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(54) Title: OZONE BASED SANITIZER

(57) Abstract: A sanitizing apparatus having an enclosure, and inlet connector and an exhaust-outlet is provided. The enclosure of the apparatus is substantially impermeable to ozone and has an inner volume and a sealable opening. Inanimate items or user's bodily extremities can be inserted into the opening which can be sealed to form an airtight barrier around or with the inserted item. Ozone can be introduced to the inner volume through the inlet- connector. Pathogens on the surface of the item are deactivated through the exposure to ozone. Clumped pathogens can be broken down using vibrational energy or rubbing. Once sanitized, the oxygen-based gas mixture contained in the enclosure can be released through the exhaust-outlet. Catalysts, such as carbon filters and heat, can be used to ensure that all ozone has been decomposed into oxygen. The sanitizing apparatus is safe, rapid, and effective.

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Ozone Based Sanitizer

Claim of Priority

This application claims priority pursuant to 35 U.S.C. § 119 from Provisional Patent Application Serial No. 60/782,988 entitled "Ozone Based Hand Sanitizer," filed March 15, 2006, the entire disclosure of which is hereby incorporated by reference.

Field of the Invention

This invention relates to an ozone based sanitizer, and more particularly to a sanitization device having a sealable enclosure that can be filled with ozone to sanitize the contents contained therein.

Background of the Invention

Hand sanitation to reduce infection and the transmission of disease is essential. This is especially true in environments that are known to have a high level of infectious organisms and in which sterility and sanitization are required, such as medical offices and hospitals where sanitization is necessary before, during, and after the handling or treating of a patient.

The healthcare worker's busy schedule forces a compromise that frequently results in bypassing or taking short cuts on hand sanitation between and during patient visits. Additionally, many sanitation techniques result in skin irritation and other skin problems. Furthermore, techniques to achieve pre-surgery hand sanitation generally require lengthy procedures, which discourage surgeons and other surgical staff from complying with the necessary sanitation procedure. If the time required and the inconvenience were minimal, and the associated skin problems resulting from using available hand sanitation technology were reduced or eliminated, then the compliance percentage would increase and nosocomial infection rates would decrease.

In addition, the requirements for hand sanitation in terms of how often it is required, and under what circumstance it is required, are demanding and not practical with the existing techniques. Existing procedures consume too much time, are not conveniently available, are not generally effective, and still cause damage and irritation to the skin.

Accordingly, if the healthcare worker can avail himself or herself of hand sanitation multiple times during a particular patient visit, it would minimize spreading pathogens by touching surfaces, another important pathway. Therefore, new technology is needed that provides effective, convenient and quick sanitization, for example ≤ 5 seconds and about 99.99% deactivation of pathogens of all types, and minimal or no irritation of the hands.

Ozone is known to kill pathogens quickly by processes that are not completely characterized for each pathogen. However, it is known that ozone can kill or deactivate all transient flora and pathogens, including all spores and possibly prions.

In a paper by *W. J. Kowalski, W. P. Bahnfleth, and T. S. Whittam* entitled "Bactericidal effects of High Airborne Ozone Concentrations on Escherichia Coli and

Staphylococcus Aureus," published in OZONE SCIENCE & ENGINEERING, 0191-9512/98 (hereinafter "Kowalski"), the disclosure of which is hereby encorporated by reference in its entirety, Kowalski describes *in vitro* experiments on rates of deactivation of bacterial cultures grown on the agar surface of petri dishes that have been ozonated. Colony forming units (CFUs) on control petri dishes are compared to those on ozonated petri dishes to obtain survival fractions as a function of exposure times (e.g., 'death curve'), which is a standard in vitro time/kill-efficacy study technique. Kowalski observes that if the concentrations of ozone in air at atmospheric conditions can be low enough to meet OSHA limits (i.e., 0.1 parts per million in room air) it can be used to deactivate pathogens in room air. Kowalski further speculates that ozone can be used to sterilize surfaces of medical equipment.

