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Preliminary Amendment

15 Prior to examination, please make the following amendments to
the above-identified application:

Amendments to the Claims

CLAIMS

What is claimed is:

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1-15. (Canceled).

16. (Currently Amended) A process for destroying a DNA or RNA of a microorganism on ~~disinfecting~~ a substance or surface comprising the steps of:

10 generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm; and

directing the photons to ~~a~~ the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms.

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17. (Canceled).

18. (Original) The process of claim 16 further comprising the step of providing an NUV source for generating the photons.

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19. (Original) The process of claim 16 wherein the directing step is performed by reflecting the photons to a desired surface.

20. (Currently Amended) A process for destroying a DNA or RNA of a microorganism ~~disinfecting a substance~~ in an air stream comprising the steps of:

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generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

directing an air stream to a source of the photons; and

exposing the air stream to the generated photons, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms in the air stream.

5 21. (Canceled).

22. (Original) The process of claim 20 further comprising the step of providing an NUV source for generating the photons.

10 23. (Original) The process of claim 20 further comprising the steps of:
determining required activity time to disinfect the air stream; and
removing the particles from the air stream after the activity time.

15 24. (Original) The process of claim 23, further comprising the step of humidifying
the air stream downstream of the removing step.

25. (Currently Amended) A process for providing a germ-free surgical space comprising the steps of:

20 generating photons of at least one wavelength corresponding to a peak
absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

 directing an air stream to a source of photons;
 exposing the air stream to the photons;
 removing particles from the air stream; and
25 directing the air stream vertically downward to a surgical area, whereby a
disinfected airflow surrounds the surgical space and prevents infected air from entering.

26. (Canceled).

27. (New) The process of claim 16 wherein the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected.

5 28. (New) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 40 mJ/cm² to the substance or surface to be disinfected.

29. (New) The process of claim 16 wherein the step of directing the photons
10 further comprises directing the photons to provide a radiant dose energy of 60 mJ/cm² to the substance or surface to be disinfected.

30. (New) The process of claim 16 wherein the step of directing the photons further comprises providing a radiant dose energy of 10 mJ/cm² to the substance or
15 surface to be disinfected.

31. (New) The process of claim 16 further comprising the step of selecting a source for generating the photons, the source for generating the photons selected to produce an irradiance of approximately 100 mw/cm² or less.
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31. (New) The process of claim 16 wherein the surface to be disinfected is human skin.

32. (New) The process of claim 16 wherein the step of directing the photons
25 further comprises exposing the substance or surface to be disinfected to the generated photons for less than 0.1 second.

33. (New) The process of claim 16 further comprising the step of selecting a source for generating the photons, wherein the source for generating photons is a hand
30 held lamp, and wherein the step of directing the photons further comprises the step of

waving the hand held lamp over the surface or substance to be disinfected, exposing the surface or substance to the generated photons for approximately 0.1 second or less.

- 34.(New) The process of claim 20 further comprising the steps of:
- 5 selecting a source of photons configured to provide an irradiance of 100 mw/cm^2 ;
 wherein the step of exposing the air stream further comprises exposing the air stream to the generated photons for at least 0.1 second, thereby providing a radiant dose to the air stream and contents therein of 10 mj/ cm^2 .
- 10 35.(New) The process of claim 20 wherein the step of exposing the air stream to the generated photons further comprises providing a radiant dose of photons to an air stream and contents therein of 40 mj/cm^2 .

Amendments to the Specification

Attached please find a substitute specification, including a marked copy and clean copy.

COMMENTS

Applicant has herein amended the claims to cancel claims 1-
5 15, 17, 21 and 26, amend claims 16, 20 and 25, and add claims
27-35. Applicant has further amended the specification.
Applicant asserts that no new matter has been added to the
claims. Specifically, support for the claim amendments can be
found in the parent specification at least at: Page 3 line 24-
10 page 4 line 11 (supporting the destruction of DNA and RNA); Page
7 lines 13-15, and page 8 lines 18-21 (support for photon source
energies); page 11 lines 17-18 (support for exposure timing);
page 12 line 5-6 (support for a hand held wand); and page 12
lines 12-14 (support for skin disinfection). As such, Applicant
15 respectfully asserts that the claims as amended and added are
supported in the specification as originally filed.

Respectfully submitted,

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METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND
PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
PRIORITY CLAIM

This application is a continuation-in-part patent application which claims the benefit to and priority from currently pending non-provisional United States utility patent application number 11/831,667 filed on July 31, 2007, which is a continuation-in-part patent application of International patent application number PCT/US2006/003393 filed on January 31, 2006, currently expired, which is a non-provisional application of United States provisional application number 60/593626 filed on January 31, 2005, currently expired.

BACKGROUND

1. Field of the Invention.

This specification teaches a new method for disinfecting and sterilizing air, surfaces of all types and food from microorganisms and toxic chemical substances. In addition, it relates to a process and apparatus for protecting surfaces in closed or captured environments (zones) from external sources of microbial contamination in an efficient and cost effective process. These zones can be large volumes such as high rise building, cruise ships and jet airliners, or small volumes such as small rooms or surgical operation areas whether in a hospital operating room or on the battle field.

2. Description of the Related Art.

All prior art for sterilizing and disinfecting air has been based on using commercially available ultra-violet (UV) lamps or by using magnetic fields. These lamps are either pulsed or continuous. Continuous lamps are mercury based and emit principally at 254 nm. A number of companies are presently producing UV light based apparatus for the destruction of "virus, bacteria, spores and pathogens" (microorganisms or VSP) that are in room air. This is an effective treatment because it continually exposes room air currents to the treatment light and over time has sufficient exposure time to treat VSP's. The required exposure times range from 10's to 100's of seconds, depending on the light absorption capability of the different virus and bacteria at the 254 nm. While this is effective for treating the room air of individual rooms, it requires a long time to be effective in treating large flowing volumes of air that pass quickly down large ducts. Its long treatment time is impractical for treating most surfaces.

Magnetic based apparatus also require time to deactivate or destroy these VSP's. Two such inventions are directed to specific applications. Wesley, U.S. Pat. No. 4,458,153 is directed

specifically towards liquid like substances enclosed in pipes, but does not discuss any test results. Sangster, U.S. Pat. No. 5,750,072 requires an injection of a sterilizing fluid as a mist or vapor for the magnetic field to produce radicals that in turn are used to alter the VSP's. He does not discuss any test results. Hofmann, U.S. Pat. No. 4,524,079 is directed specifically to treating food stuffs. He speaks of requiring up to 100 pulses at frequencies ranging from 5 to 500 kHz. Although the action time would be short, the power required to treat large areas and the apparatus design limit its practical application. None of these patents are admitted to being prior art by their mention in this background section.

The broad ultraviolet spectrum had been divided into three regions depending on its different effects on human skin. Reference to these regions are predominantly made in medical terminology with UV-A defined as a range or band between 320 nm and 400 nm, UV-B defined as a band between 280 nm and 320 nm, and UV-C defined as encompassing wavelengths shorter than 280 nm. Recently the UV-C band has been shortened because strong water absorption causes different effects on the skin below 235 nm. UV-C is now considered the band encompassing wavelengths from 280 nm to 235 nm. The Far UV begins at 235 nm and encompasses wavelengths to the beginning of vacuum UV at 185 nm. Photochemists and photobiologists do not generally use these terms because absorption spectra of chemical bonds are much narrower than these generally defined bands. Instead, they use the wavelength of the applied radiation to define the observed effects.

Claims have been made that UV-C radiation is used to alter the DNA. This is because the mercury lamp emission at 254 nm is close to a good DNA absorption band and is the most widely available UV-C radiation source. None of these claims make reference to any shorter wavelengths and to the absorption band that peaks at 200 nm (see figure 9). Most literature credits this peak to protein absorption whereas the peak centered near 260 nm is attributed to many amino acids. In fact, all literature directs researchers away from using any shorter wavelengths due to the high absorption of molecular water. Mercury lamps are used for wastewater treatment and work well for this application. However, this specification teaches that since we do not live underwater, the protein absorption band offers much more significant action spectra that can be used to alter the DNA of microorganisms more effectively. A source of Far UV photons targets this protein absorption band. This concept is a significant advancement and a step change in the technology used for sterilization and disinfection.

During the past few years, new UV emitting lamps based on the excitation of excimers are becoming commercially available. These emitters produce single line or narrow spectral emission at a wavelength determined by the gas composition of the lamp. If the treatment lamp's wavelength is

chosen to match closely to the peak of protein absorption of the microorganism's DNA, then a lethal dosage can be delivered to the VSP's in a shorter time. No patent has been found that teaches the use of "new ultra-violet" (NUV) sources coupled with supporting equipment that can effectively and efficiently disinfect and sterilize large volumes of air, large and small surfaces, and food stuffs in various stages of preparation in a practical manner.

The NUV lamp is a coaxial design that can be made as small as a pencil to as large as 1 meter long. Lamp efficiency is about 10-25% wall power to UV emission. The design has several advantages over mercury lamps. Most important is that its gas can be chosen to maximize its emission to the absorption peak of the targeted biochemical. Unlike the mercury lamp, the UV intensity can be varied from near zero to maximum. It will produce 10 to 1000 times more intensity than mercury, depending on the lamp dimensions, and it does not use mercury that will soon become regulated by the EPA.

In this specification, sterilization or sterilize refers to sterilization or high level disinfectant as defined by US FDA. The terms disinfectant and disinfection refers to all other levels of disinfection.

SUMMARY OF THE INVENTION

Destruction of pathogens is significantly improved by targeting a biochemical in its DNA/RNA with the proper wavelength so the critical dosage can be delivered in the shortest time. The concept is to direct the correct spectral emission to target specific bonds with sufficient intensity to destroy pathogens quickly and effectively on all types of surfaces and in the air.

Critical to this apparatus is the development of a new ultra-violet (NUV) source that emits a highly intense narrow wavelength band of photons that correspond to the maximum absorption band for DNA proteins and other component bonds. The preferred embodiment is the NUV source at 222 nm targets these proteins and their peptide bonds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. For some specific cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. The process is to use the irradiance from the NUV apparatus to produce high levels of disinfection on all types of contaminated surfaces and air and to destroy Biotoxins and nerve agents. The process includes support apparatus, ozone with the NUV source and preconditioning liquids and sprays that affect the tightness of the polypeptide helix which may improve absorption by the pathogen proteins or amino acids that result in improved destruction at lower dose or less time or both.

BACKGROUND FOR NUV APPARATUS

The genetic makeup of all living organisms is contained in their DNA molecule. This is a nucleic acid molecule that contains the genetic instructions to construct other components of living cells, proteins and RNA molecules. Replication occurs by the splitting of the DNA molecule, which duplicates itself through a transformation of its structure. Parts of the DNA molecule have been given names such as pyrimidine bases, cytosine, thymine or uracil that form a group of biochemicals that sustain life. The long DNA molecule holds itself together by using simple bonds like those found in sugars.

Researchers believe that the energy of the UV photon causes the formation of a strong (covalent) bond to develop between specific biochemicals. However, the bond strength of the covalent bond is very dependent on the relative position of the participating atoms. When the bond is symmetrical on both sides of a hydrogen atom in the bond, it is referred to as a dimer. A dimer is a very strong bond and is not generally broken during the vaporization of the liquid. UV light is known to produce Thymine, cytosine-thymine, and cytosine dimers. After the formation of the dimer, further replication of the DNA stops. Figure 8 shows the concept of the dimer formation in a DNA molecule.

The DNA molecule absorbs light from about 180 nm to about 300 nm. One of the most effective wavelengths to treat VSP's in water is about 254 nm because of low water absorption. However, water absorption of UV light increases steadily as the wavelength decreases below 240 nm. This limits the ability for UV light of shorter wavelengths to be as effective for water treatment.

A standard commercial light source for UV irradiation near the 260 nm absorption peak of DNA is being produced by using mercury as the source for generating photons. The mercury gas and its pressure in the lamp determine the wavelength of the emitting light. For low-pressure (LP) and low-pressure high output (LPHO) lamps, the emitting wavelength is near 254 nm. For medium pressure lamps, the emission ranges from 200 nm to above 300 nm. However, the strength of the emitted light is not effective below 245 nm for the continuous emitting lamps and below 235 nm for medium pressure lamps. Xenon gas in pulsed lamps produces a similar emission as the medium pressure mercury lamps.

DNA action spectra show that absorption increases as the wavelength decreases, with a relative maxima at 260 nm and largest at 200 nm. Many articles indicate the principal action spectra of the DNA absorption is from 245 to 280 nm range and do not address the 200 nm peak. An exception is Figure 9 which graphically shows this relationship (Von Sonntag; Disinfection by free radicals and UV-radiation. Water Supply 4, 11-18 (1986)). Since water absorption significantly increases below 240 nm, it becomes apparent that DNA effectiveness curves that omit the 200 nm peak apply only to organisms in water.

MS-2 Phage is a marker virus that is used to measure reproduction viability after UV irradiation. Figure 10 is DNA absorption without the influence of water (Gates, F.L. A study of the bactericidal action of ultra violet light III. Jour. General Physiology 14, 31-42 (1930)). Absorption is more than doubled at 220 nm.

A recent technical paper (Peak et al, UV action spectra for DNA dimer induction; Photochemistry and Photobiology, 40, 5 (613-620)-1984) suggests that dimer formation is not the only requirement to inactivate DNA. Absorption of other molecular groups in the long DNA chain increase as the wavelength is reduced from 254 nm. Damaging or destroying these bonds may be more effective in deactivating the DNA than compared to the 254 nm band. Reports show that damage caused by 254 nm light can be reversed by longer wavelength UV and blue light (Figure 12). The DNA of pathogens not expected to have this 'photo-reactivation' phenomenon after being exposed to higher energy 222 nm photons.

The energy of the emitted photon is determined by its wavelength. Photon energy is about 5ev at 250nm, and increases for shorter wavelengths. Different bonds in the DNA will be affected with photons of different energy.

The 540 kJ/mole photon energy from the NUV lamp exceeds the bond energies of many of the peptide bonds. This should cause physical damage to the microorganism. Figure 15 shows a micrograph of the *Bacillus atrophaeus* after receiving a radiant dose from a NUV lamp. It shows a magnification of 300x and 1000x taken at low power to prevent any physical damage to the organisms during the picture process. The results of photon impact can be clearly seen in the 1000x frame by the ruptured sidewalls and segmentation of the organism. This is the first indication the author has seen that photons are actually causing physical damage and destruction to pathogens. A corresponding slide that received the same radiant exposure confirmed that all organisms were dead.

A NUV lamp emitting at 222 nm is considered the most effective source because DNA molecules and biochemical's have greater absorption at this wavelength. The steep rise in absorption below 240 nm is exhibited by most proteins. It has been fairly well established that the peptide bonds in protein molecules are responsible for the steep rise in absorption. This occurs as well for nucleo-proteins, aromatic amino-acids, diglycine, triglycine, and bovine albumin (McLaren, et al, Photochemistry of Proteins and Nucleic Acids, Pergamon Press, Macmillan Company, 1964). An organic chemist suggests that this lower wavelength is more effective in breaking bonds and producing dimers in the purine bases and sugar phosphates instead of the pyrimidines.

This wavelength is not strongly absorbed by water vapor and oxygen in the air. However, at 200 nm, oxygen absorption increases by 10 times and water absorption becomes slightly greater than

oxygen. At 200 nm, ozone production vs. irradiance can not be controlled as it can at 222 nm. This would create a large amount of ozone that is harmful to humans and animals and reduce its effectiveness for applications in air, particularly for long irradiation distances.

TESTS

Using a lamp that emits 222 nm, a comparison test with and without water was made to determine the effect of this radiation on organisms. The organism used in all tests was the MS-2 virus, which has become a standard indicator of mutation effectiveness. The EPA report (811-R-96-002) reports a 4.3 average log reduction of the MS-2 virus using mercury light 254nm at an irradiance greater than 128 mj /cm².

Three wavelengths were tested: 222, 253, 259 nm. The 222 nm lamp was tested at three levels of irradiance with the virus in a thin layer of water in order to reduce the absorption effect of water. A separate test was also done with the virus in more water. The 253 and 259 nm lamps were tested at the identical irradiance levels with the virus in water. Controls were made on all tests and a single test dish on each lamp was made to check experimental error.

The 222 nm lamp (Figure 11) produced log 5 reductions at 40 mj/ cm² and log 6.5 reductions at 60 mj/ cm². The water test produced a 3.2 log reduction, which matched the equivalent calculated irradiance in air. The 253 and 259 nm lamps produced about log 4 reductions at 60 mj/cm². A 3 million reduction in population is about 10 to 100 times more effective than reported mercury 254nm results at the same irradiance.

The results of the test indicate that 222 nm light is very effective in causing mutations and destruction in microorganisms. These tests indicate an improvement of between 10 to 1000 times, depending on the intensity of the lamp. It is important to note the improvement of the 259 nm source compared to the 254 nm source. This produced a 10 times improvement in the test sample for just a 5% increase in absorption. It illustrates the importance in using a UV photon emitter that is near the absorption peak of the DNA or targeted chemical such as proteins, nucleic acids, or amino-acids.

Figure 12 illustrates the 254 nm dose required to deactivation different VSP's. The bars represent with (solid) and without (open) photo-reactivation. Note that a dose of 75 mj/cm² is required to deactivate the MS2 Phage virus and prevent photo-reactivation. In the tests shown in Figure 11, half the dose at 222 nm was just as effective as the higher dose at 254 nm. Even though the sample was under water, the 222 nm radiation was still more effective than 254 nm radiation.

The 222 nm photon has more energy and is absorbed by S-N, S-O, O-O, O-H, and many carbon bonds that do not absorb 254 nm. This suggests that 222 nm light may also prevent DNA repair that has been reported when low level 254 nm UV sources were used.

Figure 14 presents further testing done in independent research laboratories on many different pathogens. They include spores *Bacillus atrophaeus* and *Clostridium sporogenes*, feline calici virus, bacteria *Acinetobacter baumannii*, MRSA, MRSA + 1% serum. The chart plots radiant dose against a log reduction of the target microorganism. It shows that high log reductions were achieved for viruses, bacteria and spores. This chart presents data that does not determine the minimum dose but only the log reduction at the dose tested. Since many tests represented a 100% kill, a lower dose could obtain the same log reduction at or near 100% kill.

A survival plot was made of the *Bacillus atrophaeus* spore. Since it is known to be one of the most difficult spores to kill or deactivate, this curve represents the base line for the dose required to kill most pathogens for the NUV source. Future tests will generate survival plots of the other pathogens to determine the minimum dose for various log reductions.

Since the NUV source can produce an irradiance of 100 mw/cm², then a log 4 reduction of all but the *B. atrophaeus* can occur in a 0.1 second treatment resulting in a radiant dose of 10 mj/cm². The chart demonstrates that the NUV source is a potent sporicide as well as capable of producing high disinfection on VSP's.

TECHNICAL DISCUSSION

Critical to the destruction of the organism is targeting the proper biochemical with the proper wavelength so the critical dosage can be delivered in the shortest time. The critical dosage is that dosage that destroys or deactivates the organism and prevents its replication.

Pyrimidine and purine bases of nucleic acids have a strong absorption near 260 nm. But proteins also have an absorption maximum at about 280 nm due to the absorption by the aromatic amino acids phenylalanine, tyrosine and tryptophane. Numerous lipids also absorb near this peak. They include indole acetic acid and Lipase. And there are some major differences that occur in the synthesis of DNA to RNA. The protein thymine is replaced by the pyrimidine base uracil that has absorption near the 280 nm and not at lower wavelengths.

It is important to note that biochemicals of DNA and RNA will have different absorption spectra and the peak absorption will be shifted by water, pH, temperature, previously absorbed light and surrounding contaminants in the air. Uracil and cytosine are particularly susceptible to photohydrate formation. A protein crosslink can be formed between a pyrimidines base and an amino acid.

Cysteine and thymine are easily affected and uracil preferentially binds to cysteine, phenylalanine and tyrosine. Protein crosslinks induce irreversible cell damage. The disulfide group of cystine can be split into reactive sulfhydryl groups. Tryptophane (280 nm absorption) can provide the singlet energy transfer to split the disulfide groups that strongly influence the structure and function of proteins in the DNA/RNA complexes.

The presence of ozone can significantly induce damage to the long polypeptide amino acid chains and shorten the UV action kill time. For some applications, the NUV intensity is increased to produce some ozone to improve the pathogen destruction of the contaminated surface.

Test data confirmed that proteins in the RNA of the norovirus do not absorb the NUV wavelength at 222 nm effectively. However, a number of RNA proteins do exhibit strong absorption near the amino acid peak absorption of 280 nm. More likely is the fact that RNA absorption is due to the combination of the proteins and the locations and types of amino acid bonds surrounding them. Testing is underway to confirm that a NUV source at 282 nm will cause similar destruction to the RNA of the norovirus compared to the DNA destruction seen in Figure 14.

There are many UV absorption plots that indicate how the degree of absorption in the DNA/RNA molecule changes with wavelength as the pH of the carrier solution is changed. The *secondary structure* is a term used to describe the coiling of the polypeptide chain. The tightness of the coil is also significantly affected by pH of the solution. This suggests that the closeness of the different amino acids to peptide bonds affect the DNA/RNA absorption at a specific wavelength. Consequently, pre-treating the surface with a solution or spray that improves the absorption of the targeted proteins and amino acids prior to delivering a UV radiant dose is also being tested. In many cases, it may significantly improve the process by reducing the UV dose or treatment time. The concept of using the NUV source in conjunction with wipes and liquids for treating VSP's on surfaces is also contained in the scope of this specification.

Biotoxins and nerve agents can be used by terrorists as weapons against groups of people. Nothing economical has been developed that could mitigate an attack and prevent the loss of life and incapacitation at the point of attack. While government agencies of the US have developed detectors that could be used in the future to warn people in the confined areas that are under attack, nothing would prevent the attack from being effective.

Biotoxins and nerve agents are organic molecules that contain either DNA or have long chain carbon molecules. Both of these are susceptible to destruction using NUV light sources. 222 nm will destroy the C=C and C=O bonds causing the destruction of the chemical. Future testing will

determine if the molecular extinction coefficient is sufficient to make this effective means for their destruction.

The most effective means for delivery of these agents is to spread them in a gas phase through the air ventilation system. A detector would be used to turn on sufficient NUV sources so that the agents are destroyed before exiting the ventilation system into the confined area where the captured population is present. Tests still need to be done in regulated and controlled laboratories to develop the criteria for these sources to be effective and become the first line of defense.

The use of a high E field electrostatic precipitator (ESP) is important to the sterilization and disinfecting apparatus for air in some situations. Figure 13 compares the range of effectiveness with mechanical filters for different pollutant sizes. As illustrated in the fourth column, it is capable of removing some percentage of VSP's. However, since it can also capture fog and mist, it has the ability to breakdown ozone O_3 into oxygen. Its use prevents levels of ozone from exceeding the EPA exposure safe levels.

In some cases the air disinfecting apparatus includes a humidification system to provide and maintain minimum moisture content at predetermined and controllable levels. In addition, the apparatus contains baffles and zone restriction devices that enhance the zone protection and minimize the positive pressure required to maintain the protected zone.

The concept of using the NUV source with associated support equipment for air disinfection of VSP's is valid and is also contained in the scope of this specification.

APPARATUS AND PROCESS DISCUSSION

The NUV source apparatus is made to supply a narrow emission band of UV light that is close to the peak absorption of the targeted organism or chemical with sufficient photon energy that break bonds. Unique to obtaining short action (kill) times is a determination of the specific wavelength required to destroy the targeted organism or chemical.

The process is to direct the correct spectral emission to target specific bonds in proteins and amino acids in the DNA/RNA molecule with sufficient intensity to destroy pathogens quickly and effectively. It is effective for the breakdown of biofilm and protein based allergens.

The preferred embodiment is a NUV source at 222 nm. This spectral emission is 10^4 times more effective than standard mercury based lamp UV light for altering the DNA. Action times are reduced from 10's to 100's of seconds to times less than 0.1 seconds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. This may be particularly

important for single or double strand RNA of influenza or noroviruses. For some cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. And the photon energy of the NUV source is sufficiently high to break carbon bonds of chemical toxic substances or biotoxins with similar action times.

This invention uses the NUV source that makes it cost effective in treating surfaces of materials since the action time is very quick. The apparatus of this invention is designed to make direct photons to the intended target as effectively and efficiently as possible. This makes for a cost effective process for sterilizing and disinfecting air, all types of surfaces and food during normal daily activity and prevents the previous need to restrict occupation and use of areas being treated.

Surfaces

The apparatus is designed to quickly disinfect floors, hand rails, objects that are in constant contact with transient populations for the purpose of preventing transmission of disease and toxic substances that can cause injury or illness to these populations. As a hand wand, it only needs to be waved or passed over the surface to obtain a high level of disinfection.

The NUV radiation can be applied to any object or surface that needs to be disinfected and/or sterilized. An example would be the use of a caddy cart whereby all instruments, papers and pens would be exposed after a patient examination to prevent the transmission of pathogens to the next patient. The cart could also provide a means to disinfect protective gloves or face masks if a shortage occurs during a pandemic. Testing will determine the correct exposure limits to prevent any harmful effects that could occur when used to disinfect human skin, hands, animal surfaces such as skin, fur, and hair, and critical plastics and materials used in medical devices. It also has the potential to sterilize/disinfect medical equipment and surfaces and critical parts on an industrial assembly line prior to packaging.

In one specific embodiment of use, the present invention may be applied to skin disinfection. The wavelengths contemplated herein are not damaging to the epidermis, and therefore can quickly and effectively disinfect human or animal skin without skin cell damage. In one example, a doctor or nurse may expose their hands to the NUV source before, during, and/or after surgery. Because the NUV source may disinfect in a fraction of a second, hand disinfection is very quick and convenient, and can be done repeatedly to prevent any spread or growth of micro-organisms. Other examples of skin disinfection may be applied to livestock industries, food processing and treatment industries, pet cleaning, and the like. Livestock may be exposed to the NUV source to keep them clean and disinfected and prevent infection or spread of infection. Similarly, food treatment and processing

industries may use the NUV source to treat and disinfect skin of animals and/or animal carcasses, as well as exterior surfaces of food products such as eggs, fruits and vegetables, leafy greens, eggs, nuts and any food products that need some level of disinfection such as spices, grains, and horticulture such as flowers and plants.

In one embodiment that may be particularly applicable to skin and/or wound (non-skin flesh) disinfection, at least one of 207 nm, 222 nm, or both may be used as wavelengths emitted from the NUV source (or two different NUV sources). These two wavelengths may be emitted by an excimer lamp or lamps. In an embodiment emitting both 207 nm and 222 nm, two separate lamps may be used, the two lamps in close proximity to each other. In another embodiment, a dual annulus lamp may be utilized. This lamp may have three coaxial tubes defining two annuli filled with two different gasses to generate the two wavelengths. Electrodes may serve to excite the gasses, emitting the two wavelengths simultaneously and from a single source.

Because the lamp in this embodiment's wavelength is chosen to match closely to the peak of protein absorption of the microorganism's DNA, both 207 nm and 222 nm may be particularly useful for skin and wound disinfection because they do not penetrate the epidermis, and 207 in particular does not damage human or animal cells. Similarly, 222 nm kills non-epidermis cells entirely, and therefore there is no concern of DNA mutation which leads to diseases such as cancer. As such, these two particular wavelengths are particularly well suited to skin and wound disinfection: Both are useful on skin because they do not penetrate the epidermis; and both are useful on wounds because 207 nm will not damage the exposed flesh, while 222 nm will kill exposed cells, but not cause them to mutate, eliminating radiation concerns. From an effectiveness standpoint however, 222nm is approximately 3-4 times as effective at disinfection compared to 207 nm. Thus, while 207 nm alone is an option for disinfection, generally 222 nm alone or in combination emission with 207 nm will be utilized for most embodiments.

In another embodiment, the NUV source may be mounted on an automated robot, the robot being programmed and configured to disinfect a room automatically. This robot may be specifically configured to disinfect hospital rooms automatically but moving into the hospital room, and activating the NUV source. This will disinfect all air and surfaces exposed to the UV radiation from the NUV source. Further, the robot may be configured to move around the room to expose other surface and air zones to the UV radiation from the NUV source. It should be understood that this embodiment is not limited to hospital room disinfection, and could be used for any room disinfection with the NUV source attached to a robot or robot controlled device. For example, the robot may be an automated

vacuum cleaner or floor cleaner, or a robot specifically configured to enter a room in a building to disinfect the room.

In yet another embodiment, the NUV source can be used to disinfect all types of liquids by passing them through the center of the lamp where coupling efficiency with the light is maximized. Any liquid such as milk that will flow and requires some level of disinfection would be applicable. This would include wine, water for all types of uses, food products from salad dressings with low viscosity to chocolate which is most viscous. Other liquids used for medicines and health care would be disinfected at the point of container filling thereby killing any bacteria that could be resident in the piping and tubing from the supply vessel.

In another embodiment, the NUV source can be used to kill insects and psyllids that are transporting disease or harmful bacteria. As part of the killing process, it can also be used to prevent the spread of these insects by providing a containment area where they are killed if they try to fly through the irradiated zone. For example, the NUV source may be deployed in a field of crops itself, or may be used to set up a containment area around the field of crops. In a further example, containment areas may be set up around areas frequented by humans or animals to prevent infection and/or transfer of disease caused by the insects and/or psyllids.

In another embodiment, the NUV source can be used to kill fungus and molds in the fields of wheat, corn, cotton, and coffee as well as protect any other plants that need to be kept mold or fungus free. It can be further used to break down mycotoxins on food products that are produced by molds and fungus.

In another embodiment, the NUV source can be used to disinfect parts of containers that come in contact with storing food. Examples of these surfaces include bottle caps, the inside of bottles and plastic containers, and the inside of tubing and containers that handle these food products in the manufacturing and transporting in preparation to filling in consumer containers.

Other non-limiting examples of uses for the NUV source may include disinfection on foods of all types, including meat, poultry, eggs, vegetables, fruits, and the like. In particular blueberries and tomatoes may be particularly well suited for such disinfection because of their susceptibility to infection. Moreover, the NUV source may be useful for disinfection of conveyor lines, chiller liquids, water used for production requiring high levels of disinfection, hatcheries, farming, and the like. However, as noted previously, the NUV source contemplated herein may be applied to disinfection of any zone (such as a volume of air), or surface, and is in no way limited to the applications noted herein.

Because the NUV source is a light source, it can be directed to expose different levels of thick and loose materials by using light conducting fibers to distribute the light intensity. An example would have the NUV source disinfecting a floor by directing it at the floor while some of the light is directed to the bottom of a rug or floor scrubbing brush by light fibers imbedded in the brush. In a similar manner, products that have cavities or areas not exposed directly by the external source could be disinfected. An example of this would be a single fiber used to direct NUV light into a tooth cavity to disinfect the walls and tissue inside prior to sealing with a filling.

The NUV source can be used to directly disinfect room surfaces, apparatus, fixtures and clothing or particles and microbes in the room air by directly exposing all objects for the required exposure time. Several sources can be combined to assure exposure to all surfaces and to reduce total exposure time. It can provide effective treatment to isolation room air by preventing pathogens from remaining alive after exiting or entering the room. Rooms contaminated by bioterrorist agents could be treated by moving using robots to move the NUV source(s) in many directions and moving it (them) around the room during treatment.

Food

The NUV source may provide a significant improvement to the disinfection of food stuffs. The apparatus can be designed for each application that includes foodstuffs in conveyor assemblies, stationary carts and in handling routes during the movement from storage to food preparation processes. It can be use to disinfect specific types of foods such as seeds and sprouts prior to planting, raw food stock like fruits and berries and leafy greens as they are prepared for transportation from the fields to processing centers, to warehousing and storage, to supermarket handling and kitchen preparation and delivery to the consumer. Furthermore, the process can be used to disinfect cutting and working surfaces of meat and poultry packaging rooms and even the cutters and equipment used to transport meat, poultry and other food products.

E-beam sources are currently the only other mechanism being tested to protect food supplies. It does irradiate food with high energetic electrons that is now causing concerns by many about the safety of the product after irradiation.

Air

Normal breathable air contains many contaminates including moisture droplets, dust, lint, bacteria, virus, cists, and spores. The NUV apparatus can be used by itself to disinfect air. The short action time means the NUV lamp can destroy pathogens in the air as they pass by. Another important consideration for its use in disinfecting of air is that it does not contain mercury.

Sterilization sometimes requires the removal of all particles to the smallest possible size. The NUV source can produce byproducts that must be removed for some treatment applications. These byproducts include oxidized air (ozone), condensable chemical byproducts, and damaged microorganisms. Critical to the apparatus is the removal of these contaminants and byproducts. In some special applications, ozone is produced by the NUV source to make treatment more effective. Consequently, the apparatus includes the making of ozone, the use of high E field precipitators and other UV light to remove ozone downstream after the disinfection area and apparatus to make effective use of the combination of these technologies.

Sterilized air is then used to prevent microbial contamination of a protected zone by preventing the influx of untreated air from outside this zone. The apparatus includes pressurizing equipment and zone baffles that provide sufficient outflow from the protected zone so as no contamination can occur. Protected zones can be as small as a wound area on a battlefield operating table to a cruise ship, airplane, or high rise building with thousands of inhabitants.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components of the NUV source therein.

Figure 2 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting or sterilizing large volumes of air therein.

Figure 3 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting floor surfaces and other surfaces such as chairs, hand rails, counter tops, trays, table tops and the like therein.

Figure 4 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting food prior to handling by kitchen or cooks before serving therein.

Figure 5 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for sterilizing air that is used to cover and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 6 is a perspective schematic view of a preferred embodiment of the present invention illustrating the zone air sterilization apparatus in conjunction with the remote protected operation zone therein.

Figure 7 is a CFD view of a preferred embodiment of the present invention defining the emitted airflow pattern from the sterilization apparatus that is used to cover and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 8 is a graphic showing dimer formation in a DNA molecule.

Figure 9 is a graph plotting UV absorption of DNA according to wavelength.

Figure 10 is a graph plotting DNA absorption without the influence of water.

Figure 11 plots the effectiveness for reduction of the MS-2 phage virus by different wavelengths of UV radiation.

Figure 12 plots the UV dose required to achieve a four log deactivation of selected microbes using 254 nm UV light.

Figure 13 is a graphic comparing the range of effectiveness of various filters for removing airborne particles.

Figure 14 is a graph comparing tests of different pathogens for log reduction for different radiant dosages of NUV light.

Figure 15 is a low power exposure at 300x and 1000x micrographs of the *Bacillus atrophaeus* organism after receiving a radiant dose from the NUV light source.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings illustrate the invention in its different forms and the apparatus required for sterilization or disinfection of air and surfaces that contain VSP's. Figure 1 illustrates the NUV light source. Figure 1a shows the NUV source. The high voltage electrode 1 is located inside the inner tube of the annular lamp. The ground electrode screen 2 is located on the outside of the annular lamp. The gas that produces the UV photons is located in the annular region 3 between the inner and outer tubes 4. The gas type is chosen so that the emitted UV photons are absorbed by the targeted microorganism or chemical. The preferred embodiment is 222 nm but could also be 282 nm. UV radiation is emitted radially outward 5. Changing the voltage or current between the two electrodes changes the amount of UV radiation that is produced.

Figure 1b illustrates the NUV light source used to direct the UV photons towards a specific location, direction, surface, material or substance. . The NUV source is shown in the center of the drawing as an end view. The specialized reflector 6 end view incorporates a specialized 'gull wing' design so that >90% of the emitted light is directed to the planar surface below. The specialized reflector 6 also incorporates barium sulfate (Ba_2SO_4) as the reflective material in order to maximize the number of photons that are reflected onto the planar surface. In some cases, a cover 6a is

necessary to protect the NUV source and reflector from dirt. This cover is transparent to 222 nm and 282 nm light. The specialized reflector can also have different shapes that change the directed radiation for different applications.

This design provides a convenient method and apparatus to disinfect commonly touched objects that act as fomites to transmit pathogens from one person to the next. It would also provide a means for wound treatment prior and post surgery and for the treatment of chronic wounds. It is also provides a means to disinfect hospital and health care rooms, operating tables, hand rails and equipment surfaces that support patient care.

Furthermore, in cases of critical shortages of gloves, robes and masks, the NUV source can be used in this manner to disinfect periodically when appropriate instead of retrieving new ones from supply.

The NUV source(s) can also be used to disinfect patient examining tools, records, pens and equipment between patients. Everything that is brought into the room for examining the patient should be put through the medical caddy after exiting the room and retrieved only after changing gloves and/or garments.

In use, the NUV source can be made to any size and length. In air ducts, the embodiment shown in Figure 2 item 6b would have the NUV source supported from the side, top or bottom of the duct so that its irradiation travels parallel to the airflow. For unique applications, a second embodiment Figure 5 item 16 would have the NUV source and cylinder reflector supported inside the duct so that irradiation is perpendicular to the airflow. An example of this embodiment would be a NUV source positioned in the center of a tumbling dryer. All garments or objects or food stuffs would be irradiated during the drying or tumbling process for a length of time that would guarantee a high level of disinfection.

Figure 2 illustrates the apparatus required for the disinfection and sterilization of airflow inside a large duct. NUV sources 7 precede an electrostatic precipitator (ESP) 9 by some distance 8 that permits a short action time to complete the destruction of the toxic gases or VSP's. A humidifier 10 may follow the precipitator with control sensors 11 so that the humidity of the exiting air can be selected and maintained. A fan(s) 12 may also be used to pressurize the exiting air so that a slight pressurization can be applied to a protected zone to prevent contaminated air from entering. Depending on the nature of the zone, restricting baffles (not shown) are used to assist in maintaining a positive pressure inside the protective zone.

Figure 3a illustrates the NUV source 13 located inside the forward compartment of a vacuum cleaner or floor cleaning machine. The vacuum cleaner can be either a standup floor model or a

canister model. It could also be any device that would support and carry the NUV source close to the floor. The significant part is that the NUV source with reflector 6 consists of the components as described in Figure 1b. Figure 3b illustrates a preferred embodiment with the NUV source contained in a hand held wand. Sensing switches 14 can be included in this embodiment that shut off the NUV source when the wand is not directed correctly to the desired treatment surface.

