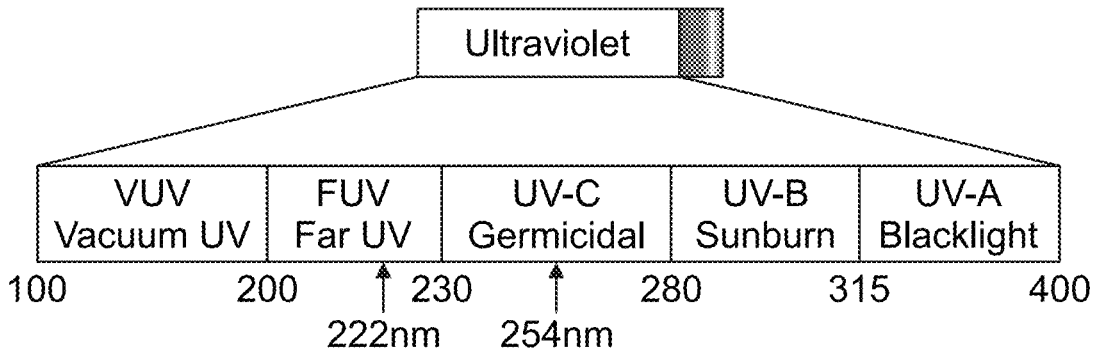


FIG. 18

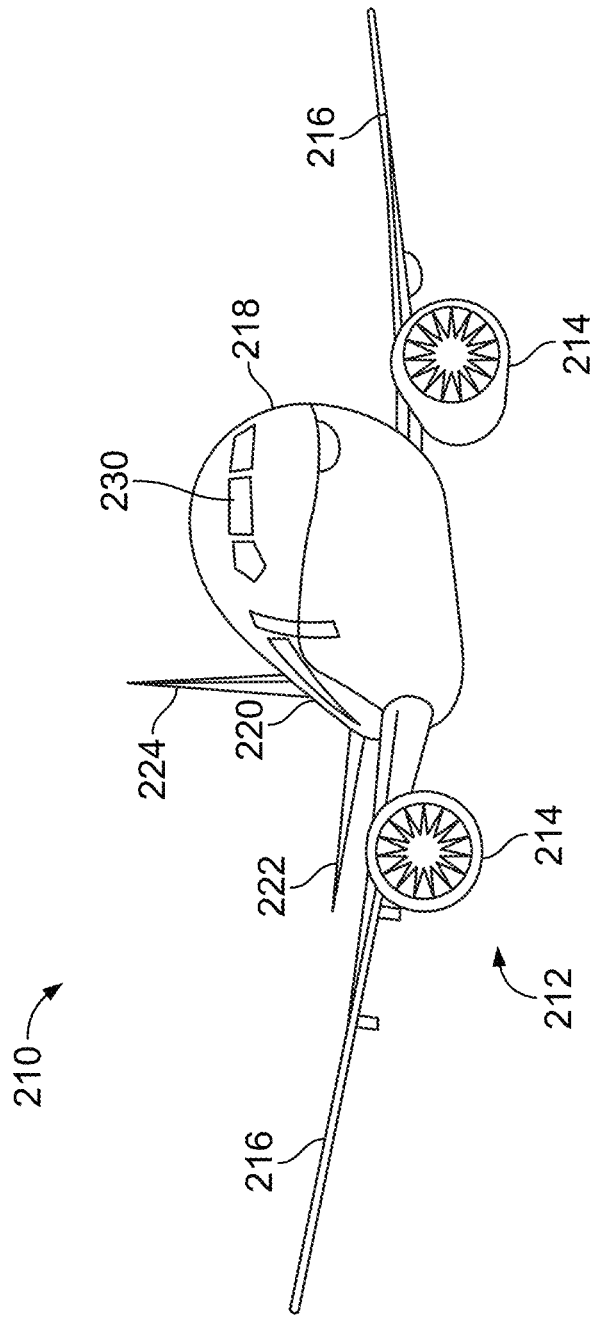


FIG. 19

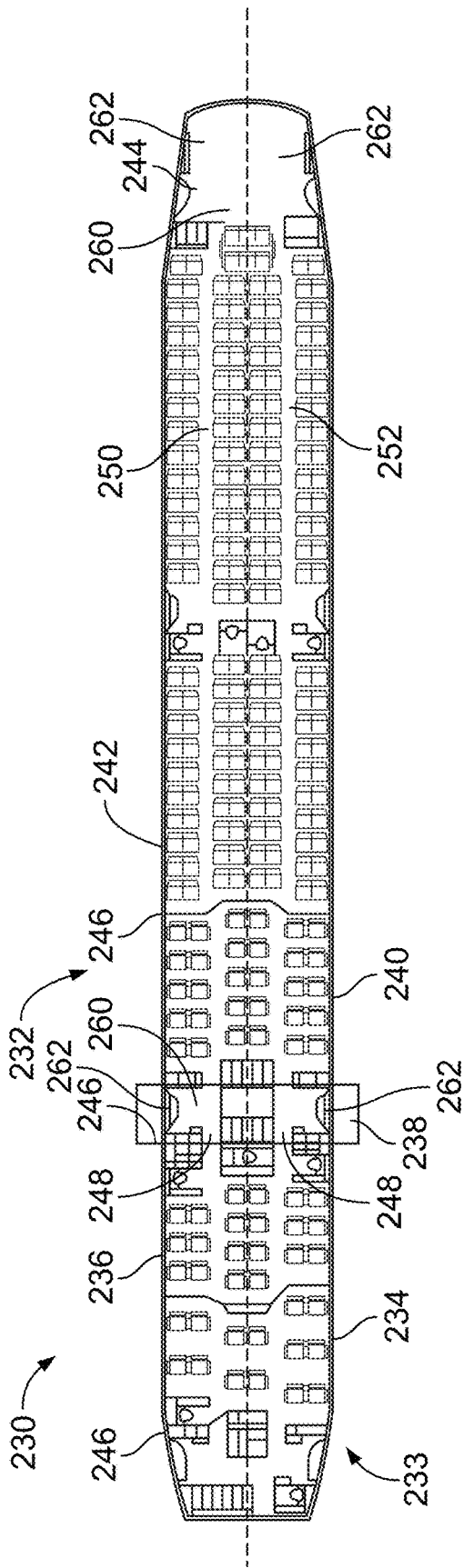


FIG. 20A

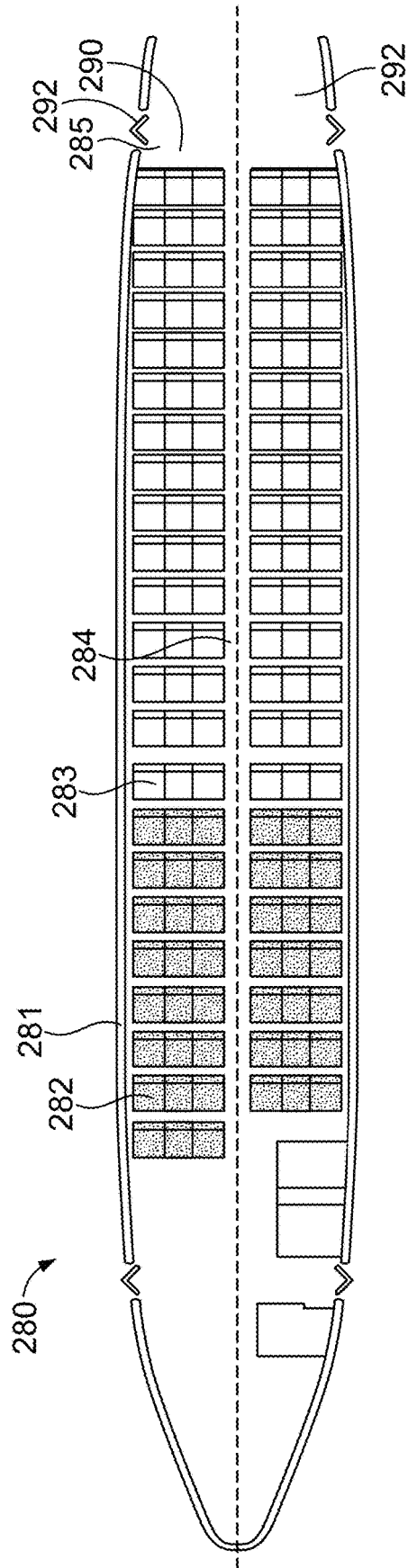


FIG. 20B