The gaseous nature of ozone results in exposure that is very close to 100% including hidden areas, folds, and crevices of the skin and other objects. Exposing one's hands to ozone can substantially expose the fingernail crevice, which has positive implications due to the localized concentration of pathogens and contaminants.

United States patent 6,254,625 to Rosenthal et al. describes a hand sanitation apparatus based on ozone and UVC. The apparatus described is the size of a small refrigerator and produces ozone from air by UVC radiation from germicidal lamps. However, Rosenthal describes no process for preventing ozone from entering room air, which is critical to the safety of using such a device.

What is needed in the art is an easy, quick, and effective hand sanitation technique that is not associated with common skin irritation and problems and does not result in unacceptable levels of ozone in the surrounding environment

Summary of the Invention

In accordance with one aspect of the present invention, a sanitizing apparatus comprising an enclosure, and inlet connector and an exhaust-outlet is provided. The enclosure is substantially impermeable to ozone and has an inner volume and a sealable opening. The sealable opening can be open to receive an item being inserted into the enclosure or closed to form an airtight volume in the enclosure. The inlet connector is attached to the enclosure and can be used to introduce ozone into the enclosure to sanitize the item placed therein. The exhaust-outlet is also attached to the enclosure and can be used to release the gas from the enclosure once the sanitization process is complete.

In accordance with a further aspect of the present invention, a method of sanitizing using ozone is provided. In accordance with the method, an item is inserted into an enclosure having an inlet-connecter, an exhaust-outlet, and a sealable opening. The opening is sealed after insertion of the item to form a substantially air tight barrier around the item. The inlet-connector is connected to an ozone source and used to fill the enclosure with ozone to sanitize the item. The ozone is allowed to convert into a resulting oxygen gas mixture, and released from the enclosure through the exhaust-outlet.

These and other aspects, features and advantages will be apparent from the following description of certain embodiments and the accompanying drawing figures.

Brief Description of the Figures

The foregoing and other features of the present invention will be more readily apparent from the following detailed description and drawings of the illustrative embodiments of the invention wherein like reference numbers refer to similar elements throughout the views and in which:

Figure 1 illustrates one embodiment of the invention including a pouch that encloses a user's hands;

Figure 2 illustrates one embodiment of the invention in which a pouch is used in combination with an ozone hood having a vacuum pump to prevent ozone from escaping the hood enclosure;

Figure 3 illustrates one embodiment of the invention comprising an ozone hood having a deformable opening; and

Figure 4 illustrate one embodiment of the invention that can be worn as a cuff around a users arm.

Description of Illustrative Embodiments of the Invention

By way of overview and introduction, the present invention comprises an enclosure into which an item can be inserted and sterilized. In operation, an item to be sanitized is inserted into a sealable opening in the enclosure. The enclosure is then sealed to completely enclose the item or surround the item, such that a portion of the item projects out of the enclosure. The enclosure is then filled with ozone which sanitizes the portion of the item inserted therein. As the item is sanitized, the ozone breaks down into oxygen. Once the sanitization is complete and the ozone has been reduced to an acceptable level, the gas contained in the enclosure is released and the sanitized item removed.

With reference now to Figure 1, the sanitizer 100 is illustrated in accordance with one embodiment of the invention. The sanitizer 100 includes an enclosure 110 that receives an item to be sanitized. Figure 1 illustrates the sanitizer 100 being used to sanitize a user's hand 190. While the invention is discussed below with respect to the sanitization of a user's hand, it would be appreciated by one of skill in the art that other bodily extremities or inanimate items can be sanitized using the sanitizer 100.

The enclosure 110 illustrated in Figure 1 includes a sealable opening 160. The opening 160 is preferably sized to accommodate a variety of objects. However, it can optionally be shaped and/or sized to accommodate a specific application. For example, the opening 160 can be circular and sized slightly larger than the average human forearm. Thus, the opening 160 can be easily sealed around the forearm while the hand 190 is inserted in the enclosure 110. Preferably the enclosure 110 is designed to be quickly removed or pulled on by a user. Furthermore, the sealable opening 160 can include a fitting to create an airtight seal, such as a snap or elastic fitting.