Figure 4a illustrates the NUV source(s) located above a conveyor that carries raw and unprepared food prior to kitchen preparation as well as industrial packaging assembly lines that carry products that require disinfection. The conveyor assembly 24 is designed to maximize the surface area exposed to the NUV source(s). In some cases, several sources 13 are required because the exposed surface of the food or product can not be changed to expose the entire surface during the illumination time of one NUV source. Tumblers or vibrators are typically used to change the orientation of the foodstuffs or parts as they move along the conveyor. However, a rotary tumbler similar to a cloth dryer with the NUV source located in the center would be the preferred embodiment for disinfecting leafy greens. Figure 4b illustrates the NUV source(s) 13 located beside heat lamps 15 or other heating surfaces used to keep the food hot on a serving counter prior to being delivered from the kitchen to the customer. In another embodiment, the NUV source is used to irradiate cool or cold foods, so heat lamps 15 are not used.

Figure 5 illustrates the NUV source located inside an air sterilization apparatus that provides air for remote and separate operation tables. The NUV source 16 is located inside a UV reflector chamber 17 in order to reduce the loss of UV photons. A light trap 18 stops the UV light prior to the turning vanes 19 that direct the air flow vertically downward onto the operation site. A diffuser 20 ensures that the airflow is uniform across the duct. A high E field electrostatic precipitator (ESP) 21 follows the diffuser to remove particulates and reduce any ozone to oxygen. The airflow then passes through a second diffuser and humidifier 22 to ensure that the airflow is uniform across the duct and that the humidity level is controlled to some preset value.

Figure 6 illustrates how the air sterilization apparatus would be used in conjunction with a remote operation site, where the doctor is using remote controlled surgical instruments that are inside the sterilized air zone.

Figure 7 illustrates the airflow pattern using CFD computational fluidic design to ensure that the air above the operation zone is uniform and prohibits contaminated air from entering the protected zone.

Figures 8 through 15 are discussed in the technical and background sections of this specification.

Although the preferred embodiments of the present invention have been described herein, the above description is merely illustrative. Further modification of the invention herein disclosed will occur to those skilled in the respective arts. All such modifications are deemed to be within the scope of the invention as defined by the appended claims and not limited thereto.

ABSTRACT

This invention relates to a method, process and apparatus for disinfecting and sterilizing all types of surfaces contaminated with microorganisms and toxic substances to render both inactive. Furthermore, this invention relates to both a method and apparatus for disinfecting and/or sterilizing breathable air and then using this air to protect a confined space from external contamination. The apparatus consists of a new ultra-violet (NUV) source that is more effective than mercury based 254 nm light for destroying DNA of virus, bacteria, spores and cists. It is most effective in breaking chemical bonds in toxic gases and Biotoxins that are useful to terrorists. It is combined with other apparatus that remove particulates and byproducts sometimes produced by the NUV source and maintains positive pressure of the confined space so as to prevent the influx of air from outside the protected zone.

METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION

PRIORITY CLAIM

This application is a continuation-in-part patent application which claims the benefit to and priority from currently pending non-provisional United States utility patent application number 11/831,667 filed on July 31, 2007, which is a continuation-in-part patent application of International patent application number PCT/US2006/003393 filed on January 31, 2006, currently expired, which is a non-provisional application of United States provisional application number 60/593626 filed on January 31, 2005, currently expired.

BACKGROUND

1. Field of the Invention.

This specification teaches a new method for disinfecting and sterilizing air, surfaces of all types and food from microorganisms and toxic chemical substances. In addition, it relates to a process and apparatus for protecting surfaces in closed or captured environments (zones) from external sources of microbial contamination in an efficient and cost effective process. These zones can be large volumes such as high rise building, cruise ships and jet airliners, or small volumes such as small rooms or surgical operation areas whether in a hospital operating room or on the battle field.

2. Description of the Related Art.

All prior art for sterilizing and disinfecting air has been based on using commercially available ultra-violet (UV) lamps or by using magnetic fields. These lamps are either pulsed or continuous. Continuous lamps are mercury based and emit principally at 254 nm. A number of companies are presently producing UV light based apparatus for the destruction of "virus, bacteria, spores and pathogens" (microorganisms or VSP) that are in room air. This is an effective treatment because it continually exposes room air currents to the treatment light and over time has sufficient exposure time to treat VSP's. The required exposure times range from 10's to 100's of seconds, depending on the light absorption capability of the different virus and bacteria at the 254 nm. While this is effective for treating the room air of individual rooms, it requires a long time to be effective in treating large flowing volumes of air that pass quickly down large ducts. Its long treatment time is impractical for treating most surfaces.

Magnetic based apparatus also require time to deactivate or destroy these VSP's. Two such inventions are directed to specific applications. Wesley, U.S. Pat. No. 4,458,153 is directed

specifically towards liquid like substances enclosed in pipes, but does not discuss any test results. Sangster, U.S. Pat. No. 5,750,072 requires an injection of a sterilizing fluid as a mist or vapor for the magnetic field to produce radicals that in turn are used to alter the VSP's. He does not discuss any test results. Hofmann, U.S. Pat. No. 4,524,079 is directed specifically to treating food stuffs. He speaks of requiring up to 100 pulses at frequencies ranging from 5 to 500 kHz. Although the action time would be short, the power required to treat large areas and the apparatus design limit its practical application. None of these patents are admitted to being prior art by their mention in this background section.

The broad ultraviolet spectrum had been divided into three regions depending on its different effects on human skin. Reference to these regions are predominantly made in medical terminology with UV-A defined as a range or band between 320 nm and 400 nm, UV-B defined as a band between 280 nm and 320 nm, and UV-C defined as encompassing wavelengths shorter than 280 nm. Recently the UV-C band has been shortened because strong water absorption causes different effects on the skin below 235 nm. UV-C is now considered the band encompassing wavelengths from 280 nm to 235 nm. The Far UV begins at 235 nm and encompasses wavelengths to the beginning of vacuum UV at 185 nm. Photochemists and photobiologists do not generally use these terms because absorption spectra of chemical bonds are much narrower than these generally defined bands. Instead, they use the wavelength of the applied radiation to define the observed effects.

Claims have been made that UV-C radiation is used to alter the DNA. This is because the mercury lamp emission at 254 nm is close to a good DNA absorption band and is the most widely available UV-C radiation source. None of these claims make reference to any shorter wavelengths and to the absorption band that peaks at 200 nm (see figure 9). Most literature credits this peak to protein absorption whereas the peak centered near 260 nm is attributed to many amino acids. In fact, all literature directs researchers away from using any shorter wavelengths due to the high absorption of molecular water. Mercury lamps are used for wastewater treatment and work well for this application. However, this specification teaches that since we do not live underwater, the protein absorption band offers much more significant action spectra that can be used to alter the DNA of microorganisms more effectively. A source of Far UV photons targets this protein absorption band. This concept is a significant advancement and a step change in the technology used for sterilization and disinfection.

During the past few years, new UV emitting lamps based on the excitation of excimers are becoming commercially available. These emitters produce single line or narrow spectral emission at a wavelength determined by the gas composition of the lamp. If the treatment lamp's wavelength is

chosen to match closely to the peak of protein absorption of the microorganism's DNA, then a lethal dosage can be delivered to the VSP's in a shorter time. No patent has been found that teaches the use of "new ultra-violet" (NUV) sources coupled with supporting equipment that can effectively and efficiently disinfect and sterilize large volumes of air, large and small surfaces, and food stuffs in various stages of preparation in a practical manner.

The NUV lamp is a coaxial design that can be made as small as a pencil to as large as 1 meter long. Lamp efficiency is about 10-25% wall power to UV emission. The design has several advantages over mercury lamps. Most important is that its gas can be chosen to maximize its emission to the absorption peak of the targeted biochemical. Unlike the mercury lamp, the UV intensity can be varied from near zero to maximum. It will produce 10 to 1000 times more intensity than mercury, depending on the lamp dimensions, and it does not use mercury that will soon become regulated by the EPA.

In this specification, sterilization or sterilize refers to sterilization or high level disinfectant as defined by US FDA. The terms disinfectant and disinfection refers to all other levels of disinfection.

SUMMARY OF THE INVENTION

Destruction of pathogens is significantly improved by targeting a biochemical in its DNA/RNA with the proper wavelength so the critical dosage can be delivered in the shortest time. The concept is to direct the correct spectral emission to target specific bonds with sufficient intensity to destroy pathogens quickly and effectively on all types of surfaces and in the air.

Critical to this apparatus is the development of a new ultra-violet (NUV) source that emits a highly intense narrow wavelength band of photons that correspond to the maximum absorption band for DNA proteins and other component bonds. The preferred embodiment is the NUV source at 222 nm targets these proteins and their peptide bonds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. For some specific cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. The process is to use the irradiance from the NUV apparatus to produce high levels of disinfection on all types of contaminated surfaces and air and to destroy Biotoxins and nerve agents. The process includes support apparatus, ozone with the NUV source and preconditioning liquids and sprays that affect the tightness of the polypeptide helix which may improve absorption by the pathogen proteins or amino acids that result in improved destruction at lower dose or less time or both.

BACKGROUND FOR NUV APPARATUS

The genetic makeup of all living organisms is contained in their DNA molecule. This is a nucleic acid molecule that contains the genetic instructions to construct other components of living cells, proteins and RNA molecules. Replication occurs by the splitting of the DNA molecule, which duplicates itself through a transformation of its structure. Parts of the DNA molecule have been given names such as pyrimidine bases, cytosine, thymine or uracil that form a group of biochemicals that sustain life. The long DNA molecule holds itself together by using simple bonds like those found in sugars.

Researchers believe that the energy of the UV photon causes the formation of a strong (covalent) bond to develop between specific biochemicals. However, the bond strength of the covalent bond is very dependent on the relative position of the participating atoms. When the bond is symmetrical on both sides of a hydrogen atom in the bond, it is referred to as a dimer. A dimer is a very strong bond and is not generally broken during the vaporization of the liquid. UV light is known to produce Thymine, cytosine-thymine, and cytosine dimers. After the formation of the dimer, further replication of the DNA stops. Figure 8 shows the concept of the dimer formation in a DNA molecule.

The DNA molecule absorbs light from about 180 nm to about 300 nm. One of the most effective wavelengths to treat VSP's in water is about 254 nm because of low water absorption. However, water absorption of UV light increases steadily as the wavelength decreases below 240 nm. This limits the ability for UV light of shorter wavelengths to be as effective for water treatment.

A standard commercial light source for UV irradiation near the 260 nm absorption peak of DNA is being produced by using mercury as the source for generating photons. The mercury gas and its pressure in the lamp determine the wavelength of the emitting light. For low-pressure (LP) and low-pressure high output (LPHO) lamps, the emitting wavelength is near 254 nm. For medium pressure lamps, the emission ranges from 200 nm to above 300 nm. However, the strength of the emitted light is not effective below 245 nm for the continuous emitting lamps and below 235 nm for medium pressure lamps. Xenon gas in pulsed lamps produces a similar emission as the medium pressure mercury lamps.

DNA action spectra show that absorption increases as the wavelength decreases, with a relative maxima at 260 nm and largest at 200 nm. Many articles indicate the principal action spectra of the DNA absorption is from 245 to 280 nm range and do not address the 200 nm peak. An exception is Figure 9 which graphically shows this relationship (Von Sonntag; Disinfection by free radicals and UV-radiation. Water Supply 4, 11-18 (1986)). Since water absorption significantly increases below 240 nm, it becomes apparent that DNA effectiveness curves that omit the 200 nm peak apply only to organisms in water.

MS-2 Phage is a marker virus that is used to measure reproduction viability after UV irradiation. Figure 10 is DNA absorption without the influence of water (Gates, F.L. A study of the bactericidal action of ultra violet light III. Jour. General Physiology 14, 31-42 (1930)). Absorption is more than doubled at 220 nm.

A recent technical paper (Peak et al, UV action spectra for DNA dimer induction; Photochemistry and Photobiology, 40, 5 (613-620)-1984) suggests that dimer formation is not the only requirement to inactivate DNA. Absorption of other molecular groups in the long DNA chain increase as the wavelength is reduced from 254 nm. Damaging or destroying these bonds may be more effective in deactivating the DNA than compared to the 254 nm band. Reports show that damage caused by 254 nm light can be reversed by longer wavelength UV and blue light (Figure 12). The DNA of pathogens not expected to have this 'photo-reactivation' phenomenon after being exposed to higher energy 222 nm photons.

The energy of the emitted photon is determined by its wavelength. Photon energy is about 5ev at 250nm, and increases for shorter wavelengths. Different bonds in the DNA will be affected with photons of different energy.

The 540 kJ/mole photon energy from the NUV lamp exceeds the bond energies of many of the peptide bonds. This should cause physical damage to the microorganism. Figure 15 shows a micrograph of the *Bacillus atrophaeus* after receiving a radiant dose from a NUV lamp. It shows a magnification of 300x and 1000x taken at low power to prevent any physical damage to the organisms during the picture process. The results of photon impact can be clearly seen in the 1000x frame by the ruptured sidewalls and segmentation of the organism. This is the first indication the author has seen that photons are actually causing physical damage and destruction to pathogens. A corresponding slide that received the same radiant exposure confirmed that all organisms were dead.

A NUV lamp emitting at 222 nm is considered the most effective source because DNA molecules and biochemical's have greater absorption at this wavelength. The steep rise in absorption below 240 nm is exhibited by most proteins. It has been fairly well established that the peptide bonds in protein molecules are responsible for the steep rise in absorption. This occurs as well for nucleo-proteins, aromatic amino-acids, diglycine, triglycine, and bovine albumin (McLaren, et al, Photochemistry of Proteins and Nucleic Acids, Pergamon Press, Macmillan Company, 1964). An organic chemist suggests that this lower wavelength is more effective in breaking bonds and producing dimers in the purine bases and sugar phosphates instead of the pyrimidines.

This wavelength is not strongly absorbed by water vapor and oxygen in the air. However, at 200 nm, oxygen absorption increases by 10 times and water absorption becomes slightly greater than

oxygen. At 200 nm, ozone production vs. irradiance can not be controlled as it can at 222 nm. This would create a large amount of ozone that is harmful to humans and animals and reduce its effectiveness for applications in air, particularly for long irradiation distances.

TESTS

Using a lamp that emits 222 nm, a comparison test with and without water was made to determine the effect of this radiation on organisms. The organism used in all tests was the MS-2 virus, which has become a standard indicator of mutation effectiveness. The EPA report (811-R-96-002) reports a 4.3 average log reduction of the MS-2 virus using mercury light 254nm at an irradiance greater than 128 mj /cm².

Three wavelengths were tested: 222, 253, 259 nm. The 222 nm lamp was tested at three levels of irradiance with the virus in a thin layer of water in order to reduce the absorption effect of water. A separate test was also done with the virus in more water. The 253 and 259 nm lamps were tested at the identical irradiance levels with the virus in water. Controls were made on all tests and a single test dish on each lamp was made to check experimental error.

The 222 nm lamp (Figure 11) produced log 5 reductions at 40 mj/ cm² and log 6.5 reductions at 60 mj/ cm². The water test produced a 3.2 log reduction, which matched the equivalent calculated irradiance in air. The 253 and 259 nm lamps produced about log 4 reductions at 60 mj/cm². A 3 million reduction in population is about 10 to 100 times more effective than reported mercury 254nm results at the same irradiance.

The results of the test indicate that 222 nm light is very effective in causing mutations and destruction in microorganisms. These tests indicate an improvement of between 10 to 1000 times, depending on the intensity of the lamp. It is important to note the improvement of the 259 nm source compared to the 254 nm source. This produced a 10 times improvement in the test sample for just a 5% increase in absorption. It illustrates the importance in using a UV photon emitter that is near the absorption peak of the DNA or targeted chemical such as proteins, nucleic acids, or amino-acids.

Figure 12 illustrates the 254 nm dose required to deactivation different VSP's. The bars represent with (solid) and without (open) photo-reactivation. Note that a dose of 75 mj/cm² is required to deactivate the MS2 Phage virus and prevent photo-reactivation. In the tests shown in Figure 11, half the dose at 222 nm was just as effective as the higher dose at 254 nm. Even though the sample was under water, the 222 nm radiation was still more effective than 254 nm radiation.

The 222 nm photon has more energy and is absorbed by S-N, S-O, O-O, O-H, and many carbon bonds that do not absorb 254 nm. This suggests that 222 nm light may also prevent DNA repair that has been reported when low level 254 nm UV sources were used.

Figure 14 presents further testing done in independent research laboratories on many different pathogens. They include spores *Bacillus atrophaeus* and *Clostridium sporogenes*, feline calici virus, bacteria *Acinetobacter baumannii*, MRSA, MRSA + 1% serum. The chart plots radiant dose against a log reduction of the target microorganism. It shows that high log reductions were achieved for viruses, bacteria and spores. This chart presents data that does not determine the minimum dose but only the log reduction at the dose tested. Since many tests represented a 100% kill, a lower dose could obtain the same log reduction at or near 100% kill.

A survival plot was made of the *Bacillus atrophaeus* spore. Since it is known to be one of the most difficult spores to kill or deactivate, this curve represents the base line for the dose required to kill most pathogens for the NUV source. Future tests will generate survival plots of the other pathogens to determine the minimum dose for various log reductions.

Since the NUV source can produce an irradiance of 100 mw/cm², then a log 4 reduction of all but the *B. atrophaeus* can occur in a 0.1 second treatment resulting in a radiant dose of 10 mj/cm². The chart demonstrates that the NUV source is a potent sporicide as well as capable of producing high disinfection on VSP's.

TECHNICAL DISCUSSION

Critical to the destruction of the organism is targeting the proper biochemical with the proper wavelength so the critical dosage can be delivered in the shortest time. The critical dosage is that dosage that destroys or deactivates the organism and prevents its replication.

Pyrimidine and purine bases of nucleic acids have a strong absorption near 260 nm. But proteins also have an absorption maximum at about 280 nm due to the absorption by the aromatic amino acids phenylalanine, tyrosine and tryptophane. Numerous lipids also absorb near this peak. They include indole acetic acid and Lipase. And there are some major differences that occur in the synthesis of DNA to RNA. The protein thymine is replaced by the pyrimidine base uracil that has absorption near the 280 nm and not at lower wavelengths.

It is important to note that biochemicals of DNA and RNA will have different absorption spectra and the peak absorption will be shifted by water, pH, temperature, previously absorbed light and surrounding contaminants in the air. Uracil and cytosine are particularly susceptible to photohydrate formation. A protein crosslink can be formed between a pyrimidines base and an amino acid.

Cysteine and thymine are easily affected and uracil preferentially binds to cysteine, phenylalanine and tyrosine. Protein crosslinks induce irreversible cell damage. The disulfide group of cystine can be split into reactive sulfhydryl groups. Tryptophane (280 nm absorption) can provide the singlet energy transfer to split the disulfide groups that strongly influence the structure and function of proteins in the DNA/RNA complexes.

The presence of ozone can significantly induce damage to the long polypeptide amino acid chains and shorten the UV action kill time. For some applications, the NUV intensity is increased to produce some ozone to improve the pathogen destruction of the contaminated surface.

Test data confirmed that proteins in the RNA of the norovirus do not absorb the NUV wavelength at 222 nm effectively. However, a number of RNA proteins do exhibit strong absorption near the amino acid peak absorption of 280 nm. More likely is the fact that RNA absorption is due to the combination of the proteins and the locations and types of amino acid bonds surrounding them. Testing is underway to confirm that a NUV source at 282 nm will cause similar destruction to the RNA of the norovirus compared to the DNA destruction seen in Figure 14.

There are many UV absorption plots that indicate how the degree of absorption in the DNA/RNA molecule changes with wavelength as the pH of the carrier solution is changed. The *secondary structure* is a term used to describe the coiling of the polypeptide chain. The tightness of the coil is also significantly affected by pH of the solution. This suggests that the closeness of the different amino acids to peptide bonds affect the DNA/RNA absorption at a specific wavelength. Consequently, pre-treating the surface with a solution or spray that improves the absorption of the targeted proteins and amino acids prior to delivering a UV radiant dose is also being tested. In many cases, it may significantly improve the process by reducing the UV dose or treatment time. The concept of using the NUV source in conjunction with wipes and liquids for treating VSP's on surfaces is also contained in the scope of this specification.

Biotoxins and nerve agents can be used by terrorists as weapons against groups of people. Nothing economical has been developed that could mitigate an attack and prevent the loss of life and incapacitation at the point of attack. While government agencies of the US have developed detectors that could be used in the future to warn people in the confined areas that are under attack, nothing would prevent the attack from being effective.

Biotoxins and nerve agents are organic molecules that contain either DNA or have long chain carbon molecules. Both of these are susceptible to destruction using NUV light sources. 222 nm will destroy the C=C and C=O bonds causing the destruction of the chemical. Future testing will

determine if the molecular extinction coefficient is sufficient to make this effective means for their destruction.

The most effective means for delivery of these agents is to spread them in a gas phase through the air ventilation system. A detector would be used to turn on sufficient NUV sources so that the agents are destroyed before exiting the ventilation system into the confined area where the captured population is present. Tests still need to be done in regulated and controlled laboratories to develop the criteria for these sources to be effective and become the first line of defense.

The use of a high E field electrostatic precipitator (ESP) is important to the sterilization and disinfecting apparatus for air in some situations. Figure 13 compares the range of effectiveness with mechanical filters for different pollutant sizes. As illustrated in the fourth column, it is capable of removing some percentage of VSP's. However, since it can also capture fog and mist, it has the ability to breakdown ozone O_3 into oxygen. Its use prevents levels of ozone from exceeding the EPA exposure safe levels.

In some cases the air disinfecting apparatus includes a humidification system to provide and maintain minimum moisture content at predetermined and controllable levels. In addition, the apparatus contains baffles and zone restriction devices that enhance the zone protection and minimize the positive pressure required to maintain the protected zone.

The concept of using the NUV source with associated support equipment for air disinfection of VSP's is valid and is also contained in the scope of this specification.

APPARATUS AND PROCESS DISCUSSION

The NUV source apparatus is made to supply a narrow emission band of UV light that is close to the peak absorption of the targeted organism or chemical with sufficient photon energy that break bonds. Unique to obtaining short action (kill) times is a determination of the specific wavelength required to destroy the targeted organism or chemical.

The process is to direct the correct spectral emission to target specific bonds in proteins and amino acids in the DNA/RNA molecule with sufficient intensity to destroy pathogens quickly and effectively. It is effective for the breakdown of biofilm and protein based allergens.

The preferred embodiment is a NUV source at 222 nm. This spectral emission is 10^4 times more effective than standard mercury based lamp UV light for altering the DNA. Action times are reduced from 10's to 100's of seconds to times less than 0.1 seconds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. This may be particularly

important for single or double strand RNA of influenza or noroviruses. For some cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. And the photon energy of the NUV source is sufficiently high to break carbon bonds of chemical toxic substances or biotoxins with similar action times.

This invention uses the NUV source that makes it cost effective in treating surfaces of materials since the action time is very quick. The apparatus of this invention is designed to make direct photons to the intended target as effectively and efficiently as possible. This makes for a cost effective process for sterilizing and disinfecting air, all types of surfaces and food (including, but not limited to meats, poultry, eggs, fruits and vegetables) during normal daily activity and prevents the previous need to restrict occupation and use of areas being treated.

Surfaces

The apparatus is designed to quickly disinfect floors, hand rails, objects that are in constant contact with transient populations for the purpose of preventing transmission of disease and toxic substances that can cause injury or illness to these populations. As a hand wand, it only needs to be waved or passed over the surface to obtain a high level of disinfection.

The NUV radiation can be applied to any object or surface that needs to be disinfected and/or sterilized. An example would be the use of a caddie cart whereby all instruments, papers and pens would be exposed after a patient examination to prevent the transmission of pathogens to the next patient. The cart could also provide a means to disinfect protective gloves or face masks if a shortage occurs during a pandemic. Testing will determine the correct exposure limits to prevent any harmful effects that could occur when used to disinfect human skin, hands, animal surfaces such as skin, fur, and hair, and critical plastics and materials used in medical devices. It also has the potential to sterilize/disinfect medical equipment and surfaces and critical parts on an industrial assembly line prior to packaging.

In one specific embodiment of use, the present invention may be applied to skin disinfection. The wavelengths contemplated herein are not damaging to the epidermis, and therefore can quickly and effectively disinfect human or animal skin without skin cell damage. In one example, a doctor or nurse may expose their hands to the NUV source before, during, and/or after surgery. Because the NUV source may disinfect in a fraction of a second, hand disinfection is very quick and convenient, and can be done repeatedly to prevent any spread or growth of micro-organisms. Other examples of skin disinfection may be applied to livestock industries, food processing and treatment industries, pet cleaning, and the like. Livestock may be exposed to the NUV source to keep them clean and

disinfected and prevent infection or spread of infection. Similarly, food treatment and processing industries may use the NUV source to treat and disinfect skin of animals and/or animal carcasses, as well as exterior surfaces of food products such as eggs, fruits and vegetables, leafy greens, eggs, nuts and any food products that need some level of disinfection such as spices, grains, and horticulture such as flowers and plants.

In one embodiment that may be particularly applicable to skin and/or wound (non-skin flesh) disinfection, at least one of 207 nm, 222 nm, or both may be used as wavelengths emitted from the NUV source (or two different NUV sources). These two wavelengths may be emitted by an excimer lamp or lamps. In an embodiment emitting both 207 nm and 222 nm, two separate lamps may be used, the two lamps in close proximity to each other. In another embodiment, a dual annulus lamp may be utilized. This lamp may have three coaxial tubes defining two annuli filled with two different gasses to generate the two wavelengths. Electrodes may serve to excite the gasses, emitting the two wavelengths simultaneously and from a single source.

Because the lamp in this embodiment's wavelength is chosen to match closely to the peak of protein absorption of the microorganism's DNA, both 207 nm and 222 nm may be particularly useful for skin and wound disinfection because they do not penetrate the epidermis, and 207 in particular does not damage human or animal cells. Similarly, 222 nm kills non-epidermis cells entirely, and therefore there is no concern of DNA mutation which leads to diseases such as cancer. As such, these two particular wavelengths are particularly well suited to skin and wound disinfection: Both are useful on skin because they do not penetrate the epidermis; and both are useful on wounds because 207 nm will not damage the exposed flesh, while 222 nm will kill exposed cells, but not cause them to mutate, eliminating radiation concerns. From an effectiveness standpoint however, 222nm is approximately 3-4 times as effective at disinfection compared to 207 nm. Thus, while 207 nm alone is an option for disinfection, generally 222 nm alone or in combination emission with 207 nm will be utilized for most embodiments.

In another embodiment, the NUV source may be mounted on an automated robot, the robot being programmed and configured to disinfect a room automatically. This robot may be specifically configured to disinfect hospital rooms automatically but moving into the hospital room, and activating the NUV source. This will disinfect all air and surfaces exposed to the UV radiation from the NUV source. Further, the robot may be configured to move around the room to expose other surface and air zones to the UV radiation from the NUV source. It should be understood that this embodiment is not limited to hospital room disinfection, and could be used for any room disinfection with the NUV source attached to a robot or robot controlled device. For example, the robot may be an automated

vacuum cleaner or floor cleaner, or a robot specifically configured to enter a room in a building to disinfect the room.

In yet another embodiment, the NUV source can be used to disinfect all types of liquids by passing them through the center of the lamp where coupling efficiency with the light is maximized. Any liquid such as milk that will flow and requires some level of disinfection would be applicable. This would include wine, water for all types of uses, food products from salad dressings with low viscosity to chocolate which is most viscous. Other liquids used for medicines and health care would be disinfected at the point of container filling thereby killing any bacteria that could be resident in the piping and tubing from the supply vessel.

In another embodiment, the NUV source can be used to kill insects and psyllids that are transporting disease or harmful bacteria. As part of the killing process, it can also be used to prevent the spread of these insects by providing a containment area where they are killed if they try to fly through the irradiated zone. For example, the NUV source may be deployed in a field of crops itself, or may be used to set up a containment area around the field of crops. In a further example, containment areas may be set up around areas frequented by humans or animals to prevent infection and/or transfer of disease caused by the insects and/or psyllids.

In another embodiment, the NUV source can be used to kill fungus and molds in the fields of wheat, corn, cotton, and coffee as well as protect any other plants that need to be kept mold or fungus free. It can be further used to break down mycotoxins on food products that are produced by molds and fungus.

In another embodiment, the NUV source can be used to disinfect parts of containers that come in contact with storing food. Examples of these surfaces include bottle caps, the inside of bottles and plastic containers, and the inside of tubing and containers that handle these food products in the manufacturing and transporting in preparation to filling in consumer containers.

Other non-limiting examples of uses for the NUV source may include disinfection on foods of all types, including meat, poultry, eggs, vegetables, fruits, and the like. In particular blueberries and tomatoes may be particularly well suited for such disinfection because of their susceptibility to infection. Moreover, the NUV source may be useful for disinfection of conveyor lines, chiller liquids, water used for production requiring high levels of disinfection, hatcheries, farming, and the like. However, as noted previously, the NUV source contemplated herein may be applied to disinfection of any zone (such as a volume of air), or surface, and is in no way limited to the applications noted herein.

Because the NUV source is a light source, it can be directed to expose different levels of thick and loose materials by using light conducting fibers to distribute the light intensity. An example would have the NUV source disinfecting a floor by directing it at the floor while some of the light is directed to the bottom of a rug or floor scrubbing brush by light fibers imbedded in the brush. In a similar manner, products that have cavities or areas not exposed directly by the external source could be disinfected. An example of this would be a single fiber used to direct NUV light into a tooth cavity to disinfect the walls and tissue inside prior to sealing with a filling.

The NUV source can be used to directly disinfect room surfaces, apparatus, fixtures and clothing or particles and microbes in the room air by directly exposing all objects for the required exposure time. Several sources can be combined to assure exposure to all surfaces and to reduce total exposure time. It can provide effective treatment to isolation room air by preventing pathogens from remaining alive after exiting or entering the room. Rooms contaminated by bioterrorist agents could be treated by moving using robots to move the NUV source(s) in many directions and moving it (them) around the room during treatment.

Food

The NUV source may provide a significant improvement to the disinfection of food stuffs. The apparatus can be designed for each application that includes foodstuffs in conveyor assemblies, stationary carts and in handling routes during the movement from storage to food preparation processes. It can be use to disinfect specific types of foods such as seeds and sprouts prior to planting, raw food stock like fruits and berries and leafy greens as they are prepared for transportation from the fields to processing centers, to warehousing and storage, to supermarket handling and kitchen preparation and delivery to the consumer. Furthermore, the process can be used to disinfect cutting and working surfaces of meat and poultry packaging rooms and even the cutters and equipment used to transport meat, poultry and other food products.

E-beam sources are currently the only other mechanism being tested to protect food supplies. It does irradiate food with high energetic electrons that is now causing concerns by many about the safety of the product after irradiation.

Air

Normal breathable air contains many contaminates including moisture droplets, dust, lint, bacteria, virus, cists, and spores. The NUV apparatus can be used by itself to disinfect air. The short action time means the NUV lamp can destroy pathogens in the air as they pass by. Another important consideration for its use in disinfecting of air is that it does not contain mercury.

Sterilization sometimes requires the removal of all particles to the smallest possible size. The NUV source can produce byproducts that must be removed for some treatment applications. These byproducts include oxidized air (ozone), condensable chemical byproducts, and damaged microorganisms. Critical to the apparatus is the removal of these contaminants and byproducts. In some special applications, ozone is produced by the NUV source to make treatment more effective. Consequently, the apparatus includes the making of ozone, the use of high E field precipitators and other UV light to remove ozone downstream after the disinfection area and apparatus to make effective use of the combination of these technologies.

Sterilized air is then used to prevent microbial contamination of a protected zone by preventing the influx of untreated air from outside this zone. The apparatus includes pressurizing equipment and zone baffles that provide sufficient outflow from the protected zone so as no contamination can occur. Protected zones can be as small as a wound area on a battlefield operating table to a cruise ship, airplane, or high rise building with thousands of inhabitants.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components of the NUV source therein.

Figure 2 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting or sterilizing large volumes of air therein

Figure 3 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting floor surfaces and other surfaces such as chairs, hand rails, counter tops, trays, table tops and the like therein.

Figure 4 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting food prior to handling by kitchen or cooks before serving therein.

Figure 5 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for sterilizing air that is used to cover and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 6 is a perspective schematic view of a preferred embodiment of the present invention illustrating the zone air sterilization apparatus in conjunction with the remote protected operation zone therein.

Figure 7 is a CFD view of a preferred embodiment of the present invention defining the emitted airflow pattern from the sterilization apparatus that is used to cover and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 8 is a graphic showing dimer formation in a DNA molecule.

Figure 9 is a graph plotting UV absorption of DNA according to wavelength.

Figure 10 is a graph plotting DNA absorption without the influence of water.

Figure 11 plots the effectiveness for reduction of the MS-2 phage virus by different wavelengths of UV radiation.

Figure 12 plots the UV dose required to achieve a four log deactivation of selected microbes using 254 nm UV light.

Figure 13 is a graphic comparing the range of effectiveness of various filters for removing airborne particles.

Figure 14 is a graph comparing tests of different pathogens for log reduction for different radiant dosages of NUV light.

Figure 15 is a low power exposure at 300x and 1000x micrographs of the *Bacillus atrophaeus* organism after receiving a radiant dose from the NUV light source.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings illustrate the invention in its different forms and the apparatus required for sterilization or disinfection of air and surfaces that contain VSP's. Figure 1 illustrates the NUV light source. Figure 1a shows the NUV source. The high voltage electrode 1 is located inside the inner tube of the annular lamp. The ground electrode screen 2 is located on the outside of the annular lamp. The gas that produces the UV photons is located in the annular region 3 between the inner and outer tubes 4. The gas type is chosen so that the emitted UV photons are absorbed by the targeted microorganism or chemical. The preferred embodiment is 222 nm but could also be 282 nm. UV radiation is emitted radially outward 5. Changing the voltage or current between the two electrodes changes the amount of UV radiation that is produced.

Figure 1b illustrates the NUV light source used to direct the UV photons towards a specific location, direction, surface, material or substance. . The NUV source is shown in the center of the drawing as an end view. The specialized reflector 6 end view incorporates a specialized 'gull wing' design so that >90% of the emitted light is directed to the planar surface below. The specialized reflector 6 also incorporates barium sulfate (Ba_2SO_4) as the reflective material in order to maximize the number of photons that are reflected onto the planar surface. In some cases, a cover 6a is

necessary to protect the NUV source and reflector from dirt. This cover is transparent to 222 nm and 282 nm light. The specialized reflector can also have different shapes that change the directed radiation for different applications.

This design provides a convenient method and apparatus to disinfect commonly touched objects that act as fomites to transmit pathogens from one person to the next. It would also provide a means for wound treatment prior and post surgery and for the treatment of chronic wounds. It is also provides a means to disinfect hospital and health care rooms, operating tables, hand rails and equipment surfaces that support patient care.

Furthermore, in cases of critical shortages of gloves, robes and masks, the NUV source can be used in this manner to disinfect periodically when appropriate instead of retrieving new ones from supply.

The NUV source(s) can also be used to disinfect patient examining tools, records, pens and equipment between patients. Everything that is brought into the room for examining the patient should be put through the medical caddy after exiting the room and retrieved only after changing gloves and/or garments.

In use, the NUV source can be made to any size and length. In air ducts, the embodiment shown in Figure 2 item 6b would have the NUV source supported from the side, top or bottom of the duct so that its irradiation travels parallel to the airflow. For unique applications, a second embodiment Figure 5 item 16 would have the NUV source and cylinder reflector supported inside the duct so that irradiation is perpendicular to the airflow. An example of this embodiment would be a NUV source positioned in the center of a tumbling dryer. All garments or objects or food stuffs would be irradiated during the drying or tumbling process for a length of time that would guarantee a high level of disinfection.

Figure 2 illustrates the apparatus required for the disinfection and sterilization of airflow inside a large duct. NUV sources 7 precede an electrostatic precipitator (ESP) 9 by some distance 8 that permits a short action time to complete the destruction of the toxic gases or VSP's. A humidifier 10 may follow the precipitator with control sensors 11 so that the humidity of the exiting air can be selected and maintained. A fan(s) 12 may also be used to pressurize the exiting air so that a slight pressurization can be applied to a protected zone to prevent contaminated air from entering. Depending on the nature of the zone, restricting baffles (not shown) are used to assist in maintaining a positive pressure inside the protective zone.

Figure 3a illustrates the NUV source 13 located inside the forward compartment of a vacuum cleaner or floor cleaning machine. The vacuum cleaner can be either a standup floor model or a

canister model. It could also be any device that would support and carry the NUV source close to the floor. The significant part is that the NUV source with reflector 6 consists of the components as described in Figure 1b. Figure 3b illustrates a preferred embodiment with the NUV source contained in a hand held wand. Sensing switches 14 can be included in this embodiment that shut off the NUV source when the wand is not directed correctly to the desired treatment surface.

Figure 4a illustrates the NUV source(s) located above a conveyor that carries raw and unprepared food prior to kitchen preparation as well as industrial packaging assembly lines that carry products that require disinfection. The conveyor assembly 24 is designed to maximize the surface area exposed to the NUV source(s). In some cases, several sources 13 are required because the exposed surface of the food or product can not be changed to expose the entire surface during the illumination time of one NUV source. Tumblers or vibrators are typically used to change the orientation of the foodstuffs or parts as they move along the conveyor. However, a rotary tumbler similar to a cloth dryer with the NUV source located in the center would be the preferred embodiment for disinfecting leafy greens. Figure 4b illustrates the NUV source(s) 13 located beside heat lamps 15 or other heating surfaces used to keep the food hot on a serving counter prior to being delivered from the kitchen to the customer. In another embodiment, the NUV source is used to irradiate cool or cold foods, so heat lamps 15 are not used.

Figure 5 illustrates the NUV source located inside an air sterilization apparatus that provides air for remote and separate operation tables. The NUV source 16 is located inside a UV reflector chamber 17 in order to reduce the loss of UV photons. A light trap 18 stops the UV light prior to the turning vanes 19 that direct the air flow vertically downward onto the operation site. A diffuser 20 ensures that the airflow is uniform across the duct. A high E field electrostatic precipitator (ESP) 21 follows the diffuser to remove particulates and reduce any ozone to oxygen. The airflow then passes through a second diffuser and humidifier 22 to ensure that the airflow is uniform across the duct and that the humidity level is controlled to some preset value.

Figure 6 illustrates how the air sterilization apparatus would be used in conjunction with a remote operation site, where the doctor is using remote controlled surgical instruments that are inside the sterilized air zone.