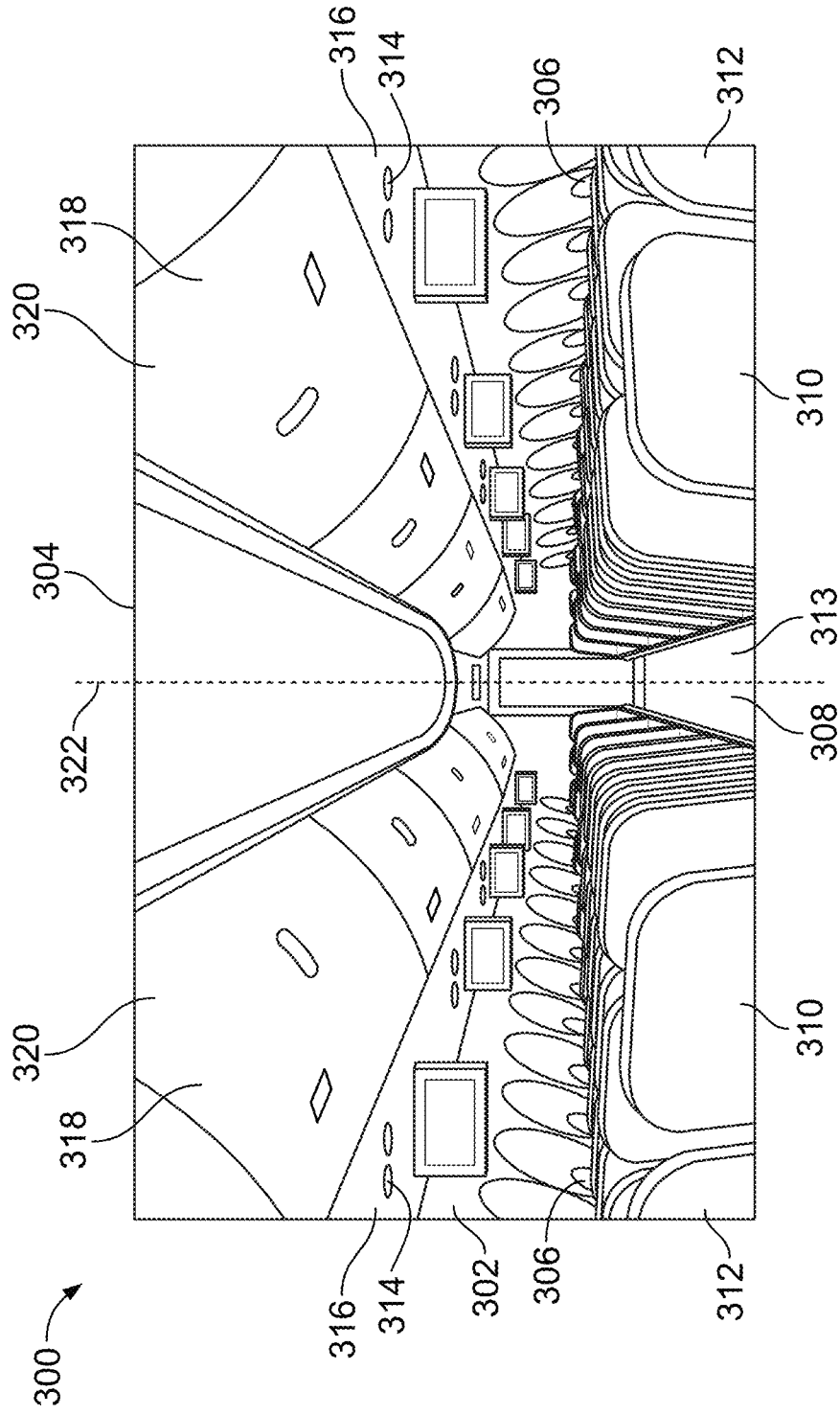


FIG. 21

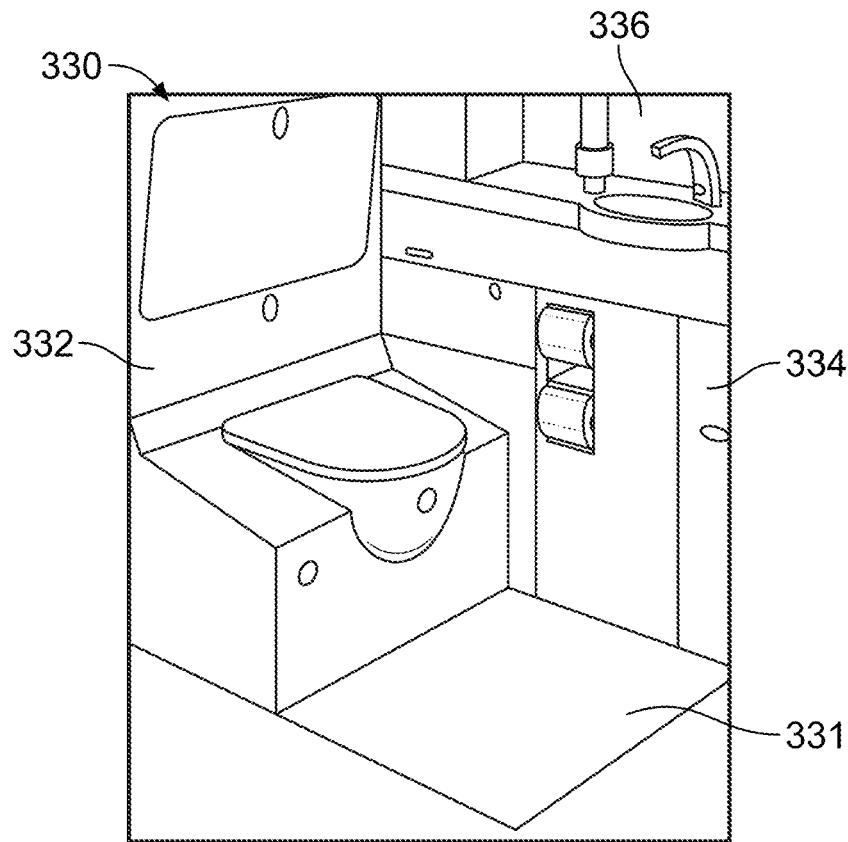


FIG. 22

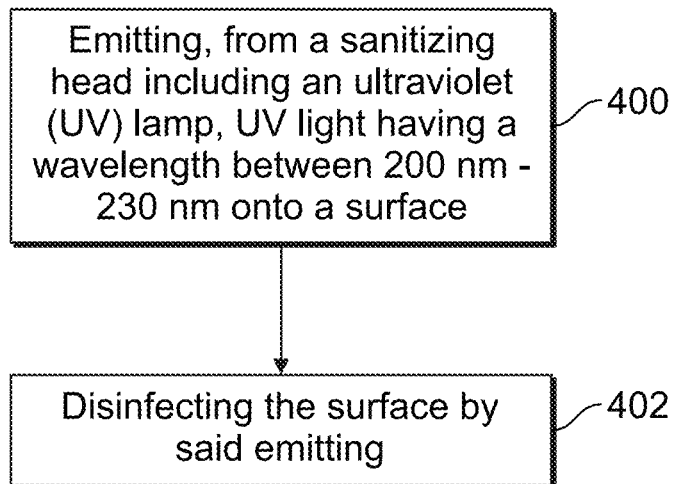


FIG. 23

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PORTABLE SANITIZING SYSTEMS AND METHODS