The enclosure 110 further includes and inlet-connector 120 that is used to fill the enclosure 110 with ozone. The inlet-connector 120 can be connected to an ozone source 130 whereby ozone can be introduced into the interior of the enclosure 110. The inlet-connector 120 preferably includes a valve 180, such as a Schrader valve, to prevent any gas contained within the sealed enclosure 110 from leaking into the surrounding environment. Furthermore, the valve 180 can ensure the ozone is not unintentionally discharged from the ozone source 130.

The enclosure 110 can accommodate various shapes and materials as required by the intended application or generic design. For example, the enclosure 110 can be made from a flexible material (e.g., polyethylene) that can expand as ozone is released through the inlet connector 120 from the ozone source 130 into the enclosure 110. Furthermore, an enclosure 110 made of a flexible material permits a user's hand 190 a degree of tactile sensation through the enclosure 110 as well as the ability to manipulate objects outside the enclosure 110. A further increased level of dexterity can be provided by shaping the enclosure 110 as a mitten or a glove into which a user's hand 190 can be inserted. For example, a glove-shaped, flexible enclosure 110 permits a user to manipulate the inlet-connector 120 and the ozone source 130 while the user's hands are inserted in the enclosure 110.

Once the user's hand 190 (i.e., the item) is inserted in the enclosure 110 and the opening 160 is sealed around the user's wrists or forearms, the enclosure 110 can be filled with ozone from the ozone source 130. A flexible enclosure 110 provides a visual indication of the pressure and ozone contained therein by the swelling of the enclosure 110. Optionally, the enclosure 110 can include a pressure gage to measure the pressure in the enclosure 110.

The ozone source 130 can be provided through various solutions. Figure 1, illustrates a pressurized cartridge based ozone source 130 solution. Cartridges can be filled with ozone at a central location and distributed throughout the environment in which the sanitizer 100 will be used. Thus, a user can have easy access to an ozone source 130 as necessary. Alternatively, the cartridge can be portable and carried by a user from site to site.

Ozone made from relatively pure oxygen can deactivate pathogens faster than ozone made from air because the greater partial pressure of ozone in the gas. The partial pressure of oxygen in air is 21%, which limits the potential ozone concentration. A high concentration results if oxygen alone is used to make the ozone. For example, a 10% concentration, 100,000 ppm is highly effective. Furthermore, a relatively high concentration and high partial pressure of ozone both contribute to enhancing the deactivation rate of the ozone. This can greatly decrease the time required to achieve hand sanitization or sterility.

However, ozone has a limited lifetime as it breaks down into oxygen molecules. Ozone's half-life depends in part on its temperature and surroundings. The following table illustrates the half-life of ozone as a function of temperature, when there are no other influences.

Typical O_3 half-life vs. Temperature	
Temp (C)	**Half-life***
-50	3-months
-35	18-days

-25	8-days
20	3-days

A ready supply of ozone can be ensured through a rigorous inventory procedure and refilling of cartridges. Alternatively, ozone can be produced on demand, or near the time of use. For example, a plastic, airtight cartridge can be filled with oxygen, preferably medical grade, at elevated pressure. The oxygen filled cartridge would have a very long storage lifetime, and can be converted to ozone on or near the day of use. The conversion from oxygen to ozone can be accomplished by disposing a coaxial pin within the cartridge that can be excited with an RF voltage, thereby initiating a corona or Tesla discharge internal to the cartridge. The discharge converts the O_2 (oxygen) to O_3 (ozone). If the walls of the cartridge are relatively transparent one can observe the color change to the light blue that is characteristic of ozone. The ozone can then be transferred to the enclosure 110 using the valve 180 of the inlet-connector 120 controlling the pressure. The cartridge can be used multiple times since not all the ozone is transferred. Furthermore, new ozone can be created on subsequent days by reapplying the RF voltage.