Figure 7 illustrates the airflow pattern using CFD computational fluidic design to ensure that the air above the operation zone is uniform and prohibits contaminated air from entering the protected zone.

Figures 8 through 15 are discussed in the technical and background sections of this specification.

Although the preferred embodiments of the present invention have been described herein, the above description is merely illustrative. Further modification of the invention herein disclosed will occur to those skilled in the respective arts. All such modifications are deemed to be within the scope of the invention as defined by the appended claims and not limited thereto.

ABSTRACT

This invention relates to a method, process and apparatus for disinfecting and sterilizing all types of surfaces contaminated with microorganisms and toxic substances to render both inactive. Furthermore, this invention relates to both a method and apparatus for disinfecting and/or sterilizing breathable air and then using this air to protect a confined space from external contamination. The apparatus consists of a new ultra-violet (NUV) source that is more effective than mercury based 254 nm light for destroying DNA of virus, bacteria, spores and cists. It is most effective in breaking chemical bonds in toxic gases and Biotoxins that are useful to terrorists. It is combined with other apparatus that remove particulates and byproducts sometimes produced by the NUV source and maintains positive pressure of the confined space so as to prevent the influx of air from outside the protected zone.

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Application Number:				
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Title of Invention:		METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		
First Named Inventor/Applicant Name:		S. Edward Neister		
Filer:		Gary Ervery Lambert/David Connaughton		
Attorney Docket Number:		14-016-EN		
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Utility under 35 USC 111(a) Filing Fees				
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Utility Search Fee	2111	1	300	300
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Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	613673 3624fb2a9e24fdaaaa07054387877c991665c067	no	7
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	Specification		1	18	
	Claims		19	22	
	Abstract		23	23	
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	Specification		6	6	
	Preliminary Amendment		7	7	
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Information:					
9	Specification	Replacement-Spec-Marked.pdf	110089 d00c78e58f6a802e382ab24659b77d755405dd2a	no	19
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Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	33213 9a6507625b863be0bbb7f5e85764cd3c558f999d	no	2
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14-016-EN
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.</p> <p>This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	32118		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.			
Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation in part of	11831667	2007-07-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
11831667	Continuation in part of	PCT/US2006/003393	2006-01-31
Prior Application Status	Expired	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
PCT/US/2006/03393	non provisional of	60593626	2005-01-31
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Foreign Priority Information:

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14-016-EN
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

<input type="button" value="Remove"/>			
Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			<input type="button" value="Add"/>

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

Authorization to Permit Access:

☐ Authorization to Permit Access to the Instant Application by the Participating Offices
<p>If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.</p> <p>In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.</p> <p>In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.</p>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14-016-EN
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.				
Applicant 1				Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.				
Clear				
☐ Assignee	☐ Legal Representative under 35 U.S.C. 117		☐ Joint Inventor	
☐ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest		
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:				
Name of the Deceased or Legally Incapacitated Inventor :				
If the Applicant is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information:				
Address 1				
Address 2				
City		State/Province		
Country i		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Applicant Data may be generated within this form by selecting the Add button.				
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Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	14-016-EN
		Application Number	
Title of Invention	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		

Assignee 1				
Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).				
Remove				
If the Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information:				
Address 1				
Address 2				
City		State/Province		
Country i		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee Data may be generated within this form by selecting the Add button.				
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Signature: [Remove](#)

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications					
Signature	/David J. Connaughton, Jr./			Date (YYYY-MM-DD)	2014-04-13
First Name	David	Last Name	Connaughton	Registration Number	67275
Additional Signature may be generated within this form by selecting the Add button.					
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This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4317041		1982-02-23	Schenck	
	2	5843374		1998-12-01	Sizer et al.	
	3	6099799		2000-08-08	Anderson	
	4	7326387		2008-02-05	Arts et al.	
	5	5364645		1994-11-15	Lagunas-Solar, et al.	
	6	5753106		1998-05-19	Schenck	
	7	4458153		1984-07-03	Wesley	
	8	4524079		1985-06-18	Hofmann	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number			
	Filing Date			
	First Named Inventor	S. Edward Neister		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		14-016-EN	

	9	5750072		1998-05-12	Sangster et al.	
	10	6235090		2001-05-22	Bernstein et al.	
	11	5492676		1996-02-20	Katatani et al.	
	12	3672126		1972-06-27	Goettle	
	13	5505904		1996-04-09	Haidinger et al.	
	14	5993738		1999-11-30	Goswani	
	15	6149717		2000-11-21	Satyapal et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20060188835		2006-08-24	Nagel et al.	
	2	20040166018		2004-08-26	Clark et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number			
	Filing Date			
	First Named Inventor	S. Edward Neister		
	Art Unit			
	Examiner Name			
	Attorney Docket Number	14-016-EN		

	3	20070045561		2007-03-01	Cooper	
	4	20040120846		2004-06-24	Bates et al.	
	5	20040120850		2004-06-24	Kaiser	
	6	20050173652		2005-08-11	Ressler	
	7	20050186108		2005-08-25	Fields	

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	2139811Y	CN		1993-08-11	HONG YONGFENG		☐
	2	2604181Y	CN		2004-02-25	LIU GANG		☐
	3	2662909Y	CN		2004-12-15	UNIV JILIN		☐
	4	2005061396	WO		2005-07-07	Marine Environmental Partners, Inc. et al.		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number			
	Filing Date			
	First Named Inventor	S. Edward Neister		
	Art Unit			
	Examiner Name			
	Attorney Docket Number	14-016-EN		

	5	2003207165	JP		2003-07-25	Sanyo Electric Co. Ltd.		☐
	6	20040097758	KR		2004-11-18	Modine Korea, LLC		☐
	7	0023552	WO		2000-05-10	Clean Earth Technologies, LLC		☐
	8	0238447	WO		2002-05-16	Tribelsky et al.		☐
	9	0245756	WO		2002-06-13	Tribelsky et al.		☐
	10	02078754	WO		2002-10-10	L2B Environmental Systems, Inc.		☐
	11	10-071192	JP		1998-03-17	Takashi et al		☐
	12	2002-316041	JP		2002-10-29	Hiromitsu et al		☐
	13	2005/061396 A1	WO		2005-07-07	Leffler et al		☐
	14	2005/081338 A1	WO		2005-09-01	BORMET		☐
	15	2007/084145 A2	WO		2007-07-26	Neister		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number			
	Filing Date			
	First Named Inventor	S. Edward Neister		
	Art Unit			
	Examiner Name			
	Attorney Docket Number	14-016-EN		

	16	2007-522843	JP		2007-08-16			☐
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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1		☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2014-04-03
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82A (07-12)

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**TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE
REGISTERED PRACTITIONERS**

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	
First Named Inventor	S. Edward Neister
Title	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
Art Unit	
Examiner Name	
Attorney Docket Number	14-016-EN

SIGNATURE of Applicant or Patent Practitioner

Signature	/David J. Connaughton, Jr./	Date	
Name	David J. Connaughton, Jr.	Telephone	
Registration Number	67275		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

☐ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

- ☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

32118

OR

- ☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number		Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

- ☒ The address associated with the above-mentioned Customer Number.

OR

- ☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name				
Address				
City		State		Zip
Country				
Telephone		Email		

I am the Applicant:

- ☒ Inventor or Joint Inventor
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor
- ☐ Assignee or Person to Whom the Inventor is Under an Obligation to Assign
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature	/S. Edward Neister/	Date	4/17/14
Name	S. Edward Neister	Telephone	
Title and Company			

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below *.

- ☐ *Total of 1 forms are submitted.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
<p>As the below named inventor, I hereby declare that:</p> <p>This declaration is directed to: ☒ The attached application, or ☐ United States application or PCT international application number _____ filed on _____.</p> <p>The above-identified application was made or authorized to be made by me.</p> <p>I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.</p> <p>I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.</p> <p style="text-align: center;">WARNING:</p> <p>Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.</p>	
<p>LEGAL NAME OF INVENTOR</p> <p>Inventor: <u>S. Edward Neister</u> Date (Optional) : _____</p> <p>Signature: <u>/S. Edward Neister/</u></p>	
<p>Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.</p>	

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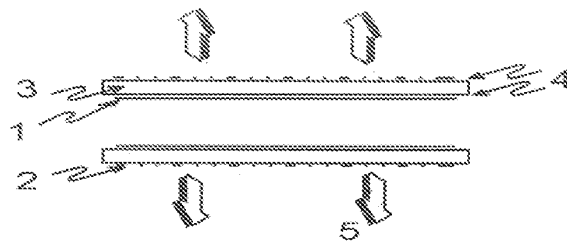
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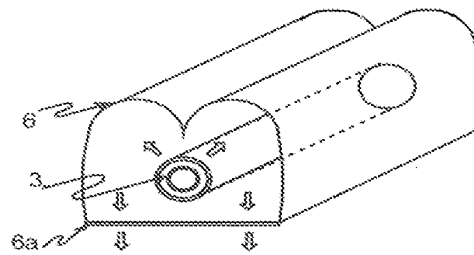
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a. NUV Lamp



b. Directed Radiation

Figure 1: NUV Source

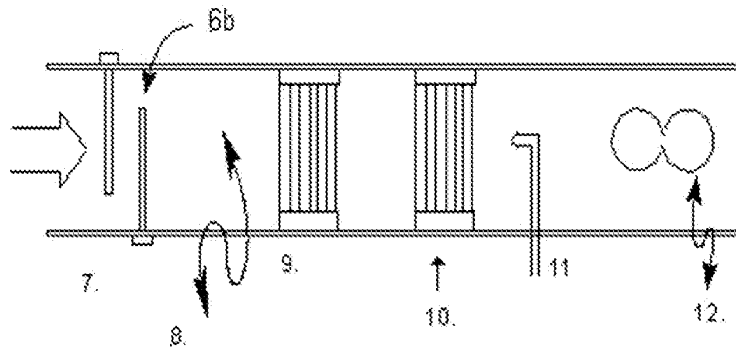
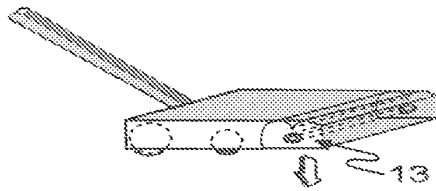
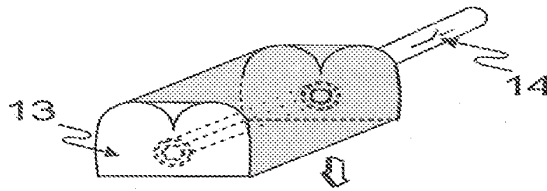


Figure 2: Volumetric Air Treatment

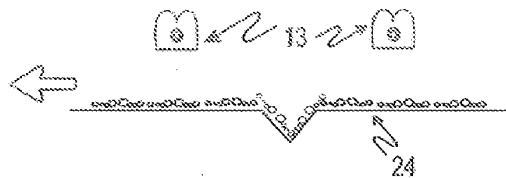


a. floor Treatment & Cleaner

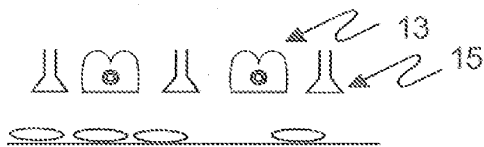


b. Handheld Surface Treatment

Figure 3: Surface Treatment



a. Unprepared Food



b. Serving Counter

Figure 4: Food Treatment

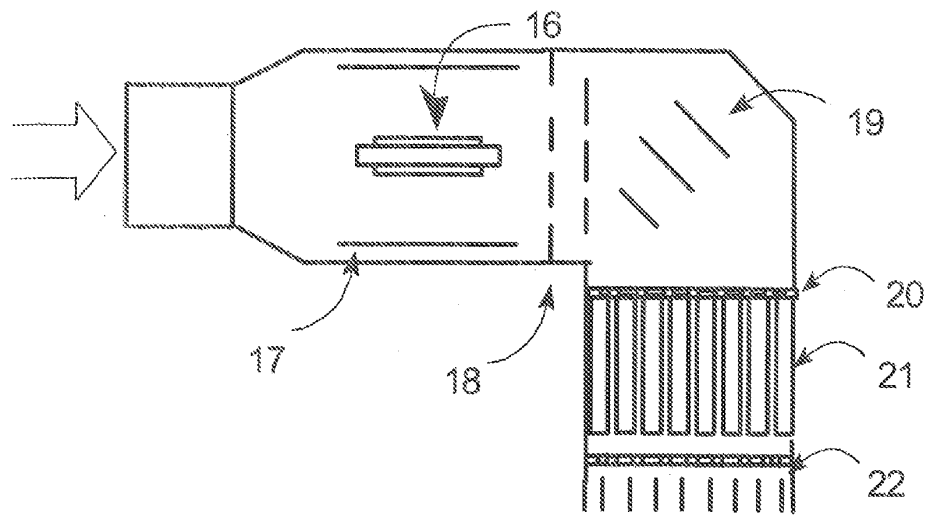


Figure 5: Zone Air Purifier & Sterilizer

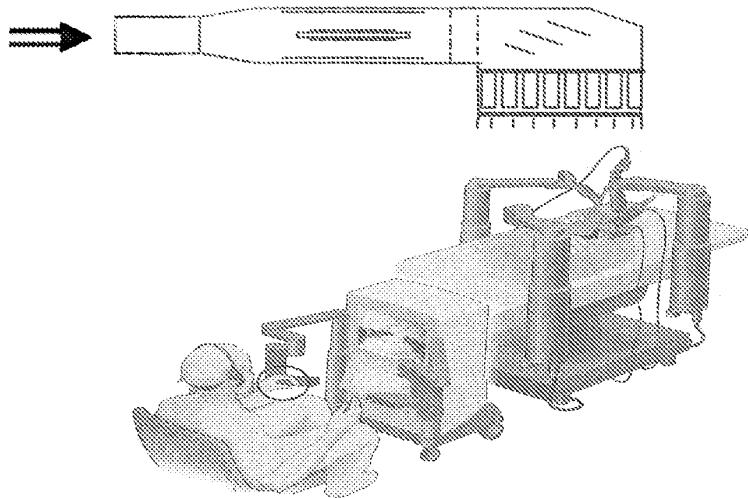


Figure 6: Operating Zone with Sterilizer

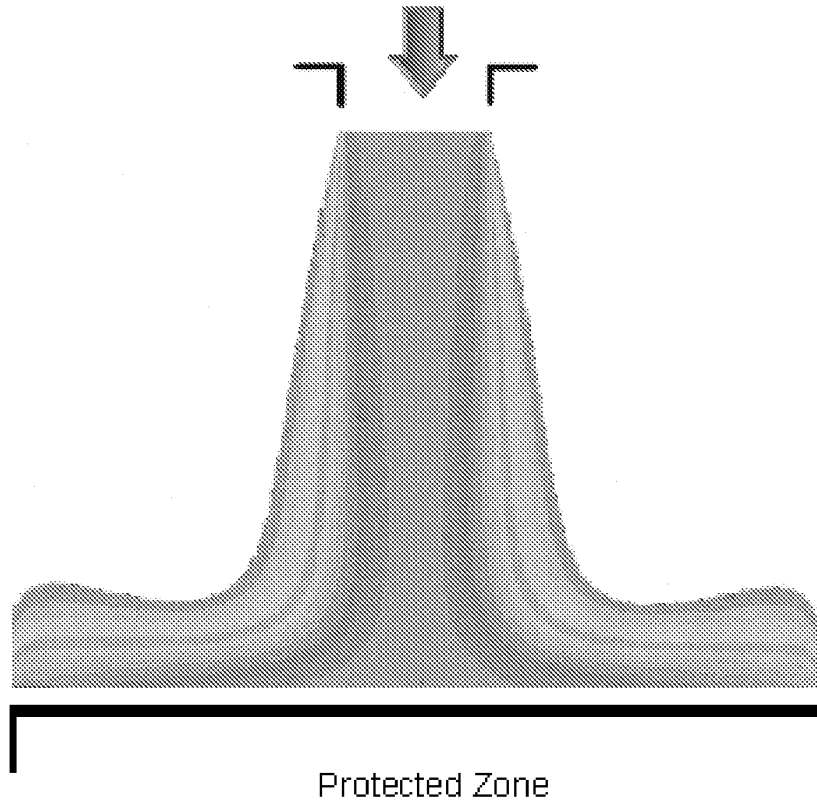
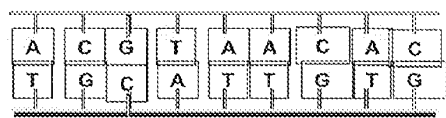
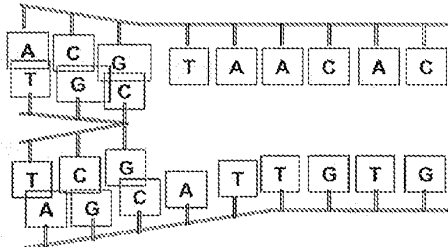


Figure 7: CFD Air Flow



HYPOTHETICAL
DNA DOUBLE
STRAND



REPLICATING DNA



DIMERIZATION
OF THYMINE
NUCLEOTIDES

Figure 8: Dimer Formation by UV Photon
(by permission of ERG @ UNH)

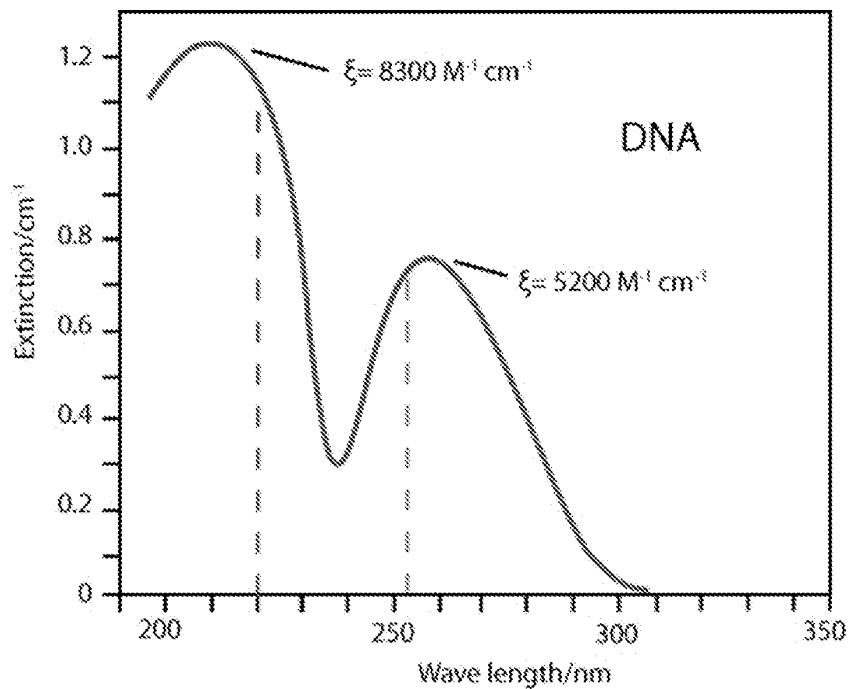


Figure 9: UV Absorption of DNA

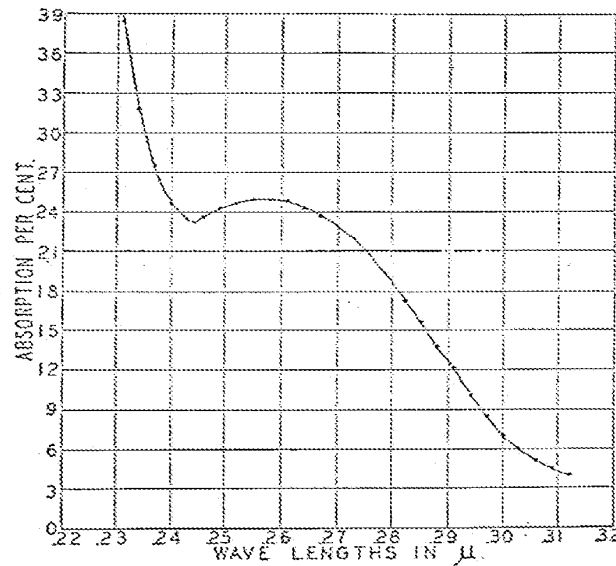


Figure 10: B. coli @ 0.8u absorption

% Reduction of MS-2 Phage Virus

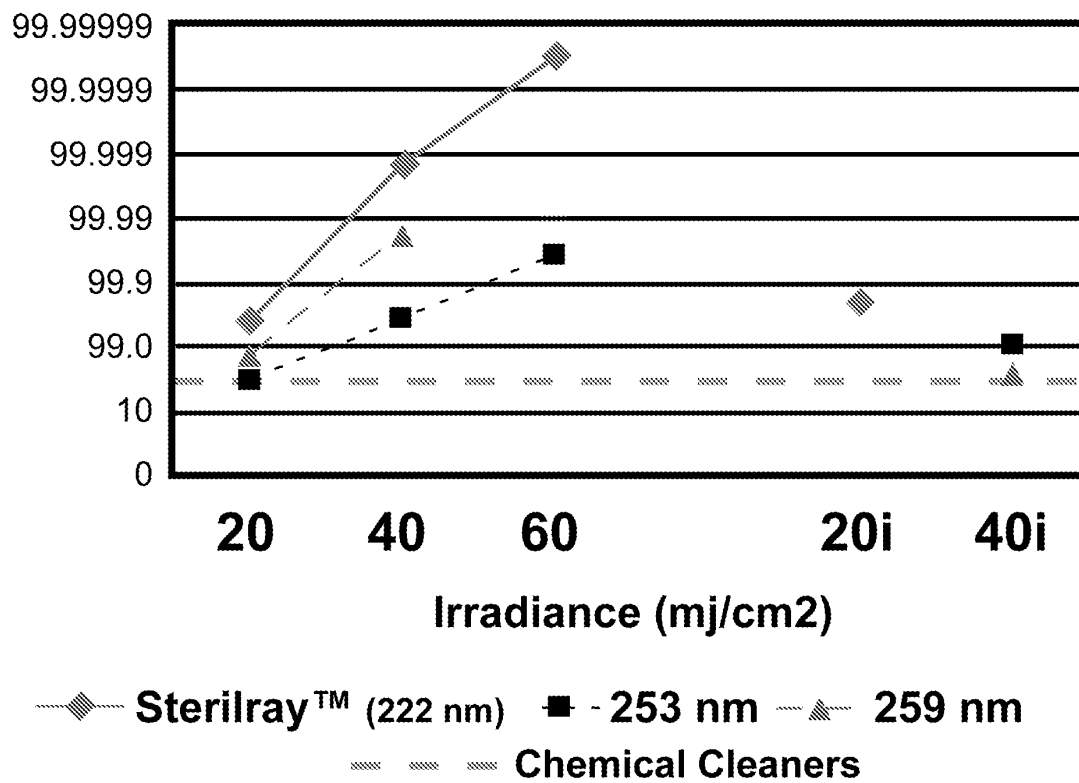


Figure 11: UV Irradiation Test on MS2

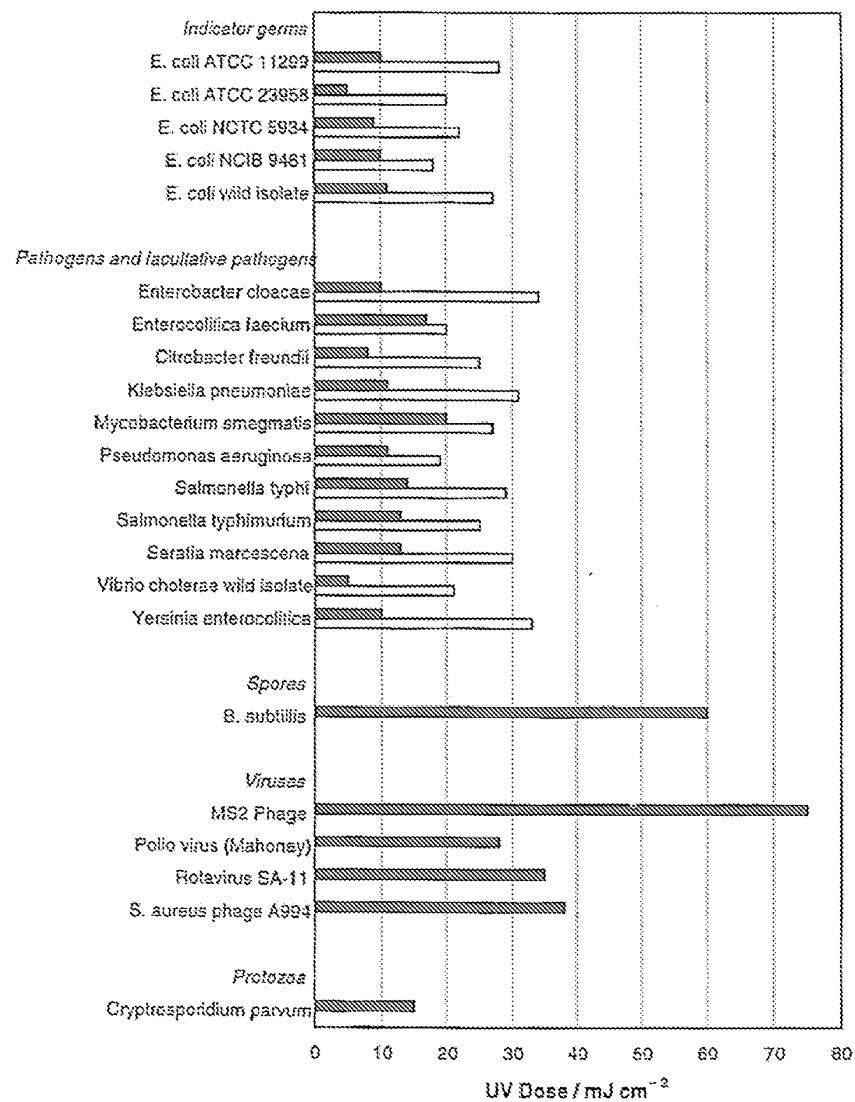


Figure 12: UV dose required for 4 log (99.99%) deactivation

RANGE OF EFFECTIVENESS

THE SIZE OF AIRBORNE PARTICLES IN MICRONS
(1 micron 1/25,400th of an inch)

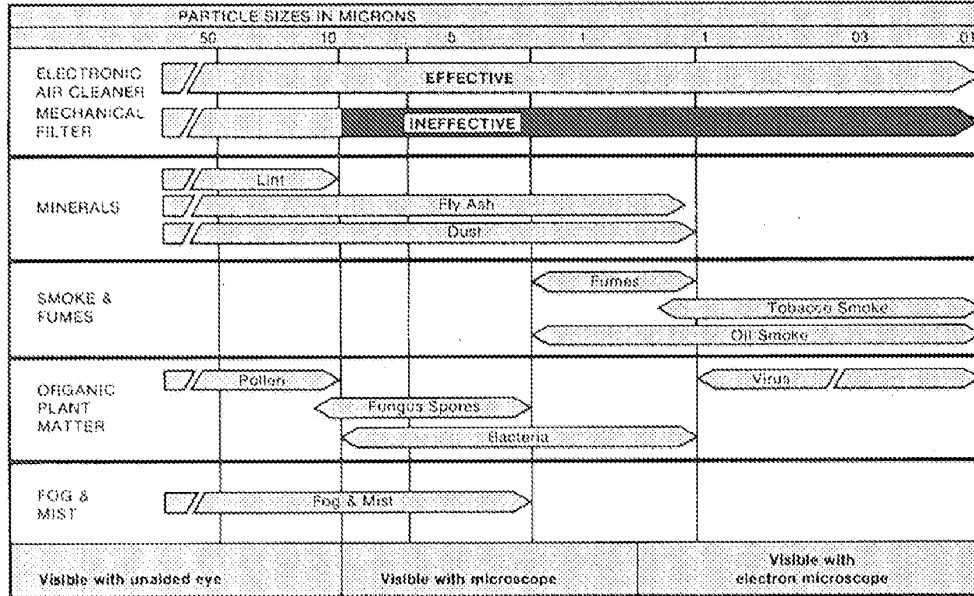


Figure 13: ESP range of effectiveness

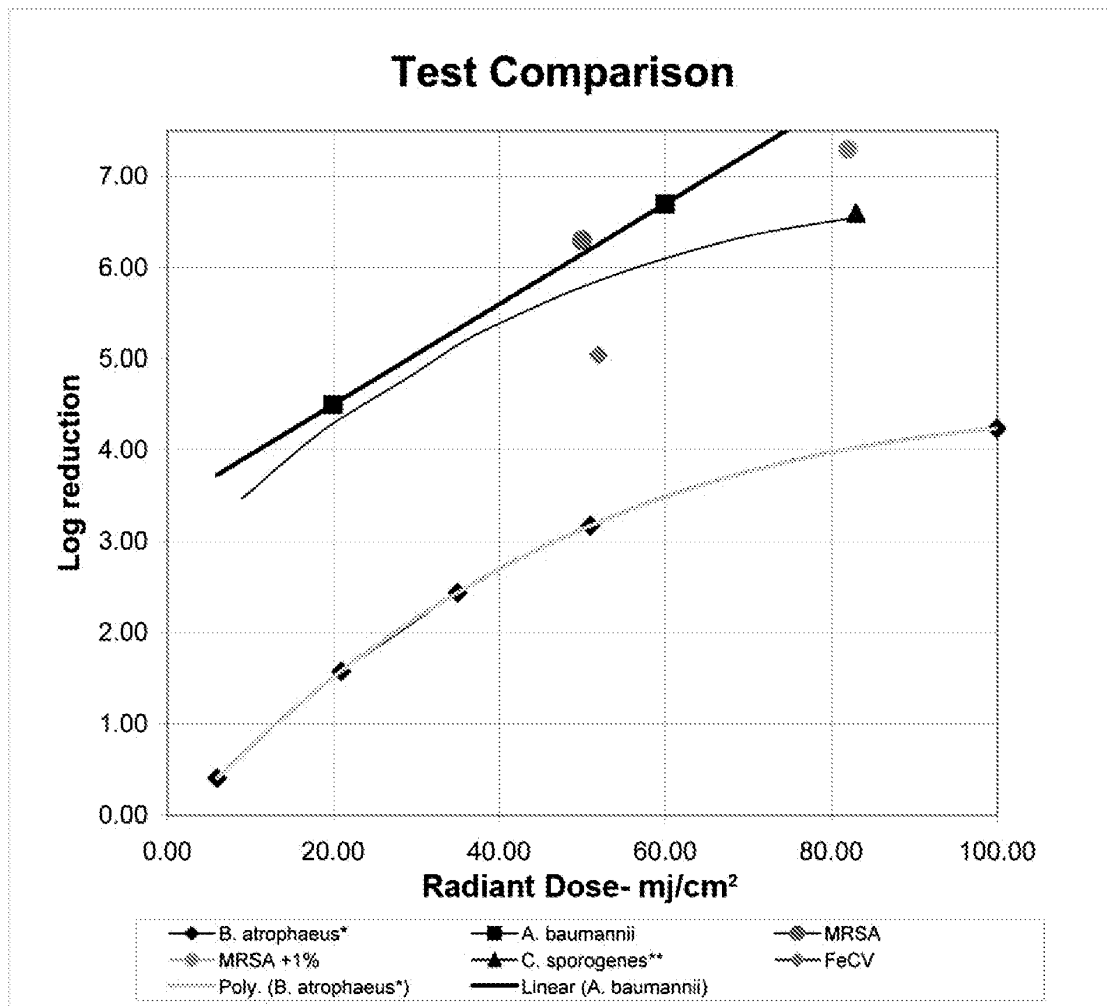


Figure 14: Sterilray Technology Test Data

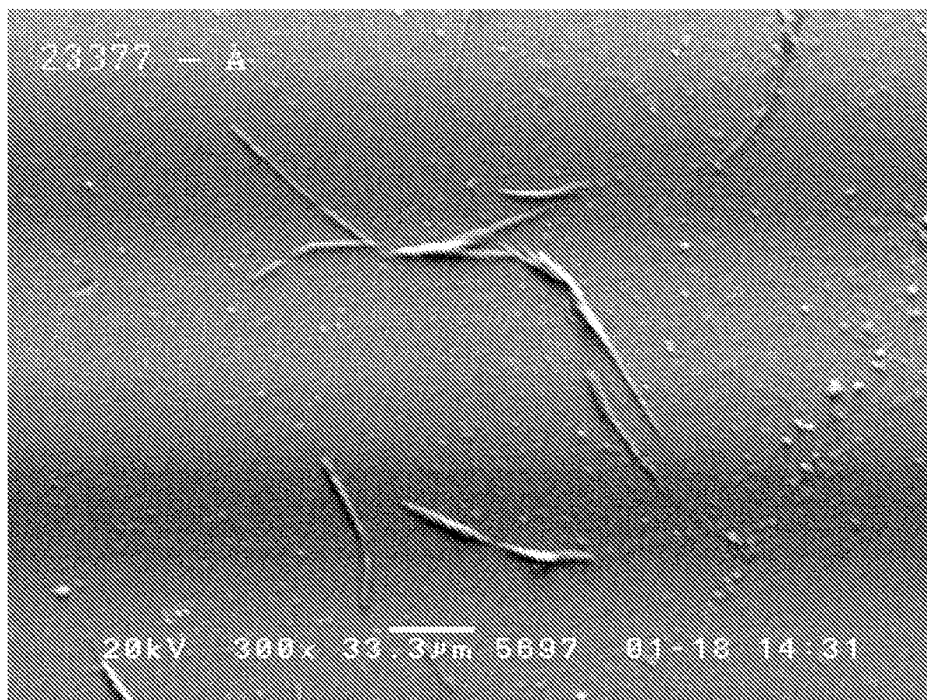
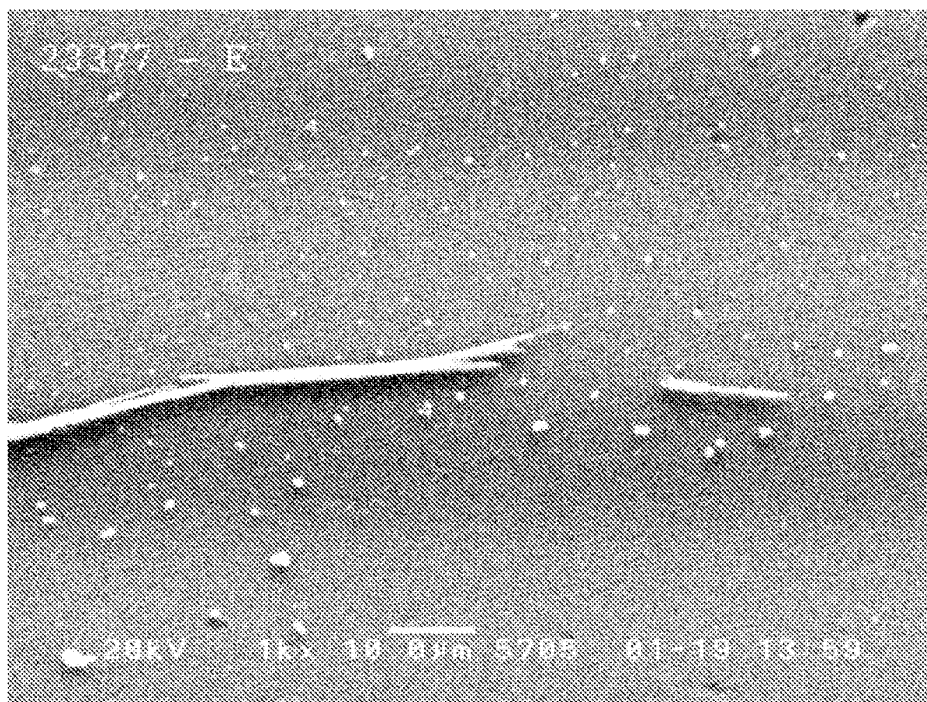


Figure 15: 300x and 100x micrographs of *Bacillus atrophaeus*

METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND
SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL
CONTAMINATION

5 BACKGROUND

1. Field of the Invention.

This specification teaches a new method for disinfecting and sterilizing air, surfaces of all types and food from microorganisms and toxic chemical substances. In addition, it relates to a process and apparatus for protecting surfaces in closed or
10 captured environments (zones) from external sources of microbial contamination in an efficient and cost effective process. These zones can be large volumes such as high rise building, cruise ships and jet airliners, or small volumes such as small rooms or surgical operation areas whether in a hospital operating room or on the battle field.

2. Description of the Related Art.

15 All prior art for sterilizing and disinfecting air has been based on using commercially available ultra-violet (UV) lamps or by using magnetic fields. These lamps are either pulsed or continuous. Continuous lamps are mercury based and emit principally at 254 nm. A number of companies are presently producing UV light based apparatus for the destruction of "virus, bacteria, spores and pathogens"
20 (microorganisms or VSP) that are in room air. This is an effective treatment because it continually exposes room air currents to the treatment light and over time has sufficient exposure time to treat VSP's. The required exposure times range from 10's to 100's of seconds, depending on the light absorption capability of the different virus and bacteria at the 254 nm. While this is effective for treating the room air of individual rooms, it
25 requires a long time to be effective in treating large flowing volumes of air that pass quickly down large ducts. Its long treatment time is impractical for treating most surfaces.

Magnetic based apparatus also require time to deactivate or destroy these VSP's. Two such inventions are directed to specific applications. Wesley, U.S. Pat. No.
30 4,458,153 is directed specifically towards liquid like substances enclosed in pipes, but does not discuss any test results. Sangster, U.S. Pat. No. 5,750,072 requires an

injection of a sterilizing fluid as a mist or vapor for the magnetic field to produce radicals that in turn are used to alter the VSP's. He does not discuss any test results. Hofmann, U.S. Pat. No. 4,524,079 is directed specifically to treating food stuffs. He speaks of requiring up to 100 pulses at frequencies ranging from 5 to 500 kHz. Although the
5 action time would be short, the power required to treat large areas and the apparatus design limit its practical application. None of these patents are admitted to being prior art by their mention in this background section.

The broad ultraviolet spectrum had been divided into three regions depending on its different effects on human skin. Reference to these regions are predominantly made
10 in medical terminology with UV-A defined as a range or band between 320 nm and 400 nm, UV-B defined as a band between 280 nm and 320 nm, and UV-C defined as encompassing wavelengths shorter than 280 nm. Recently the UV-C band has been shortened because strong water absorption causes different effects on the skin below 235 nm. UV-C is now considered the band encompassing wavelengths from 280 nm to
15 235 nm. The Far UV begins at 235 nm and encompasses wavelengths to the beginning of vacuum UV at 185 nm. Photochemists and photobiologists do not generally use these terms because absorption spectra of chemical bonds are much narrower than these generally defined bands. Instead, they use the wavelength of the applied radiation to define the observed effects.