RELATED APPLICATIONS

This application relates to and claims priority benefits from U.S. Provisional Patent Application No. 63/021,984, entitled "Portable Sanitizing Systems and Methods," filed May 8, 2020, which is hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

Embodiments of the present disclosure generally relate to sanitizing systems, such as may be used to sanitize structures and areas within vehicles, such as commercial aircraft.

BACKGROUND OF THE DISCLOSURE

Vehicles such as commercial aircraft are used to transport passengers between various locations. Systems are currently being developed to disinfect or otherwise sanitize surfaces within aircraft, for example, that use ultraviolet (UV) light.

In order to sanitize a surface of a structure, a known UV light sterilization method emits a broad spectrum UVC light onto the structure. However, UVC light typically takes a significant amount of time (for example, three minutes) to kill various microbes. Further, various microbes may not be vulnerable to UVC light. That is, such microbes may be able to withstand exposure to UVC light.

Also, certain types of microbes may develop a resistance to UVC light. For example, while UVC light may initially kill certain types of microbes, with continued exposure to UVC light over time, the particular species of microbe may develop a resistance to UVC light and able to withstand UVC light exposure.

Additionally, direct exposure of certain types of UV light may pose risk to humans. For example, certain known UV systems emit UV light having a wavelength of 254 nm, which may pose a risk to humans. As such, certain known UV light disinfection systems and methods are operated in the absence of individuals. For example, a UV light disinfection system within a lavatory may be operated when no individual is within the lavatory, and deactivated when an individual is present within the lavatory.

Further, known UV light sanitizing systems are typically large, bulky, and often require fixed, stationary infrastructure.

SUMMARY OF THE DISCLOSURE

A need exists for a system and a method for efficiently sterilizing surfaces within an internal cabin of a vehicle. Further, a need exists for a mobile, compact, easy-to-use, and safe system and method for using UV light to sterilize surfaces within an internal cabin.

With those needs in mind, certain embodiments of the present disclosure provide a portable sanitizing system that includes a sanitizing head including an ultraviolet (UV) lamp. The UV lamp is configured to emit UV light having a wavelength between 200 nm-230 nm to disinfect a surface. In at least one embodiment, the UV lamp is configured to emit the UV light having a wavelength of 222 nm.

In at least one embodiment, a wand assembly includes the sanitizing head. In at least one embodiment, the wand assembly further includes a handle coupled to the sanitizing head. The wand assembly may include a coupler that move-

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ably couples the handle to the sanitizing head. For example, the sanitizing head is configured to one or both of linearly translate or swivel in relation to the handle. Further, the handle may be configured to linearly translate.

In at least one embodiment, the sanitizing head includes a shroud that retains the UV lamp. In at least one embodiment, the shroud includes one or more openings that are configured to allow air to flow into the shroud.

In at least one embodiment, a reflector is secured to an underside of the shroud. The reflector is configured to reflect a portion of the UV light that is emitted by the UV lamp.

In at least one embodiment, a bumper is secured to an exposed lower circumferential edge of the shroud.

In at least one embodiment, the portable sanitizing system includes a backpack assembly, and a hose that couples the backpack assembly to the sanitizing head. In at least one embodiment, the backpack assembly includes an airflow device that is configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head. At least one air filter may be configured to filter air drawn from the sanitizing head. The backpack assembly may contain one or more batteries that provide power to the UV lamp.

In at least one embodiment, the sanitizing head further includes a reflector, and a cover plate. The UV lamp is secured within an interior chamber defined between a reflector and the cover plate.

Certain embodiments of the present disclosure provide a portable sanitizing method, including emitting, from a sanitizing head including an ultraviolet (UV) lamp, UV light having a wavelength between 200 nm-230 nm onto a surface, and disinfecting the surface by said emitting.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a perspective view of a portable sanitizing system worn by an individual, according to an embodiment of the present disclosure.

FIG. 2 illustrates a perspective lateral top view of a wand assembly, according to an embodiment of the present disclosure.

FIG. 3 illustrates a perspective rear view of the wand assembly of FIG. 2.

FIG. 4 illustrates a perspective lateral view of the wand assembly of FIG. 2.

FIG. 5 illustrates a perspective view of the portable sanitizing system in a compact deployed position, according to an embodiment of the present disclosure.

FIG. 6 illustrates a perspective view of the portable sanitizing system having a sanitizing head in an extended position, according to an embodiment of the present disclosure.

FIG. 7 illustrates a perspective view of the portable sanitizing system having the sanitizing head in an extended position and a handle in an extended position, according to an embodiment of the present disclosure.

FIG. 8 illustrates a perspective view of the portable sanitizing system having the sanitizing head rotated in relation to the handle, according to an embodiment of the present disclosure.

FIG. 9 illustrates a perspective end view of a UV lamp and a reflector of the sanitizing head, according to an embodiment of the present disclosure.

FIG. 10 illustrates a perspective end view of a UV lamp and a reflector of the sanitizing head, according to an embodiment of the present disclosure.

FIG. 11 illustrates a perspective end view of a UV lamp and a reflector of the sanitizing head, according to an embodiment of the present disclosure.

FIG. 12 illustrates a perspective top view of the sanitizing head.

FIG. 13 illustrates a perspective bottom view of the sanitizing head.

FIG. 14 illustrates an axial cross-sectional view of the sanitizing head through line 14-14 of FIG. 12.

FIG. 15 illustrates a perspective end view of the UV lamp secured to a mounting bracket, according to an embodiment of the present disclosure.

FIG. 16 illustrates a perspective exploded view of a backpack assembly, according to an embodiment of the present disclosure.

FIG. 17 illustrates a perspective front view of a harness coupled to a backpack assembly, according to an embodiment of the present disclosure.

FIG. 18 illustrates an ultraviolet light spectrum.

FIG. 19 illustrates a perspective front view of an aircraft, according to an embodiment of the present disclosure.

FIG. 20A illustrates a top plan view of an internal cabin of an aircraft, according to an embodiment of the present disclosure.

FIG. 20B illustrates a top plan view of an internal cabin of an aircraft, according to an embodiment of the present disclosure.

FIG. 21 illustrates a perspective interior view of an internal cabin of an aircraft, according to an embodiment of the present disclosure.

FIG. 22 illustrates a perspective internal view of a lavatory within an internal cabin of an aircraft.