Alternatively, an ozone source can be placed in each room in which it is needed. The ozone source can include a small, closed, discharge and storage volume (DSV) with a pressure gauge. The DSV preferably contains an electrode that supports an RF corona type discharge. Medical grade oxygen from an oxygen cartridge or a small oxygen storage tank is connected to the DSV to let oxygen into the DSV at a prescribed pressure greater than atmospheric. No ozone is transferred into the DSV, and no pump is needed.

The electrical discharge takes place in relatively pure oxygen and some of the oxygen within the volume is converted to ozone. The pressure decreases as a result of the conversion to ozone and the measured internal pressure of the DSV indicates conversion. The lifetime of the ozone in the box can be several hours at room temperature. As the ozone converts back to oxygen the pressure rises towards, and equals, the original pressure as all the ozone becomes oxygen. The pressure within the DSV after all oxygen has been converted to ozone is preferably above atmospheric to ensure that the enclosure 110 inflates with an ozone/oxygen mixture.

After the enclosure 110 is filled with ozone, the inlet-connector can be disconnected from the ozone source. The ozone then begins to convert to oxygen (two ozone molecules become three oxygen molecules) and the pressure in the enclosure 110 increases. The increased pressure indicates that the process of killing pathogens is complete.

The resulting gas mixture in the enclosure 110 is eliminated by activating an exhaust-outlet 140. The exhaust-outlet 140 preferably includes a filter of charcoal, or other catalyst which completely converts the ozone to oxygen. Alternatively the exhaust-outlet 140 includes a sintered plug heated to high temperature which increases the rate of conversion from ozone to oxygen. Effectively, a minimal amount of ozone is released in the air. The user's hand 190 is then removed from the enclosure 110.

It can be desirable to sanitize both hands 190 of a user at the same time. The sanitizer 100 is readily adapted to this task. An optional inter-connect 150 that allows the passage of gases can be used to connect two enclosures 110 together. Thus, a user can place one hand 190 in each enclosure 110 and the ozone released from the ozone source 130 will fill both enclosures 110. Furthermore, because the enclosures 110 can be glove-shaped and made from a flexible material, the user can still independently manipulate the inlet-connector 120, ozone source 130, and exhaust-outlet 140.

Ozone can reduce the surviving fraction of hand pathogens can to less than 10^{-4} with an exposure of no more than a few seconds. Additionally, ozone does not cause cancer or any other serious damage to the skin. Minor irritations resulting from ozone exposure, similar to those associated with hand washing and alcohol rubs, can be treated Vitamin E based skin emollients. However, ozone does not crack or dry the skin, or cause allergic reactions and rashes.

The rate of a chemical reaction between a single pathogen and surrounding ozone molecules, is proportional to the concentration of ozone molecules. While ozone exposure is clearly effective at sanitizing, it requires contact exposure to oxidize pathogens. A small fraction of pathogens clump together and tend to screen one another from the ozone so that the deactivation rate is lower. However, unclumped pathogens are quickly deactivated.

One way to reduce clumping is to rub the hands together, or rub the item being sanitized. The friction created by rubbing causes surface pathogens to slough off and expose previously shielded pathogens or to break up clumps.

A further way to address clumping is the use of vibrations, and in particular ultrasonic energy, such as that used for ultrasonic cleaning. The introduction of vibrational energey to reduce clumping increases the level of deactivation and reduces the necessary ozone exposure time.

Thus, the enclosure 110 can include a vibrational coupler 170 which allows introduction of vibrational (e.g., ultrasonic) energy at high intensity into the enclosure 110 containing the hands. Vibrational sources, such as ultrasonic transducers can be included on the ozone source. The enclosure 110 can be placed against the ozone source for both ozone filling and providing ultrasonic energy.