20 Claims have been made that UV-C radiation is used to alter the DNA. This is because the mercury lamp emission at 254 nm is close to a good DNA absorption band and is the most widely available UV-C radiation source. None of these claims make reference to any shorter wavelengths and to the absorption band that peaks at 200 nm (see figure 9). Most literature credits this peak to protein absorption whereas the peak
25 centered near 260 nm is attributed to many amino acids. In fact, all literature directs researchers away from using any shorter wavelengths due to the high absorption of molecular water. Mercury lamps are used for wastewater treatment and work well for this application. However, this specification teaches that since we do not live underwater, the protein absorption band offers much more significant action spectra that
30 can be used to alter the DNA of microorganisms more effectively. A source of Far UV

photons targets this protein absorption band. This concept is a significant advancement and a step change in the technology used for sterilization and disinfection.

During the past few years, new UV emitting lamps based on the excitation of excimers are becoming commercially available. These emitters produce single line or narrow spectral emission at a wavelength determined by the gas composition of the lamp. If the treatment lamp's wavelength is chosen to match closely to the peak of protein absorption of the microorganism's DNA, then a lethal dosage can be delivered to the VSP's in a shorter time. No patent has been found that teaches the use of "new ultra-violet" (NUV) sources coupled with supporting equipment that can effectively and efficiently disinfect and sterilize large volumes of air, large and small surfaces, and food stuffs in various stages of preparation in a practical manner.

The NUV lamp is a coaxial design that can be made as small as a pencil to as large as 1 meter long. Lamp efficiency is about 10-25% wall power to UV emission. The design has several advantages over mercury lamps. Most important is that its gas can be chosen to maximize its emission to the absorption peak of the targeted biochemical. Unlike the mercury lamp, the UV intensity can be varied from near zero to maximum. It will produce 10 to 1000 times more intensity than mercury, depending on the lamp dimensions, and it does not use mercury that will soon become regulated by the EPA.

In this specification, sterilization or sterilize refers to sterilization or high level disinfectant as defined by US FDA. The terms disinfectant and disinfection refers to all other levels of disinfection.

SUMMARY OF THE INVENTION

Destruction of pathogens is significantly improved by targeting a biochemical in its DNA/RNA with the proper wavelength so the critical dosage can be delivered in the shortest time. The concept is to direct the correct spectral emission to target specific bonds with sufficient intensity to destroy pathogens quickly and effectively on all types of surfaces and in the air.

Critical to this apparatus is the development of a new ultra-violet (NUV) source that emits a highly intense narrow wavelength band of photons that correspond to the maximum absorption band for DNA proteins and other component bonds. The

preferred embodiment is the NUV source at 222 nm targets these proteins and their peptide bonds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. For some specific cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. The process is to use the irradiance from the NUV apparatus to produce high levels of disinfection on all types of contaminated surfaces and air and to destroy Biotoxins and nerve agents. The process includes support apparatus, ozone with the NUV source and preconditioning liquids and sprays that affect the tightness of the polypeptide helix which may improve absorption by the pathogen proteins or amino acids that result in improved destruction at lower dose or less time or both.

BACKGROUND FOR NUV APPARATUS

The genetic makeup of all living organisms is contained in their DNA molecule. This is a nucleic acid molecule that contains the genetic instructions to construct other components of living cells, proteins and RNA molecules. Replication occurs by the splitting of the DNA molecule, which duplicates itself through a transformation of its structure. Parts of the DNA molecule have been given names such as pyrimidine bases, cytosine, thymine or uracil that form a group of biochemicals that sustain life. The long DNA molecule holds itself together by using simple bonds like those found in sugars.

Researchers believe that the energy of the UV photon causes the formation of a strong (covalent) bond to develop between specific biochemicals. However, the bond strength of the covalent bond is very dependent on the relative position of the participating atoms. When the bond is symmetrical on both sides of a hydrogen atom in the bond, it is referred to as a dimer. A dimer is a very strong bond and is not generally broken during the vaporization of the liquid. UV light is known to produce Thymine, cytosine-thymine, and cytosine dimers. After the formation of the dimer, further replication of the DNA stops. Figure 8 shows the concept of the dimer formation in a DNA molecule.

The DNA molecule absorbs light from about 180 nm to about 300 nm. One of the most effective wavelengths to treat VSP's in water is about 254 nm because of low

water absorption. However, water absorption of UV light increases steadily as the wavelength decreases below 240 nm. This limits the ability for UV light of shorter wavelengths to be as effective for water treatment.

5 A standard commercial light source for UV irradiation near the 260 nm absorption peak of DNA is being produced by using mercury as the source for generating photons. The mercury gas and its pressure in the lamp determine the wavelength of the emitting light. For low-pressure (LP) and low-pressure high output (LPHO) lamps, the emitting wavelength is near 254 nm. For medium pressure lamps, the emission ranges from 200 nm to above 300 nm. However, the strength of the emitted light is not effective below
10 245 nm for the continuous emitting lamps and below 235 nm for medium pressure lamps. Xenon gas in pulsed lamps produces a similar emission as the medium pressure mercury lamps.

DNA action spectra show that absorption increases as the wavelength decreases, with a relative maxima at 260 nm and largest at 200 nm. Many articles
15 indicate the principal action spectra of the DNA absorption is from 245 to 280 nm range and do not address the 200 nm peak. An exception is Figure 9 which graphically shows this relationship (Von Sonntag; Disinfection by free radicals and UV-radiation. Water Supply 4, 11-18 (1986)). Since water absorption significantly increases below 240 nm, it becomes apparent that DNA effectiveness curves that omit the 200 nm peak apply
20 only to organisms in water.

MS-2 Phage is a marker virus that is used to measure reproduction viability after UV irradiation. Figure 10 is DNA absorption without the influence of water (Gates, F.L. A study of the bactericidal action of ultra violet light III. Jour. General Physiology 14, 31-42 (1930)). Absorption is more than doubled at 220 nm.

25 A recent technical paper (Peak et al, UV action spectra for DNA dimer induction; Photochemistry and Photobiology, 40, 5 (613-620)-1984) suggests that dimer formation is not the only requirement to inactivate DNA. Absorption of other molecular groups in the long DNA chain increase as the wavelength is reduced from 254 nm. Damaging or destroying these bonds may be more effective in deactivating the DNA than compared
30 to the 254 nm band. Reports show that damage caused by 254 nm light can be reversed by longer wavelength UV and blue light (Figure 12). The DNA of pathogens

not expected to have this 'photo-reactivation' phenomenon after being exposed to higher energy 222 nm photons.

The energy of the emitted photon is determined by its wavelength. Photon energy is about 5ev at 250nm, and increases for shorter wavelengths. Different bonds
5 in the DNA will be affected with photons of different energy.

The 540 kJ/mole photon energy from the NUV lamp exceeds the bond energies of many of the peptide bonds. This should cause physical damage to the microorganism. Figure 15 shows a micrograph of the *Bacillus atrophaeus* after receiving a radiant dose from a NUV lamp. It shows a magnification of 300x and 1000x
10 taken at low power to prevent any physical damage to the organisms during the picture process. The results of photon impact can be clearly seen in the 1000x frame by the ruptured sidewalls and segmentation of the organism. This is the first indication the author has seen that photons are actually causing physical damage and destruction to pathogens. A corresponding slide that received the same radiant exposure confirmed
15 that all organisms were dead.

A NUV lamp emitting at 222 nm is considered the most effective source because DNA molecules and biochemical's have greater absorption at this wavelength. The steep rise in absorption below 240 nm is exhibited by most proteins. It has been fairly well established that the peptide bonds in protein molecules are responsible for the
20 steep rise in absorption. This occurs as well for nucleo-proteins, aromatic amino-acids, diglycine, triglycine, and bovine albumin (McLaren, et al, Photochemistry of Proteins and Nucleic Acids, Pergamon Press, Macmillan Company, 1964). An organic chemist suggests that this lower wavelength is more effective in breaking bonds and producing dimers in the purine bases and sugar phosphates instead of the pyrimidines.

This wavelength is not strongly absorbed by water vapor and oxygen in the air. However, at 200 nm, oxygen absorption increases by 10 times and water absorption becomes slightly greater than oxygen. At 200 nm, ozone production vs. irradiance can not be controlled as it can at 222 nm. This would create a large amount of ozone that is harmful to humans and animals and reduce its effectiveness for applications in air,
30 particularly for long irradiation distances.

TESTS

Using a lamp that emits 222 nm, a comparison test with and without water was made to determine the effect of this radiation on organisms. The organism used in all tests was the MS-2 virus, which has become a standard indicator of mutation effectiveness. The EPA report (811-R-96-002) reports a 4.3 average log reduction of the MS-2 virus using mercury light 254nm at an irradiance greater than 128 mj /cm².

Three wavelengths were tested: 222, 253, 259 nm. The 222 nm lamp was tested at three levels of irradiance with the virus in a thin layer of water in order to reduce the absorption effect of water. A separate test was also done with the virus in more water. The 253 and 259 nm lamps were tested at the identical irradiance levels with the virus in water. Controls were made on all tests and a single test dish on each lamp was made to check experimental error.

The 222 nm lamp (Figure 11) produced log 5 reductions at 40 mj/ cm² and log 6.5 reductions at 60 mj/ cm². The water test produced a 3.2 log reduction, which matched the equivalent calculated irradiance in air. The 253 and 259 nm lamps produced about log 4 reductions at 60 mj/cm². A 3 million reduction in population is about 10 to 100 times more effective than reported mercury 254nm results at the same irradiance.

The results of the test indicate that 222 nm light is very effective in causing mutations and destruction in microorganisms. These tests indicate an improvement of between 10 to 1000 times, depending on the intensity of the lamp. It is important to note the improvement of the 259 nm source compared to the 254 nm source. This produced a 10 times improvement in the test sample for just a 5% increase in absorption. It illustrates the importance in using a UV photon emitter that is near the absorption peak of the DNA or targeted chemical such as proteins, nucleic acids, or amino-acids.

Figure 12 illustrates the 254 nm dose required to deactivation different VSP's. The bars represent with (solid) and without (open) photo-reactivation. Note that a dose of 75 mj/cm² is required to deactivate the MS2 Phage virus and prevent photo-reactivation. In the tests shown in Figure 11, half the dose at 222 nm was just as effective as the higher dose at 254 nm. Even though the sample was under water, the 222 nm radiation was still more effective than 254 nm radiation.

The 222 nm photon has more energy and is absorbed by S-N, S-O, O-O, O-H, and many carbon bonds that do not absorb 254 nm. This suggest that 222 nm light may also prevent DNA repair that has been reported when low level 254 nm UV sources were used.

5 Figure 14 presents further testing done in independent research laboratories on many different pathogens. They include spores *Bacillus atrophaeus* and *Clostridium sporogenes*, feline calici virus, bacteria *Acinetobacter baumannii*, MRSA, MRSA + 1% serum. The chart plots radiant dose against a log reduction of the target microorganism. It shows that high log reductions were achieved for viruses, bacteria
10 and spores. This chart presents data that does not determine the minimum dose but only the log reduction at the dose tested. Since many tests represented a 100% kill, a lower dose could obtain the same log reduction at or near 100% kill.

A survival plot was made of the *Bacillus atrophaeus* spore. Since it is known to be one of the most difficult spores to kill or deactivate, this curve represents the base
15 line for the dose required to kill most pathogens for the NUV source. Future tests will generate survival plots of the other pathogens to determine the minimum dose for various log reductions.

Since the NUV source can produce an irradiance of 100 mw/cm^2 , then a log 4 reduction of all but the *B. atrophaeus* can occur in a 0.1 second treatment resulting in a
20 radiant dose of 10 mj/cm^2 . The chart demonstrates that the NUV source is a potent sporicide as well as capable of producing high disinfection on VSP's.

TECHNICAL DISCUSSION

Critical to the destruction of the organism is targeting the proper biochemical with the proper wavelength so the critical dosage can be delivered in the shortest time. The
25 critical dosage is that dosage that destroys or deactivates the organism and prevents its replication.

Pyrimidine and purine bases of nucleic acids have a strong absorption near 260 nm. But proteins also have an absorption maximum at about 280 nm due to the absorption by the aromatic amino acids phenylalanine, tyrosine and tryptophane.
30 Numerous lipids also absorb near this peak. They include indole acetic acid and Lipase. And there are some major differences that occur in the synthesis of DNA to

RNA. The protein thymine is replaced by the pyrimidine base uracil that has absorption near the 280 nm and not at lower wavelengths.

It is important to note that biochemicals of DNA and RNA will have different absorption spectra and the peak absorption will be shifted by water, pH, temperature, previously absorbed light and surrounding contaminants in the air. Uracil and cytosine are particularly susceptible to photohydrate formation. A protein crosslink can be formed between a pyrimidines base and an amino acid. Cysteine and thymine are easily affected and uracil preferentially binds to cysteine, phenylalanine and tyrosine. Protein crosslinks induce irreversible cell damage. The disulfide group of cystine can be split into reactive sulfhydryl groups. Tryptophane (280 nm absorption) can provide the singlet energy transfer to split the disulfide groups that strongly influence the structure and function of proteins in the DNA/RNA complexes.

The presence of ozone can significantly induce damage to the long polypeptide amino acid chains and shorten the UV action kill time. For some applications, the NUV intensity is increased to produce some ozone to improve the pathogen destruction of the contaminated surface.

Test data confirmed that proteins in the RNA of the norovirus do not absorb the NUV wavelength at 222 nm effectively. However, a number of RNA proteins do exhibit strong absorption near the amino acid peak absorption of 280 nm. More likely is the fact that RNA absorption is due to the combination of the proteins and the locations and types of amino acid bonds surrounding them. Testing is underway to confirm that a NUV source at 282 nm will cause similar destruction to the RNA of the norovirus compared to the DNA destruction seen in Figure 14.

There are many UV absorption plots that indicate how the degree of absorption in the DNA/RNA molecule changes with wavelength as the pH of the carrier solution is changed. The *secondary structure* is a term used to describe the coiling of the polypeptide chain. The tightness of the coil is also significantly affected by pH of the solution. This suggests that the closeness of the different amino acids to peptide bonds affect the DNA/RNA absorption at a specific wavelength. Consequently, pre-treating the surface with a solution or spray that improves the absorption of the targeted proteins and amino acids prior to delivering a UV radiant dose is also being tested. In many

cases, it may significantly improve the process by reducing the UV dose or treatment time. The concept of using the NUV source in conjunction with wipes and liquids for treating VSP's on surfaces is also contained in the scope of this specification.

Biotoxins and nerve agents can be used by terrorists as weapons against groups of people. Nothing economical has been developed that could mitigate an attack and prevent the loss of life and incapacitation at the point of attack. While government agencies of the US have developed detectors that could be used in the future to warn people in the confined areas that are under attack, nothing would prevent the attack from being effective.

Biotoxins and nerve agents are organic molecules that contain either DNA or have long chain carbon molecules. Both of these are susceptible to destruction using NUV light sources. 222 nm will destroy the C=C and C=O bonds causing the destruction of the chemical. Future testing will determine if the molecular extinction coefficient is sufficient to make this effective means for their destruction.

The most effective means for delivery of these agents is to spread them in a gas phase through the air ventilation system. A detector would be used to turn on sufficient NUV sources so that the agents are destroyed before exiting the ventilation system into the confined area where the captured population is present. Tests still need to be done in regulated and controlled laboratories to develop the criteria for these sources to be effective and become the first line of defense.

The use of a high E field electrostatic precipitator (ESP) is important to the sterilization and disinfecting apparatus for air in some situations. Figure 13 compares the range of effectiveness with mechanical filters for different pollutant sizes. As illustrated in the fourth column, it is capable of removing some percentage of VSP's. However, since it can also capture fog and mist, it has the ability to breakdown ozone O_3 into oxygen. Its use prevents levels of ozone from exceeding the EPA exposure safe levels.

In some cases the air disinfecting apparatus includes a humidification system to provide and maintain minimum moisture content at predetermined and controllable levels. In addition, the apparatus contains baffles and zone restriction devices that

enhance the zone protection and minimize the positive pressure required to maintain the protected zone.

The concept of using the NUV source with associated support equipment for air disinfection of VSP's is valid and is also contained in the scope of this specification.

5 APPARATUS AND PROCESS DISCUSSION

The NUV source apparatus is made to supply a narrow emission band of UV light that is close to the peak absorption of the targeted organism or chemical with sufficient photon energy that break bonds. Unique to obtaining short action (kill) times is a determination of the specific wavelength required to destroy the targeted organism or chemical.

The process is to direct the correct spectral emission to target specific bonds in proteins and amino acids in the DNA/RNA molecule with sufficient intensity to destroy pathogens quickly and effectively. It is effective for the breakdown of biofilm and protein based allergens.

The preferred embodiment is a NUV source at 222 nm. This spectral emission is 10^4 times more effective than standard mercury based lamp UV light for altering the DNA. Action times are reduced from 10's to 100's of seconds to times less than 0.1 seconds.

The NUV source can also be made to emit photons at 282 nm to target a mixture of amino acids and some proteins that absorb at this longer wavelength. This may be particularly important for single or double strand RNA of influenza or noroviruses. For some cases, the NUV source may also produce 254 nm photons so as to target specific amino acids. And the photon energy of the NUV source is sufficiently high to break carbon bonds of chemical toxic substances or biotoxins with similar action times.

This invention uses the NUV source that makes it cost effective in treating surfaces of materials since the action time is very quick. The apparatus of this invention is designed to make direct photons to the intended target as effectively and efficiently as possible. This makes for a cost effective process for sterilizing and disinfecting air, all types of surfaces and food during normal daily activity and prevents the previous need to restrict occupation and use of areas being treated.

Surfaces

The apparatus is designed to quickly disinfect floors, hand rails, objects that are in constant contact with transient populations for the purpose of preventing transmission of disease and toxic substances that can cause injury or illness to these populations.

- 5 As a hand wand, it only needs to be waved or passed over the surface to obtain a high level of disinfection.

- The NUV radiation can be applied to any object or surface that needs to be disinfected and/or sterilized. An example would be the use of a caddie cart whereby all instruments, papers and pens would be exposed after a patient examination to prevent the transmission of pathogens to the next patient. The cart could also provide a means to disinfect protective gloves or face masks if a shortage occurs during a pandemic. Testing will determine the correct exposure limits to prevent any harmful effects that could occur when used to disinfect human skin, hands, animal surfaces such as skin, fur, and hair, and critical plastics and materials used in medical devices. It also has the potential to sterilize/disinfect medical equipment and surfaces and critical parts on an industrial assembly line prior to packaging,
- 10
- 15

- Because the NUV source is a light source, it can be directed to expose different levels of thick and loose materials by using light conducting fibers to distribute the light intensity. An example would have the NUV source disinfecting a floor by directing it at the floor while some of the light is directed to the bottom of a rug or floor scrubbing brush by light fibers imbedded in the brush. In a similar manner, products that have cavities or areas not exposed directly by the external source could be disinfected. An example of this would be a single fiber used to direct NUV light into a tooth cavity to disinfect the walls and tissue inside prior to sealing with a filling.
- 20

- The NUV source can be used to directly disinfect room surfaces, apparatus, fixtures and clothing or particles and microbes in the room air by directly exposing all objects for the required exposure time. Several sources can be combined to assure exposure to all surfaces and to reduce total exposure time. It can provide effective treatment to isolation room air by preventing pathogens from remaining alive after exiting or entering the room. Rooms contaminated by bioterrorist agents could be
- 25
- 30

treated by moving using robots to move the NUV source(s) in many directions and moving it (them) around the room during treatment.

Food

The NUV source may provide a significant improvement to the disinfection of food stuffs. The apparatus can be designed for each application that includes foodstuffs in conveyor assemblies, stationary carts and in handling routes during the movement from storage to food preparation processes. It can be use to disinfect specific types of foods such as seeds and sprouts prior to planting, raw food stock like fruits and berries and leafy greens as they are prepared for transportation from the fields to processing centers, to warehousing and storage, to supermarket handling and kitchen preparation and delivery to the consumer. Furthermore, the process can be used to disinfect cutting and working surfaces of meat and poultry packaging rooms and even the cutters and equipment used to transport meat, poultry and other food products.

E-beam sources are currently the only other mechanism being tested to protect food supplies. It does irradiate food with high energetic electrons that is now causing concerns by many about the safety of the product after irradiation.

Air

Normal breathable air contains many contaminants including moisture droplets, dust, lint, bacteria, virus, cists, and spores. The NUV apparatus can be used by itself to disinfect air. The short action time means the NUV lamp can destroy pathogens in the air as they pass by. Another important consideration for its use in disinfecting of air is that it does not contain mercury.

Sterilization sometimes requires the removal of all particles to the smallest possible size. The NUV source can produce byproducts that must be removed for some treatment applications. These byproducts include oxidized air (ozone), condensable chemical byproducts, and damaged microorganisms. Critical to the apparatus is the removal of these contaminants and byproducts. In some special applications, ozone is produced by the NUV source to make treatment more effective. Consequently, the apparatus includes the making of ozone, the use of high E field precipitators and other UV light to remove ozone downstream after the disinfection area and apparatus to make effective use of the combination of these technologies.

Sterilized air is then used to prevent microbial contamination of a protected zone by preventing the influx of untreated air from outside this zone. The apparatus includes pressurizing equipment and zone baffles that provide sufficient outflow from the protected zone so as no contamination can occur. Protected zones can be as small as
5 a wound area on a battlefield operating table to a cruise ship, airplane, or high rise building with thousands of inhabitants.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components of the NUV source
10 therein.

Figure 2 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting or sterilizing large volumes of air therein

Figure 3 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting floor
15 surfaces and other surfaces such as chairs, hand rails, counter tops, trays, table tops and the like therein.

Figure 4 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for disinfecting food
20 prior to handling by kitchen or cooks before serving therein.

Figure 5 is a perspective schematic view of a preferred embodiment of the present invention defining the location of important components for sterilizing air that is used to cover and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 6 is a perspective schematic view of a preferred embodiment of the present invention illustrating the zone air sterilization apparatus in conjunction with the remote protected operation zone therein.
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Figure 7 is a CFD view of a preferred embodiment of the present invention defining the emitted airflow pattern from the sterilization apparatus that is used to cover
30 and protect the zone around a surgical operation or procedure independent of the location of the operation therein.

Figure 8 is a graphic showing dimer formation in a DNA molecule.

Figure 9 is a graph plotting UV absorption of DNA according to wavelength.

Figure 10 is a graph plotting DNA absorption without the influence of water.

Figure 11 plots the effectiveness for reduction of the MS-2 phage virus by
5 different wavelengths of UV radiation.

Figure 12 plots the UV dose required to achieve a four log deactivation of
selected microbes using 254 nm UV light.

Figure 13 is a graphic comparing the range of effectiveness of various filters for
removing airborne particles.

10 Figure 14 is a graph comparing tests of different pathogens for log reduction for
different radiant dosages of NUV light.

Figure 15 is a low power exposure at 300x and 1000x micrographs of the
Bacillus atrophaeus organism after receiving a radiant dose from the NUV light source.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 The drawings illustrate the invention in its different forms and the apparatus
required for sterilization or disinfection of air and surfaces that contain VSP's. Figure 1
illustrates the NUV light source. Figure 1a shows the NUV source. The high voltage
electrode 1 is located inside the inner tube of the annular lamp. The ground electrode
screen 2 is located on the outside of the annular lamp. The gas that produces the UV
20 photons is located in the annular region 3 between the inner and outer tubes 4. The
gas type is chosen so that the emitted UV photons are absorbed by the targeted
microorganism or chemical. The preferred embodiment is 222 nm but could also be
282 nm. UV radiation is emitted radially outward 5. Changing the voltage or current
between the two electrodes changes the amount of UV radiation that is produced.

25 Figure 1b illustrates the NUV light source used to direct the UV photons towards
a specific location, direction, surface, material or substance. . The NUV source is
shown in the center of the drawing as an end view. The specialized reflector 6 end view
incorporates a specialized 'gull wing' design so that >90% of the emitted light is directed
to the planar surface below. The specialized reflector 6 also incorporates barium sulfate
30 (Ba_2SO_4) as the reflective material in order to maximize the number of photons that are
reflected onto the planar surface. In some cases, a cover 6a is necessary to protect the

NUV source and reflector from dirt. This cover is transparent to 222 nm and 282 nm light. The specialized reflector can also have different shapes that change the directed radiation for different applications.

This design provides a convenient method and apparatus to disinfect commonly touched objects that act as fomites to transmit pathogens from one person to the next. It would also provide a means for wound treatment prior and post surgery and for the treatment of chronic wounds. It is also provides a means to disinfect hospital and health care rooms, operating tables, hand rails and equipment surfaces that support patient care.

Furthermore, in cases of critical shortages of gloves, robes and masks, the NUV source can be used in this manner to disinfect periodically when appropriate instead of retrieving new ones from supply.

The NUV source(s) can also be used to disinfect patient examining tools, records, pens and equipment between patients. Everything that is brought into the room for examining the patient should be put through the medical caddie after exiting the room and retrieved only after changing gloves and/or garments.

In use, the NUV source can be made to any size and length. In air ducts, the embodiment shown in Figure 2 item 6b would have the NUV source supported from the side, top or bottom of the duct so that its irradiation travels parallel to the airflow. For unique applications, a second embodiment Figure 5 item 16 would have the NUV source and cylinder reflector supported inside the duct so that irradiation is perpendicular to the airflow. An example of this embodiment would be a NUV source positioned in the center of a tumbling dryer. All garments or objects or food stuffs would be irradiated during the drying or tumbling process for a length of time that would guarantee a high level of disinfection.

Figure 2 illustrates the apparatus required for the disinfection and sterilization of airflow inside a large duct. NUV sources 7 precede an electrostatic precipitator (ESP) 9 by some distance 8 that permits a short action time to complete the destruction of the toxic gases or VSP's. A humidifier 10 may follow the precipitator with control sensors 11 so that the humidity of the exiting air can be selected and maintained. A fan(s) 12 may also be used to pressurize the exiting air so that a slight pressurization can be

applied to a protected zone to prevent contaminated air from entering. Depending on the nature of the zone, restricting baffles (not shown) are used to assist in maintaining a positive pressure inside the protective zone.

Figure 3a illustrates the NUV source 13 located inside the forward compartment of a vacuum cleaner or floor cleaning machine. The vacuum cleaner can be either a
5 standup floor model or a canister model. It could also be any device that would support and carry the NUV source close to the floor. The significant part is that the NUV source with reflector 6 consists of the components as described in Figure 1b. Figure 3b illustrates a preferred embodiment with the NUV source contained in a hand held wand.
10 Sensing switches 14 can be included in this embodiment that shut off the NUV source when the wand is not directed correctly to the desired treatment surface.

Figure 4a illustrates the NUV source(s) located above a conveyor that carries raw and unprepared food prior to kitchen preparation as well as industrial packaging assembly lines that carry products that require disinfection. The conveyor assembly
15 is designed to maximize the surface area exposed to the NUV source(s). In some cases, several sources 13 are required because the exposed surface of the food or product can not be changed to expose the entire surface during the illumination time of one NUV source. Tumblers or vibrators are typically used to change the orientation of the foodstuffs or parts as they move along the conveyor. However, a rotary tumbler
20 similar to a cloth dryer with the NUV source located in the center would be the preferred embodiment for disinfecting leafy greens. Figure 4b illustrates the NUV source(s) 13 located beside heat lamps 15 or other heating surfaces used to keep the food hot on a serving counter prior to being delivered from the kitchen to the customer. In another embodiment, the NUV source is used to irradiate cool or cold foods, so heat lamps 15
25 are not used.

Figure 5 illustrates the NUV source located inside an air sterilization apparatus that provides air for remote and separate operation tables. The NUV source 16 is located inside a UV reflector chamber 17 in order to reduce the loss of UV photons. A light trap 18 stops the UV light prior to the turning vanes 19 that direct the air flow
30 vertically downward onto the operation site. A diffuser 20 ensures that the airflow is uniform across the duct. A high E field electrostatic precipitator (ESP) 21 follows the

diffuser to remove particulates and reduce any ozone to oxygen. The airflow then passes through a second diffuser and humidifier 22 to ensure that the airflow is uniform across the duct and that the humidity level is controlled to some preset value.

5 Figure 6 illustrates how the air sterilization apparatus would be used in conjunction with a remote operation site, where the doctor is using remote controlled surgical instruments that are inside the sterilized air zone.

Figure 7 illustrates the airflow pattern using CFD computational fluidic design to ensure that the air above the operation zone is uniform and prohibits contaminated air from entering the protected zone.

10 Figures 8 through 15 are discussed in the technical and background sections of this specification.

Although the preferred embodiments of the present invention have been described herein, the above description is merely illustrative. Further modification of the invention herein disclosed will occur to those skilled in the respective arts. All such
15 modifications are deemed to be within the scope of the invention as defined by the appended claims and not limited thereto.

CLAIMS

What is claimed is:

1. A disinfecting apparatus comprising:
 - a source of photons having a wavelength that corresponds to an absorption peak
5 of amino acids or proteins in microorganisms; and
 - a photon reflector secured in a spaced relationship to the photon source,
whereby the apparatus produces photons that are directed to a selected zone or
surface and efficiently destroys DNA or RNA of microorganisms.
- 10 2. The apparatus of claim 1 wherein the wavelength is at least one of 222 nm, 254 nm,
and 282 nm.
3. The apparatus of claim 1, wherein the source of photons is an excimer lamp
discharge.
- 15 4. The apparatus of claim 1, wherein the source of photons is a NUV lamp discharge.
5. The apparatus of claim 1, wherein the photon reflector is one of a gull wing-shape
and a shape selected to direct at least 90% of emitted light to a planar surface.
- 20 6. The apparatus of claim 1 the photon reflector comprising barium sulfate for
enhancing its reflective properties.
7. The apparatus of claim 3, wherein the photon source intensity and apparatus size
25 are selected to produce ozone at a rate that coupled with the photons is effective for
disinfection.

8. The apparatus of claim 1 further comprising:

a handle attached to the photon source; and

a surface detection mechanism adapted to shut off the photon source when it is not near a surface to be disinfected.

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9. The apparatus of claim 1 further comprising:

an air duct surrounding the photon source; and

a particle removal means in the duct secured in a spaced relationship to the photon source selected to provide a particular action time in the airflow to disinfect the air.

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10. The apparatus of claim 9, wherein the particle removal means is an electrostatic precipitator.

11. The apparatus of claim 10, further comprising a humidifier in the air duct downstream of the electrostatic precipitator.

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12. The apparatus of claim 11, further comprising a humidity sensor downstream of the humidifier.

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13. The apparatus of claim 9, further comprising a light trap disposed between the photon source and the particle removal means.

14. The apparatus of claim 9, further comprising turning vanes within the duct to change the direction of airflow.

25

15. The apparatus of claim 9, further comprising a diffuser.
16. A process for disinfecting a substance or surface comprising the steps of
generating photons of at least one wavelength corresponding to a peak
5 absorption wavelength of DNA or RNA; and
directing the photons to a substance to be disinfected, whereby the photons
destroy the DNA or RNA of microorganisms.
17. The process of claim 16, wherein the wavelength is at least one of 222 nm, 254 nm,
10 and 282 nm.
18. The process of claim 16 further comprising the step of providing an NUV source for
generating the photons.
- 15 19. The process of claim 16 wherein the directing step is performed by reflecting the
photons to a desired surface.
20. A process for disinfecting a substance in an air stream comprising the steps of
generating photons of at least one wavelength corresponding to a peak
20 absorption wavelength of DNA or RNA;
directing an air stream to a source of the photons; and
exposing the air stream to the photons, whereby the photons destroy the DNA or
RNA of microorganisms.
- 25 21. The process of claim 20, wherein the wavelength is at least one of 222 nm, NUV
254 nm, and 282 nm.

22. The process of claim 20 further comprising the step of providing an NUV source for generating the photons.
- 5 23. The process of claim 20, further comprising the steps of
determining required activity time to disinfect the air stream; and
removing particles from the air stream after the activity time.
24. The process of claim 23, further comprising the step of humidifying the air stream
10 downstream of the removing step.
25. A process for providing a germ-free surgical space comprising the steps of:
generating photons of at least one wavelength corresponding to a peak
absorption wavelength of DNA or RNA
15 directing an air stream to a source of photons;
exposing the air stream to the photons;
removing particles from the air stream; and
directing the air stream vertically downward to a surgical area, whereby a
disinfected airflow surrounds the surgical space and prevents infected air from entering.
20
26. The process of claim 25 wherein the wavelength is at least one of 222 nm, NUV
254 nm, and 282 nm.

ABSTRACT

This invention relates to a method, process and apparatus for disinfecting and sterilizing all types of surfaces contaminated with microorganisms and toxic substances to render both inactive. Furthermore, this invention relates to both a method and
5 apparatus for disinfecting and/or sterilizing breathable air and then using this air to protect a confined space from external contamination. The apparatus consists of a new ultra-violet (NUV) source that is more effective than mercury based 254 nm light for destroying DNA of virus, bacteria, spores and cists. It is most effective in breaking chemical bonds in toxic gases and Biotoxins that are useful to terrorists. It is combined
10 with other apparatus that remove particulates and byproducts sometimes produced by the NUV source and maintains positive pressure of the confined space so as to prevent the influx of air from outside the protected zone.

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 14/254,957		Filing Date 04/17/2014		☐ To be Mailed				
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO													
APPLICATION AS FILED – PART I													
(Column 1)			(Column 2)										
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A							
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A							
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A							
TOTAL CLAIMS (37 CFR 1.16(j))		minus 20 =		*		X \$ =							
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		X \$ =							
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).											
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))													
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL							
APPLICATION AS AMENDED – PART II													
(Column 1)			(Column 2)			(Column 3)							
AMENDMENT	04/17/2014		CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))		* 18		Minus	** 20		= 0		X \$40 =		0	
	Independent (37 CFR 1.16(h))		* 3		Minus	***3		= 0		X \$210 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
	TOTAL ADD'L FEE											0	
(Column 1)			(Column 2)			(Column 3)							
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
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	Independent (37 CFR 1.16(h))		*		Minus	***		=		X \$ =			
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	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
	TOTAL ADD'L FEE												
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>											<p>LIE /JACKIE WHITE/</p>		

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 14/254,957				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)	OR	RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A				
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	300		N/A				
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A				
TOTAL CLAIMS (37 CFR 1.16(j))	18	minus 20 = *	x 40 =	0.00	OR					
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *	x 210 =	0.00						
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00						
				TOTAL		TOTAL				
				730						
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	OR	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	OR	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.</p>										



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
14/254,957	04/17/2014		730	14-016-EN	18	3

CONFIRMATION NO. 7908

32118
LAMBERT & ASSOCIATES
92 STATE STREET
BOSTON, MA 02109-2004

FILING RECEIPT



OC000000068227491

Date Mailed: 05/06/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

S. Edward Neister, Dover, NH;

Applicant(s)

S. Edward Neister, Dover, NH;

Power of Attorney: The patent practitioners associated with Customer Number 32118

Domestic Priority data as claimed by applicant

This application is a CIP of 11/831,667 07/31/2007
which is a CIP of PCT/US2006/003393 01/31/2006
which claims benefit of 60/593,626 01/31/2005

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 05/02/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/254,957**

Projected Publication Date: 08/14/2014

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/254,957	04/17/2014	S. Edward Neister	14-016-EN

CONFIRMATION NO. 7908

32118
LAMBERT & ASSOCIATES
92 STATE STREET
BOSTON, MA 02109-2004

PUBLICATION NOTICE



Title:METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION

Publication No.US-2014-0227132-A1

Publication Date:08/14/2014

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publicly available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <http://pair.uspto.gov/>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908
32118 7590 11/06/2015 LAMBERT & ASSOCIATES 92 STATE STREET BOSTON, MA 02109-2004			EXAMINER YOO, REGINA M	
			ART UNIT 1799	PAPER NUMBER
			NOTIFICATION DATE 11/06/2015	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

lambert@lambertpatentlaw.com
shortell@lambertpatentlaw.com
connaughton@lambertpatentlaw.com

Office Action Summary	Application No. 14/254,957	Applicant(s) NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on _____.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
- 2a) ☐ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 16,18-20,22-25 and 27-35 is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 6) ☐ Claim(s) _____ is/are allowed.
- 7) ☐ Claim(s) _____ is/are rejected.
- 8) ☐ Claim(s) _____ is/are objected to.
- 9) ☒ Claim(s) 16,18-20,22-25 and 27-35 are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date _____.
- 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 4) ☐ Other: _____.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Election/Restrictions

2. This application contains claims directed to the following patentably distinct species:
 - Specie A, drawn to a process of destroying DNA or RNA of microorganism on a substance or a surface;
 - Specie B, drawn to a process of destroying DNA or RNA of microorganism in airstream.
3. The species are independent or distinct because claims to the different species recite the mutually exclusive characteristics of such species. In addition, these species are not obvious variants of each other based on the current record.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable. Currently, no claim is generic.

The following claims appear to read on each species:

- Specie A: claims 16, 18-19, 25, and 27-33;
- Specie B: claims 20, 22-24, and 34-35.

There is an examination and search burden for these patentably distinct species due to their mutually exclusive characteristics. The species require a different field of

search (e.g., searching different classes/subclasses or electronic resources, or employing different search queries); and/or the prior art applicable to one species would not likely be applicable to another species; and/or the species are likely to raise different non-prior art issues under 35 U.S.C. 101 and/or 35 U.S.C. 112, first paragraph.

4. **Applicant is advised that the reply to this requirement to be complete must include (i) an election of a species to be examined** even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected species**, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

The election of the species may be made with or without traverse. To preserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the election of species requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable on the elected species.

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the species unpatentable over the

prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other species.

5. Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which depend from or otherwise require all the limitations of an allowable generic claim as provided by 37 CFR 1.141.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to REGINA M. YOO whose telephone number is (571)272-6690. The examiner can normally be reached on M-F 10:30 am - 7 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Marcheschi can be reached on 571-272-1374. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/REGINA M YOO/
Primary Examiner, Art Unit 1799

<p align="center"><i>Index of Claims</i></p> 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant
☐ CPA
☐ T.D.
☐ R.1.47

CLAIM		DATE									
Final	Original	11/02/2015									
	1	-									
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	3	-									
	4	-									
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	14/254,957
Filing Date	04/17/2014
First Named Inventor	S. Edward Neisler
Attorney Docket No.	14-016-EN
Examiner:	Yoo, Regina M.
Art Unit:	1799

ELECTION WITHOUT TRAVERSE AS REQUIRED UNDER 35 USC §121

In response to the Office communication mailed November 6, 2016 requiring restriction of Claims 16, 18-20, 22-25 and 27-35 of the above-identified Application. With a one month extension of time, requested herein, a response to this communication is due on February 6, 2016. Applicant respectfully requests that the following amendments to the Application be entered:

Amendments to the Claims:

CLAIMS

What is claimed is:

1-15. (Canceled).