FIG. 23 illustrates a flow chart of a portable sanitizing method, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

The foregoing summary, as well as the following detailed description of certain embodiments will be better understood when read in conjunction with the appended drawings. As used herein, an element or step recited in the singular and preceded by the word “a” or “an” should be understood as not necessarily excluding the plural of the elements or steps. Further, references to “one embodiment” are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments “comprising” or “having” an element or a plurality of elements having a particular condition can include additional elements not having that condition.

Certain embodiments of the present disclosure provide a sanitizing system and method that includes an ultraviolet (UV) lamp (such as an excimer lamp) that emits UV light in a far UV light spectrum, such as at a wavelength of 222 nm, which neutralizes (such as kills) microbes (for example, viruses and bacteria), while posing no risk to humans. The UV lamp may be used within an internal cabin to decontaminate and kill pathogens. Embodiments of the present disclosure provide safer and more effective sanitation as compared to certain known UV systems. The UV lamp may be used in a portable sanitizing system or a fixed sanitizing system. For example, operating the UV lamp to emit sanitizing UV light having a wavelength of 222 nm may be used with a portable system or a fixed system.

Certain embodiments of the present disclosure provide a portable sanitizing system for disinfecting surfaces, such as within an internal cabin of a vehicle. The portable sanitizing system includes a wand assembly and a backpack assembly. The wand assembly includes a housing, a UV lamp, a reflector, mounts to secure the UV lamp to the housing, an inlet to allow air to be drawn across the UV lamp, and an extension handle that is configured to extend a reach of the wand assembly. The backpack assembly includes a main body or housing, a power supply, one or more batteries (such as rechargeable batteries), a plug for recharging the backpack, an air blower, a carbon filter, an exhaust vent, and a harness to allow an individual to wear the portable sanitizing system.

FIG. 1 illustrates a perspective view of a portable sanitizing system 100 worn by an individual 101, according to an embodiment of the present disclosure. The portable sanitizing system 100 includes a wand assembly 102 coupled to a backpack assembly 104 that is removably secured to the individual through a harness 105. The wand assembly 102 includes a sanitizing head 106 coupled to a handle 108. In at least one embodiment, the sanitizing head 106 is moveably coupled to the handle 108 through a coupler 110.

As shown in FIG. 1, the wand assembly 102 is in a stowed position. In the stowed position, the wand assembly 102 is removably secured to a portion of the backpack assembly 104, such as through one or more tracks, clips, latches, belts, ties, and/or the like.

FIG. 2 illustrates a perspective lateral top view of the wand assembly 102, according to an embodiment of the present disclosure. The sanitizing head 106 couples to the handle 108 through the coupler 110. The sanitizing head 106 includes a shroud 112 having an outer cover 114 that extends from a proximal end 116 to a distal end 118. As described herein, the shroud 112 contains a UV lamp.

A port 120 extends from the proximal end 116. The port 120 couples to a hose 122, which, in turn, couples to the backpack assembly 104 (shown in FIG. 1). The hose 122 contains electrical cords, cables, wiring, or the like that couples a power source or supply (such as one or more batteries) within the backpack assembly 104 (shown in FIG. 1) to a UV lamp 140 within the shroud 112. Optionally, the electrical cords, cables, wiring, or the like may be outside of the hose 122. The hose 122 also contains an air delivery line, such as an air tube) that fluidly couples an internal chamber of the shroud 112 to an air blower, vacuum generator, air filters, and/or the like within the backpack assembly 104.

The coupler 110 is secured to the outer cover 114 of the shroud 112, such as proximate to the proximal end 116. The coupler 110 may include a securing beam 124 secured to the outer cover 114, such as through one or more fasteners, adhesives, and/or the like. An extension beam 126 outwardly extends from the securing beam 124, thereby spacing the handle 108 from the shroud 112. A bearing assembly 128 extends from the extension beam 126 opposite from the securing beam 124. The bearing assembly 128 includes one or more bearings, tracks, and/or the like, which allow the handle 108 to linearly translate relative to the coupler 110 in the directions of arrows A, and/or pivot about a pivot axle 129 in the directions of arc B. Optionally, the securing beam 124 may include a bearing assembly that allows the sanitizing head 106 to translate in the directions of arrows A, and/or rotate (for example, swivel) in the directions of arc B in addition to, or in place of, the handle 108 being coupled to the bearing assembly 128 (for example, the handle 108 may be fixed to the coupler 110).

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In at least one embodiment, the handle **108** includes a rod, pole, beam, or the like **130**, which may be longer than the shroud **112**. Optionally, the rod **130** may be shorter than the shroud **112**. One or more grips **132** are secured to the rod **130**. The grips **132** are configured to be grasped and held by an individual. The grips **132** may include ergonomic tactile features **134**.

Optionally, the wand assembly **102** may be sized and shaped differently than shown. For example, in at least one embodiment, the handle **108** may be fixed in relation to the shroud **112**. Further, the handle **108** may or may not be configured to move relative to itself and/or the shroud **112**. For example, the handle **108** and the shroud **112** may be integrally molded and formed as a single unit.

FIG. 3 illustrates a perspective rear view of the wand assembly **102** of FIG. 2. FIG. 4 illustrates a perspective lateral view of the wand assembly **102** of FIG. 2. Referring to FIGS. 3 and 4, the handle **108** may pivotally couple to the coupler **110** through a bearing **136** having a pivot axle **138** that pivotally couples the handle **108** to the coupler **110**. The handle **108** may further be configured to linearly translate into and out of the bearing **136**. For example, the handle **108** may be configured to telescope in and out. Optionally, or alternatively, in at least one embodiment, the handle **108** may include a telescoping body that allows the handle **108** to outwardly extend and inwardly recede.

FIG. 5 illustrates a perspective view of the portable sanitizing system **100** in a compact deployed position, according to an embodiment of the present disclosure. The wand assembly **102** is removed from the backpack assembly **104** (as shown in FIG. 1) into the compact deployed position, as shown in FIG. 5. The hose **122** connects the wand assembly **102** to the backpack assembly **104**. In the compact deployed position, the sanitizing head **106** is fully retracted in relation to the handle **108**.

FIG. 6 illustrates a perspective view of the portable sanitizing system **100** having the sanitizing head **106** in an extended position, according to an embodiment of the present disclosure. In order to extend the sanitizing head **106** relative to the handle **108**, the sanitizing head **106** is outwardly slid relative to the handle **108** in the direction of arrow A' (or the handle **108** is rearwardly slid relative to the sanitizing head **106**). As noted, the sanitizing head **106** is able to linearly translate in the direction of arrow A' relative to the handle **108** via the coupler **110**. The outward extension of the sanitizing head **106**, as shown in FIG. 6, allows for the portable sanitizing system **100** to easily reach distant areas. Alternatively, the sanitizing head **106** may not linearly translate relative to the handle **108**.

FIG. 7 illustrates a perspective view of the portable sanitizing system **100** having the sanitizing head **106** in an extended position and the handle **108** in an extended position, according to an embodiment of the present disclosure. To reach even further, the handle **108** may be configured to linearly translate, such as through a telescoping portion, to allow the sanitizing head **106** to reach further outwardly. Alternatively, the handle **108** may not be configured to extend and retract.

In at least one embodiment, the handle **108** may include a lock **109**. The lock **109** is configured to be selectively operated to secure the handle **108** into a desired extended (or retracted) position.