For example, piezoelectric transducers at 40 KHz, about 1 cm in diameter, are commonly used in commercial ultrasonic cleaners. Such transducers would produce acoustic energy that is inaudible and at an intensity that is not damaging to the human ear. Furthermore, the 40 KHz, ultrasonic radiation can be introduced into the pouch through a low loss, vibration coupler 170 in the enclosure 110 wall. Ultrasonic energy can thus be directed directly into the hand, for example by virtue placing a finger against the coupler 170, optionally covered by a layer of enclosure material. Human tissue, being comprised of mostly water, readily transmits the acoustic energy and vibrates the skin surface thereby declumping pathogens on the skin as the ozone in the enclosure 110 sanitizes. The energy levels are preferably sufficiently low to avoid or minimize damage to body tissue. Other vibration sources and ways of exposing the area being disinfected to vibrational energy can be used.

While the amount of ozone released into the atmosphere using the sanitation device 100 illustrated in Figure 1 is minimal. It may be beneficial to use additional precautions to further minimize the ozone exposure of the user.

Figure 2 illustrates an embodiment of the invention that includes a gas exhaust system. As illustrated in Figure 1, the user's hand 290 is inserted through a sealable opening 260 into an enclosure 210, such as a glove or pouch having an inlet-connector 220. The enclosure 210 is then inserted into a second enclosure 280 through an opening 265. The second enclosure 210 can be integrated with the ozone source 230 and vibrational energy source 270.

An exhaust apparatus 235, such as a small vacuum pump or fan, can be included in the second enclosure 280. The exhaust apparatus moves air into the opening 265 and out an exhaust outlet 240. Thus, any ozone that escapes the enclosure 210 is moved away from the user and vented through exhaust outlet 240, which is preferably located opposite the user. Furthermore, the exhaust outlet 240 can include a filter 245 that increases the conversion of ozone to oxygen. Filters for the exhaust sintered from a variety of materials, for example stainless steel or activated carbon particles, provide good catalysts for converting ozone to oxygen. This conversion can be further enhanced by heating the filter, for example to a temperature greater than 250 degrees C.

The second enclosure 280 can also include a heat source 250 along the interior of the enclosure to further convert any ozone that leaks from the first enclosure 210 to oxygen. The heat source can 250 include incandescent light bulbs or other heating elements known in the art.

The exhaust apparatus of the sanitizing device 200 makes the system substantially ozone leak-proof. The enclosure 210 preferably remains within the second enclosure 280 during the treatment period for protection against a leak and for the ultrasonic input provided by the vibrational coupler 270 for declumping. This configuration allows for higher concentrations of ozone to be provided by the ozone source 230 because the danger of a potential leak is virtually eliminated

In yet a further feature of the present invention, as illustrated in Figure 3, the enclosure 310 can include a deformable elastic opening 360 that provides a nominal seal to gas flow. Thus the enclosure 310 can be a rigid or flexible structure.

To use of the sanitization device 300 illustrated in Figure 3, the user inserts a hand 390 into the enclosure 310 through the elastic opening 360. The opening 360 can be shaped to provide an opening smaller than a user's forearm or wrist. Thus, the user must stretch the opening to insert the hand 390 and the opening will be flush and tight around the user's extremity thereby preventing leaks.

However, if the user must push through the elastic opening 360, brushing his hands against the opening 360 in the process, when the user withdraws his hands from the opening, the hands will again rub against the opening. Thus, pathogens and contaminants that are attached to the seal of the opening 360 can be transferred back onto the user's hands as they are withdrawn from the device 300.

Use of an inflatable ring opening 360 can greatly decrease this potential of cross contamination between uses. The user's hand 390 can thus be inserted into the opening 360 into the enclosure 310. The opening 360 ring can then be inflated to form an air tight seal with the user's extremity. When sanitization is complete, the ring can be deflated so that the user's hand can be removed from the enclosure 310 through the opening 360 without rubbing against the side of the opening 360. Thus the risk of cross contamination is reduced.