16. (Currently Amended) A process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm; and

directing the photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms.

17. (Canceled).

18. (Original) The process of claim 16 further comprising the step of providing an NUV source for generating the photons.

19. (Original) The process of claim 16 wherein the directing step is performed by reflecting the photons to a desired surface.

20. (Withdrawn) A process for destroying a DNA or RNA of a microorganism in an air stream comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

directing an air stream to a source of the photons; and

exposing the air stream to the generated photons, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganism in the air stream.

21. (Canceled).

22. (Withdrawn) The process of claim 20 further comprising the step of providing an NUV source for generating the photons.

23. (Withdrawn) The process of claim 20 further comprising the steps of:
determining required activity time to disinfect the air stream; and
removing the particles from the air stream after the activity time.

24. (Withdrawn) The process of claim 23, further comprising the step of humidifying the air stream downstream of the removing step.

25. (Previously Presented) A process for providing a germ-free surgical space comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

directing an air stream to a source of photons;

exposing the air stream to the photons;

removing particles from the air stream; and

directing the air stream vertically downward to a surgical area, whereby a disinfected airflow surrounds the surgical space and prevents infected air from entering.

26. (Canceled).

27. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected.

28. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 40 mJ/cm² to the substance or surface to be disinfected.

29. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 60 mJ/cm² to the substance or surface to be disinfected.

30. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises providing a radiant dose energy of 10 mJ/cm² to the substance or surface to be disinfected.

31. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, the source for generating the photons selected to produce an irradiance of approximately 100 mw/cm² or less.

31. (Previously Presented) The process of claim 16 wherein the surface to be disinfected is human skin.

32. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises exposing the substance or surface to be disinfected to the generated photons for less than 0.1 second.

33. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, wherein the source for generating photons is a hand held lamp, and wherein the step of directing the photons further comprises the step of waving the hand held lamp over the surface or substance to be disinfected, exposing the surface or substance to the generated photons for approximately 0.1 second or less.

34. (Withdrawn) The process of claim 20 further comprising the steps of:
selecting a source of photons configured to provide an irradiance of 100 mw/cm²;

wherein the step of exposing the air stream further comprises exposing the air stream to the generated photons for at least 0.1 second, thereby providing a radiant dose to the air stream and contents therein of 10 mj/ cm².

35.(Withdrawn) The process of claim 20 wherein the step of exposing the air stream to the generated photons further comprises providing a radiant dose of photons to an air stream and contents therein of 40 mj/cm².

REMARKS

Applicant thanks the Office for the attention accorded the present Application in the November 6, 2016, Office Action.

The Office has required election of one of the following three allegedly patentably distinct inventions and accordingly required restriction:

- i. Specie A, drawn to a process of destroying DNA or RNA of microorganism on a substance or a surface; claims 16, 18-19, 25, and 27-33
- ii. Specie B, drawn to a process of destroying DNA or RNA of microorganism in airstream; claims 20, 22-24, and 34-35

Without addressing the propriety of this restriction requirement, Applicant has elected to continue prosecution of Invention I, Claims 16, 18-19, 25, and 27-33 without traverse.

CONCLUSION

Allowance of Claims 16, 18-19, 25, and 27-33 is therefore requested. With a one month extension of time, requested herein, a response to this communication is due on February 6, 2016. Therefore, this response is being timely filed.

Applicant believes that all of the pending claims should now be in condition for allowance. Early and favorable action is respectfully requested.

The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

Respectfully submitted,

/David J. Connaughton, Jr./
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Electronic Patent Application Fee Transmittal				
Application Number:		14254957		
Filing Date:		17-Apr-2014		
Title of Invention:		METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		
First Named Inventor/Applicant Name:		S. Edward Neister		
Filer:		Gary Ervery Lambert		
Attorney Docket Number:		14-016-EN		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension - 1 month with \$0 paid	2251	1	100	100
Miscellaneous:				
Total in USD (\$)				100

Electronic Acknowledgement Receipt	
EFS ID:	24819707
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	04-FEB-2016
Filing Date:	17-APR-2014
Time Stamp:	12:18:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$100
RAM confirmation Number	11986
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	Response-Restrictive-Election.pdf	31615 0624864e9a9bb78525893d90013015856c4db671	no	7
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30611 1d8d86974887c4a3b28ca35f333d5ecb65e1d8f	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			62226		
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 14/254,957		Filing Date 04/17/2014		☐ To be Mailed				
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO													
APPLICATION AS FILED – PART I													
(Column 1)			(Column 2)										
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A							
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A							
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A							
TOTAL CLAIMS (37 CFR 1.16(j))		minus 20 =		*		X \$ =							
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		X \$ =							
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).											
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))													
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL							
APPLICATION AS AMENDED – PART II													
(Column 1)			(Column 2)			(Column 3)							
AMENDMENT	02/04/2016		CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))		* 18		Minus	** 20		= 0		X \$40 =		0	
	Independent (37 CFR 1.16(h))		* 3		Minus	***3		= 0		X \$210 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
	TOTAL ADD'L FEE											0	
(Column 1)			(Column 2)			(Column 3)							
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))		*		Minus	**		=		X \$ =			
	Independent (37 CFR 1.16(h))		*		Minus	***		=		X \$ =			
	☐ Application Size Fee (37 CFR 1.16(s))												
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))												
	TOTAL ADD'L FEE												
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>											<p>LIE /GLORIA NORRIS/</p>		

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908
32118 7590 02/29/2016 LAMBERT & ASSOCIATES 92 STATE STREET BOSTON, MA 02109-2004			EXAMINER YOO, REGINA M	
			ART UNIT 1799	PAPER NUMBER
			NOTIFICATION DATE 02/29/2016	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

lambert@lambertpatentlaw.com
shortell@lambertpatentlaw.com
connaughton@lambertpatentlaw.com

Office Action Summary	Application No. 14/254,957	Applicant(s) NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 2/4/16.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 16,18-20,22-25 and 27-35 is/are pending in the application.
5a) Of the above claim(s) 20,22-24,34 and 35 is/are withdrawn from consideration.
- 6) ☐ Claim(s) ____ is/are allowed.
- 7) ☒ Claim(s) 16,18,19,25, 27 and 31 is/are rejected.
- 8) ☒ Claim(s) 28-33 is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☐ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|--|
| 1) ☒ Notice of References Cited (PTO-892) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____ |
| 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date <u>4/17/2014</u> . | 4) ☐ Other: ____. |

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Election/Restrictions

2. Applicant's election without traverse of Specie A in the reply filed on 2/04/2016 is acknowledged.
3. Claims 34-35 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected specie, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 2/04/2016.

Claim Objections

4. The numbering of claims is not in accordance with 37 CFR 1.126 which requires the original numbering of the claims to be preserved throughout the prosecution. When claims are canceled, the remaining claims must not be renumbered. When new claims are presented, they must be numbered consecutively beginning with the number next following the highest numbered claims previously presented (whether entered or not).

Misnumbered claims 31-35 have been renumbered 32-36.

5. Claims 16, 18-19, 25, and 27-34 are objected to because of the following informalities:

- in line 1 of Claim 16, delete "Currently Amended" and insert --Previously Presented--;
- in line 3 of Claim 28, delete "cm2" and insert --cm²--
- in line 3 of Claim 29, delete "cm2" and insert --cm²--;
- in line 2 of Claim 30, delete "cm2" and insert --cm²--;
- in line 3 of Claim 31, delete "cm2" and insert --cm²--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

6. The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claim 18 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. It is not clear what the limitation "NUV" stands for and no explanation is given within the claims.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

9. Claims 16 and 18 are rejected under pre-AIA 35 U.S.C. 102(e) as being anticipated by Ressler (20050173652 in view of Provisional appl. No. 60/543,710).

Ressler ('652) discloses a process for destroying a microorganism on a substance or surface ((see entire document, particularly Abstract) comprising the steps of:

provide an NUV source (108) for generating photons;

generating photons (via 108) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm (see entire document, particularly p. 2 [0019] – particularly last 4 lines, p. 5 claim 2); and

directing the photons to the substance or surface to be disinfected (see entire document, particularly Abstract, p. 2 [0019]-[0021], p. 4 [0029]), whereby the photons of the UV light source 108 are intrinsically selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms (see entire document, particularly p. 2 [0019]).

10. Claims 16, 18-19, and 31 are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Sizer (5843374).

Sizer ('374) discloses a process for destroying a microorganism on a substance or surface (36) (see entire document, particularly Abstract) comprising the steps of:

provide/selecting an NUV source (20) for generating photons to produce an irradiance of approximately 100 mw/cm² or less (see entire document, particularly Col. 13 lines 41-43);

generating photons (via 20) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm (see entire document, particularly Col. 5 line 53 to Col. 6 line 11, Col. 6 lines 2-3, Col. 7 lines 37-40); and

directing the photons to the substance or surface to be disinfected by reflecting the photons to a desired surface (see entire document, particularly Abstract, Col. 3 lines 30-32, Col. 7 lines 21-27, Col. 7 line 66 to Col. 8 line 7), whereby the photons of the UV light source 20 are intrinsically selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms (see entire document, particularly Col. 7 lines 39-40).

Claim Rejections - 35 USC § 103

11. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
 2. Ascertaining the differences between the prior art and the claims at issue.
 3. Resolving the level of ordinary skill in the pertinent art.
 4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
12. Claim 25 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Benoit (20040238344) in view of Goswami (5933702).

Benoit ('344) discloses a process for providing a germ-free space comprising the steps of:

generating photons (via 14) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength at least one of 222 nm and 282 nm (see p. 1 [0022], p. 2 Table 1 – KrCl, XeBr); and

directing an air stream (12) to a source (14) of photons (see Figure 1);

removing particles from the air stream; and

directing a disinfected airflow (16) to an area (see Figure 1).

Benoit ('344) does not appear to specifically teach that the space is a surgical space or that the process comprises steps of removing particles from the air stream and directing the air stream vertically downward to the surgical area.

It was known in the art at the time of invention to provide a germ-free surgical space using steps such as removing particles from air stream and directing air stream downward to a space. Goswami ('702) discloses a process for providing a germ-free

surgical space (see entire document, particularly Col. 3 lines 36-38 and 40-41)

comprising the steps of:

generating photons (via 24; 98) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA (see Col. 9 lines 51-52, Col. 10 lines 25-26);

directing (via 18; 82, 84, 90) an air stream to a source (24; 98) of photons (see Figures 1, 3, and 7);

removing particles (via 12; 85) from the air stream (see Figures 1 and 7, Col. 10 lines 15-20); and

directing the air stream (see Col. 7 lines 5-7) to a surgical area (see Col. 3 lines 36-38), whereby a disinfected airflow surrounds the surgical space and prevents infected air from entering (see entire document, particularly Col. 3 lines 36-38 and 40-41),

in order to destroy microorganisms found in indoor air (see entire document, particularly Col. 3 lines 21-26).

It would have been obvious to one of ordinary skill in this art at the time of invention to provide step of removing particles from an air stream along with exposing the air to photons and directing the treated air stream in a surgical space in the method of Benoit in order to provide a high degree of purification and ensure sterility of air in a critical/sensitive space as shown by Goswami.

While Goswami ('702) does not appear to specifically teach that the air is directed vertically downward, Goswami ('702) teaches that the air may be directed

vertically downward (see entire document, particularly Col. 3 lines 1-15), and thus, it would have been obvious to and well within the purview of one of ordinary skill that disinfected air flowing from a room register includes a flow pattern of vertically downward as a known air flow pattern. Only the expected results would be attained.

Thus, Claim 25 would have been obvious within the meaning of 35 U.S.C. 103(a) over the combined teachings of Benoit ('344) and Goswami ('702).

13. Claim 27 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Ressler (20050173652 in view of Provisional appl. No. 60/543,710) or Sizer (5843374) as applied to claim 16 above, and further in view of Lembersky (20050205206).

Ressler ('652) is relied upon for disclosure described in the rejection of claim 16 under 35 U.S.C. 102(e).

Sizer ('374) is relied upon for disclosure described in the rejection of claim 16 under 35 U.S.C. 102(b).

Neither Ressler ('652) or Sizer ('374) appears to specifically teach that the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected. However, it was known in the art at the time of invention that photons with wavelength of 222 nm provides 540 kJ/mole of photon energy. Lembersky ('206) discloses that photons generated from KrCl with wavelength of 222 nm is equivalent to the energy of about 540 kJ/mole (see entire document, particularly p. 13 [0195] – last 3 lines). It would have been well within the purview and obvious to one of ordinary skill in this art at the time of invention that the

photons generated by the UV source utilizing KrCl at wavelength of 222 nm in the method of Ressler and Sizer would intrinsically provide 540 kJ/mole of photon energy to the substance or surface to be disinfected. Only the expected results would be attained.

Thus, Claim 27 would have been obvious within the meaning of 35 U.S.C. 103(a) over the combined teachings of Ressler ('652) or Sizer ('374) and Lembersky ('206).

Allowable Subject Matter

14. Claims 28-30 and 32-34 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The following references relate either to the field of the invention or subject matter of the invention, but are not relied upon in the rejection of record: 20030188740, 6160835, 6770069, 6165170, 5647890, 6063170, 20020089275, 6673137, 20020177118, 20050118078, 20030170151.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to REGINA M. YOO whose telephone number is (571)272-6690. The examiner can normally be reached on M-F 10:30 am - 7 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Marcheschi can be reached on 571-272-1374. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/REGINA M YOO/
Primary Examiner, Art Unit 1799

Notice of References Cited	Application/Control No. 14/254,957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	Page 1 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-5,647,890 A	07-1997	Yamamoto; Yujiro	B03C3/155	95/69
*	B	US-5,843,374 A	12-1998	Sizer; Charles	A23L3/28	422/24
*	C	US-5,933,702 A	08-1999	Goswami; D. Yogi	A61L9/205	422/186.3
*	D	US-6,063,170 A	05-2000	Deibert; Ronald H.	A61L9/015	261/80
*	E	US-6,160,835 A	12-2000	Kwon; Young Key	B23K26/06	219/121.68
*	F	US-6,165,170 A	12-2000	Wynne; James Jeffrey	A61B18/203	606/10
*	G	US-2002/0089275 A1	07-2002	Falkenstein, Zoran	A61L2/10	313/29
*	H	US-2002/0177118 A1	11-2002	Coogan, John J. JR.	A61M1/3681	435/2
*	I	US-2003/0170151 A1	09-2003	Hunter, Charles Eric	A61L2/10	422/186.3
*	J	US-2003/0188740 A1	10-2003	Tribelsky, Zamir	C02F9/00	128/200.14
*	K	US-6,673,137 B1	01-2004	Wen; Sheree H.	A61L9/015	422/121
*	L	US-6,770,069 B1	08-2004	Hobart; James L.	A61B18/203	128/898
*	M	US-2004/0238344 A1	12-2004	Benoit, Jeffrey T.	A61L9/20	204/157.3

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Provisional Application 60/543,710, 2/11/2004
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Notice of References Cited	Application/Control No. 14/254,957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	Page 2 of 2

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2005/0118078 A1	06-2005	Dobbs, Gregory M.	B01D53/885	422/186.3
*	B	US-2005/0173652 A1	08-2005	Ressler, Barry	A23B4/015	250/455.11
*	C	US-2005/0205206 A1	09-2005	Lembersky, Robert	A61L2/0011	156/345.5
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	W	
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Search Notes 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

CPC- SEARCHED		
Symbol	Date	Examiner
A61L 2/10, 2/0011, 9/20	2/23/2016	RY
A23L 3/28	2/23/2016	RY
A23B 7/015	2/23/2016	RY
B08B 17/00	2/23/2016	RY

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (US-PGPUB, USPAT, USOCR, FPRS, EPO, JPO, DERWENT, IBM_TDB) - See Search History Printout	2/24/2016	RY
EAST - Inventor Search neister-s-edward	2/22/2016	RY
PALM - Inventor Search	2/22/2016	RY

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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Receipt date: 04/17/2014

14254957 -- GAU: 1799

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 07/31/2012. OMB 0851-0031

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
/R.M.Y/	1	4317041		1982-02-23	Schenck	
	2	5843374		1998-12-01	Sizer et al.	
	3	6099799		2000-08-08	Anderson	
	4	7326387		2008-02-05	Arts et al.	
	5	5364645		1994-11-15	Lagunas-Solar, et al.	
	6	5753106		1998-05-19	Schenck	
	7	4458153		1984-07-03	Wesley	
/R.M.Y/	8	4524079		1985-06-18	Hofmann	

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	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

/R.M.Y/	9	5750072		1998-05-12	Sangster et al.	
	10	6235090		2001-05-22	Bernstein et al.	
	11	5492676		1996-02-20	Katatani et al.	
	12	3672126		1972-06-27	Goettle	
	13	5505904		1996-04-09	Haidinger et al.	
	14	5993738		1999-11-30	Goswani	
/R.M.Y/	15	6149717		2000-11-21	Satyapal et al.	

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/R.M.Y/	1	20060188835		2006-08-24	Nagel et al.	
/R.M.Y/	2	20040166018		2004-08-26	Clark et al.	

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number		
Filing Date		
First Named Inventor	S. Edward Neister	
Art Unit		
Examiner Name		
Attorney Docket Number	14-016-EN	

/R.M.Y/	3	20070045561		2007-03-01	Cooper	
/R.M.Y/	4	20040120846		2004-06-24	Bates et al.	
/R.M.Y/	5	20040120850		2004-06-24	Kaiser	
/R.M.Y/	6	20050173652		2005-08-11	Ressler	
/R.M.Y/	7	20050186108		2005-08-25	Fields	

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
/R.M.Y/	1	2139811Y	CN		1993-08-11	HONG YONGFENG		☐
/R.M.Y/	2	2604181Y	CN		2004-02-25	LIU GANG		☐
/R.M.Y/	3	2662909Y	CN		2004-12-15	UNIV JILIN		☐
	4	2005001398	WO		2005-07-07	Marine Environmental Partners, Inc. et al.		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

/R.M.Y/	5	2003207165	JP		2003-07-25	Sanyo Electric Co. Ltd.		☐
/R.M.Y/	6	20040097758	KR		2004-11-18	Modine Korea, LLC		☐
/R.M.Y/	7	0023552	WO		2000-05-10	Clean Earth Technologies, LLC		☐
/R.M.Y/	8	0238447	WO		2002-05-16	Tribelsky et al.		☐
/R.M.Y/	9	0245756	WO		2002-06-13	Tribelsky et al.		☐
/R.M.Y/	10	02078754	WO		2002-10-10	L2B Environmental Systems, Inc.		☐
	11	10-071192	JP		1998-03-17	Takashi et al.		☐
	12	2002-010041	JP		2002-10-29	Hirimitsu et al.		☐
/R.M.Y/	13	2005/061396 A1	WO		2005-07-07	Leffler et al		☐
	14	2005/081338 A1	WO		2005-09-01	BORMET		☐
	15	2007/084145 A2	WO		2007-07-26	Neister		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	S. Edward Neister	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	14-016-EN	

	16	2007-522043	JP		2007-08-16			☐

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EXAMINER SIGNATURE

Examiner Signature	/REGINA M YOO/	Date Considered	02/21/2016
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Receipt date: 04/17/2014

14254957 - GAU: 1799

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number			
Filing Date			
First Named Inventor	S. Edward Neister		
Art Unit			
Examiner Name			
Attorney Docket Number		14-016-EN	

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2014-04-03
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	22	("20040120846" "20040120850" "20040166018" "20050173652" "20050186108" "20060188835" "20070045561" "3672126" "4317041" "4458153" "4524079" "5364645" "5492676" "5505904" "5750072" "5753106" "5843374" "5993738" "6099799" "6149717" "6235090" "7326387").PN.	US-PGPUB; USPAT	OR	OFF	2016/02/22 09:13
S2	3	S1 and UV and ("222 nm" or "282 nm")	US-PGPUB; USPAT	OR	OFF	2016/02/22 09:23
S3	13	S1 and UV and wavelength	US-PGPUB; USPAT	OR	OFF	2016/02/22 09:45
S4	13	S1 and UV and wavelength and ("nm" or nanometer)	US-PGPUB; USPAT	OR	OFF	2016/02/22 09:47
S5	16	neister-s-edward.in.	US-PGPUB; USPAT	OR	OFF	2016/02/22 11:25
S6	5	S5 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm")).clm.	US-PGPUB; USPAT	OR	OFF	2016/02/22 11:26
S7	0	S5 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and microorganisms).clm.	US-PGPUB; USPAT	OR	OFF	2016/02/22 11:26
S8	4	S5 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA)).clm.	US-PGPUB; USPAT	OR	OFF	2016/02/22 11:26
S9	1	S5 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying).clm.	US-PGPUB; USPAT	OR	OFF	2016/02/22 11:27
S10	22	("20040120846" "20040120850" "20040166018" "20050173652" "20050186108" "20060188835" "20070045561" "3672126" "4317041" "4458153" "4524079" "5364645" "5492676" "5505904" "5750072" "5753106" "5843374" "5993738" "6099799" "6149717" "6235090" "7326387").PN.	US-PGPUB; USPAT	OR	OFF	2016/02/22 13:51
S11	9	S10 and UV and wavelength and ("nm" or nanometer) and reflect\$	US-PGPUB; USPAT	OR	OFF	2016/02/22 13:51
S12	22	("20040120846" "20040120850" "20040166018" "20050173652" "20050186108" "20060188835" "20070045561" "3672126" "4317041"	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:15

		"4458153" "4524079" "5364645" "5492676" "5505904" "5750072" "5753106" "5843374" "5993738" "6099799" "6149717" "6235090" "7326387").PN.				
S13	10	S12 and UV and ("nm" or nanometer) and air	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:15
S14	2	S12 and air and ("222 nm" or "282 nm")	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:27
S15	1152	UV and air and ("222 nm" or "282 nm")	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:33
S16	305	UV and air and ("222 nm" or "282 nm") and (steriliz\$ or disinfect or decontaminat\$)	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:34
S17	453	UV and air and ("222 nm" or "282 nm") and (steriliz\$ or disinfect or decontaminat\$ or clean)	US-PGPUB; USPAT	OR	OFF	2016/02/22 17:34
S18	21	("20040120846" "20040120850" "20040166018" "20050173652" "20060188835" "20070045561" "3672126" "4317041" "4458153" "4524079" "5364645" "5492676" "5505904" "5750072" "5753106" "5843374" "5993738" "6099799" "6149717" "6235090" "7326387").PN. OR ("8753575").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2016/02/22 18:33
S19	38	UV and ("222 nm" or "282 nm") and (air with (steriliz\$ or disinfect or decontaminat\$ or clean))	US-PGPUB; USPAT	OR	OFF	2016/02/23 09:53
S20	0	UV and ("222 nm" or "282 nm") and (HVAC with (steriliz\$ or disinfect or decontaminat\$ or clean))	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:07
S21	1	UV and ("222 nm" or "282 nm") and HVAC and(steriliz\$ or disinfect or decontaminat\$ or clean)	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:07
S22	1	UV and ("222 nm" or "282 nm" or (("222" or "282") with (nm or nanometer))) and HVAC and(steriliz\$ or disinfect or decontaminat\$ or clean)	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:08
S23	991	UV and HVAC and(steriliz\$ or disinfect or decontaminat\$ or clean)	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:09
S24	991	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean)	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:09
S25	372	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:09
S26	16	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and excimer	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:10
S27	10	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and excimer and filter	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:19
S28	1471	UV and air and room and (steriliz\$ or disinfect	US-	OR	OFF	2016/02/23

		or decontaminat\$ or clean) and wavelength and excimer and filter	PGPUB; USPAT			10:36
S29	206	UV and (air with room) and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and excimer and filter	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:36
S30	2837	UV and (air with room) and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and filter	US-PGPUB; USPAT	OR	OFF	2016/02/23 10:43
S31	1421	UV and (air with room) and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and filter and laser	US-PGPUB; USPAT	OR	OFF	2016/02/23 11:08
S32	0	UV and (air with room) and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and filter and (laser with "KrCl")	US-PGPUB; USPAT	OR	OFF	2016/02/23 11:08
S33	14	UV and (air with room) and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and filter and ("KrCl")	US-PGPUB; USPAT	OR	OFF	2016/02/23 11:08
S34	2400	A61L2/10.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:39
S35	9	S34 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:40
S36	13	S34 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:53
S37	888	A61L2/0011.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:55
S38	3	S37 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:56
S39	3	S37 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:56
S40	791	A61L9/20.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 13:56
S41	7	S40 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:00
S42	7	S40 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:02
S43	326	A23L3/28.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:08
S44	5	S43 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:08
S45	5	S43 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:25
S46	128	A23B7/015.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:27
S47	4	S46 and (photons and wavelength and ("222	US-	OR	OFF	2016/02/23

		nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	PGPUB; USPAT			14:28
S48	4	S46 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:28
S49	388	B08B17/00.cpc.	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:28
S50	3	S49 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm") and (DNA or RNA) and destroying)	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:28
S51	3	S49 and (photons and wavelength and ("222 nm" or "282 nm" or "222nm" or "282nm"))	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:29
S52	20	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("operating room" or "operating theater" or "surgical suite" or "surgical room") and filter	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:38
S53	0	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("operating room" or "operating theater" or "surgical suite" or "surgical room") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:38
S54	5	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("operating room" or "operating theater" or "surgical suite" or "surgical room") and filter and laser	US-PGPUB; USPAT	OR	OFF	2016/02/23 14:39
S55	62	("1891256" "20010043887" "3230033" "3478758" "3817703" "3915180" "3926556" "4207286" "4468372" "4513470" "4536914" "4542557" "4577365" "4591485" "4610048" "4836684" "4924548" "5120499" "5244629" "5320805" "5364645" "5492882" "5589396" "5593476" "5647890" "5651811" "5656063" "5725623" "5779769" "5927304" "5944873" "6029712" "6056808" "6063170" "6094775" "6171375" "6190437" "6203600" "6295692" "6296692" "6333004" "6434785" "6468433").PN. OR ("6673137").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2016/02/23 17:56
S56	230	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and filter	US-PGPUB; USPAT	OR	OFF	2016/02/23 21:24
S57	298	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg)	US-PGPUB; USPAT	OR	OFF	2016/02/23 21:24
S58	1	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/23 21:24
S59	13	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and excimer	US-PGPUB; USPAT	OR	OFF	2016/02/23 21:35

S60	9	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and excimer and laser	US-PGPUB; USPAT	OR	OFF	2016/02/23 21:54
S61	24497	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and filter	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:33
S62	2101	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and filter and excimer	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:34
S63	1502	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and filter and "excimer laser"	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:34
S64	2520	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and "excimer laser"	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:34
S65	52	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and "excimer laser" and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:35
S66	380	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (skin or human or hand or arm or leg) and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:43
S67	39	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and (human with (skin or hand or arm or leg)) and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:58
S68	63	UV and wavelength and (human with (skin or hand or arm or leg)) and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 08:58
S69	2376	UV and wavelength and (human with (skin or hand or arm or leg)) and pulsed	US-PGPUB; USPAT	OR	OFF	2016/02/24 09:03
S70	271	UV and wavelength and (human with (skin or hand or arm or leg)) and pulsed and excimer	US-PGPUB; USPAT	OR	OFF	2016/02/24 09:04
S71	4	UV and wavelength and (human with (skin or hand or arm or leg)) and pulsed and excimer and "KrCl"	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:11
S72	4	UV and wavelength and (human with (skin or hand or arm or leg)) and pulsed and excimer and "KrCl"	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:11
S73	0	UV and HVAC and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("0.1 s" or "0.1 second") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:37
S74	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("0.1 s" or "0.1 second") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:37

S75	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("0.1 s" or "0.1 second") and filter and ("excimer laser" with KrCl)	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:37
S76	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("40 mJ/cm2" or "40 mJ/cm.sub.2") and filter and ("excimer laser" with KrCl)	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:52
S77	1	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("40 mJ/cm2" or "40 mJ/cm.sub.2") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:52
S78	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("60 mJ/cm2" or "60 mJ/cm.sub.2") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:53
S79	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("60 mJ/cm2" or "60 mJ/cm.sub.2") and filter and ("excimer laser" with KrCl)	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:53
S80	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("10 mJ/cm2" or "10 mJ/cm.sub.2") and filter and ("222 nm" or "282 nm" or "222nm" or "282nm")	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:54
S81	0	UV and (steriliz\$ or disinfect or decontaminat\$ or clean) and wavelength and ("10 mJ/cm2" or "10 mJ/cm.sub.2") and filter and ("excimer laser" with KrCl)	US-PGPUB; USPAT	OR	OFF	2016/02/24 10:54

EAST Search History (Interference)

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2/ 24/ 2016 11:41:48 AM**C:\ Users\ ryoo\ Documents\ EAST\ Workspaces\ 14254957 on 022216b.wsp**



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BIB DATA SHEET

CONFIRMATION NO. 7908

SERIAL NUMBER 14/254,957	FILING or 371(c) DATE 04/17/2014 RULE	CLASS 422	GROUP ART UNIT 1799	ATTORNEY DOCKET NO. 14-016-EN		
APPLICANTS INVENTORS S. Edward Neister, Dover, NH; ** CONTINUING DATA ***** This application is a CIP of 11/831,667 07/31/2007 PAT 8753575 which is a CIP of PCT/US2006/003393 01/31/2006 RY which claims benefit of 60/593,626 01/31/2005 ** FOREIGN APPLICATIONS ***** None RY ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 05/02/2014						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /REGINA M YOO/ Acknowledged Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY NH	SHEETS DRAWINGS 10	TOTAL CLAIMS 18	INDEPENDENT CLAIMS 3
ADDRESS LAMBERT & ASSOCIATES 92 STATE STREET BOSTON, MA 02109-2004 UNITED STATES						
TITLE METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION						
FILING FEE RECEIVED 730	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:			☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

<i>Index of Claims</i> 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant				☐ CPA				☐ T.D.				☐ R.1.47			
CLAIM		DATE													
Final	Original	11/02/2015	02/24/2016												
	1	-	-												
	2	-	-												
	3	-	-												
	4	-	-												
	5	-	-												
	6	-	-												
	7	-	-												
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	15	-	-												
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	17	-	-												
	18	÷	✓												
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	25	÷	✓												
	26	-	-												
	27	÷	✓												
	28	÷	O												
	29	÷	O												
	30	÷	O												
	31	÷	✓												
	31	÷	O												
	32	÷	O												
	33	÷	O												
	34	÷	N												
	35	÷	N												

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
 Stylesheet Version v1.2

EPAS ID: PAT3933987

SUBMISSION TYPE:	NEW ASSIGNMENT	
NATURE OF CONVEYANCE:	DISCHARGE/RELEASE OF ATTACHMENT AND ASSIGNMENT	
CONVEYING PARTY DATA		
Name		Execution Date
RICHARD CASALE		06/20/2016
RECEIVING PARTY DATA		
Name:	S. EDWARD NEISTER	
Street Address:	30 CENTRE ROAD	
Internal Address:	SUITE 6	
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Street Address:	273-B LOCUST STREET	
City:	DOVER	
State/Country:	NEW HAMPSHIRE	
Postal Code:	03820	
PROPERTY NUMBERS Total: 4		
Property Type	Number	
Patent Number:	8753575	
Patent Number:	8481985	
Patent Number:	8975605	
Application Number:	14254957	
CORRESPONDENCE DATA		
Fax Number:	(617)720-0091	
<i>Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.</i>		
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NAME OF SUBMITTER:	DAVID J. CONNAUGHTON, JR.
SIGNATURE:	/David J. Connaughton, Jr./
DATE SIGNED:	06/24/2016
	This document serves as an Oath/Declaration (37 CFR 1.63).
Total Attachments: 1 source=DISCHARGE-RELEASE OF ATTACHMENT & ASSIGNMENT#page1.tif	

Return to:
S. Edward Nicotri
c/o James D. Kelly, Esq.
Kelly Law PLLC
16 Bond Street
Nashua, NH 03064
Telephone: 603-899-4230

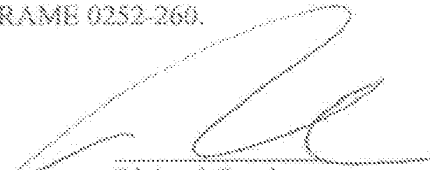
DISCHARGE/RELEASE OF ATTACHMENT & ASSIGNMENT

For value received, Richard Casale, of 55 Hermit Road, Alton Bay, NH 03810 hereby discharges
the attachment granted to him by Belknap County Superior Court Order on July 10, 2015 and;
Discharges and releases the Attachments/Assignment, to:

1. Patent/Publication Number US 8,753,575 with Serial Number 11/831,667.
2. Patent/Publication Number US 2014-0227132 with Serial Number 14/254,957.
3. Patent/Publication Number US 8,481,985 with Serial Number 13/145,663.
4. Patent/Publication Number US 8,975,605 with Serial Number 13/936,306.

Recorded at U.S. Patent and Trademark Office as a New Assignment on July 28, 2015 as docket
503411774, at PATENT REEL: 036201 FRAME 0252-260.

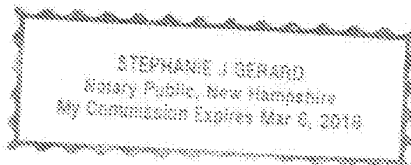
June 20, 2016


Richard Casale

THE STATE OF NEW HAMPSHIRE
COUNTY OF Belknap

The foregoing Discharge was acknowledged before me this 20th day of June, 2016 by Richard
Casale.


Notary Public/Judge of the Peace
My commission expires: 03/06/2018



UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.: 14/254,957

Applicant: S. Edward Neisler

Art Unit: 1799

Filed: April 17, 2014

Examiner: Yoo, Regina M.

Lambert & Associates
92 State Street
Boston, MA 02109

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT IN RESPONSE TO FEBRUARY 29, 2016 OFFICE ACTION

This is a response to the Office Action issued on February 29, 2016 by the U.S. Patent and Trademark Office in connection with the above-identified application. With a two month extension of time, requested herein, a response July 29, 2016. Accordingly, this response is being timely filed.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1-15. (Canceled).

16. (Currently Amended) A process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm; [[and]]

directing the photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms; and

wherein the surface to be disinfected is human or animal skin.

17. (Canceled).

18. (Currently Amended) The process of claim 16 further comprising the step of providing an ~~NUV~~ new ultra violet source for generating the photons.

19. (Original) The process of claim 16 wherein the directing step is performed by reflecting the photons to a desired surface.

20-24. (Canceled).

25. (Currently Amended) A process for providing a germ-free surgical space comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

directing an air stream to a source of photons;

exposing the air stream to the generated photons;
removing particles from the air stream; and
directing the air stream vertically downward to a surgical area, whereby a disinfected airflow created after exposure to the generated photons surrounds the surgical ~~space~~ area, forming a surgical space and prevents infected air from entering the surgical space.

26. (Canceled).

27. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected.

28. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 40 mJ/cm² to the substance or surface to be disinfected.

29. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 60 mJ/cm² to the substance or surface to be disinfected.

30. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises providing a radiant dose energy of 10 mJ/cm² to the substance or surface to be disinfected.

31. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, the source for generating the photons selected to produce an irradiance of approximately 100 mw/cm² or less.

32. (Canceled).

33. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises exposing the substance or surface to be disinfected to the generated photons for less than 0.1 second.

34. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, wherein the source for generating photons is a hand held lamp, and wherein the step of directing the photons further comprises the step of waving the hand held lamp over the surface or substance to be disinfected, exposing the surface or substance to the generated photons for approximately 0.1 second or less.

35.-36 (Canceled).

37. (New) A process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of:

generating photons of at least two single line wavelengths corresponding to a peak absorption wavelength of DNA or RNA, the at least two wavelengths being at least two of 222nm, 254 and 282nm; and

directing the photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms.

38. (New) The process of claim 16 wherein the at least one wavelength is 222 nm and wherein the step of generating photons further comprises generating photons at a wavelength of 207 nm.

Remarks

Applicant thanks the Office for the attention accorded to the present application in the February 29, 2016 Office Action. Claims 16, 18-20, 22-25 and 27-35 were pending in the subject application.

Without prejudice or disclaimer, Applicant has herein amended claims 16, 18, and 25, cancelled claims 20-24, 32, and 35-36 and added claims 37 and 38. Upon entry of this amendment, claims 16, 18-19, 25, 27-31, 33-34 and 37-38 will be pending in the present application.

The amendments to the claims are primarily to correct matters of form and/or clarity in response to the Office's recommendation. Applicant asserts that all claims are supported in the specification as originally filed. No new matter has been added. Support for new claim 37 can be found at, for example, original claim 17 in the application as filed, as well as at page three, second and third paragraphs of the summary. Support for new claim 38 can be found at, for example, page 11, first full paragraph.

The claim amendments and cancellations made herein are made solely to expedite prosecution of the instant application, and should not be construed as acquiescence to the Office's rejections. Applicant reserves the right to pursue the cancelled and/or non-elected subject matter in one or more divisional or continuation applications.

Applicant respectfully traverses all rejections and asserts that the claims are now in condition for allowance.

Rejection based 35 U.S.C. §112, Second Paragraph

In the present Office Action, the Examiner rejected claim 18 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. In response, Applicant has herein amended claim 18 to clarify the invention contemplated therein. As such, Applicant respectfully asserts that the 35 U.S.C. 112 rejections are now moot, and Applicant respectfully requests that the Examiner remove the rejection.

35 U.S.C. 102 Rejections

In the present Office Action, the Examiner rejected claims 16 and 18 under 35 U.S.C. 102(b) as being anticipated by Ressler (20050173652 in view of Provisional appl. No. 60/543,710). Without prejudice or disclaimer, Applicant has amended claim 16 to now include allowable claim 32. As such, Applicant respectfully asserts that the 35 U.S.C. 102(b) rejection based on Ressler is overcome, and respectfully requests that the Examiner remove this rejection.