FIG. 8 illustrates a perspective view of the portable sanitizing system **100** having the sanitizing head **106** rotated in relation to the handle **108**, according to an embodiment of the present disclosure. As noted, the sanitizing head **106** is configured to rotate relative to the handle **108** via the coupler

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110. Rotating the sanitizing head **106** relative to the handle **108** allows the sanitizing head **106** to be moved to a desired position, and sweep or otherwise reach into areas that would otherwise be difficult to reach if the sanitizing head **106** was rigidly fixed to the handle **108**. Alternatively, the sanitizing head **106** may not be rotatable relative to the handle **108**.

FIG. 9 illustrates a perspective end view of a UV lamp **140** and a reflector **142** of the sanitizing head **106**, according to an embodiment of the present disclosure. The UV lamp **140** and the reflector **142** are secured within the shroud **112** (shown in FIG. 2, for example) of the sanitizing head **106**. In at least one embodiment, the reflector **142** is secured to an underside **141** of the shroud **112**, such as through one or more adhesives. As another example, the reflector **142** is an integral part of the shroud **112**. For example, the reflector **142** may be or otherwise provide the underside **141** of the shroud **112**. The reflector **142** provides a reflective surface **143** (such as formed of Teflon, a mirrored surface, and/or the like) that is configured to outwardly reflect UV light emitted by the UV lamp **140**. In at least one example, shroud **112** may be or include a shell formed of fiberglass, and the reflector **142** may be formed of Teflon that provides a 98% reflectivity.

The reflector **142** may extend along an entire length of the underside **141** of the shroud **112**. Optionally, the reflector **142** may extend along less than an entire length of the underside **141** of the shroud **112**.

The UV lamp **140** may extend along an entire length (or along substantially the entire length, such as between the ends **116** and **118**). The UV lamp **140** is secured to the reflector **142** and/or the shroud **112** through one or more brackets, for example. The UV lamp **140** includes one or more UV light emitters, such as one more bulbs, light emitting elements (such as light emitting diodes), and/or the like. In at least one embodiment, the UV lamp **140** is configured to emit UV light in the far UV spectrum, such as at a wavelength between 200 nm-230 nm. In at least one embodiment, the UV lamp **140** is configured to emit UV light having a wavelength of 222 nm. For example, the UV lamp **140** may be or include a 300 W bulb that is configured to emit UV light having a wavelength of 222 nm.

As shown, the reflector **142** includes flat, upright side walls **144** connected together through an upper curved wall **146**. The upper curved wall **146** may be bowed outwardly away from the UV lamp **140**. For example, the upper curved wall **146** may have a parabolic cross-section and/or profile.

It has been found that the straight, linear side walls **144** provide desired reflection and/or focusing of UV light emitted from the UV lamp **140** toward and onto a desired location. Alternatively, the side walls **144** may not be linear and flat.

FIG. 10 illustrates a perspective end view of the UV lamp **140** and a reflector **142** of the sanitizing head, according to an embodiment of the present disclosure. The reflector **142** shown in FIG. 10 is similar to the reflector **142** shown in FIG. 9, except that the side walls **144** may outwardly cant from the upper curved wall **146**.

FIG. 11 illustrates a perspective end view of the UV lamp **140** and the reflector **142** of the sanitizing head, according to an embodiment of the present disclosure. In this embodiment, the side walls **144** may be curved according to the curvature of the upper curved wall **146**.

FIG. 12 illustrates a perspective top view of the sanitizing head **106**. FIG. 13 illustrates a perspective bottom view of the sanitizing head **106**. FIG. 14 illustrates an axial cross-sectional view of the sanitizing head **106** through line 14-14 of FIG. 12. Referring to FIGS. 12-14, air **150** is configured

to be drawn into the sanitizing head **106** through one or more openings **152** (or simply an open chamber) of the shroud **112**. The air **150** is drawn into the sanitizing head **106**, such as via a vacuum generator within the backpack assembly **104** (shown in FIG. 1). The air **150** is drawn into the shroud **112**, and cools the UV lamp **140** as it passes over and around the UV lamp **140**. The air **150** passes into the port **120** and into the hose **122**, such as within an air tube within the hose **122**. The air **150** not only cools the UV lamp **140**, but also removes ozone, which may be generated by operation of the UV lamp **140**, within the shroud **112**. The air **150** may be drawn to an air filter, such as an activated carbon filter, within the backpack assembly **104**.

In at least one embodiment, the portable sanitizing system **100** may also include an alternative ozone mitigation system. As an example, the ozone mitigation system may be disposed in the shroud **112** or another portion of the system, and may include an inert gas bath, or a face inert gas system, such as in U.S. Pat. No. 10,232,954.

Referring to FIG. 13, in particular, a bumper **153** may be secured to an exposed lower circumferential edge **155** of the shroud **112**. The bumper **153** may be formed of a resilient material, such as rubber, another elastomeric material, open or closed cell foam, and/or the like. The bumper **153** protects the sanitizing head **106** from damage in case the sanitizing head **106** inadvertently contacts a surface. The bumper **153** also protects the surface from damage.

The openings **152** may be spaced around the lower surface of the shroud **112** such that they do not provide a direct view of the UV lamp **140**. For example, the openings **152** may be positioned underneath portions that are spaced apart from the UV lamp **140**.

Referring to FIG. 14, in particular, the sanitizing head **106** may include a cover plate **154** below the UV lamp **140**. The cover plate **154** may be formed of glass, for example, and may be configured to filter UV light emitted by the UV lamp **140**. The UV lamp **140** may be secured within an interior chamber **156** defined between the reflector **142** and the cover plate **154**. In at least one embodiment, the cover plate **154** is or otherwise includes a far UV band pass filter. For example, the cover plate **154** may be a 222 nm band pass filter that filters UV light emitted by the UV lamp **140** to a 222 nm wavelength. As such, UV light that is emitted from the sanitizing head **106** may be emitted at a wavelength of 222 nm.

Referring to FIGS. 13 and 14, a rim **157** (such as a 0.020" thick Titanium rim) may connect the cover plate **154** to the shroud **112**. The rim **157** may distribute impact loads there-through and/or therearound.

In at least one embodiment, ranging light emitting diodes (LEDs) **159** may be disposed proximate to ends of the UV lamp **140**. The ranging LEDs **159** may be used to determine a desired range to a structure that is to be sanitized, for example. In at least one embodiment, the ranging LEDs **159** may be disposed on or within the rim **157** and/or the cover plate **154**.

FIG. 15 illustrates a perspective end view of the UV lamp **140** secured to a mounting bracket or clamp **160**, according to an embodiment of the present disclosure. Each end of the UV lamp **140** may be coupled to mounting bracket or clamp **160**, which secures the UV lamp **140** to the shroud **112** (shown in FIGS. 12-14). A buffer, such as a thin (for example, 0.040") sheet of silicon may be disposed between the end of the UV lamp **140** and the bracket **160**. Optionally, the UV lamp **140** may be secured to the shroud **112** through brackets or clamps that differ in size and shape than shown.

As another example, the UV lamp **140** may be secured to the shroud **112** through adhesives, fasteners, and/or the like.

FIG. 16 illustrates a perspective exploded view of the backpack assembly **104**, according to an embodiment of the present disclosure. The backpack assembly **104** includes a front wall **170** that couples to a rear shell **172**, a base **174**, and a top cap **176**. An internal chamber **178** is defined between the front wall **170**, the rear shell **172**, the base **174**, and the top cap **176**. One or more batteries **180**, such as rechargeable Lithium batteries, are contained within the internal chamber **178**. An air generation sub-system **182** is also contained within the internal chamber **178**. The air generation sub-system **182** is in fluid communication with an air tube within the hose **122** (shown in FIG. 2, for example). The air generation sub-system **182** may include an airflow device, such as a vacuum generator, an air blower, and/or the like. The airflow device is configured to generate airflow to cool the UV lamp, draw air from the sanitizing head **106** into the backpack assembly **104** and out through an exhaust, draw or otherwise remove generated ozone away from the shroud **112**, and/or the like.