Alternatively, any opening 360 of sufficiently large diameter or perimeter which can be closed around the forearm or wrist during sanitization and withdrawn after the process is completed (e.g., a retractable barrier) can decrease the risk of cross contamination. The sealable opening is preferably made of a material that is not damages by ozone, such as Teflon.

As discussed above, it may be beneficial to sanitize both of a user's hands 390 at the same time. The sanitizing device 300 can provide this benefit by including two openings 360. Each opening 360 can include its own elastic opening that seals the interface of the opening 360 and the user's wrist of forearm.

The enclosure 310 can also include vibrational transducers (e.g., ultrasonic transducers 370. When the user's hands 390 are inserted into the enclosure 310, one or more fingers from each hand can touch the ultrasonic transducers 370 to declump the pathogens on the hands. Furthermore, the ultrasonic transducers 370 can be used to initiate the sanitization process.

The capacity for ozone to deactivate pathogens can be increased through the introduction of water vapor. Ozone in a high humidity ambient is known to be highly effective at deactivating pathogens. The dominant contributor is the production of hydroxyl ions, which are more effective at oxidizing pathogens than ozone. Furthermore, hydroxyl ions are generally short lived so do not pose a health or safety risk to the user.

Water vapor can be introduced by evaporation or injection into the enclosure through the inlet-connector 340 similar to the introduction of ozone. Alternatively it can be applied in the ozone storage volume. Thus, the sanitizing benefit of hydroxyl ions is provided.

Figure 4 illustrates a further use of the sanitizing device 400 that provides easy access and fast application. The device 400 can include an enclosure 410 made of a flexible material, such as lightweight polyethylene, that can be worn like a cuff on the forearm of the user's arm. The enclosure 410 has elastic fitting 450 that provides an airtight seal around the forearm. When the enclosure is pulled forward and the opening 460 sealed, by way of a zipper or reusable adhesive, it forms a closed volume around the hand 490 of the user.

After sealing the enclosure 410, the use of the device 400 is similar to that described above. Ozone can be introduced into the enclosure 410 through inlet-connector 420. The hand is sanitized and the ozone converts into oxygen. The enclosure 410 will expand as the ozone is converted to oxygen. Once complete, the ozone can be released from the enclosure 410 through the exhaust-outlet 440. The sealable opening 460 is opened and the enclosure 410 cuff is pulled back. The procedure utilized by the device 400 greatly reduces the risk of recontamination.

While the preceding discussion generally addresses the application of the sanitization device to sanitize a user's hands, it would be understood by one skilled in the art that the invention can also be used in other applications. For example, the enclosure and opening can be adapted to receive various bodily extremities such as a user's foot.

Thus, the sanitizing device can be used to treat athlete's foot or nail fungi using a foot pouch or enclosure similar to the glove for the hands. A body pouch can also be designed to wrap around portions of the body to treat large area wounds or burns.

Additionally, the sanitizing device can be used to sanitize inanimate objects. For example, it is crucial to sanitize surgical devices before they can be reused. Ozone sanitization can be used to locally and quickly sterilize these surgical/medical instruments. The sanitization device is used as described above. However, the opening of the enclosure is sealed to surround the item.

While the invention has been described in connection with a certain embodiment thereof, the invention is not limited to the described embodiments but rather is more broadly defined by the recitations in the claims below and equivalents thereof.

I Claim:

1. A sanitizing apparatus comprising:

an enclosure substantially impermeable to ozone and having an inner volume and a first sealable opening, the first sealable opening having at least two configurations, a first open configuration through which the inner volume can receive and item to be sanitized, and a second closed configuration forming a substantially airtight seal.;

an inlet-connecter fixedly attached to the enclosure and configure to introduced ozone to the inner volume; and

and exhaust-outlet fixedly attached to the enclosure.

2. The sanitizing apparatus of claim 1, further comprising an ozone source having a connecter for engaging the inlet connector.