In the present Office Action, the Examiner rejected claims 16, 18-19, and 31 under 35 U.S.C. 102(b) as being anticipated by Sizer (5843374). Without prejudice or disclaimer, Applicant has amended claim 16 to now include allowable claim 32. As such, Applicant respectfully asserts that the 35 U.S.C. 102(b) rejection based on Sizer is overcome, and respectfully requests that the Examiner remove this rejection.

Rejections under 35 U.S.C. § 103(a)

The Examiner has rejected claim 25 under 35 U.S.C. 103(a) as being unpatentable over Benoit (20040238344) in view of Goswami (5933702).

Without prejudice or disclaimer, Applicant has amended claim 25, to clarify the operation of the process claimed. The combination of Benoit and Goswami does not teach the creation of an air space that is filled with disinfected air flow which prevents entry of infected air. The invention claimed in claim 25 utilizes a flow disinfected air directed specifically at a particular area (the surgical space) that is at a higher pressure than surrounding air. This air flow directed downward is necessarily at a higher pressure than the surrounding atmosphere because otherwise it would not be directed and would not flow to create the claimed disinfected air space. A result of this higher pressure is that infected air does not immediately enter until the air is mixed once dissipated outside of the surgical space. In the surgical space immediately about the surgical area (see Figs. 6 and 7), infected air does not enter, because there is a continuous flow of higher pressure disinfected air. An embodiment of the flow profile is demonstrated in the computational fluidic design of Fig. 7 of a flow claimed that ensures that the air in the operation zone is uniform in flow and prohibits contaminated air from entering the protected zone

By contrast, the combination of Benoit and Goswami does not create such an air space, and does not render the claimed invention obvious. Primarily, Goswami does not teach directing the air stream vertically downward to form a surgical space of disinfected air that prevents entry of infected air, as required by the claim. Goswami merely teaches the circulation and dissipation of air that is disinfected when passed through the circulation device. The air of Goswami is immediately mixed with the existing room air and is not directed to any particular surface or area to create a zone of disinfected air in that particular

area. It would not be obvious to modify Goswami in this way because the desired result of Goswami is a mixed air which is the opposite of what is claimed.

For example, Examiner notes at page 8 of the present office action that it would be obvious to direct air downward from a room register. However, it is well known that such ceiling mounted room registers have a number of baffles that direct outgoing air in multiple different directions for the purpose of dissipating the air throughout the room. This is the goal of Goswami and what is taught therein. The claimed invention operates in the opposite manner to the combination of Benoit and Goswami. It directs air downward in an air stream such that it surrounds a surgical space, forming a surgical area that has a flow profile and pressure zone that prevents entry of the surrounding infected air. This functional and structural distinction between the invention of claim 25 is not rendered obvious based on the combination of Benoit and Goswami.

Applicant further notes that it does not appear that the step of claim 25 of removing particles from the air stream is taught by the prior art. Applicant respectfully notes that this lack of teaching would not be obvious in the combination of Benoit and Goswami.

Therefore, the combination of references does not establish a *prima facie* case of obviousness under 35 U.S.C. 103(a). Thus, Applicant respectfully asserts that claim 25 is now patentably distinguished from Benoit and Goswami. Applicant further asserts that Claim 25 is now in condition for allowance.

The Examiner has rejected claim 27 under 35 U.S.C. 103(a) as being unpatentable over Ressler (20050173652 in view of Provisional appl. No. 60/543,710) or Sizer (5843374) as applied to claim 16 above, and further in view of Lembersky (20050205206).

Without prejudice or disclaimer, Applicant has amended claim 16, from which claim 27 depends, as discussed above. The addition of Lembersky does not teach the elements of claim 16 that are missing from Ressler and Sizer. Therefore, the combination of references does not establish a prima facie case of obviousness under 35 U.S.C. 103(a).

Thus, Applicant respectfully asserts that claim 27 is now patentably distinguished from Ressler or Sizer and Lembersky. Applicant further asserts that this claim is now in condition for allowance.

Comments on Newly Added Claims

Applicant has herein added independent claim 37, which is similar to claim 16, but which requires two wavelengths of 222, 254, and 282 nm. Applicant respectfully asserts that the prior art does not teach the exposure of a substance or surface to two single line wavelengths selected from this group as claimed. Accordingly, Applicant respectfully asserts that this claim is in condition for allowance.

Conclusion

Applicant again thanks the Office for the attention accorded to the present Application in the February 29, 2016 office action. Applicant has herein amended claims amended claims 16, 18, and 25, cancelled claims 20-24, 32, and 35-36 and added claims 37 and 38. Applicant asserts that based on the amendments and comments presented herein, all of the pending claims are in condition for allowance. Early and favorable action is respectfully requested.

The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

Respectfully submitted,

/David J. Connaughton, Jr./
David J. Connaughton, Jr.
USPTO Reg. #67275
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92 State Street
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(617) 720-0091

Electronic Patent Application Fee Transmittal				
Application Number:		14254957		
Filing Date:		17-Apr-2014		
Title of Invention:		METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		
First Named Inventor/Applicant Name:		S. Edward Neister		
Filer:		Gary Ervery Lambert		
Attorney Docket Number:		14-016-EN		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension - 2 months with \$0 paid	2252	1	300	300
Miscellaneous:				
Total in USD (\$)				300

Electronic Acknowledgement Receipt	
EFS ID:	26495961
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	29-JUL-2016
Filing Date:	17-APR-2014
Time Stamp:	14:49:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$ 300
RAM confirmation Number	1109
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response-Non-FinalOA-7-29-16.pdf	49999	yes	10
			164e0b1ff6a4e680d8373d3677cfae98a288077f		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	4	
	Applicant Arguments/Remarks Made in an Amendment		5	10	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30710	no	2
			6fbcd037c4a551e3dd1840b3a3e595e176d3fe35		
Warnings:					
Information:					
Total Files Size (in bytes):			80709		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 14/254,957		Filing Date 04/17/2014		☐ To be Mailed	
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO									
APPLICATION AS FILED – PART I									
		(Column 1)		(Column 2)					
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)	
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A			
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A			
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A			
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =		*		X \$ =			
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =		*		X \$ =			
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL			
APPLICATION AS AMENDED – PART II									
		(Column 1)		(Column 2)		(Column 3)			
AMENDMENT	07/29/2016		CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		
	Total (37 CFR 1.16(i))		* 13		Minus	** 20	= 0		
	Independent (37 CFR 1.16(h))		* 3		Minus	*** 3	= 0		
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE		0	
		(Column 1)		(Column 2)		(Column 3)			
AMENDMENT			CLAIMS REMAINING AFTER AMENDMENT			HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		
	Total (37 CFR 1.16(i))		*		Minus	**	=		
	Independent (37 CFR 1.16(h))		*		Minus	***	=		
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE			
<p>* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.</p> <p>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".</p> <p>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".</p> <p>The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.</p>									

LIE
CAROL BARNES

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

U.S. PATENTS							Remove	
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1							
If you wish to add additional U.S. Patent citation information please click the Add button.							Add	
U.S. PATENT APPLICATION PUBLICATIONS							Remove	
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1	20070102280		2007-05-10	Hunter et al.			
If you wish to add additional U.S. Published Application citation information please click the Add button.							Add	
FOREIGN PATENT DOCUMENTS							Remove	
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							
If you wish to add additional Foreign Patent Document citation information please click the Add button.							Add	
NON-PATENT LITERATURE DOCUMENTS							Remove	
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.						T ⁵

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

1	
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If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2016-08-01
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt	
EFS ID:	26525156
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	02-AUG-2016
Filing Date:	17-APR-2014
Time Stamp:	16:42:21
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_2.pdf	611937	no	4
			c93e3066ff919a1cf6b5d13008056b60f6fadc		

Warnings:

Information:	
Total Files Size (in bytes):	611937
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

U.S. PATENTS							Remove	
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1							
If you wish to add additional U.S. Patent citation information please click the Add button.							Add	
U.S. PATENT APPLICATION PUBLICATIONS							Remove	
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1	20070102280		2007-05-10	Hunter et al.			
If you wish to add additional U.S. Published Application citation information please click the Add button.							Add	
FOREIGN PATENT DOCUMENTS							Remove	
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ² i	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							
If you wish to add additional Foreign Patent Document citation information please click the Add button.								Add
NON-PATENT LITERATURE DOCUMENTS								Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.						T ⁵

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

1	
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If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

CERTIFICATION STATEMENT

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That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2016-08-01
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt	
EFS ID:	26729378
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	24-AUG-2016
Filing Date:	17-APR-2014
Time Stamp:	08:51:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_2.pdf	611937	no	4
			c93e3066ff919a1cf6b5d13008056b60f6fadc		

Warnings:

Information:	
Total Files Size (in bytes):	611937
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908
32118 7590 10/28/2016 LAMBERT & ASSOCIATES 92 STATE STREET BOSTON, MA 02109-2004			EXAMINER YOO, REGINA M	
			ART UNIT 1799	PAPER NUMBER
			NOTIFICATION DATE 10/28/2016	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

lambert@lambertpatentlaw.com
shortell@lambertpatentlaw.com
connaughton@lambertpatentlaw.com

Office Action Summary	Application No. 14/254,957	Applicant(s) NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 7/29/2016.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.
- 4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

- 5) ☒ Claim(s) 16,18,19,25,27-31,33,34,37 and 38 is/are pending in the application.
5a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 6) ☒ Claim(s) 16,18,19,27-31,33,34,37 and 38 is/are allowed.
- 7) ☒ Claim(s) 25 is/are rejected.
- 8) ☒ Claim(s) 16,18,19,27-31,33,34,37 and 38 is/are objected to.
- 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

- 10) ☒ The specification is objected to by the Examiner.
- 11) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some** c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|--|
| 1) ☐ Notice of References Cited (PTO-892) | 3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____ |
| 2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date <u>8/02/16, 8/24/16</u> | 4) ☐ Other: ____ |

1. The present application is being examined under the pre-AIA first to invent provisions.

FINAL ACTION

Response to Amendment

The amendment filed on 7/29/2016 has been received and claims 16, 18-19, 25, 27-31, 33-34, and 37-38 are pending.

Specification

2. The abstract of the disclosure is objected to because in line 6 of Abstract, delete "cists" and insert --cysts--. Correction is required. See MPEP § 608.01(b).

Claim Objections

3. Claims 16, 18-19, 27-31, 33-34, and 37-38 are objected to because of the following informalities:

- in line 9 of Claim 16, insert --substance or-- before "surface";
- in line 4 of Claim 37, insert --single line-- between "two" and "wavelengths";
- in line 5 of Claim 37, insert --nm-- after "254".

Appropriate correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claim 25 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Benoit (20040238344) in view of Goswami (5933702).

Benoit ('344) discloses a process for providing a germ-free space comprising the steps of:

generating photons (via 14) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength at least one of 222 nm and 282 nm (see p. 1 [0022], p. 2 Table 1 – KrCl, XeBr); and

directing an air stream (12) to a source (14) of photons (see Figure 1);

exposing the air stream (12) to the generated photons (see Figure 1, p. 1 [0020]);
and

directing a disinfected airflow (16) to an area (see Figure 1).

Benoit ('344) does not appear to specifically teach that the space is a surgical space or that the process comprises steps of removing particles from the air stream and directing the air stream vertically downward to the surgical area.

It was known in the art at the time of invention to provide a germ-free surgical space using steps such as removing particles from air stream and directing air stream downward to a space. Goswami ('702) discloses a process for providing a germ-free surgical space (see entire document, particularly Col. 3 lines 36-38 and 40-41) comprising the steps of:

generating photons (via 24; 98) of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA (see Col. 9 lines 51-52, Col. 10 lines 25-26);

directing (via 18; 82, 84, 90) an air stream to a source (24; 98) of photons (see Figures 1, 3, and 7);

exposing the air stream to the generated photons (see Figures 1, 3 and 7);

removing particles (via 12; 85) from the air stream (see Figures 1 and 7, Col. 10 lines 15-20); and

directing the air stream (see Col. 7 lines 5-7) to a surgical area (see Col. 3 lines 36-38), whereby a disinfected airflow surrounds the surgical space and prevents

infected air from entering (see entire document, particularly Col. 3 lines 36-38 and 40-41),

in order to destroy microorganisms found in indoor air (see entire document, particularly Col. 3 lines 21-26).

It would have been obvious to one of ordinary skill in this art at the time of invention to provide step of removing particles from an air stream along with exposing the air to photons and directing the treated air stream in a surgical space in the method of Benoit in order to provide a high degree of purification and ensure sterility of air in a critical/sensitive space as shown by Goswami.

While Goswami ('702) does not appear to specifically teach that the air is directed vertically downward, Goswami ('702) teaches that the air may be directed vertically downward (see entire document, particularly Col. 3 lines 1-15), and thus, it would have been obvious to and well within the purview of one of ordinary skill that disinfected air flowing from a room register includes a flow pattern of vertically downward as a known air flow pattern. Only the expected results would be attained.

Thus, Claim 25 would have been obvious within the meaning of 35 U.S.C. 103(a) over the combined teachings of Benoit ('344) and Goswami ('702).

Allowable Subject Matter

7. Claims 16, 18-19, 27-31, 33-34, and 38 are allowed.

8. The following is an examiner's statement of reasons for allowance: the primary reason for allowance of the claims is due to inclusion of limitation (of Claim 32) indicated to contain allowable subject matter as set forth in the Office Action mailed 2/29/2016.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

9. Applicant's arguments filed 7/29/2016 have been fully considered but they are not persuasive. Specifically, as to Applicant's argument in last 7 lines on p. 3 and in lines 1-12 on p. 4 of Remarks that "Goswami does not teach directing the air stream vertically downward" "such that it surrounds a surgical space, forming a surgical area that has a flow profile and pressure zone that prevents entry of the surrounding infected air", Examiner would disagree and note that the features upon which applicant relies (i.e., a flow profile and pressure zone) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). In addition, Applicant's argument that "it is well known that such ceiling mounted room registers have a number of baffles that direct outgoing air in multiple different directions for the purpose of dissipating the air throughout the room", Examiner would disagree and indicate that it is also well known that ceiling mounted room

registers have knob/control which allows a user to adjust and configure the baffles to direct the air vertically downward and thus, disclosing the claim limitation.

Moreover, as to Applicant's argument in lines 13-15 on p. 4 of Remarks that "it does not appear that the step of claim 25 of removing particles from the air stream is taught by the prior art", Examiner would disagree and point out that Goswami does disclose this filtering step via filter 12 or 85 as was disclosed in lines 8-9 on p. 7 of the Office Action mailed 2/29/2016 and in paragraph 6 above.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to REGINA M. YOO whose telephone number is (571)272-6690. The examiner can normally be reached on M-F 10:30 am - 7 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Marcheschi can be reached on 571-272-1374. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/REGINA M YOO/
Primary Examiner, Art Unit 1799

Receipt date: 08/02/2016

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	14254957
	Filing Date	2014-04-17
	First Named Inventor	S. Edward Neister
	Art Unit	1799
	Examiner Name	YOO, REGINA M
	Attorney Docket Number	14-016-EN

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Receipt date: 08/02/2016

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	Attorney Docket Number	14-016-EN

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Examiner Signature	/REGINA M YOO/	Date Considered	10/18/2016
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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Receipt date: 08/02/2016

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14254957
Filing Date	2014-04-17
First Named Inventor	S. Edward Neister
Art Unit	1799
Examiner Name	YOO, REGINA M
Attorney Docket Number	14-016-EN

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2016-08-01
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

<i>Index of Claims</i> 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant					☐ CPA					☐ T.D.					☐ R.1.47				
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Receipt date: 08/24/2016

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Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

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Receipt date: 08/24/2016

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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Receipt date: 08/24/2016

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	14254957
Filing Date	2014-04-17
First Named Inventor	S. Edward Neister
Art Unit	1799
Examiner Name	YOO, REGINA M
Attorney Docket Number	14-016-EN

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Connaughton, Jr./	Date (YYYY-MM-DD)	2016-08-01
Name/Print	David J. Connaughton, Jr.	Registration Number	67275

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.: 14/254,957

Applicant: S. Edward Neisler

Art Unit: 1799

Filed: April 17, 2014

Examiner: Yoo, Regina M.

Lambert & Associates
92 State Street
Boston, MA 02109

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT IN RESPONSE TO OCTOBER 28, 2016 OFFICE ACTION

This is a response to the Office Action issued on October 28, 2016 by the U.S. Patent and Trademark Office in connection with the above-identified application. A response is due January 28, 2017. Because January 28 is a Saturday, the response is due on Monday, January 30, 2017. Accordingly, this response is being timely filed. Entry of this after final amendment is respectfully requested because it merely elects allowable claims as indicated in the October 28, 2016 office action.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1-15. (Canceled).

16. (Currently Amended) A process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of:

generating photons of at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222nm and 282nm;

directing the photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms; and

wherein the substance or surface to be disinfected is human or animal skin.

17. (Canceled).

18. (Previously Presented) The process of claim 16 further comprising the step of providing an new ultra violet source for generating the photons.

19. (Original) The process of claim 16 wherein the directing step is performed by reflecting the photons to a desired surface.

20-24. (Canceled).

25. (Canceled).

26. (Canceled).

27. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected.

28. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 40 mJ/cm² to the substance or surface to be disinfected.

29. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 60 mJ/cm² to the substance or surface to be disinfected.

30. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises providing a radiant dose energy of 10 mJ/cm² to the substance or surface to be disinfected.

31. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, the source for generating the photons selected to produce an irradiance of approximately 100 mw/cm² or less.

32. (Canceled).

33. (Previously Presented) The process of claim 16 wherein the step of directing the photons further comprises exposing the substance or surface to be disinfected to the generated photons for less than 0.1 second.

34. (Previously Presented) The process of claim 16 further comprising the step of selecting a source for generating the photons, wherein the source for generating photons is a hand held lamp, and wherein the step of directing the photons further comprises the step of waving the hand held lamp over the surface or substance to be disinfected, exposing the surface or substance to the generated photons for approximately 0.1 second or less.

35.-36 (Canceled).

37. (Currently Amended) A process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of:

generating photons of at least two single line wavelengths corresponding to a peak absorption wavelength of DNA or RNA, the at least two single line wavelengths being at least two of 222nm, 254nm and 282nm; and

directing the photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms.

38. (Previously Presented) The process of claim 16 wherein the at least one wavelength is 222 nm and wherein the step of generating photons further comprises generating photons at a wavelength of 207 nm.

39. (New) The process of claim 37 wherein the directing step is performed by reflecting the photons to a desired surface.

40. (New) The process of claim 37 wherein the step of directing the photons further comprises the step of providing 540 kJ/mole of photon energy to the substance or surface to be disinfected.

41. (New) The process of claim 37 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 40 mJ/cm² to the substance or surface to be disinfected.

42. (New) The process of claim 37 wherein the step of directing the photons further comprises directing the photons to provide a radiant dose energy of 60 mJ/cm² to the substance or surface to be disinfected.

43.(New) The process of claim 37 wherein the step of directing the photons further comprises providing a radiant dose energy of 10 mJ/cm^2 to the substance or surface to be disinfected.

44. (New) The process of claim 37 further comprising the step of selecting a source for generating the photons, the source for generating the photons selected to produce an irradiance of approximately 100 mw/cm^2 or less.

Amendments to the Specification

Please replace the Abstract with the following amended paragraph:

This invention relates to a method, process and apparatus for disinfecting and sterilizing all types of surfaces contaminated with microorganisms and toxic substances to render both inactive. Furthermore, this invention relates to both a method and apparatus for disinfecting and/or sterilizing breathable air and then using this air to protect a confined space from external contamination. The apparatus consists of a new ultra-violet (NUV) source that is more effective than mercury based 254 nm light for destroying DNA of virus, bacteria, spores and ~~eists~~ cysts. It is most effective in breaking chemical bonds in toxic gases and Biotoxins that are useful to terrorists. It is combined with other apparatus that remove particulates and byproducts sometimes produced by the NUV source and maintains positive pressure of the confined space so as to prevent the influx of air from outside the protected zone.

Remarks

Applicant thanks the Office for the attention accorded to the present application in the October 28, 2016 Office Action. Claims 16, 18-20, 22-25 and 27-38 were pending in the subject application.

Without prejudice or disclaimer, Applicant has herein amended claims 16 and 37, canceled claim 25, and added claims 39-44, which depend from independent claim 37. Upon entry of this amendment, claims 16, 18, 19, 27-31, 33, 34 and 37-44 will be pending in the present application.

The amendments to the claims are primarily to correct matters of form and/or clarity in response to the Office's recommendation. Applicant asserts that all claims are supported in the specification as originally filed. No new matter has been added.

The claim amendments and cancellations made herein are made solely to expedite prosecution of the instant application, and should not be construed as acquiescence to the Office's rejections. Applicant reserves the right to pursue the cancelled and/or non-elected subject matter in one or more divisional or continuation applications.

Applicant respectfully traverses all rejections and asserts that the claims are now in condition for allowance.

Objection to the Specification

The Examiner has objected to the Abstract. Applicant has herein amended the Abstract as suggested by Examiner. As such, Applicant believes that this objection is overcome.

Objection to the Claims

The Examiner has objected to the Claims. Applicant has herein amended claims 16 and 37 as suggested by Examiner. As such, Applicant believes that this objection is overcome.

Rejections under 35 U.S.C. § 103(a)

The Examiner has rejected claim 25 under 35 U.S.C. 103(a) as being unpatentable over Benoit (20040238344) in view of Goswami (5933702).

Without prejudice or disclaimer, Applicant has canceled claim 25. As such, Applicant respectfully asserts that this rejection is now moot.

Conclusion

Applicant again thanks the Office for the attention accorded to the present Application in the October 28, 2016 office action. Applicant has herein amended claims 16 and 37, canceled claim 25, and added claims 39-44. Applicant asserts that based on the amendment and comments presented herein, all of the pending claims are in condition for allowance. Early and favorable action is respectfully requested.

The Examiner is invited to telephone the undersigned, Applicant's attorney of record, to facilitate advancement of the present application.

Respectfully submitted,

/David J. Connaughton, Jr./
David J. Connaughton, Jr.
USPTO Reg. #67275
LAMBERT & ASSOCIATES
92 State Street
Boston, MA 02109

(617) 720-0091

Electronic Acknowledgement Receipt	
EFS ID:	28207550
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	30-JAN-2017
Filing Date:	17-APR-2014
Time Stamp:	16:16:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response-Final-OA.pdf	42081	yes	9
			5d0617a11d9bb8591b0eb8e4dcfe71773c3113e5		

Multipart Description/PDF files in .zip description			
Document Description		Start	End
Applicant Arguments/Remarks Made in an Amendment		1	1
Claims		2	5
Specification		6	6
Applicant Arguments/Remarks Made in an Amendment		7	9

Warnings:

Information:

Total Files Size (in bytes):	42081
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908
32118 7590 02/03/2017 LAMBERT & ASSOCIATES 92 STATE STREET BOSTON, MA 02109-2004			EXAMINER YOO, REGINA M	
			ART UNIT 1799	PAPER NUMBER
			NOTIFICATION DATE 02/03/2017	DELIVERY MODE ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

lambert@lambertpatentlaw.com
shortell@lambertpatentlaw.com
connaughton@lambertpatentlaw.com

<i>Applicant-Initiated Interview Summary</i>	Application No. 14/254,957	Applicant(s) NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	

All participants (applicant, applicant's representative, PTO personnel):

(1) REGINA M. YOO. (3) ____.

(2) David Connaughton. (4) ____.

Date of Interview: 30 January 2017.

Type: ☒ Telephonic ☐ Video Conference
 ☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
 If Yes, brief description: ____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
 (For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 25.

Identification of prior art discussed: Benoit and Goswami.

Substance of Interview
 (For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant discussed potential amendment to claim 25 to further specify the existence of separate zones of air (disinfected and non-disinfected) within the surgical space. Examiner indicated that such an amendment appears to overcome the prior art of Benoit and Goswami but further search and/or consideration will be required when such amendment is officially submitted to the Office.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☒ Attachment

/REGINA M YOO/ Primary Examiner, Art Unit 1799	
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Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record

A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews

Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.

All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:

- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:

- 1) A brief description of the nature of any exhibit shown or any demonstration conducted,
- 2) an identification of the claims discussed,
- 3) an identification of the specific prior art discussed,
- 4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
- 5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
- 6) a general indication of any other pertinent matters discussed, and
- 7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.



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UNITED STATES DEPARTMENT OF COMMERCE
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NOTICE OF ALLOWANCE AND FEE(S) DUE

32118 7590 03/10/2017
LAMBERT & ASSOCIATES
92 STATE STREET
BOSTON, MA 02109-2004

EXAMINER

YOO, REGINA M

ART UNIT

PAPER NUMBER

1799

DATE MAILED: 03/10/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908

TITLE OF INVENTION: METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	06/12/2017

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

32118 7590 03/10/2017
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92 STATE STREET
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Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908

TITLE OF INVENTION: METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$480	\$0	\$0	\$480	06/12/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
YOO, REGINA M	1799	422-121000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)

- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908

32118	7590	03/10/2017
LAMBERT & ASSOCIATES		
92 STATE STREET		
BOSTON, MA 02109-2004		

EXAMINER	
YOO, REGINA M	

ART UNIT	PAPER NUMBER
1799	

DATE MAILED: 03/10/2017

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/254,957	Applicant(s) NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendment filed 1/30/2017.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 16,18,19,27-31,33,34 and 37-44. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

- a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|--|
| 1. ☒ Notice of References Cited (PTO-892) | 5. ☒ Examiner's Amendment/Comment |
| 2. ☐ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date _____ | 6. ☒ Examiner's Statement of Reasons for Allowance |
| 3. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material | 7. ☐ Other _____. |
| 4. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____. | |

/REGINA M YOO/
Primary Examiner, Art Unit 1799

1. The present application is being examined under the pre-AIA first to invent provisions.

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

- in line 4 of Claim 16, delete "222nm" and insert --222 nm--;
- in line 5 of Claim 16, delete "282nm" and insert --282 nm--;
- in line 3 of Claim 28, delete "cm²" and insert --cm²--;
- in line 3 of Claim 29, delete "cm²" and insert --cm²--;
- in line 2 of Claim 30, delete "cm²" and insert --cm²--;
- in line 3 of Claim 31, delete "cm²" and insert --cm²--;
- in line 5 of Claim 37, delete "222nm, 254nm and 282nm" and insert --222 nm, 254 nm and 282 nm--;
- in line 2 of Claim 41, delete "cm²" and insert --cm²--;
- in line 2 of Claim 42, delete "cm²" and insert --cm²--;
- in line 2 of Claim 43, delete "cm²" and insert --cm²--;
- in line 3 of Claim 44, delete "cm²" and insert --cm²--.

REASONS FOR ALLOWANCE

3. The following is an examiner's statement of reasons for allowance: the primary reason for allowance of all claims is due to cancellation of claim 25, which was the only claim under a rejection (i.e. 35 U.S.C. 103(a)). In addition, see paragraph 8 on p. 6 of Final Action mailed on 10/28/2016 for reason for allowance. Moreover, while prior art of Tribelsky (WO 2004/011038) appears to teach a process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of generating photons and directing photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms, and wherein the substance or surface to be disinfected is human skin (see entire document, particularly p.11 lines 7-12, p.14 lines 1-11, p.15 lines 24-26, p.16 lines 15-19, p.21 lines 23-26) and while Tribelsky appears to teach a wavelength range of 220 nm-357 nm (see entire document, particularly p.28 lines 12-16) and 266 nm to about 1000 nm (see entire document, particularly p.47 lines 27-28), use of a laser with wavelength in the range from about 193 nm to about 308 and 351 nm (see entire document, particularly p.39 lines 24-27), operating the laser at wavelength of about 266 nm (see entire document, particularly p.35 line 16, p.40 line 2, p.41 lines 6-9, p.47 lines 31-32) and an alternate mode of operation where more than one wavelength of light may be used simultaneously (see entire document, particularly p.41 lines 16-20), Tribelsky does not teach that the photons have at least one wavelength corresponding to a peak absorption wavelength of DNA or RNA, the at least one wavelength being at least one of 222 nm and 282 nm, or at least two of 222, 254 nm and 282 nm. Thus, it

would not have been obvious to one of ordinary skill in the art at the time of the invention to provide a process for destroying a DNA or RNA of a microorganism on a substance or surface comprising the steps of generating photons and directing photons to the substance or surface to be disinfected, whereby the photons are selected to destroy a plurality of chemical bonds within the DNA or RNA of the microorganisms, wherein the generated photons have at least one wavelength or at least two wavelengths corresponding to a peak absorption wavelength of DNA or RNA, specifically where the at least one wavelength being at least one of 222 nm and 282 nm, or the at least two wavelengths being at least two of 222 nm, 254 nm and 282 nm, and wherein the substance or surface to be disinfected is human or animal skin.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to REGINA M. YOO whose telephone number is (571)272-6690. The examiner can normally be reached on M-F 10:30 am - 7 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Marcheschi can be reached on 571-272-1374. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/REGINA M YOO/
Primary Examiner, Art Unit 1799

Notice of References Cited	Application/Control No. 14/254,957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD	
	Examiner REGINA M. YOO	Art Unit 1799	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	US-				
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N	WO 2004011038 A1	02-2004	IL	TRIBELSKY ZAMIR	A23B7/015
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



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5 February 2004 (05.02.2004)

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(10) International Publication Number
WO 2004/011038 A1

(51) International Patent Classification⁷: **A61L 2/10**, A23L 3/28, B67C 7/00, G02B 6/20

(74) Agent: **REINHOLD COHN & PARTNERS**; P.O. Box 4060, 61040 Tel-Aviv (IL).

(21) International Application Number:
PCT/IL2003/000621

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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(71) Applicant (*for all designated States except US*): **AT-LANTIUM LASERS LIMITED** [CY/CY]; 2-4 Makarios III Av., Capital Center, 9th floor, P.C. 1505, Nicosia (CY).

(72) Inventor; and

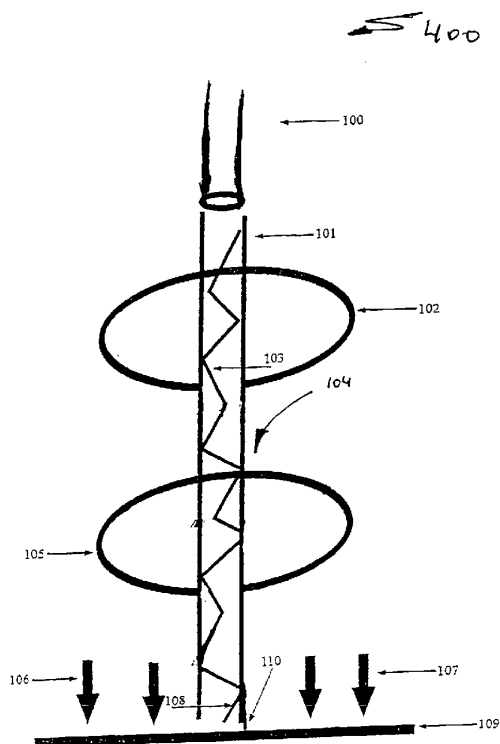
(75) Inventor/Applicant (*for US only*): **TRIBELSKY, Zamir** [IL/IL]; 37 Hador st., 90805 Mevaseret Zion (IL).

Published:

— with international search report

[Continued on next page]

(54) Title: METHOD AND DEVICE FOR AFFECTING A CHEMICAL OR MECHANICAL PROPERTY OF A TARGET SITE



(57) Abstract: A method and device are presented for affecting at least one chemical or mechanical property of a target site (109). A stream of liquid towards a contact with the target site (109) is provided with a predetermined flow rate. Also provided is UV-radiation (103) having predetermined parameters in terms of power, wavelength, duty cycle and repetition rate. The UV-radiation (103) is directed within the stream of liquid (101) along a trajectory of the stream. The stream carrying the UV radiation is maintained in contact with the target site for a time period and under conditions sufficient for affecting the at least one chemical or mechanical property.

WO 2004/011038 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND DEVICE FOR AFFECTING A CHEMICAL OR MECHANICAL PROPERTY OF A TARGET SITE

FIELD OF THE INVENTION

The present invention is generally in the field of radiation transmission techniques, and relates to a method and device for guiding UV radiation to a target site. The invention can be used for various photochemical treatments, for example aseptic filling of liquids into containers.

BACKGROUND OF THE INVENTION

Optical device operable with the deep UV and other regions of the electro magnetic spectrum (UVA, UVB, UVC, VIS, NIR, IR) have been of interest for many years. Most of the conventional available optics are not able to withstand the great energy and thermal dynamics associated with cooling a high-power light beam to water, air, or combination of liquids and gases. Most types of glasses have been tried, and wide varieties of high grade fused silica are available to deliver deep UV light. However, these elements are expensive, and are limited to the energy levels that could be delivered. Further more, spatial limitations and damage threshold limitation have been imposing strict limitations as to the ability of quartz type and synthetic glass elements to deliver the energy levels often required for commercial material processing, lithography, and photo induced chemistry. More specifically, strict limitations to produce a UV reflective coating, have hindered progress in this field, leaving many spatial processing only available from quartz and expensive optical grade polymers, and crystals, all of which are mainly used for processing and manipulating light beams in other spectral regions, such as can be seen in the VIS, NIR, IR (i.e., such as in telecomm, & IT).

Powerful or accurate light sources (including one or more lasers, or hybrid light sources including lamp(s) and laser(s)) often require expensive optics and optical grade manufacturing methodologies using HGFS (High Grade Fused Silica), SHGFS (Synthetic Fused Silica), and expensive semi-conductor coatings often applying several layers of AR/RC (Anti-Reflecting/Reflecting type coatings). Devices using such light sources are subject to physical limitations, photo damage and deterioration affecting all optical

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components in the beam path and thus often cannot reach the desired performance parameters, damage threshold, and physical properties associated with truly industrial, continuous, repeatable operation. These limitations have dictated to designers, producers and end users to integrate expensive cooling units negatively effecting energy consumption, wall plug efficiencies, increasing periodical maintenance and replacements, while increasing capital cost associated with devices using currently limited methodologies, such that are effected by thermal dynamics and optical damage thresholds.

Current evolution in laser, electro optics, electronics, and solid state electronics have pushed energies higher, and increase substantially time domain optronic manipulation capabilities (i.e. creating more peak power densities), and increase demand for wide variety of coupling, switching methodologies. Currently used optical grade production techniques rely on high temperature, skilled engineering, and considerable infrastructure, and energy demanding production sites limiting the scope and commercial and industrial high power laser applications, laser induced photochemistry, and material processing applications requiring lasers operating at high average, high peak powers, often at very high repetition rates.

Currently used production methodologies for high grade optical elements mainly utilize high energy driven temperature generators, heavy machinery, heaters driven mold processes, furnaces, often pose safety threats, and expensive surface processing, and coating treatments for polishing the finished element or lenses.

Current commercial efforts aimed at manufacturing such high damage threshold UVC optics, have failed to provide industrially acceptable high quality, high damage threshold, optical grade UVC optics and repeatable optronic processing free of thermal conventional limitation of optical grade materials.

Several technologies exist for the provision of surface treatment applications. These currently used technologies introduce strict safety, reliability, and credibility and efficiency limitations due to their chemical, residual, often toxic, expensive, slow, labor and material driven procedures and processes. Further more, current methodologies for surface treatment of instrumentation is cumbersome, and could not easily be adapted to cover applications requiring actual treatment of physiological damage to tissues, and/or for cuts, sores, wounds, to living human beings. Further more, in the field, or as in during critical medical procedures under time constraints, wherein often there is no sufficient time

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available to wait for certain chemical action to proceed (such as when using biocides, or chemical disinfectants), or for instrumentation to be returned from central, often far autoclaving, and disinfection equipment centre (i.e. such as in hospitals, and medical centers, or clinics), failed to provide adequate safety measures for vital tools and instrumentation, often results in making their associated working cycles longer, less efficient, requiring substantial replacement hardware components, and leads to unnecessary manual procedures, and subsequent expenses in human resources, and high energy consumption (high capital, and operation costs) as well as potential failure of vital medical procedures.

Most medical instrumentation is in need of sterilization, or disinfection leaving bacteria, and/or noxious species at a sufficiently low concentration according to standards, health, and safety regulations. Further more, medical instrumentation used in wide variety of medical procedures is currently being treated with chemical disinfectants. As heat already being considered as one of the most expensive disinfectant, or sterilizing methodology often requiring long and wasteful work cycles schedule. More specifically, the long time cycle chemical disinfectant takes for effective inactivation of DNA & RNA replication sequences or for oxidizing thus inactivating noxious species fuels the drive for new more efficient, non chemical methodologies.

Currently used methodologies utilizing UV light for disinfection, and photo-treatment is making use of (CW) Continuous Wave, often polychromatic light sources, most of which having radial emission, and not sufficient peak power (i.e. such as generated by P.W. type light sources). More specifically, the principle means for the generation of Ultra Violet light for disinfection and for photo-treatment is by using Mercury type light sources, or lamps. These lamps generate continuous type of light (i.e. CW), and the majority of the light they generate (their peak emission) (mercury) is at the region of about 254nm. These light sources/lamps, thus do not have the required wavelength for offering efficient disinfection, and sterilization of wide varieties of medical instrumentation. More specifically, current methodologies for disinfection and sterilization of medical instrumentation include heat, Gamma rays, X-rays, Y-rays, radio waves, Ultra Violet, microwaves, chemicals. These methodologies while offering currently implemented solutions, imposed strict limitations on the device performance.

Conventional treatment technologies available today include: Heat, ozonation, chlorination, oxidation, Gamma rays, X rays, Y rays, UVA,B,C photons, radio waves,

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micro-waves, and several types of ionizing radiation, oxidation technologies, AOTs (Advance Oxidation Technologies such as using H₂O₂/UV, TiO₂). These currently used treatment technologies are often dangerous, expensive, and require substantial periodical maintenance and replacements. Furthermore, instrumentation using such ionizing radiation types requires sophisticated support means, and infrastructure safety measurements, further complicating design criteria, and implementation. Several of these radiation types have already confirmed as causing cancer, and public confidence in these technologies at manufacturing plants is declining. Stringent legislation and standards further fuel the need for alternative, safer, more economical methodologies for non interfering treatment. Conventional chemical technologies are limited since there is always the need to clear the liquids and gases (of the "harmful" chemicals), and remove them from the specific volume to be consumed (i.e. after disinfection, or purification have occurred) once they have finished their useful cycle, or their disinfection, and oxidation activities.