One or more air filters **183**, such as carbon filters, are within the backpack assembly **104**. The air filters **183** are in communication with the air tube or other such delivery duct or line that routes air through the hose **122** and into the backpack assembly **104**. The air filters **183** are configured to filter the air that is drawn into the backpack assembly **104** from the shroud **112**. For example, the air filters **183** may be configured to remove, deactivate, or otherwise neutralize ozone.

The batteries **180** and/or a power supply within the backpack assembly **104** provides operating power for the UV lamp **140** of the sanitizing head **106** (shown in FIG. 2, for example). The top wall **176** may be removably coupled to the front wall **170** and the rear shell **172**. The top wall **176** may be removed to provide access to the batteries **180** (such as to remove and/or recharge the batteries), for example. Additional space may be provided within the backpack assembly **104** for storage of supplies, additional batteries, additional components, and/or the like. In at least one embodiment, the front wall **170**, the rear shell **172**, the base **174**, and the top cap **176** may be formed of fiberglass epoxy.

FIG. 17 illustrates a perspective front view of the harness **105** coupled to the backpack assembly **104**, according to an embodiment of the present disclosure. The harness **105** may include shoulder straps **190** and/or a waist or hip belt or strap **192**, which allow the individual to comfortably wear the backpack assembly **104**.

Referring to FIGS. 1-17, in operation, the individual may walk through an area wearing the backpack assembly **104**. When a structure to be sanitized is found, the individual may position grasp the handle **108** and position the sanitizing head **106** as desired, such as by extending and/or rotating the sanitizing head **106** relative to the handle **108**. The individual may then engage an activation button on the handle **108**, for example, to activate the UV lamp **140** to emit sanitizing UV light onto the structure. As the UV lamp **140** is activated, air **150** is drawn into the shroud **112** to cool the UV lamp **140**, and divert any generated ozone into the backpack assembly **104**, where it is filtered by the air filters **183**.

The extendable wand assembly **102** allows the sanitizing head **106** to reach distant areas, such as over an entire set of three passenger seats, from a row within an internal cabin of a commercial aircraft.

FIG. 18 illustrates an ultraviolet light spectrum. Referring to FIGS. 1-18, in at least one embodiment, the sanitizing

head **106** is configured to emit sanitizing UV light (through operation of the UV lamp **140**) within a far UV spectrum, such as between 200 nm to 230 nm. In at least one embodiment, the sanitizing head **106** emits sanitizing UV light having a wavelength of 222 nm.

It has been found that sanitizing UV light having a wavelength of 222 nm kills pathogens (such as viruses and bacteria), instead of inactivating pathogens. In contrast, UVC light at a wavelength of 254 nm inactivates pathogens by interfering with their DNA, resulting in temporary inactivation, but may not kill the pathogens. Instead, the pathogens may be reactivated by exposure to ordinary white light at a reactivation rate of about 10% per hour. As such, UVC light at a wavelength of 254 nm may be ineffective in illuminated areas, such as within an internal cabin of a vehicle. Moreover, UVC light at 254 nm is not recommended for human exposure because it may be able to penetrate human cells.

In contrast, sanitizing UV light having a wavelength of 222 nm is safe for human exposure and kills pathogens. Further, the sanitizing UV light having a wavelength of 222 nm may be emitted at full power within one millisecond or less of the UV lamp **140** being activated (in contrast the UVC light having a wavelength of 254 nm, which may take seconds or even minutes to reach full power).

FIG. **19** illustrates a perspective front view of an aircraft **210**, according to an embodiment of the present disclosure. The aircraft **210** includes a propulsion system **212** that includes engines **214**, for example. Optionally, the propulsion system **212** may include more engines **14** than shown. The engines **214** are carried by wings **216** of the aircraft **210**. In other embodiments, the engines **214** may be carried by a fuselage **218** and/or an empennage **220**. The empennage **220** may also support horizontal stabilizers **222** and a vertical stabilizer **224**.

The fuselage **218** of the aircraft **210** defines an internal cabin **230**, which includes a flight deck or cockpit, one or more work sections (for example, galleys, personnel carry-on baggage areas, and the like), one or more passenger sections (for example, first class, business class, and coach sections), one or more lavatories, and/or the like. The internal cabin **230** includes one or more lavatory systems, lavatory units, or lavatories, as described herein.

Alternatively, instead of an aircraft, embodiments of the present disclosure may be used with various other vehicles, such as automobiles, buses, locomotives and train cars, watercraft, and the like. Further, embodiments of the present disclosure may be used with respect to fixed structures, such as commercial and residential buildings.

FIG. **20A** illustrates a top plan view of an internal cabin **230** of an aircraft, according to an embodiment of the present disclosure. The internal cabin **230** may be within the fuselage **232** of the aircraft, such as the fuselage **218** of FIG. **19**. For example, one or more fuselage walls may define the internal cabin **230**. The internal cabin **230** includes multiple sections, including a front section **233**, a first class section **234**, a business class section **236**, a front galley station **238**, an expanded economy or coach section **240**, a standard economy or coach section **242**, and an aft section **244**, which may include multiple lavatories and galley stations. It is to be understood that the internal cabin **230** may include more or less sections than shown. For example, the internal cabin **230** may not include a first class section, and may include more or less galley stations than shown. Each of the sections may be separated by a cabin transition area **246**, which may include class divider assemblies between aisles **248**.

As shown in FIG. **20A**, the internal cabin **230** includes two aisles **250** and **252** that lead to the aft section **244**. Optionally, the internal cabin **230** may have less or more aisles than shown. For example, the internal cabin **230** may include a single aisle that extends through the center of the internal cabin **230** that leads to the aft section **244**.

The aisles **248**, **250**, and **252** extend to egress paths or door passageways **260**. Exit doors **262** are located at ends of the egress paths **260**. The egress paths **260** may be perpendicular to the aisles **248**, **250**, and **252**. The internal cabin **230** may include more egress paths **260** at different locations than shown. The portable sanitizing system **100** shown and described with respect to FIGS. **1-18** may be used to sanitize various structures within the internal cabin **230**, such as passenger seats, monuments, stowage bin assemblies, components on and within lavatories, galley equipment and components, and/or the like.

FIG. **20B** illustrates a top plan view of an internal cabin **280** of an aircraft, according to an embodiment of the present disclosure. The internal cabin **280** is an example of the internal cabin **230** shown in FIG. **19**. The internal cabin **280** may be within a fuselage **281** of the aircraft. For example, one or more fuselage walls may define the internal cabin **280**. The internal cabin **280** includes multiple sections, including a main cabin **282** having passenger seats **283**, and an aft section **285** behind the main cabin **282**. It is to be understood that the internal cabin **280** may include more or less sections than shown.

The internal cabin **280** may include a single aisle **284** that leads to the aft section **285**. The single aisle **284** may extend through the center of the internal cabin **280** that leads to the aft section **285**. For example, the single aisle **284** may be coaxially aligned with a central longitudinal plane of the internal cabin **280**.