3. The sanitizing apparatus of claim 2, wherein the ozone source comprises a portable ozone cartridge.

4. The sanitizing apparatus of claim 1, wherein the exhaust-outlet includes a filter to catalyze the conversion of ozone to oxygen as it leaves the enclosure.

5. The sanitizing apparatus of claim 1, further comprising a vibration coupler attached to the enclosure and for transferring vibrations external to the enclosure to the inner volume of the enclosure.

6. The sanitizing apparatus of claim 5, wherein the vibration coupler is an ultrasonic coupler.

7. The sanitizing apparatus of claim 1, further comprising:

a second enclosure; and

an interconnect having a first and second end, the first end configured to engage the first enclosure and the second end configured to engage the second enclosure, such that gases can be transported between the first and second enclosure.

8. The sanitizing apparatus of claim 1, wherein the enclosure further includes a second sealable opening, the second sealable opening having at least two configurations, a first open configuration through which the inner volume can receive the item to be sanitized, and a second closed configuration forming a substantially airtight seal.;

9. The sanitizing apparatus of claim 1, further comprising a second enclosure having an inner volume and an opening for receiving the first enclosure, an exhaust outlet opposite the opening, and an air-circulation device configured to draw air into the first opening and out the exhaust outlet.

10. The Sanitizing apparatus of claim 9, further comprising a heat source attached to the inside of the second enclosure for converting ozone to oxygen.

11. The sanitizing apparatus of claim 10, wherein the heat source includes a light source.

12. The sanitizing apparatus of claim 1, wherein the inlet-connector is further configured to introduce water vapor into the first enclosure.

13. The sanitizing apparatus of claim 1, further comprising a valve disposed within the inlet-connector to prevent the flow of gas out of the first enclosure through the inlet-connector.

14. The sanitizing apparatus of claim 1, wherein the exhaust connector is heated to catalyze the conversion of ozone to oxygen.

15. The sanitizing apparatus of claim 1, wherein the first sealable opening of the enclosure includes an elastic surface that be stretched to accommodate the item being inserted therethrough.

16. The sanitizing apparatus of claim 15, wherein the elastic surface includes an inflatable ring that can be expanded to form a seal with the item inserted therethrough.

17. A method of sanitizing using ozone comprising the steps of:

inserting an item into a first enclosure, the first enclosure having an inlet-connecter, an exhaust path, and a first sealable opening in an open configuration;

closing the sealable opening to form a closed configuration around the item to create a substantially air tight barrier;

connecting the inlet-connector to an ozone source;

filling the first enclosure with ozone from the ozone source to sanitize the item contained therein;

allowing the ozone to breakdown into a resulting gas mixture; and

releasing the resulting gas mixture from the first enclosure through the exhaust-outlet.

18. The method of claim 17, wherein the item being sanitized comprises a part of a user's body, and the substantially airtight barrier includes an engagement of the first sealable opening and the user's body part.

19. The method of claim 17, wherein the item being sanitized comprises a gloved hand, and the substantially airtight barrier includes an engagement of the first sealable opening and the user's body.

20. The method of claim 17, wherein the sealable opening include an inflatable elastic ring and the step of closing the sealable opening includes the step of inflating the elastic ring to form a substantially air tight barrier with the item inserted therethrough.

21 The method of claim 17, further comprising the step of introducing water vapor into the first enclosure prior to allowing the ozone to breakdown.