The present invention takes advantage of the known technique of guiding light, especially UV radiation, via a liquid medium (e.g., water). Guiding light inside water has been used for the purpose of decorative functional fountains and illuminated falls, such that can be found in ancient and/or modern architecture. Various waveguides for transmitting UV radiation have been developed and are disclosed for example in the following U.S. Patents: 4,009,382; 5,412,750; 5,546,493; 6,163,641; 6,314,226; 6,418,257; and 6,507,688.

The use of a liquid jet or stream to conduct light has been proposed. For example, WO 85/05167 discloses a liquid outlet adapted to provide lighting effects and/or for illumination, that may be used in the fields of domestic plumbing ware as water taps, faucets, drinking fountains; ornamental and display fountains; beverage dispensers; in laboratory or industrial processes. According to this technique, light of arbitrary wavelength(s) is introduced into a jet or stream of liquid, either hollow, solid or subdivided, such that this light is totally or partially conducted by the jet or stream. A light source organ is placed inside the liquid-stream close to the outlet, such that the light source organ is in heat exchange relationship with the liquid flowing through the outlet and the light output into the liquid stream is maximized, or at a distance from the outlet but optically coupled to that outlet along any curved or bent pathway by means of some auxiliary light guiding mechanism.

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WO 95/29300 discloses an apparatus and method for introducing electromagnetic waves (especially visible light and infrared or ultraviolet light) into water or water streams in sanitary installations such as shower systems, taps and bath tubs. When the electromagnetic waves are visible light, the illumination of water takes place in one or combination of two forms: illumination by light reflection from the turbulent or broken water streams and illumination by light carried by the unbroken water streams or waters, where the electromagnetic waves being introduced into the water streams are able to be carried and guided by the water streams because of higher optical refractive index of the water compared to the air. Part of sanitary installations such as part or whole of the shower head is illuminated by the light sources. The colours and/or patterns and/or the intensities of the light source is able to be adjusted manually or automatically according to certain water conditions such as the temperature or the flowrate/pressure or cleanness of the water in use. The optical source is placed at the shower/tap head or separated from it. In the latter case, reflective mirror means or optical wave guide means or fiber optic means is used to guide the optical energy from the light source to the appropriate water streams. When the light source resembles sun light, combined sun bathing and shower unit can result.

SUMMARY OF THE INVENTION

The present invention discloses a novel methodology for combining a liquid medium with light for the purpose of creating a flowing liquid light guide.

The present invention provides a method for executing a certain processing (e.g., chemical treatment or mechanical treatment) through a jet or stream of light transmitting liquid. According to one broad aspect of the invention, there is provided a method for affecting at least one chemical or mechanical property of a target site, the method comprising:

- (a) providing a stream of liquid having a predetermined flow rate towards a contact with the target site;
- (b) providing UV-radiation having predetermined parameters in terms of power, wavelength, duty cycle and repetition rate;
- (c) directing said UV-radiation within said stream of liquid along a trajectory of said stream;

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- (d) maintaining said stream in contact with said target site for a time period and under conditions sufficient for affecting said at least one chemical or mechanical property.

The liquid stream may be free-space flowing along at least one portion of its trajectory.

The target site is an item or a substance suspected as afflicted by noxious biological or chemical species. The target site is selected from pre-filled containers, filled containers, surfaces, humans, mammals, vehicles, medical instrumentation, conveyors, conveyor belts, foods, fruits, vegetables, salads.

The UV-radiation is generated by a laser source, which is preferably a high-frequency pulsed laser. For example, the laser source is a pulsed 266nm laser, or pulsed 355nm laser. The laser source may be a high intensity sub-microsecond pulsed laser.

The technique provides the chemical or mechanical change applied to at least 50 percent of particle type or microorganism species predetermined as a subject for having the change.

The same UV radiation carried by the stream of liquid performs may be used for the disinfection of the liquid on its way to the target site.

The method may comprise recycling the liquid by gathering it from the vicinity of the target site and returning it towards another contact with a target site.

More specifically, method comprises the following steps:

- (a) generating at least one light beam having wavelength, intensity and duration selected to be effective for the initiation of the treatment;
- (b) forming at least one unpiped jet stream of light transmitting liquid, said jet having a predetermined launching point, trajectory, and target site, said liquid having a refractive index (N_1) greater than a refractive index (N_2) of the surroundings of said jet;
- (c) directing said light beam into said jet such that said light beam is being guided throughout said jet, locked within along its trajectory towards the target site; thereby enabling said treatment by said guided beam in between the launching point and the target site.

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Various types of photochemical treatments may utilize the new innovative method of the present invention, all of which are based on the same novel advantageous principle of using an unpiped liquid jet as a “flowing wave guide” for light radiation adapted to the specific required treatment. These various type treatments, their advantages comparing to corresponding treatments using conventional existing methods, and the ways for performing them will be further explained in detail.

According to the present invention, a novel methodology is disclosed, for non destructively coupling high intensity beams of light in the germicidal range (220-380) to flowing liquid and gases thus creating a real time flowing liquid wave guiding methodology and for spatial processing using flowing suspended liquid formation having a higher refractive index therein, then the refractive index of the space, air, gas or liquid surrounding it. More specifically, triple guiding; (a) said light spatially locking it inside the flow homogeneously so as to fit variable boundaries formed of a continuum of refractive index profile between said (b) flowing liquid having a higher refractive index (1.33) therein then the (c) air or gas outside it (normally 1.00), and liquid and gases hydraulic, and pneumatic interactions (shapes, and variable space dimensions) into hydro optical fusion geared for photo-induced chemistry, and for sterilization and disinfection of liquids and gases, water, and air or surface combinations.

The present invention provides a novel methodology for creating a real time flowing liquid wave guide or photochemistry. According to this technique, output from at least one radiation unit having a high intensity pulsed sub-microsecond laser UV light beams is inserted or coupled into an input opening in a hollow aerobic, non toxic, liquid (water) projection means. The latter is a conduit or a chamber having integral conductive, dielectric, semi conductive or super conductive link having at least one inlet and an outlet launcher shaped for dynamic hydro-optical and photochemical predetermined processing effects. Said conduit or chamber has at least one opening un-hindered for passage of liquids and light simultaneously throughout. Each of said openings is equipped with optical input or output having predetermined diameter, acceptance angle and biocompatible or photo catalytically immobilized inner or outer surface area layer or thin film coating and at least one venturi suction point sufficiently large for light to be inserted through said opening passage, and sufficiently small for the liquid to remain inside flowing forward in a continuum of laminar or turbulent or combinations flow formats. A predetermined volume of liquids or gasses or combination thereof is pumped simultaneously through said inlet of said liquid projection means to be processed or triggered by the interactions of said

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guided light. At least one jet stream with a refractive index N_1 higher than a refractive index N_2 of the air or gas surroundings (e.g., $N_1=1.3$ and $N_2=1.00$) is launched forward simultaneously, such that said jet streams form a refractive index profiles N_1/N_2 with its surrounding, adequate for guiding said pulses of light by total internal reflection. The jet stream may contain at least one bubble. A continuum of predetermined volume of said liquids, and gases are delivered simultaneously to said outlet launcher positioned further along said hollow water projection means, at a predetermined pressure volume, or flow rate or combination sufficient for the formation of at least one venturi pressure point at said non hindering opening eliminating the need to use solid state optical grade elements or lenses, reducing the number of elements in the optical path length from air through water to surface reducing attenuation, increasing damage threshold, reducing periodical maintenance and replacements. A predetermined oxygen concentration, or singlet oxygen species, or predetermined oxidizer, or photo-catalytic semi conductive metal, or metal oxide particles, or nano porous, or non porous multi-components or semi conductive or dielectric combinations may be added or subtracted to the flowing liquid jet stream proportionately so as to form radical species or for photolytic, or photo catalytically triggering or for directly photo chemically effecting disinfecting, or sterilizing, dissociating, mineralizing or oxidizing, cleaning or decontaminating said liquid or gases or surfaces or combination in a single simultaneous action within a predetermined period of time.

The invention is especially beneficial for disinfection through the skin of internal blood flow (using the flowing liquid waveguide of the present invention), and bodily fluids without causing any damage, for treating medical instrumentation and engineering tools with pulsed UVA, UVB, UVC laser light guided by the UVJET of the present invention - where the geometrical curvature is often difficult to reach using conventional disinfection, or purification technologies. The method of the present invention can also be used wherein the cork, or lid themselves are made of polymer varieties having higher refractive index then the liquids, and/or gases therein (i.e. in the packaging), in order to maximize geometrical utilization.

More specifically, the UVJET of the present invention may be easily scaled up or down modularly. As an example; the methodology of the present invention for surface treatment is also beneficial for improving the hygiene of the mouth by harnessing the illumination or irradiation of a wave guiding dielectric brush [WDB] sterilizing its complex curvature inner surfaces, and volumes, having variable depth of penetration catalytically using new generation of paste, comprising:

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Constructing or integrating a multi-component compound structurally modular, containing predetermined portion of yielding Oxygen Charge (SYOCH) in a U.P.W, PH stabilized, held temporarily or permanently in a 3D polymeric frame work of biodegradable biocompatible carbomer or BI-polymers expanded to contain photo-catalytic, and, or centillating conversion elementally each having predetermined electron charge transfer co.-efficiencies and absorption, refractive index profile, and acoustic properties, selected pre-production for quantum objective application specific efficiencies driven thus from supper conductive, to dielectric, or semi conducting, wherein the flexibility of water may provide generic structurally yielding Oxygen Charge accommodating into manageable forms the decomposed species inactivated radically (SYOCH1), within water, liquid or gas or air suspension, body fluids, or inside mouth using new generation of paste according to the methodology of the present invention.

The device may be used for dentistry, general dentists, perio-dentists, orthodontists, exodontists, pediatric dentists, endodontists, oral/maxillofacial surgeons, and orthodontists, wherein the duty cycle of procedures thus performed in these respective field when using multicomponent catalytic U.P.W based compound or coupling gel, spray, or liquid or gas facilitating the shortening, and time and resources saving, as results of effectively reduction of the population of noxious species on surface or volume, within predetermined area or dimension, thus increasing the level of health, and therapeutic applications of devices according to the methodology of the present invention. Duty cycle is a time period during which the laser beam is actually cutting, drilling, welding, or heat-treating, as compared to the entire work cycle time.

More specifically, the methodology of the present invention also relates to a catalytic tooth paste capable of scintillating or repeatable triggering by using visible, UVA, UVB, UVC, optical triggering signal eliminating the need for repeatable brushing. More specifically the present invention facilitates the dissolving of pluck formation catalytically, scintillating, and deep disinfection, and dissociation therapeutic effective treatment.

Considering the refractive index of water (1.3), and the refractive index of air (1.00), when light is coupled to a real time flowing liquid wave guide it gets locked, and reflected by T.I.R (Total Internal Reflections) thus creating a light jet (UVJET) according to the methodology of the present invention.

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In the context of the present invention VOCs reduction means reduction of Volatile Organic Compounds by the use of a flowing liquid wave guide (could be used also for TOC reduction in the same principle)

In the context of the present invention Virus means a sub-microscopic microbe that causes infectious disease. A virus can reproduce only in living cells.

The usual wavelength range in Photochemistry is 100 - 1000 nm. Light photons with wavelengths longer than 1000 nm have a photon energy too low to cause chemical change when absorbed, and photons with wavelengths shorter than 100 nm have so high energy that ionization and molecular disruptions characteristic of radiation chemistry prevail. The total wavelength range is divided into bands with specific names as given below.

Spectral range naming in the context of the present invention (in nanometers):

<u>Range Name</u>	<u>Wavelength</u>
Near Infrared	700-10000
Visible	400 - 700
Ultraviolet	100 - 400
UVA	315 -400
UVB	280-315
UVC	100-280

Little photochemistry occurs in the Near Infrared. Except for some photosynthetic bacteria, which are capable of storing solar energy at wavelengths out to 980 nm, the Visible range is completely active for photosynthesis in green plants and algae. Also many dyes can undergo photochemical transformations themselves or sensitize reactions in other molecules. Most studies in photochemistry involve the Ultraviolet range. The division into three sub-ranges [UVA, UVB, UVC] is associated with the human skin's sensitivity to ultraviolet light. The UVA range causes changes in the skin that lead to sun tanning. The UVB range can cause sun burning and is known to eventually induce skin cancer. The UVC range is extremely dangerous since it is absorbed by proteins, RNA and DNA and can lead to cell mutations and/or cell death. The UVC range is sometimes called the "germicidal range", since it is very effective in inactivating bacteria and viruses. The Vacuum Ultraviolet range is absorbed by almost all substances (including water and air).

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Thus it can only be transmitted in a vacuum. The absorption of a VUV photon causes one or more bond breaks. However, even though photons with wavelengths less than 561.6 nm are capable of splitting the H_2O_2 molecule, no photolysis, or proteolysis occurs in this wavelength region because H_2O_2 does not begin to absorb ultraviolet light until below 300 nm. This illustrates the first Law of Photochemistry; namely that no photochemical reaction can occur unless photon(s) of light is absorbed.

In the context of the present invention, coherent and incoherent light means light sources used in photochemistry that can either be coherent (all emitted photons are in phase with each other as they propagate) or incoherent (all emitted photons have random phases). All lasers emit coherent radiation and usually at one wavelength. The dispersion is very small so that a laser beam remains at or near its original diameter as it propagates; the light emitted by all other light sources is almost always incoherent. Most of these sources are either "hot element" sources (e.g., incandescent light bulb) or "plasma" sources (e.g., a fluorescent light tube).

In the context of the present invention, "point source" means light sources that have finite dimensions (e.g., often a cylindrical shape). Emission from such a source is difficult to treat mathematically. It is convenient to model these sources as a collection of point sources, in which all light is emitted from the point equally in all directions. The optics treatment for point sources is especially simple.

In the context of the present invention, the terms and concepts associated with the emission of light, are herewith included for clarity of explanation and to simplify the understanding of the method of the present invention for real time flowing liquid wave guiding (of light and liquid simultaneously), especially wherein photochemistry is involved, or photochemical polishing (meaning enhancing an already implemented processes such that a larger treatment objective is achieved) is active in the processing according to the present invention:

The light emitted from a source can be viewed in many different ways. In this Section, the various terms that may be used to describe this emission are defined and explained.

Radiant emittance or excitance: The Radiant emittance or excitance of a source is the radiant power emitted from an infinitesimal area on the surface of the source.

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Radiance: Radiance (L) is defined as the radiant power d^2P , emitted from an infinitesimal area dA of the source surface in a given direction about the solid angle $d\Omega$, divided both by the solid angle $d\Omega$ and the orthogonal projected area.

The emittance M from an infinitesimal surface element dA is obtained by integrating L in spherical polar coordinates over the hemisphere of all outward-bound directions above dA .

An isotropic light source is defined as one in which the radiance L is uniform over all Outward directions. Terms and concepts associated with the receipt of light when light is emitted from a source, it radiates outward at the speed of light, when it impinges on an object, and it may be reflected, transmitted or absorbed. There are several terms that relate to the receipt of light.

Fluence Rate: Fluence Rate (E) (W / m^2) is the radiant power of all wavelengths passing from all

Directions through an infinitesimally small sphere of cross-sectional area d , divided by CM

Irradiance: Irradiance (symbol E ; units W / m^2) is defined as the total radiant power of wavelengths incident on an infinitesimal element of surface of area as containing the point under consideration divided by as . The following are some important points regarding characteristics and differences between "irradiance" and "fluence rate":

Examples: For a parallel and perpendicularly incident beam, not scattered or reflected, irradiance and fluence rate becomes identical. For any UV source within a three-dimensional volume, the integration of UV irradiance over the interior surface of the volume, normally yields the UV power of the lamp. This is not true for UV fluence rate which characterized the use of sub-microsecond pulsed UV lasers in accordance with the methodology of the present invention for UVJET real time flowing liquid light guide.

The appropriate term for UV disinfection is "UV fluence rate" because a microorganism can receive UV power from any direction, especially when there is more than one UV lamp in the vicinity. In general usage, the irradiance or fluence rate may be expressed as $MW cm^{-2}$. The irradiance is often incorrectly termed "light intensity". the proper definition of "radiant intensity" (I) ($W sr^{-1}$), is the total radiant power P emitted by a source in a given direction about an infinitesimal solid angle.

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In the context of the present invention, Light Dose or Fluence means the light dose or fluence (symbol H , units $J\ m^{-2}$) is the total radiant energy of all wavelengths passing from all directions through an infinitesimally small sphere of cross-sectional area dA , divided by dA . It is given by the average fluence rate times the exposure time in seconds. The term UV dose is often used in UV disinfection literature. It represents the UV exposure of a given organism in the germicidal range.

Spectral units: All of the terms for light emission or incidence refer to all relevant wavelengths. One can define spectral derivatives for each of these terms. For example, the light power emission of a LIV lamp is often expressed as the spectral power ($W\ nm^{-1}$), defined as the power output in a narrow wavelength band divided by the width of the band. The solar spectrum received at the Earth's surface is described in terms of the solar spectrum irradiance. Also the spectral distribution of a lamp emission is often given as a plot of spectral power versus wavelength.

Photon based units: Photochemistry involves the interaction of photons of light with molecules and means: the definitions units that are based on photons.

Photon irradiance, photon fluence rate and photon flow: Each of the spectral terms can be converted to a corresponding equivalent photon flow and fluence rate by dividing the term by the average photon energy in the narrow wavelength band.

In the context of the present invention Quantum Yield, means the quantum yield (unitless) Q is a measure of the photon efficiency of a photochemical reaction. It is defined as the number of moles of product formed or reactant removed (P) per Einstein of photons absorbed

In the context of the present invention Peak power means the energy generated when squeezing (i.e., such as when pulsing) electromagnetic energy in short duration of time, for example, a pulse of a given average energy and power – lasting, or having a pulse width of around 1 second (1s) will generate several watts in peak power, a pulse lasting or having width of microseconds (ms) will generate peak powers reaching the kilo-watts scale, while a pulse lasting nano (ns) seconds will generate peak powers reaching into the hundreds of million of watts which is especially beneficial for purposes such as optical dissociation, optical inactivation, optical polishing, and optical secretion and spectroscopy for control and diagnostics, so in short the shorter the pulse duration the higher its respective peak power.

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Multi-photon – absorption - processes means a process which when harnessed could be very beneficial for the photochemistry involved in the processing according to the present invention, for example when 10mj of energy (250,000 photons) are projected into a liquid or gas, the time it takes this projection is very important, if these photons will be furnished over 1 second time domain, then it leaves sufficient time for the electrons in said liquid or gasses molecules to relax back to the relaxed state before an additional photon is absorbed, but if we apply these photons in a time domain of 5 nanoseconds, then we do not leave time for the electrons to relax and the process is called “multiphoton absorption” process, which is non linear in nature and yields much higher quantum yield, or efficiencies, or speed of the reactivation, or a more efficient methodology for optical treatment, processing and polishing

A hybrid of light sources means plurality of light sources and wherein their total spectral emittance, or total spectral distribution, or their total irradiance will cause multiphoton absorption processes by means of super imposing their time domain (example: 1 light source is slow = 1s pulse duration, and additional light sources are very fast =5ns laser for example), their total irradiance is great and beneficial for the processes of the method of the present invention to occur efficiently, further more, such hybridization could include lamps and lasers, lasers and flash lamps, or any combination of CW or PW type of light source working together, in synchronicity, and or sequentially or link or resolved by time domain manipulation for maximizing photonic interaction in matter, especially beneficial for triggering the catalytic scintillating elemental compound according to the present invention.

Photo catalysis means the use of energy of a photon of light to catalyze chemical reactions. More specifically, such reaction may include the decomposition of water into hydrogen, and oxygen, and the complete oxidation of organic contaminants in aqueous environments. More specifically, the first step in photo catalysis is for the catalyst material to absorb photon of light in order to excite an electron from the valance band (VB), to the conduction band (CB), thus creating electron-hole-pairs. Each species must then migrate to the surface before recombination occurs. If this condition is met, the electron can be transferred to a surface adsorbed molecule, reducing it. It is important to note that for the processes to occur efficiently (preventing pre-matured recombination of the electron-hole pairs), the rates of reduction and oxidation must be comperable. The position of the band edges is critical for each step of the process, a photocatalyst material which is stable in water is Titanium Oxide (TiO₂).

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Electro catalysis similar to photo-catalysis described above, but, instead of photons, utilizes an electrical charge, through the use of semiconductor material which has been specially selected (its band gap) for the charge applied. For the context of the present invention, an electro catalysis stable in water is I.T.O, or known in its chemical name and signature Indium Tin oxide. Further more, it is especially beneficial to combine and operate both electro catalysis and photo-catalysis simultaneously, or serially, or sequentially or in unison, or each separate catalytic is triggered separately in order to maximize the collective efficiencies, thus harnessing and improving the performance of current and future catalytic technological evolution according to the methodology of the present invention. This process may be beneficially harnessed and simultaneously applied in unison or in sequences, or in step time or in any combination thereof. The method of the present invention also relates to detoxification and sterilization of surfaces from dangerous bacteria and chemicals contaminating the surface either through normal application or by hostile action (when used not for aseptic filling but for NBC decontamination applications (not shown).

The principle is combination of UV/VIS light with photo catalytic materials in the context of a real time flowing liquid waveguide of the present invention.

The chemicals (oxidants, photo catalysts) will be sprayed/scattered in the form of liquid solution or suspension stream or droplets or cloud from one or more containers, with the light pulses synchronized so that illumination reaches the active chemicals in the right place (at or near the surface) at the right time. Pretreatment of surfaces with non-volatile materials such as TiO_2 , ZnO , etc., is another mode of application of the various components of the invention.

According to the technique of the present invention, locked and reflected pulsed laser light beams in the UVA, UVB, UVC, X-Ray, and visible regions of the electro-magnetic spectrum are utilized. The pulse duration, width, or time is sub-microseconds, adhering to the conditions for 2nd order interactions between light and matter performing multi photon absorption processes, amplification, and spatially controlling the TIR (Total Internal Reflection) patterns of the delivered light within the jet stream. This is especially beneficial for treatment of liquids and surfaces, as light is locked reflecting in the jet stream and thus can provide a multi functional feature enabling washing, filling, sterilizing any conduit or chamber simultaneously. More specifically, the method of the present invention discloses novel methodology for aseptically filling bottles in the bottling industries, or for aseptically

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filling and simultaneously washing and disinfecting the inner walls or surfaces of bottles, conduits or chambers. More specifically, an array of UV jet (hereinafter referred to also as “UVJET”) units, may be used for aseptic filling a plurality of bottles simultaneously, driven by a solid-state optical fiber harness for delivering adequate energy dose for each jet in arrays of jets or for single remote clean room or production halls requiring 100% electrical safety or high level of biocompatibility. Especially beneficial for disinfection and aseptic filling of bottled water, mineral water, flavored water and beverage and agro-food industries. Furthermore, the method of the present invention is especially beneficial for bio-photonics and biomedical applications wherein light can be delivered externally or internally (*in vitro* or *in vivo*) within the flowing jet stream of UPW (Ultra Pure Water with reduced TOCs, VOCs) class water jet or any water based suspension. This facilitates the ability to remove catalytically (photo-catalytically or via photochemical process) tumors and excess or unwanted pluck formation (within main Aorta) or remove smoothly restenosis, tissues or sterilize area or dimension or liquid such as blood or water, or gas such as air or oxygen or combinations as well as disinfect surface such as human skin or tissue, polymers. The methodology of the present invention is also beneficial for washing and disinfection and advanced oxidation of human skin from BW, CW eventualities, or for the protection and cleaning of metropolitan areas from biological and chemical contamination.

The present invention provides for production of UVJET, (or a water stream carrying pulsed UV light or sprinkler, or jet or fall or vapor) wherein pulsed UV laser light beams are locked and guided in the flowing variable liquid geometry by total internal reflection (TIR) thus forming UVJET, or VISIJET, or X-RAYJET. More specifically, liquid (water) with a refractive index N_1 (e.g., 1.3) is flying, projected/rejected in space, i.e. in air, or from air to surface, wherein the air or gas surrounding the liquid jet has a refractive index N_2 (e.g., 1.00) lower than that of the liquid, thus creating a refractive index profile (interface) N_1/N_2 within the JET stream. As a result, light transferring the jet at appropriate angular orientation stays locked, reflecting in the jet stream itself. The time domain differences of (a) hydraulic non uniformities, and (b) pulse width, PW or the duration in which a pulse of light transverse the jet stream, facilitate many advantages in photo-induced chemistry according to the methodology of the present invention.

Creating internal reflection therein (i.e. sub-microsecond pulses reflecting in the jet stream) is especially beneficial for applications requiring surface, and/or dimension, volume, and wherein light for disinfection or detoxification, or purification of surfaces

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having complex curvature is performed efficiently. The UVJET concept is especially beneficial for guiding light therein (in the water, liquid or gas or combination) for wide variety of photo-induced chemistry. More specifically, such treatment may be initiated wherein the jet stream is dielectric, semi-conductive, or super conductive or any combination thereof which may maximize yields and efficiencies in photolytic, photo catalytic, or for advanced oxidation processes involving the formation of radical species (such as OH radicals for example). Furthermore, the methodology of the present invention facilitates the production of a beam containing high energy density zone, producing radical species, offering disinfection and washing in a single action radical may be produced by photolysis of Oxygen or by photo catalytic interactions formed as a result of adding semi-conductor metal oxides, or nano particles or suspension which creates electron pair holes when pulses of light having sufficient e/V are introduced reflecting within the UVJET stream. Furthermore, production of a UVJET wherein high peak power UVA, UVB, UVC pulsed sub-microsecond light is encapsulated within the flowing water stream (according to the methodology of the present invention), enables potent photochemical, photo catalysis, photolysis and photo – electro catalysis processes to be performed simultaneously or separately or sequentially or in combinations. More specifically, using the UVJET hydro-optic reactor architecture both producers and end users benefit. More specifically, no reflective coating or hardware reactor type are needed, no optical elements are required for replacement reducing periodical maintenance and replacement associated with current technologies using heat or ionizing radiation. Furthermore, time domain interactions within the real time flowing liquid waveguide of the present invention may be harnessed and monitored spectroscopically (i.e., in a spatially flexible geometrical variant reactor) architectures, all which are beneficial for programmable computer controlled photochemistry and photo treatment within the real time flowing liquid pulsed light guide the UVJET, VISIJET, X-RAYJET according to the methodology of the present invention.

The present invention provides for agricultural, environmental protection, disinfection, and sterilization, water and medical and biomedical and health related fields and for producing hydro-optical elements for laser industry and markets (hydro-optical means simultaneously processing light and liquid flow dynamics to create unique optical and photochemical effects). Furthermore, the methodology of the present invention discloses a novel architecture wherein lasing may occur without the need for cooling as actual lasing occurs within the flowing liquid being the cooling element itself. More specifically,

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the present invention discloses a novel water laser amplifier facilitating unique set of advantages in two main categories as follows:

The first category relates to the ability to surpass conventional thermal limitation in conventional light sources, for example, actual lasing interaction occurs within the liquid itself acting as cooling element thus no external or integrated cooling units are needed.

The second category relates to the ability to process and offer sterilization of liquids that is not available with conventional thermal pasteurization technologies, especially beneficial for bottled water industries for filling and for sterilization or disinfection of drinks, beverages, and agro-food products such as flavored drinks. The present invention also facilitates biocompatibility and purity required for water and liquids used in the biomedical and pharmaceutical industries or for producing ultra pure water (UPW) for electronic and chip manufacturing industries. The method of the present invention also relates to detoxification and sterilization of surfaces from dangerous bacteria and chemicals contaminating the surface either through normal application or by hostile action (when used not for aseptic filling but for NBC decontamination applications (not shown)). The principle is combination of UV/VIS light with photo catalytic materials in the context of a real time flowing liquid waveguide of the present invention. The chemicals (oxidants, photo catalysts) will be sprayed/scattered (etc.) in the form of liquid solution or suspension stream or droplets or cloud (etc.) from one or more containers, with the light pulses synchronized so that illumination reaches the active chemicals in the right place (at or near the surface) at the right time. Pretreatment of surfaces with non-volatile materials such as TiO_2 , ZnO , etc. is another mode of application of the various components of the invention.

A UVJET according to the methodology of the present invention is having unique variable parameters creating new and exciting spatial optical processing especially beneficial for manipulating light beams having high average powers, and high peak powers or quasi combinations. Such beams as those generated by today's modern lasers may be adequate to form 2nd order interactions such as those created by multi-photon absorption processes.

The methodology of the present invention surpassed current strict limitations by creating a flowing liquid waveguide in real time creatively assimilating hydraulic, pneumatic, electro-optic and photochemical effects simultaneously for purpose of sterilization, photo catalysis, photolysis, especially beneficial for environmental protection applications which

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does not necessarily require the stability and temperature stabilization and optical grade element effecting capital cost of laser engines and reducing the number of component in the beam path. The elimination of conventional optical elements substantially reduces the cost and periodical maintenance and replacements associated with conventional treatment technologies such as heat based sterilization, ionizing radiation and conventional electromagnetic radiation such as eradiation coming from lamps (mercury vapor lamps). Lamps are not generally good candidates for driving the UVJET of the present invention. The principle means for the generation of ultra violet light from lamps is using mercury vapor lamps. These lamps are self limited as they have radial emission, polychromatic wavelength and sport mostly continuous wave type of light. More specifically, conventional UV lamps require reflecting coating for the deep UV which is not available yet. More specifically due to the radial emission of these lamps it is impossible to harness their light efficiently and couple it to the UVJET, unless the light from the lamps is coupled to the jet stream externally or across its cross sections to increase photon flow, fluence rate. In line with the physical limitation of conventional UV lamps wherein the more pressure the lamp carry – the more energy can be produced, but not in the UV part of the spectrum (lamps carrying high pressure output more infra red IR and visible then UV). As pressure is reduced, the lamp produces much more UV, but with no power thus conventional UV lamps are not adequately positioned to operate the UVJET of the present invention classically, however hybrid combination involving sub-microsecond pulsed UV lasers and lamps are indeed beneficial for increasing photon fluence rates and increasing the background light in the jet stream through which pulsed UV laser light is being reflected simultaneously or sequentially or singularly or in combination.

As the limitations imposed by thermal co-eficiencies, and damage threshold prohibit progress in these beneficial research fields such as (a) conventional quantum laser developments, (b) FELs developments, and (c) solid state, diode pumped lasers, in view of current technological evolution taking place, thus involving several key industries the search for economical, industrial optical processing techniques, materials, and production methodologies is ever imminent, and important. The methodology of the present invention provides a unique and creative spatial optical manipulation, guiding, and projecting using a flowing liquid waveguide having a higher refractive index then the space surrounding the liquid flow, thus while in motion guide light therein (i.e. in the jet, stream, fall, flows or combination) for purpose of sterilization or lasing, photo catalysis or photolysis or combination for achieving the photochemical effect desired.

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More specifically, by creating a refractive index profile wherein the flowing liquid refractive index is higher than the refractive index of the air (or gas, or combination) (or gas) surrounding it light is guided within the flowing jet stream. Furthermore the present invention facilitates the formation of high efficiencies in coupling light to surfaces having complex curvatures, and to the simultaneous motion, process co-efficiencies, and beneficiary advantages of washing, and disinfecting in a single action. Such efficient cleaning action and sterilization may be applied to wide varieties of surfaces, substrate materials, including the ability to reach, and cover (i.e. disinfect, sterilize, purify, trigger) complex surface curvatures. Such surface curvatures that can be found in medical tools, instrumentations, and wide variety of accessories from many industries including packaged water products such as bottles and jugs (bottles & 5 gallons jugs for example).

Refractive index value of water generally stands on 1.33 and wide variety of liquids exhibits refractive index which is higher than the refractive index of air, thus light projected or delivered accurately, according to the methodology of the present invention, will be guided through the flowing liquid jet, or distributed to the jet using optical fibers or other solid state optical waveguides or fibers (such as high grade fused silica or synthetic fused silica, HGFS, SFS, or photonic band gap crystals) or combinations. Light may also be diffused prior to entering the jet-stream, within the jet stream or after passing or transferring the jet stream by total internal reflections. For certain application using the UVJET according to the methodology of the present invention, treatment may be applied using the edge, or distal remote tip of the jet stream. For other applications, the UVJET stream itself may serve virtual reactor architecture wherein photochemical, photolytic, or photo catalytic processes and combination interactions are occurring being performed using the methodology of the present invention.

When the liquid is flowing, light coupled to the flowing waveguide is locked, reflecting by internal reflections (TIR). More specifically, the present invention also disclosed a novel methodology for treating surfaces with changing, and/or variable curvature parameters due to the novelty of locking beams of pulsed laser light in jets, falls, and water in motion thus forming geometries (hydraulic, pneumatic, electronic, and, electro optical, and photochemical interactions, and combinations) of water. Furthermore, the inventive creative progress embedded in the textual disclosure according to the present invention describes a novel interaction which further enhances time domain interactions allowing controllable maneuverability from 1st, 2nd, 3rd order optronic, electro-optic, and photochemical and photo biological interactions. A method for the production of catalytic

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liquids, and gasses jet forming plasma driven flowing liquid light guide, and all electro-hydro-photo catalytic devices for use thereof is especially beneficial for the production, coupling, distributing, and applying dose of a predetermined energy levels, within a predetermined space, over a predetermined time, but with the vital inclusion of a refractive index profile which encapsulate the light beams as they propagate throughout the path length of the flowing liquid(s). Furthermore, the invention provides the variable dimension of the specific liquid in motion (i.e. water/air) forming a refractive index therein for keeping, reflecting, and locking the UVB,UVC pulsed laser energy, maximizing its photochemical applications for the benefit and the protection of public health.

More specifically, as an example; the present invention may include photo catalytically initiating protection for inner space of the mouth, or for the removal of pluck formation from teeth or inner cavities sterilization and washing and cleaning simultaneously. More specifically, by forming a catalytic light barrier technology such that creates a "fire wall", or in simple words a hydro-optical drilling and sterilization effects may be produced using the UVJET of the present invention. Such cleaning lightjet for specific dental or periodontal procedures is most beneficial for medical and biomedical industries as it provides 100% electrical safety and extremely high levels of biocompatibility. More specifically, the present invention facilitates the formation of a flowing liquid (water) light guide (using deep UV) for specific photo catalysis interactions, or for photo induced chemistry, or for removing, and dissolving pluck in arteries or tooth, or residues, and for generally applying water and light combined for physio-optical interactions, and for photo-induced chemistry in vivo and in vitro.

The technique of the present invention provides for development of devices wherein no known noxious species may penetrate and replicate, (i.e. bacteria, viruses) and thus have no ability to infect (present invention causing inactivation of their DNA, and RNA replication sequences). The technique of the present invention is especially beneficial for the removal of pluck formation in periodontal treatment, and in arteries, and in keeping maintaining, and repeating triggering photo catalytically, photolytic, or by centilating processes causing appropriate triggering of H_2O_2 , or TiO_2 , or TiO_2/ITO or combination of photo-catalytic semi conductor coatings, or substrates, or surface encapsulation. This treatment provides for oxidizing predetermined noxious species which may inhibit the surfaces curvature, and the deeper layers, and volume surrounding the mouth area, body parts, inlets, or outlets, conduits, and chambers, or surfaces and volumes. With the technique of the present invention, such catalytic, and/or photo catalytic interactions may

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be triggered by a UVJET, or a flowing liquid waveguide able to deliver the right level of dissolved oxygen, stabilize PH, and offer powerful delivery medium for photo catalysis interactions (i.e. such as may be selected according to application requirements, H₂O₂, TiO₂).

More specifically, wherein cuts and sores to body external surface, may cause damage to external body parts/tissues, and thus open the potential for infectious events entering the body, such events introduce potential threat of contamination, and cross contamination through use, and thus the methodology according to the present invention offers the realization and harnessing of advance catalytic oxidation technology facilitating uncontested technological advantages due to the fact that the boundaries of the flowing liquid light guide are reflecting deep UVB, UVC, UVA pulsed laser light thus allowing a specific photon of light to transverse more efficiently to a given geometry, molecule or target organism. Use of the UVJET enhances the probability for 2nd order interaction (i.e. multi photon absorption processes). These non linear effects greatly accelerate the rate of photochemical processes in aqua suspensions, water, or any liquid or gas or combination and surpass limitation of conventional 1st order interaction driven treatment processes currently available using a continuous wave UVA, UVB, UVC (CW) often with polychromatic spectral characteristics, normally offered by CW UV lamps.

The methodology of the present invention utilizes the ability to couple light from sub-micro second pulsed UV lasers operating at high average powers, and high peak powers, often at high repetition rates. Hence, the technique of the present invention does not require optical windows, lenses, and additional optical elements normally associated with spatial optical processing in the UV range, at such high powers (sub-microseconds, yielding high peak powers, ns, ps, Fs, as pulse width PW or time domain).

More specifically, by preparing in advance all relevant parameters for efficient oxidation processes to occur (i.e. such as Oxygen, PH levels, stabilization, and the photo catalysts) in a tight cohesive, and homogenic and/or multi-component system or suspension, the present invention simplifies and guarantees photo catalysis processes in the presence of triggering energy density thresholds. The present invention provides competitive advantages when geometrically utilizing thoroughly space, and time, and light causing sterilization by pulsed ultraviolet (time domain driven) laser light for disinfection of wide variety of medical instrumentation and engineering tools by having the ability to guide light through a flowing liquid waveguide having a higher refractive index therein (i.e. in the jet

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stream, fall, or flow or combinations) then the refractive index of the surrounding space (i.e. air). Such refractive profile thus created (water at 1.33, and air at 1.00) causes light to be guided using total internal reflections (TIR).

The methodology according to the present invention is not so limited, that's why the present invention could be utilized for wide variety of application including but not limited to (a) treatment of ultrasound equipment (b) treatment of medical surgical procedures, (c) Dental treatment procedures, (d) Cosmetic procedures, (e) Gynecological procedures, (f) 1st aid treatment applications, (g) Bulk sterilization of tools and medical instruments, (h) Medical preparation, (i) Transplant procedures, (j) Diagnostic procedures, (k) By-pass operations, (l) Skin, and dermatological treatment procedures, (m) Chemical production sites for drugs, and medicine (n) Rehabilitation centers, (o) Hospitals, (p) Clinics, (q) Operation procedures in cancer treatment, (r) Medical procedures for birth, and pregnancy diagnostics, and treatment, (s) Treatment of burns, (t) Treatment of cuts, bruises, wounds, (w) Treatment of areas exposed to radiation, (x) Treatment of packaging of medical preparation, and drugs production or analysis, (y) Treatment of surgical instrumentation, (z) Treatment of diabetes wounds, treatment of liters, and gallons conduits or chamber containers, and bottles of mineral waters, flavored water, return lines of mineral water containers, beverage conduits, and chambers, washing of ships, transport vehicles, disinfection of devices and tools for the medical fields, instrumentation, and for photo induced chemistry. The UVJET according to the methodology of the present invention is also beneficial for dissolving pluck formation in the main aorta, and for unblocking clogged restenosis and residual compounding volumes in stenting procedures or for enhancing artery cleaning procedures.