The aisle **284** extends to an egress path or door passageway **290**. Exit doors **292** are located at ends of the egress path **290**. The egress path **290** may be perpendicular to the aisle **284**. The internal cabin **280** may include more egress paths than shown. The portable sanitizing system **100** shown and described with respect to FIGS. **1-18** may be used to sanitize various structures within the internal cabin **230**, such as passenger seats, monuments, stowage bin assemblies, components on and within lavatories, galley equipment and components, and/or the like.

FIG. **21** illustrates a perspective interior view of an internal cabin **300** of an aircraft, according to an embodiment of the present disclosure. The internal cabin **300** includes outboard walls **302** connected to a ceiling **304**. Windows **306** may be formed within the outboard walls **302**. A floor **308** supports rows of seats **310**. As shown in FIG. **21**, a row **312** may include two seats **310** on either side of an aisle **313**. However, the row **312** may include more or less seats **310** than shown. Additionally, the internal cabin **300** may include more aisles than shown.

Passenger service units (PSUs) **314** are secured between an outboard wall **302** and the ceiling **304** on either side of the aisle **313**. The PSUs **314** extend between a front end and rear end of the internal cabin **300**. For example, a PSU **314** may be positioned over each seat **310** within a row **312**. Each PSU **314** may include a housing **316** that generally contains vents, reading lights, an oxygen bag drop panel, an attendant request button, and other such controls over each seat **310** (or groups of seats) within a row **312**.

Overhead stowage bin assemblies **318** are secured to the ceiling **304** and/or the outboard wall **302** above and inboard from the PSU **314** on either side of the aisle **313**. The overhead stowage bin assemblies **318** are secured over the

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seats **310**. The overhead stowage bin assemblies **318** extend between the front and rear end of the internal cabin **300**. Each stowage bin assembly **318** may include a pivot bin or bucket **320** pivotally secured to a strongback (hidden from view in FIG. **21**). The overhead stowage bin assemblies **318** may be positioned above and inboard from lower surfaces of the PSUs **314**. The overhead stowage bin assemblies **318** are configured to be pivoted open in order to receive passenger carry-on baggage and personal items, for example.

As used herein, the term “outboard” means a position that is further away from a central longitudinal plane **322** of the internal cabin **300** as compared to another component. The term “inboard” means a position that is closer to the central longitudinal plane **322** of the internal cabin **300** as compared to another component. For example, a lower surface of a PSU **314** may be outboard in relation to a stowage bin assembly **318**.

The portable sanitizing system **100** shown and described with respect to FIGS. **1-18** may be used to sanitize various structures shown within the internal cabin **300**. As an example, the portable sanitizing system **100** may be used to sanitize various components within a cockpit or flight deck of an aircraft.

When not in use, the portable sanitizing system **100** may be stored within a closet, galley cart bay, or galley cart, such as within the internal cabin of the vehicle.

FIG. **22** illustrates a perspective internal view of a lavatory **330** within an internal cabin of a vehicle, such as any of the internal cabins described herein. The lavatory **330** is an example of an enclosed space, monument or chamber, such as within the internal cabin a vehicle. The lavatory **330** may be onboard an aircraft, as described above. Optionally, the lavatory **330** may be onboard various other vehicles. In other embodiments, the lavatory **330** may be within a fixed structure, such as a commercial or residential building. The lavatory **330** includes a base floor **331** that supports a toilet **332**, cabinets **334**, and a sink **336** or wash basin. The lavatory **330** may be arranged differently than shown. The lavatory **330** may include more or less components than shown. The portable sanitizing system **100** shown and described with respect to FIGS. **1-18** may be used to sanitize the various structures, components, and surfaces within the lavatory **330**.

FIG. **23** illustrates a flow chart of a portable sanitizing method, according to an embodiment of the present disclosure. The method includes emitting (**400**), from a sanitizing head including an ultraviolet (UV) lamp, UV light having a wavelength between 200 nm-230 nm onto a surface; and disinfecting (**402**) the surface by said emitting (**400**). In at least one embodiment, said emitting (**400**) includes emitting the UV light having a wavelength of 222 nm.

In at least one embodiment, the portable sanitizing method further includes moveably coupling a handle to the sanitizing head. For example, said moveably coupling includes one or both of linearly translating or swiveling the sanitizing head in relation to the handle.

In at least one embodiment, the portable sanitizing method includes coupling a backpack assembly to the sanitizing head through a hose.

Referring to FIGS. **1-23**, the portable sanitizing system **100** can be used to safely and effectively sanitize high-touch surfaces in the flight deck and internal cabin in a timely and cost-effective manner. UV disinfection allows the internal cabin to be quickly and effectively disinfected, such as between flights. In at least one embodiment, the portable sanitizing system **100** is used to augment a cleaning process, such as after manual cleaning.

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Further, the disclosure comprises embodiments according to the following clauses:

Clause 1. A portable sanitizing system, comprising: a sanitizing head including an ultraviolet (UV) lamp, wherein the UV lamp is configured to emit UV light having a wavelength between 200 nm-230 nm to disinfect a surface.

Clause 2. The portable sanitizing system of Clause 1, wherein the UV lamp is configured to emit the UV light having a wavelength of 222 nm.

Clause 3. The portable sanitizing system of Clauses 1 or 2, further comprising a wand assembly, wherein the wand assembly comprises the sanitizing head.

Clause 4. The portable sanitizing system of Clause 3, wherein the wand assembly further comprises a handle coupled to the sanitizing head.

Clause 5. The portable sanitizing system of Claim 4, wherein the wand assembly further comprises a coupler that moveably couples the handle to the sanitizing head.

Clause 6. The portable sanitizing system of Clauses 4 or 5, wherein the sanitizing head is configured to one or both of linearly translate or swivel in relation to the handle.

Clause 7. The portable sanitizing system of any of Clauses 4-6, wherein the handle is configured to linearly translate.

Clause 8. The portable sanitizing system of any of Clauses 1-7, wherein the sanitizing head comprises a shroud that retains the UV lamp.

Clause 9. The portable sanitizing system of Clause 8, wherein the shroud comprises one or more openings that are configured to allow air to flow into the shroud.

Clause 10. The portable sanitizing system of Clauses 8 or 9, further comprising a reflector secured to an underside of the shroud, wherein the reflector is configured to reflect a portion of the UV light that is emitted by the UV lamp.

Clause 11. The portable sanitizing system of any of Clauses 8-10, further comprising a bumper secured to an exposed lower circumferential edge of the shroud.

Clause 12. The portable sanitizing system of any of Clauses 1-11, further comprising: a backpack assembly; and a hose that couples the backpack assembly to the sanitizing head.

Clause 13. The portable sanitizing system of Clause 12, wherein the backpack assembly comprises an airflow device that is configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head.

Clause 14. The portable sanitizing system of Clauses 12 or 13, wherein the backpack assembly comprises at least one air filter that is configured to filter air drawn from the sanitizing head.

Clause 15. The portable sanitizing system of any of Clauses 12-14, wherein the backpack assembly contains one or more batteries that provide power to the UV lamp.

Clause 16. The portable sanitizing system of any of Clauses 1-15, wherein the sanitizing head further comprises: a reflector; and

a cover plate, wherein the UV lamp is secured within an interior chamber defined between a reflector and the cover plate.

Clause 17. A portable sanitizing method, comprising: emitting, from a sanitizing head including an ultraviolet (UV) lamp, UV light having a wavelength between 200 nm-230 nm onto a surface; and disinfecting the surface by said emitting.