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Figure 1

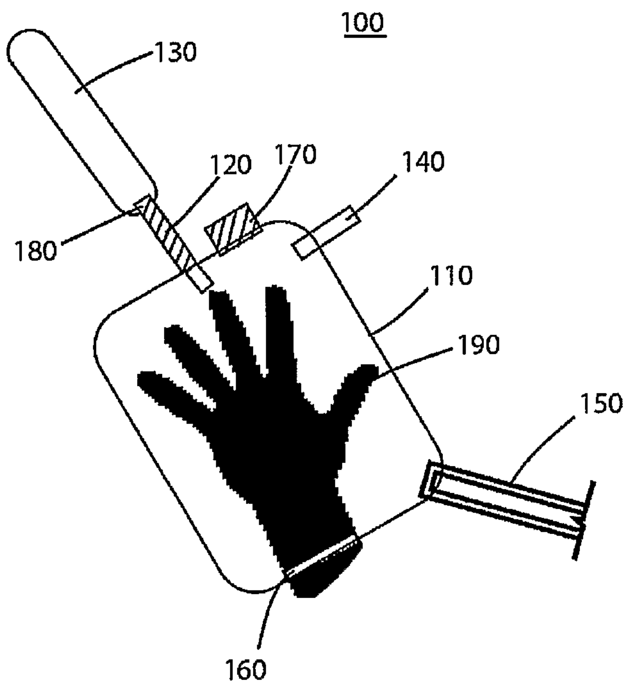

Figure 2

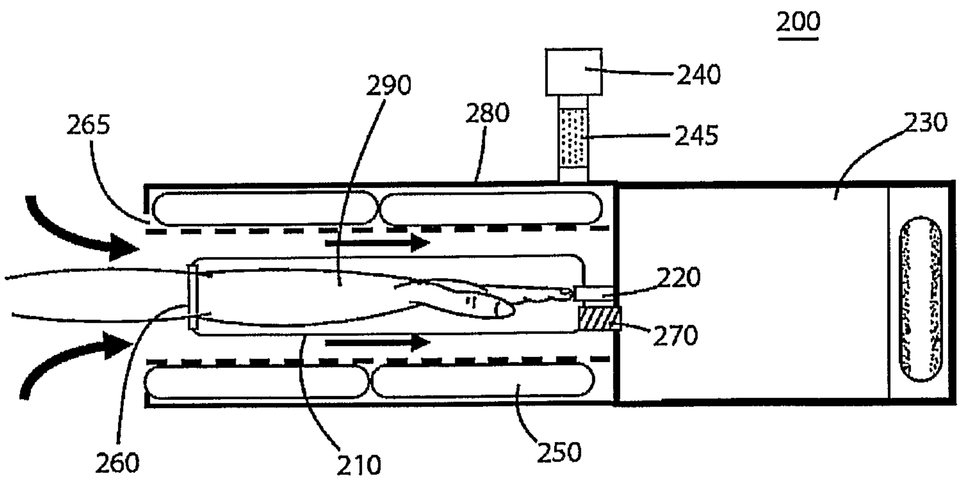

Figure 3

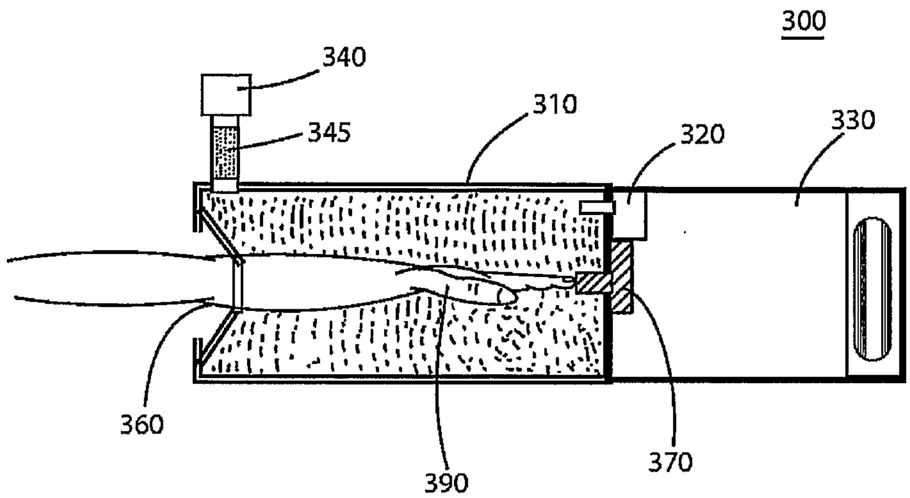

Figure 4