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Clause 18. The portable sanitizing method of Clause 17, wherein said emitting comprises emitting the UV light having a wavelength of 222 nm.

Clause 19. The portable sanitizing method of Clauses 17 or 18, further comprising moveably coupling a handle to the sanitizing head.

Clause 20. The portable sanitizing method of any of Clauses 17-19, wherein said moveably coupling comprises one or both of linearly translating or swiveling the sanitizing head in relation to the handle.

Clause 21. The portable sanitizing method of any of Clauses 17-20, further comprising coupling a backpack assembly to the sanitizing head through a hose.

Clause 22. A portable sanitizing system, comprising:

a wand assembly including a sanitizing head having a shroud that retains an ultraviolet (UV) lamp, a handle moveably coupled to the sanitizing head, and a coupler that moveably couples the handle to the sanitizing head, wherein the sanitizing head is configured to one or both of linearly translate or swivel in relation to the handle, wherein the handle is configured to linearly translate, wherein the shroud comprises one or more openings that are configured to allow air to flow into the shroud;

a backpack assembly, wherein the backpack assembly comprises one or more batteries that provide power to the UV lamp, at least one air filter that is configured to filter air drawn from the sanitizing head, and an airflow device that is configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head; and

a hose that couples the backpack assembly to the sanitizing head,

wherein the UV lamp is configured to emit UV light having a wavelength of 222 nm to disinfect a surface.

As described herein, embodiments of the present disclosure provide systems and a methods for efficiently sterilizing surfaces, components, structures, and/or the like within an internal cabin of a vehicle. Further, embodiments of the present disclosure provide compact, easy-to-use, and safe systems and methods for using UV light to sterilize surfaces within an internal cabin.

While various spatial and directional terms, such as top, bottom, lower, mid, lateral, horizontal, vertical, front and the like can be used to describe embodiments of the present disclosure, it is understood that such terms are merely used with respect to the orientations shown in the drawings. The orientations can be inverted, rotated, or otherwise changed, such that an upper portion is a lower portion, and vice versa, horizontal becomes vertical, and the like.

As used herein, a structure, limitation, or element that is “configured to” perform a task or operation is particularly structurally formed, constructed, or adapted in a manner corresponding to the task or operation. For purposes of clarity and the avoidance of doubt, an object that is merely capable of being modified to perform the task or operation is not “configured to” perform the task or operation as used herein.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) can be used in combination with each other. In addition, many modifications can be made to adapt a particular situation or material to the teachings of the various embodiments of the disclosure without departing from their scope. While the dimensions and types of materials described

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herein are intended to define the parameters of the various embodiments of the disclosure, the embodiments are by no means limiting and are exemplary embodiments. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the various embodiments of the disclosure should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims and the detailed description herein, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Moreover, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. § 112(f), unless and until such claim limitations expressly use the phrase “means for” followed by a statement of function void of further structure.

This written description uses examples to disclose the various embodiments of the disclosure, including the best mode, and also to enable any person skilled in the art to practice the various embodiments of the disclosure, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the various embodiments of the disclosure is defined by the claims, and can include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if the examples have structural elements that do not differ from the literal language of the claims, or if the examples include equivalent structural elements with insubstantial differences from the literal language of the claims.

What is claimed is:

1. A portable sanitizing system, comprising:

a wand assembly including:

a sanitizing head having an ultraviolet (UV) lamp; a handle moveably coupled to the sanitizing head; and a coupler that moveably couples the handle to the sanitizing head; and

a backpack assembly comprising:

one or more batteries that provide power to the UV lamp; at least one air filter configured to filter air drawn from the sanitizing head; an airflow device configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head; and a hose that couples the backpack assembly to the sanitizing head.

2. The portable sanitizing system of claim 1, wherein the UV lamp is configured to emit UV light having a wavelength between 200 nm-230 nm to disinfect a surface.

3. The portable sanitizing system of claim 1, wherein a reflector is secured to an underside of the shroud, and wherein the reflector is configured to reflect a portion of the UV light that is emitted by the UV lamp.

4. The portable sanitizing system of claim 1, further comprising a bumper secured to an exposed lower circumferential edge of the shroud.

5. The portable sanitizing system of claim 1, wherein the sanitizing head further comprises:

a reflector; and a cover plate,

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wherein the UV lamp is secured within an interior chamber defined between the reflector and the cover plate.

6. The portable sanitizing system of claim 1, wherein the airflow device is configured to generate airflow to cool the UV lamp, draw air from the sanitizing head, and remove ozone from the sanitizing head.

7. The portable sanitizing system of claim 1, wherein the UV lamp is configured to emit UV light having a wavelength of 222 nm to disinfect a surface.

8. The portable sanitizing system of claim 1, wherein the sanitizing head has a shroud that retains the UV lamp.

9. The portable sanitizing system of claim 8, wherein the shroud comprises one or more openings that are configured to allow air to flow into the shroud.

10. The portable sanitizing system of claim 1, wherein the sanitizing head is configured to one or both of linearly translate or swivel in relation to the handle, and wherein the handle is configured to linearly translate.

11. A portable sanitizing system, comprising:

a wand assembly including a sanitizing head having a shroud that retains an ultraviolet (UV) lamp, a handle moveably coupled to the sanitizing head, and a coupler that moveably couples the handle to the sanitizing head, wherein the sanitizing head is configured to one or both of linearly translate or swivel in relation to the handle, wherein the handle is configured to linearly translate, wherein the shroud comprises one or more openings that are configured to allow air to flow into the shroud;

a backpack assembly, wherein the backpack assembly comprises one or more batteries that provide power to the UV lamp, at least one air filter that is configured to filter air drawn from the sanitizing head, and an airflow device that is configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head; and

a hose that couples the backpack assembly to the sanitizing head, wherein the UV lamp is configured to emit UV light having a wavelength of 222 nm to disinfect a surface.

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12. The portable sanitizing system of claim 11, further comprising a bumper secured to an exposed lower circumferential edge of the shroud.

13. The portable sanitizing system of claim 11, wherein a reflector is secured to an underside of the shroud, and wherein the reflector is configured to reflect a portion of the UV light that is emitted by the UV lamp.

14. The portable sanitizing system of claim 11, wherein the sanitizing head further comprises a reflector, and a cover plate.

15. The portable sanitizing system of claim 14, wherein the UV lamp is secured within an interior chamber defined between the reflector and the cover plate.

16. A portable sanitizing method, comprising: moveably coupling a handle to a sanitizing head having a shroud that retains an ultraviolet (UV) lamp, wherein a coupler moveably couples the handle to the sanitizing head;

coupling a backpack assembly to the sanitizing head, wherein the backpack assembly comprises one or more batteries that provide power to the UV lamp, at least one air filter that is configured to filter air drawn from the sanitizing head, an airflow device that is configured to one or more of generate airflow to cool the UV lamp, draw air from the sanitizing head, or remove ozone from the sanitizing head, and a hose that couples the backpack assembly to the sanitizing head;

one or both of linearly translating or swiveling the sanitizing head in relation to the handle; and emitting, from the sanitizing head UV light having a wavelength between 200 nm-230 nm onto a surface.

17. The portable sanitizing method of claim 16, wherein the shroud comprises one or more openings that are configured to allow air to flow into the shroud.

18. The portable sanitizing system of claim 16, further comprising disinfecting the surface by said emitting.

19. The portable sanitizing method of claim 16, wherein said emitting comprises emitting the UV light having a wavelength of 222 nm.

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