The present invention is also beneficial for cleaning applications such as Cleaning vehicles, Cleaning airplanes, cleaning ships, and busses, Lories, and semi-trailers, tankers on land, sea, and air. Further more, several applications illustrated herewith as having best mode for utilization of the methodology of the present invention wherein coupling of high rep rate, high peak powers, high average powers lasers into water is disclosed, eliminating the need to use expensive optical lenses, saving on periodical maintenance, and replacements of devices using the methodology of the present invention.

More specifically, such preferred applications clearly illustrate an important innovative solution wherein the size of the actual triggering light (or energy, and/or energy density) under no circumstances dictate the size of the catalytic "fire", or free radical species thus

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generated by the processes according to the present invention. The present invention provides a novel methodology for hybrid disinfection of surfaces, to disinfection of volumes, to static storage sites, to large installations treating high flow rates or complexes surface curvatures (i.e. 2D/3D) such as appearing to shape modern medical instrumentations, and wide varieties of engineering tools. More specifically, by guiding light in the flowing liquid light guide the high energies which normally (when using conventional optical elements) generate heat, limiting the scope, and power capacities of currently used coupling methodologies, the present invention generate no heat due to the fact that the light is transferring actual cooling element i.e. the water or liquid used. In simple words, the present invention facilitates the coupling of high power laser devices to liquids, and gasses eliminating the need to use conventional HGFS (High Grade Fused Silica, high purity glasses) quartz elements, instead it is possible according to the present invention to utilize water flowing. Given that the refractive index of water, and its transparency, when pure to the UVA, UVB, UVC bands of the electromagnetic spectrum further emphasis the novelty and inventive step of the present invention.

More specifically, the method of the present invention for creating a real time flowing liquid wave guide or photochemistry consists of the following steps: The output from at least one radiation unit having a high intensity pulsed sub-microsecond laser UV light beams is inserted into or coupled to an inlet (input opening) of a hollow aerobic, non toxic, water projection means. The latter is a conduit or a chamber having integral conductive, dielectric, semi conductive or super conductive link, one or more inlet and an outlet launcher shaped for dynamic hydro-optical and photochemical predetermined processing effects. This conduit or chamber has at least one opening un-hindered for passage of liquids and light simultaneously throughout and wherein each opening is equipped with optical input or output having predetermined diameter, acceptance angle and biocompatible or photo catalytically immobilized inner or outer surface area layer or thin film coating and at least one venturi suction point sufficiently large for light to be inserted through said opening passage, and sufficiently small for the liquid to remain inside flowing forward in a continuum of laminar or turbulent or combinations flow formats. A predetermined volume of liquids or gasses or combinations is pumped simultaneously through the inlet of the water projection means to be processed or triggered by the interactions of the guided light. At least one jet stream having a higher refractive index N_1 (at about 1.3) than the refractive index N_2 of air or gas surroundings (of about 1.00), is launching forward simultaneously, such that the jet streams form a refractive index profiles N_1/N_2 with its surrounding, adequate for guiding the pulses of light by total internal

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reflection. The so-obtained UVJET stream is guided or delivering projected and simultaneously fills packaged liquids or undergoes sequential spatial processing, or said pulses and liquid are distributed directionally to a predetermined surface target site or to the liquid package having a refractive index N_3 lower or higher than the flowing liquid light waveguide. The jet stream may contain at least one bubble; delivering a continuum of predetermined volume of said liquids and gases simultaneously to said outlet launcher positioned further along said hollow water projection means at a predetermined pressure volume, or flow rate or combination sufficient for the formation of at least one ventury pressure point at said non hindering opening, eliminating the need to use solid state optical grade elements or lenses, reducing the number of elements in the optical path length from air through water to surface reducing attenuation, increasing damage threshold, reducing periodical maintenance and replacements. A predetermined oxygen concentration, or singlet oxygen species, or predetermined oxidizer, or photo-catalytic semi conductive metal, or metal oxide particles, or nano poruse, or non porous multi-components or semi conductive or dielectric combinations can be added or subtracted to the flowing liquid jet stream proportionately so as to form radical species or for photolytic, or photo catalytically triggering or for directly photo chemically effecting disinfecting, or sterilizing, dissociating, mineralizing or oxidizing, cleaning or decontaminating said liquid or gases or surfaces or combination in a single simultaneous action within a predetermined period of time.

Due to the UVJET ability to deliver light without the thermal limitation quantum conventional lasers suffer from (i.e. generation of heat, subsequent cooling systems currently in use and which increase dramatically the capital cost associated with conventional light sources), the methodology of the present invention may be used for the creation of water based lasers, amplifiers, and spatial processors using a flowing liquid waveguide according to the present invention. Examples include air based catalytic compound oxygen charged and triggered; catalytic globulin mixture wherein its best mode of being triggered is by at least one pulse of light being generated by a high peak power, high repetition rate laser; a catalytic compound lighter or heavier then air being triggered while in transition or drifting, and wherein its catalytic actions produces sufficient free radicals to efficiently dissolve toxic substances, traces, or any liquid or gas or combination containing noxious or poisonous nature; steam type catalytic multi-component compound produced on the ground or from a flying vehicle or plain, or propelled to/from different locations according to needs. Indeed, this is the goal of many scientist, biotechnologists, medical engineers, doctors, and surgeon to have tools for dealing with infectious events

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with the ability to reduce working cycle, periodical maintenance, and replacements, and offer a more efficient treatment methodology thus able to remedy larger portions of the population in need, and to offer enhancement to currently available socio-economical performance. The method according to the present invention presents competitive advantages, and important saving benefits especially for medical, biotechnological, hospitals, clinics, and agricultural, and industrial applications, thus enhancing the quality of life in the human sphere by having the ability to use the method of the present invention to create devices able to wash, and disinfect simultaneously. (Such that are illustrated by the UVJET, or flowing liquid waveguide, or spatial processors for the deep UVC from water).

Furthermore, the methodology of the present invention provides for a real time treatment methodology by pulse power triggering of photochemical, and/or photo-catalytically surface treatment processes, and further penetrative techniques (using surface treatment to trigger volume treatment). It is already known in theory that every material may oxidize or break down if energy is applied to it, having at least equivalent amount of energy as the one holding it's molecules and atoms together.

The methodology of the present invention provides for several techniques for performing light TIR (Total Internal Reflections, i.e. guiding light in the flowing stream of the liquid), offers the ability to keep operating equipment use in medical procedures safe at all times, and eliminates the need to replace expensive optical elements. The methodology of the present invention is also offering much quicker turn over, shorter working cycle, and the ability to ensure high level of biocompatibility, while turning noxious species on the surface of said medical instrumentation into more innocuous sources.

The present invention provides manageable forms in real time, especially beneficial for clean and safe ultrasound procedures (examples include: in biomedical applications, or in monitoring pregnancies) using photo catalytic water based carbomer coupling gel, and for the protection of wide variety of medical instrumentation using the UVJET according to the present invention. More specifically, equipment peripherals (such as ultrasound accessories or probes) could be washed, and disinfected/sterilized using the method of the present invention.

The method of the present invention is a non chemical, non residual treatment technology. By using a photo catalytic compound made out of water, silicon, and photo catalytic material, such as TiO_2 , for example, the present invention provides for treating

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wide variety of surfaces (of medical instrumentation) in short time facilitating the formation of workstations. Devices using the method of the present invention provides for transferring pulsed laser light to a remote receptive interface, activating photo catalytic agent therein (in the coupling solution used). More specifically, the methodology of the present invention is using Ultraviolet light from about 200nm to about 400nm to activate the photo catalytic agent present in a water based coupling gel (normally made out of silicon/water solution). By exposing the thin film coating left on probes, and ultrasound accessories, or body parts externally wounded, or for cuts, to a plurality of laser pulses in the region of the UVA, UVB, UVC, the present invention triggers the thin film catalytically, and thus photo catalytically inducing beneficial photochemical processes (for example disinfection, and sterilization), thus purifying, disinfecting, and inactivating noxious species on the plurality of surface described above (i.e. such as the surface of the medical instrumentations, wounds, cuts, sores, or externally damaged body surfaces). Furthermore, according to the method of the present invention the laser pulses having germicidal wavelength, and sufficient e/V energy for the specific treatment required for a particular application provide mild dissociation effects and are beneficial for providing an active source of hydroxyl radicals (i.e. OH^* radical species) to offer photo catalytic solution in the field, or in disaster areas, or in places wherein the population is exposed to unexpected conditions dictating medical procedures to be performed without the infrastructure normally associated with hardware equipment for disinfection (I. Such as autoclave, ovens, Gamma rays, Radio waves, X-rays, microwaves, heat, cold, Sonication).

The present invention provides for forming a flowing real time liquid wave guide for the delivery, and distribution, spatial processing and manipulation of pulsed UVA, UVB, UVC lasers operating at high powers for the purpose of disinfecting surfaces, volumes, spaces, and substrates, inner surfaces of containers, and wide variety of tools, instrumentations, and devices in medical, engineering, agricultural, and industrial washing and disinfecting simultaneously. Photo reactive disinfection of surfaces and beneficial disinfection, and treatment of wide varieties of medical instrumentation is possible using the method of the present invention. Additionally, it would be a preferred mode of operation to cover the washed, disinfected, sterilized and/or treated surfaces items using a thin-film coating, and activation on the surface of wounds, cuts, bruises, sores, damaged parts of external body surface), and in air, such as when infectious events may pose threat to humans, animals, and plants. Furthermore, by integrating into high purity water enriched with oxygen, and mixed with catalytic powder, or liquid, or gas, or light, the methodology of the

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present invention facilitates the formation of active free radical layer swiftly making the surface curvature/proximities sterilized. Noxious species on said surface are then inactivated, thus the surface is been made safe from infectious events, (bacteria, viruses, and other health threatening noxious species). The present invention is extremely beneficial for much medical application hence there are no need for actual physical touching, tiring, or swiveling of tissues, or there is no need for physically interfering with an already sensitive, and often critical medical treatment scenarios. The present invention facilitates the formation of a free sterilized zone extending to reach the entirety of the spread of said catalytic compound, naturally in line with environmental conditions such as wind, air compound, PH levels, dissolved Oxygen and other factors effecting photo catalysis quantum yield of efficiency.

Disinfection, purification, and sterilization and photo-treatment by Ultra Violet light technology is well known. This technology is preferred due to its non residual, non chemical, and effective (wavelength range from about 220nm-357nm) inactivation of DNA & RNA replication sequences in wide variety of noxious species (such as bacteria, viruses, Cysts, and Pathogens).

The present invention is aimed at environmental protection, and the protection of public health, and tools associated with domestic industrial, medical, engineering and environmental fields. Coupling light non invasively into the flowing jet stream of liquids, and gases using pulsed power optronic technology in the UVA/B/C electro-magnetic spectrum, and associated hydro optically resolved and aligned peripheries, provides for no need of the conventional optical elements. The driving principle behind the technology is synchronized control of the time domain, and facilitating an interactive variable platform for guiding light, and for spatially processing light therein (i.e. in the jet. When appropriate dose of light is delivered into specified water forming flanged geometry, or predetermined surface area causing specific electro optical, and photochemical effects in said water, and the target contacted by the jet/beam extension, the method of the present invention offers simultaneously washing, disinfecting, sterilization, and dissociation capabilities in a single simple, creative platform, surpassing limitation imposed by the use of conventional optical grade lenses, and elements, eliminating thermal limitation, maximizing time domain interaction in the liquids, and gasses thus delivered, flowing through, or utilized therein (in the jet stream or flowing water).

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More specifically, the present invention discloses a novel methodology for harnessing a multigradient refractive index profiles causing light in the relevant germicidal spectral regions to stay locked, guided, and reflected within the water of the get, stream, falls, sprinklers, or shower tub, or filtration system, especially beneficial for water treatment of drinking, wastewater, aquaculture, and water reclamation, water recycling, and water purification workstation driven applications and platforms. The present invention could be further utilized for surface disinfection, and purification, and for dimensional coupling light from about 1 mJ, to about 1 mw/Cm2 regime to the TW/Cm2, average power, and to peak powers reaching up to hundreds of billions of watts in cross sectional energy densities, and such high intensities are coupled to water according to the methodology of the present invention harnessing the quality of life through implementation of total bio-security for water and air, and other liquids and gases.

The present invention facilitates efficient socio-economical treatment platforms for the protection of public health and the environment by facilitating the catalytic formation of radical species (such as OH^*) barrier technology (CFRS, ref 3 a-z), a layer which upon triggering turns to “fire wall” (thus preventing passage through of noxious species due to the short duration of time $[\text{Fs}]$ in which the catalytic processes occurs) made out of multiple layers of highly radical species, lasting extremely short fraction of time, for the purpose of forming photo reactive layer wherein the preferred mode for advance Catalytic Oxidation, Electro catalytic Oxidation, photolysis, and photo dissociation (of upper surface layers of medical instrumentation, as well as actual damaged tissues of the Human body) occurs, the present invention by guiding light in a real time flowing liquid wave guide offers many advantages, remove thermal limitation, and provide an important socio-economical benefits helping protect mankind, and its environment.

More specifically, the present invention facilitates the provision of a protective photo reactive barrier technology (PPRBT), by means and utilization of light, liquid, gasses, and optronic time domain triggering (such as can be produced by high peak power high rep. rate UV lasers), increasing the probability for multiphoton absorption processes to occur, assist and expand spatial characteristics and conversion procedures wherein a specific wavelength is desired, for specific application. By introducing additional oxidant, oxidation agents, and reactive species, photo reactive scintillating, or fluorescence species so as, these in turn are non linear in nature, and cause dramatic increase in the efficiencies and co-efficiencies associated with effective photo treatment, and disinfection, sterilization and

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bio-security in wide variety of environmental, agricultural, medical, and commercial, domestic, and municipal treatment applications.

While disclosing a creative solution to couple high intensities into the spatial characteristics of the continuum jet water virtual reactor geometries, the method of the present invention offers a methodology for cases wherein external cuts may hinder physiological activity, and may lead for infection, or further complications. Further more, the present invention facilitate photo treatment of surfaces faster then any previous methodology in the field by using photo catalysis, electro catalysis, and hybridization techniques. The novel methodology of the present invention facilitates the protection of large areas from harmful effects of contact with bacteria, or from contact with noxious or poisonous species.

By calibrating the action spectrum (i.e. absorption, transmittance, transparency, refractive index, or refractive index profile of the air/body, air/instrument, liquid or gas encapsulating layer (i.e. the layer “barrier between the surface of the actual instrumentation or body surface, and entering/triggering beams of pulsed light, and the required coupling of light to the surface to be treated, thus taking into account specie specific wavelength interactions of the laser light (source used in accordance with the methodology of the present invention), the present invention offers economical solution using energy efficient methodology, and extremely safe operation procedures, requiring no skill operators, or special complex hardware procedures. The method of the present invention is simple to implement, and includes fully automatic procedures management, so easy integration into already made set up is simplified, and conserve time and energy during integration, installation, and operation procedures.

More specifically, the method of the present invention by using for example, a pulsed, high repetition rate, high peak power laser light sources, facilitates the formation of high energy density zone through which liquids, or gasses carrying contamination, or may be penetrated by invading antigens, are thus treated according to the methodology of the present invention.

One best mode among the many utilizing the method of the present invention is especially beneficial for disinfection of wide variety of medical instrumentation.

Further more, the methodology disclosed by the present invention offers solution for medical procedures requiring short working cycles, and thus offer important benefits in

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terms of shorter duty cycles, faster processing time, safer inactivation/dissociation effectiveness, and important capital savings due to the novelty of the methodology of the present invention for photo catalytic protection of medical instrumentation or surfaces, or dimensions, or volumes by using UVA, UVB, UVC light produces by high repetition rates, high peak power lasers, lamps and wide variety of hybrid integrations.

The method of the present invention also relates to detoxification and sterilization of surfaces from dangerous bacteria and chemicals contaminating the surface either through normal application or by hostile action (when used not for aseptic filling but for NBC decontamination applications (not shown). The principle is combination of UV/VIS light with photo catalytic materials in the context of a real time flowing liquid waveguide of the present invention. The chemicals (oxidants, photo catalysts) will be sprayed/scattered (Etc) in the form of liquid solution or suspension stream or droplets or cloud (Etc) from one or more containers, with the light pulses synchronized so that illumination reaches the active chemicals in the right place (at or near the surface) at the right time. Pretreatment of surfaces with non-volatile materials such as TiO₂, ZnO etc is another mode of application of the various components of the invention.

Modern technology has failed to provide adequate coating techniques able to provide efficient reflection for commercial applications. Furthermore, most coating reflective efficiencies often not exceeding the 30% mark respectively when wavelength is below the 270nm. As progress in microelectronics, hydraulics, laser pumping architectures, cooling, pneumatics, and photochemistry yield more accurate diagnostic tools, and software based ray tracing and time analysis, the methodology according to the present invention disclosed a novel proven conceptual design criteria, not available before in any conventional reactor design's historical track record. The method of the present invention which surpasses these limitations imposed by conventional technologies is making available to engineers, producers, scientists, and end users, managers and quality controllers a flowing light guide with plasma coupling centre facilitating efficient light coupling to variable changing refractive index profile driven virtual reactor geometry made out of water, or liquids and gases combinations. This unique coupling ensure optronic efficiencies not available in conventional lenses driven coupling optics (ref 1:A-Z) wherein high average power, high peak power, intensity driven UVA,UVB,UVC pulsed laser photo induced chemistry is efficiently generating free radical species, or oxidizing, or dissolving and/or dissociating and wherein the actual flowing liquid light guide is made of or complimented with or mixed with photo catalytic substances, and elements which once

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activated greatly increase the efficiencies associated with the photochemical task or application device interoperability and interconnectivity needed to achieve repeatable, standardized operation. Such operation is aimed at the protection of public health, and the environment.

The method of the present invention is especially beneficial for environmental protection applications such as: Sterilization of surfaces and volumes, tools, and interfaces, devices, and global system methodological architectures, disinfection, laser beam management, lithographic processing and optical spatial processing for the deep UV. Such applications may include the need for thermal management, and temperature gradient which may effect material selections, procedures, and design criteria's. The methodology of the present invention may be used to solve many industrialize, agricultural, domestic, medical, infrastructural, economical, and technological challenges given the fact that the cooling element itself (the liquid, gas combination) is the medium in which the light propagates thus substantially increasing cooling efficiencies associated with the need to evacuate heat from a predetermined area, space, volume or boundaries of conventional optical elementals (such as used in conventional disinfection reactor geometries orientations.

The technique of the present invention can advantageously be used in the production of multiphoton absorption processes, and thus provides solution in water and aquaculture treatment sites, mass production of bottled mineral waters, microlithography applications, chip manufacturing sites (water, air, lithographic, TOC reductions, TX reduction, UPW) and food, drink, and beverages industries. The methodology of the present invention also increase the efficiencies associated with conventional treatment technologies and surface and volume photo treatment applications. Further more, the type of free radical species (OH*) which accelerates the reaction rates during treatment operation are produced according to the methodology of the present invention in a controllable, amplified, logged, and monitored multiprocessing reaction processes forming a platform for unique high intensity radical jet trajectory spatial workstation in situ with fusion abilities to produce high intensity radiation within a predetermined space and/or variable liquid or gas geometries over a predetermined period of time.

Recent activities in solid state electronics, lasers, and advanced polymer for optronic, laser pumping architectures, all have contributed to production of light sources small enough to be incorporated, or integrated into system in close proximities to bottles, lids,

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corks, packaging production processes, and wide variety of packaging for foods, drinks, and many biotechnology products, and applications. More specifically the benefits of the method according to the present invention may be implemented in many treatment applications of water, or air, aquaculture, and UPW, drinking, recycling, reclamation or beverages, and mineral water production sites. The methodology of the present invention implements evolution of waveguide technology, and production techniques for creating refractive index profile design in flowing liquid waveguide for partial, or total internal reflection therein for equalizing the concentration of bacteria, viruses, cysts, pathogens, or biological, or organic, non organic, or toxic or noxious species therein (in the flowing liquid “virtual” reactor geometries). Major benefit according to the methodology of the present invention is wherein the flowing liquid light guide is providing in situ continuous cooling to prevent thermal damage to system elements.

The method of the present invention also relates to detoxification and sterilization of surfaces from dangerous bacteria and chemicals contaminating the surface either through normal application or by hostile action (when used not for aseptic filling but for NBC decontamination applications (not shown). The principle is combination of UV/VIS light with photo catalytic materials in the context of a real time flowing liquid waveguide of the present invention. The chemicals (oxidants, photo catalysts) will be sprayed/scattered (Etc) in the form of liquid solution or suspension stream or droplets or cloud (Etc) from one or more containers, with the light pulses synchronized so that illumination reaches the active chemicals in the right place (at or near the surface) at the right time. Pretreatment of surfaces with non-volatile materials such as TiO₂, ZnO etc is another mode of application of the various components of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, preferred embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic illustration of a real time flowing liquid waveguide according to the invention for guiding UVA, UVB, UVC light from a water projection means to produce a UV jet stream;

Fig. 2 exemplifies a system utilizing the technique of the present invention;

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Figs. 3A and 3B illustrate devices formed of an array of UV-jet for aseptic filling using the method of the present invention;

Fig. 4 shows a cross sectional view of a device of the present invention for photochemical treatment through a jet stream of light transmitting liquid; and

Fig. 5 illustrates the use of the present invention in a hydrodynamic nozzle projecting a liquid jet stream having a trajectory terminating on a target site.

DETAILED DESCRIPTION OF THE INVENTION

The present invention discloses a novel methodology for creating a real time flowing liquid waveguide or photochemistry.

Referring to Fig. 1, there is schematically illustrated a device **100** according to the invention presenting a real time flowing liquid waveguide for guiding pulsed UVA, UVB, UVC light from a water projection means producing a UV jet stream. The device **100** comprises an elongated (tube-like) hollow body of the UVJET water projection means **1** having first and second inlet ports **2** and **4** and an outlet **14**; and a hollow conduit **5** (full of air, or gas) installed in the body **1** so as to project from the body **1** by its pre-pipe portion **6** and define a region **9** inside the body **1** where substances coming from the conduit **5** and the region of the body outside the conduit meet each other. The inlet **2** has the appropriate outer rim diameter (e.g, smaller then the 5-gallon container inlet/outlet) and serves for receiving a laser beam **8** (UV radiation) propagating from a laser device (not shown) in a direction **7** towards the device **100**. Here, the laser beam is considered as an output of the laser of a diameter containing 86% of the output power. The inlet **4** serves for inputting water (or another liquid or liquid and gas combination). In the region **9** of the body **1**, the UV radiation is coupled to the water stream and this UVJET stream is output from the body **1** through the outlet **14**. The water inlet **4** is positioned further along the jet length so as to form venturi pressure where pulsed up laser beams of light are coupled to the UVJET. The laser pulsed UV radiation have energy per pulse of between 1mJ to about 10 Js. The laser radiation is preferably of about 266nm wavelength and is trajected, or projected or guided so as to reach the flowing liquid waveguide outlet accurately, thus being launched into the flowing jet-stream. Once water is pumped at the jet inlet at the appropriate pressure forming venturi pressure, preventing the water from spilling out of the jet, simultaneously the laser beam is coupled to the guiding pre-pipe, reaching the jet-stream as it is output the UVJET body, thus forming a flowing liquid waveguide due to the fact that the refractive index of the flowing water (real time) is higher (1.3) then the

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refractive index of the surrounding air (1.00). Thus, the output **3** of the device **100** is a water-UVJET stream flowing in air.

The time domain optronic (i.e. sub-microsecond pulse durations) sees the water as standing, thus guiding light, resulting from the Total Internal Reflections (TIR) of laser radiation, through the UVJET flowing stream of water can advantageously be used for washing and disinfection of mineral water 5-gallons containers, bottles, and wide variety of surfaces, volumes, conduits, and chambers in industrial, agricultural, medical, and environmental and industrial disinfection and purification applications, or in places wherein washing and disinfection/sterilization is required simultaneously to save energy, time, and duty cycle, conserve energy, and increase efficiencies, and protect public health and the environment.

The technique of the present invention provides a novel methodology for creating a real time flowing liquid wave guide or photochemistry. The laser (generally, at least one radiation unit) suitable to be used in the present invention is preferably a high-intensity pulsed sub-microsecond laser generating UV light beams from 1mJ per pulse to about 10Js per pulse at wavelength of about 266nm and at pulse repetition rates of between 1Hz to about 100MHz. The conduit or chamber **1** is aerobic non toxic water projector integrated with at least one dielectric, semi-conductive or super-conductive link or interface, having at least one inlet **6** (generally, water and light can be input through the same inlet), the outlet launcher **9** shaped for dynamic hydro-optical and photochemical predetermined processing effects, and at least one opening **14** un-hindered for passage of liquids and light simultaneously throughout. Each of these openings in the chamber **1** is equipped with optical input or output having predetermined diameter, acceptance angle and biocompatible or photo catalytically immobilized inner or outer surface area layer or thin film coating and at least one venturi suction point sufficiently large for light to be inserted through said opening passage, and sufficiently small for liquid to remain inside flowing forward in a continuum of laminar or turbulent or combinations flow formats. A predetermined volume of liquids or gasses or combinations is simultaneously pumped through the inlet (**4** in the example of Fig. 1) of the water projection means to be processed or triggered by the interactions of the guided light. The jet stream (at least one stream), having a higher refractive index (N_1) of about 1.3 than that of air or gas surroundings (N_2 of about 1.00), is launched forward simultaneously such that the jet streams form a refractive index profiles N_1/N_2 with the surrounding, adequate for guiding pulses of UV light by total internal reflection. The UVJET-water stream is guided or delivering projected and simultaneously fills packaged liquids, or allows for sequentially

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spatially processing the pulses of light and liquid therein, and the pulses and liquid are throughout or distributed directionally to a predetermined surface target site or to the liquid package having a refractive index (N_3) lower or higher than the flowing liquid light waveguide (namely higher than N_1 and N_2). The jet stream may contain at least one bubble. A continuum of predetermined volume of the liquids and gases is simultaneously delivered to the outlet launcher positioned further along the hollow water projection means, at a predetermined pressure volume and/or flow rate sufficient for the formation of at least one venturi pressure point at the non hindering opening, thereby eliminating the need for solid state optical grade elements or lenses, reducing the number of elements in the optical path length from air through water to surface, reducing attenuation, increasing damage threshold, reducing periodical maintenance and replacements. A predetermined oxygen concentration, or singlet oxygen species, or predetermined oxidizer, or photo-catalytic semi conductive metal, or metal oxide particles, or nano porous, or non porous multi-components or semi conductive or dielectric combinations, is added or subtracted to the flowing liquid jet stream proportionately so as to form radical species, or to cause photolytic or photo catalytically triggering or to directly photo chemically affect disinfection, or to sterilize, dissociate, mineralize or oxidize, clean or decontaminate the liquid or gases or surfaces or combination in a single simultaneous action within a predetermined period of time.

The method of the present invention also relates to detoxification and sterilization of surfaces liquid or gases from dangerous bacteria and chemicals contaminating the surface (or volume) either through normal application or by hostile action (when used not for aseptic filling but for NBC decontamination applications (not shown). The principle is combination of UV/VIS light with photo catalytic Materials in the context of a real time flowing liquid waveguide of the present invention. The chemicals (oxidants, photo catalysts) will be sprayed/scattered (Etc) in the form of liquid solution or suspension stream or droplets or cloud (Etc) from one or more containers, with the light pulses synchronized so that illumination reaches the active chemicals in the right place (at or near the surface) at the right time. Pretreatment of surfaces with non-volatile materials such as TiO_2 , ZnO etc is another mode of application of the various components of the invention.

At least one UV beam of pulsed sub-micro second laser light from at least one radiation unit, having a high intensity peak power source of light, is inserted into or coupled to at least one venturi input of a biocompatible UV water or liquid jet projector means. One or

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more pulsed UV laser beam can be fiber driven to or directly exposing one or more inputs (e.g., array of such inputs). The JET streams from liquid or water has a refractive index N_1 of around 1.3 (e.g., $N_1=1.33$). A predetermined volume or flow rate from this water or liquid jet stream (N_1) is projected forward hydro dynamically and hydro-optically into air having a refractive index N_2 of about 1.00, and then onto a certain surface (target) having refractive index N_3 , such that the water or liquid jet stream has sufficient geometrical angular integrity to form a refractive index profile with its surrounding air or gas. The sub microsecond pulsed UV beams are guided therein and throughout by total internal reflection TIR forming high energy density zones (HEDZs) increasing fluence rate and geometrical utilization of the jet stream. The water or liquid, air or surface or combination is exposed to a predetermined spectral distribution over predetermined space over a predetermined period of time from the radiation unit for processing said water or liquid, air or surface to be cleaner more hygienically orientated, biocompatible ensuring more innocuous, more manageable form eliminating noxious species. This technique is especially beneficial for performing aseptic filling and for washing and sterilization of complex surface curvatures simultaneously on a single platform, as well as especially beneficial for defense applications wherein washing and sterilization and advanced oxidation processes are interwoven into the interoperability and interconnectivity of the UVJET platform according to the methodology of the present invention.

The present invention eliminates the need to use hardware type reactors, such as cylindrical conduits or chambers for photochemistry and thus saves on reflecting coating of inner surfaces. The present invention eliminates periodical maintenance and replacement associated with conventional optical elements. By eliminating the use of conventional optical elements such as lenses which are subject to damage threshold optically, the method of the present invention discloses means by which UVJET devices using the method of the present invention perform photolytic and photo catalytic processes thus increasing biocompatibility and processing ability therein (in the UVJET, or throughout the UVJET, VISIJET, or EX-RAYJET), or combination thereof.

The present invention reduces and eliminates the need to use conventional optical elements, hence the venturi pressure and suction point at the back of the UVJET water projection means of the present invention. By manipulating the pressure above a certain threshold the pulsed UV laser beams are inserted at the center of the venturi point thus no lenses are required and no additional optical grade elements are needed, no liquid is spilled out due to the venturi suction. This ensures that the periodical maintenance and

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replacements associated with conventional sterilization methodologies have been substantially reduced using the method of the present invention and a more streamlined optical design (such as that of the UVJET) contains much less optical elements in the beam path reducing losses and removing the barrier of damage threshold allowing the use of much higher average powers, peak powers or combination thereof.

The radiation unit may include an Argon laser, namely, a laser filled with argon gas. It gives off green and blue light. The strongest lines are at 514 nm (green) and 488 nm (blue). Argons range from small 15 milliwatt 110 volt air-cooled models to large 50 watt 440 volt water-cooled systems. Argon lasers are the most common type of light show lasers since they provide unbleached brightness at a reasonable cost.

The radiation unit may include an axial-flow laser, which is the simplest and most efficient of the gas lasers. An axial flow of gas is maintained through the tube to replace those gas molecules depleted by the electrical discharge used to excite the gas molecules to the lasing state.

The radiation unit may include a Co₂ laser, which is widely used in industry and in which the primary lasing medium is carbon dioxide.

Most laser welding is done with a shield of inert gas flowing over the work surface to prevent plasma oxidation and absorption, to blow away debris, and to control heat reaction. The gas jet has the same axis as the beam so the two can be aimed together.

The present invention may utilize coherent light, namely radiation composed of wave trains vibrating in phase with each other. Coherent light waves all travel the same direction (spatial coherence) at the same frequency and in phase (temporal coherence).

Depth of field (namely, the working range of the beam, a function of wavelength, diameter of the unfocused beam, and focal length of the lens) is adjusted to achieve a small diameter spot size, and thus a high power density. To this end, a short depth of field is accepted.

Water laser in the context of the present invention means the creation of lasing in the water (i.e. while flowing), thus harnessing the flowing liquid wave guide for the formation of a flowing light guiding cavity which could be utilized to create a water laser.

Photochemical effects in the context of the present invention means effects that occur from long exposure durations at incident power levels insufficient to cause damaging

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photo thermal effects. It is an energy dependent process (a function of the total quantity of radiation absorbed rather than its rate of absorption).

Currently, solid-state lasers are too expensive for most light show uses. This may change over the next few years. The most promising solid-state laser uses a material called nd:YAG, which produces infrared light. This can be frequency doubled (second harmonic generation) to produce up to 60 watts of green light at 532 nm. The green light can again frequency doubled (fourth harmonic generation) to produce up light at 266 nm, up to several watts.

A medium (environment) to be processed (treated) by the technique of the present invention may be the content of a bottle, conduit, or chamber, for example such as beverages, wine, medical preparation, juice, drinking water, mineral water, insulin products or medical preparation. Spring water, flavored water, flavored beverages, biological traceable compounds, Drug delivery using water based, and/or expanded or flavored water drinks containing vitamins or nutrients, alcohol, blood products, plasma products, air products, gases for propelling medications, sprays, or any liquid or gasses or hybrid combination thereof.

The present invention may utilize a high peak power laser of the Nd:Yag, or Nd:Glass, or Nd: YLF, type or any combination thereof driving the UVJET, or spatially processing pulsed laser light therein, or throughout, or triggering advanced oxidation processes using oxidizers, or using photo catalytic components such as metal oxides (TiO₂, ZnO₃, ITO), or predetermined concentration of singlet oxygen, or oxygen concentration, or O₃ ozone, or peroxide or combination and operating in the Fourth Harmonic generation mode (i.e. FHG).

A solid state laser (i.e. Nd: Yag type for example), working in the Third Harmonic Generation mode (i.e. THG), may be utilized. An electrical discharge laser such as an excimer laser operating in wavelength from about 193nm to about 308 and 351nm, can be utilized.

Each of the pulses of light is aligned into the content of the bottled liquids or gasses for purifying, disinfecting, and ensuring that DNA, and RNA replication sequences are thus inactivated, providing a non invasive disinfecting methodology wherein light pulses from the laser are penetrating the material from which the bottles, (i.e. conduits or chambers, or bottles, or pipes) are made.

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A preferred mode for operation of the UVJET is wherein the wavelength of the pulsed sub microsecond laser is about 266nm, and wherein energy per pulse is from about 1mJ to about 10 Js, and wherein pulse repetition rate is between about 1Hz to about 100MHz and wherein repetition rates or energy density or cumulative energy per Cm², or average energy or peak power is selected to fit different applications requiring different doses of energy, and subsequent different volumes of liquid to be simultaneously delivered using the methodology of the present invention.

Generally speaking, the laser light source is selected from the following: gas discharge laser, diode pumped lasers, plasma discharged lasers, solid state lasers, semi conductor lasers, crystal type of lasers, X-rays pumped lasers, E-beam pumped gas lasers types, or any combination thereof.

Free Electron Laser (FEL) amplifier), or Electrostatically Accelerated Free Electron Laser (EAFEL), or organic laser types or any combination thereof can be used.

The laser light source may be tunable from about 1nm to about 3000nm, or from about 333nm to about 360nm. The peak power density of individual pulses reach from about 1nJ/Cm² to about 50Js/Cm². The pulsed laser light source may pulse at repetition rates from about 1 Hz to about 300MHz.

The present invention is suitable for wide ranging application involving different packaging materials, thus their specie specific optical calibration standards are calculated for a specific biodosimetric value or curve to appropriately correspond (being lower) with damage threshold of the substrate material used in a specific application, or tool, or device.

Examples of using the present invention especially beneficial for biomedical application, dentistry and periodontology applications aimed at implementation and for improving the hygiene of the mouth, may include the following: harnessing the illumination or irradiation of a wave guiding dielectric brush [WDB] containing a sub-miniature version of the UVJET of the present invention. Light is delivered to the UVJET via optical fibers or via direct optical stirring means embedded in an integrated arm having delivery capacity from about one quarter of a million of photons per Cm²/Second to about 999 trillion photons per Cm²/second. Light is delivered to the brush via at least one optical fiber waveguide delivering at least one pulse having peak power or pulse width of between about 7 picoseconds, to about 100 Femtoseconds. Such a brush may be driven via direct laser exposure to its

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input. The brush may be comprised of a plurality of sub-miniaturized jets according to the invention. Such brush may take the form of a UVJET, visijet, ex-rayjet, or any combination thereof. This is especially beneficial for dentistry applications and for periodontology for purpose of cleaning plaque formation and for sterilizing and cleaning, washing and disinfecting the inner cavity space and root canals of the mouth or teeth.

The operation of the UVJET may include coupling of high intensity sub-microsecond pulses of laser light to the venturi suction of the water projection means (UVJET, VISIJET, EX-RAYJET, IRJET, NIRJET), such that no conventional optical elements are required. The EMJET is driven by at least one pulse having wavelength of about 266nm and pulse duration or width extending from about 0.1 microsecond to about 100 Attoseconds, with the pulse repetition rates extending the range from between 1 Hz to about 1GHz (one hertz to about one Giga hertz) to suit adaptation of the real time flowing liquid waveguide to different applications in accordance with the methodology of the present invention. Another suitable mode for operation is wherein light is diffused prior to entering the venturi input suction or light is diffused on entry to the JET stream, or during transversing of the jet stream, or at the end of the jet stream or any combination thereof. Yet another mode for operation is wherein multi line laser is coupled to the jet such that more than one wavelength of light may be used simultaneously. This is beneficial for triggering photo reactive components in the jet stream, or for optical marking of the treated area, especially when treating surfaces.

An array of UVJET may be driven by at least one high intensity, high repetition rate laser engine for providing aseptic filling for the bottled water and agro-food industries replacing conventional heat based pasteurization processes, reducing their capital costs and providing substantial reduction on periodical maintenance and replacements. Using wavelength of about 266nm which sits right on the most sensitive action spectrum of DNA (i.e. the Thiamin base in DNA Davidson et al 1969), provides for aseptically filling, washing and disinfecting simultaneously bottled water, flavored water, beverages, juices, drinking water, water for washing, water for cooling, water for heating, blood and bodily fluids (when sub-miniaturized devices using the method of the present invention), for chemical plants, for pharmaceutical production lines, desalination plants, water treatment plants, metropolitan areas in need of cleaning and sterilization from biological contamination, surface areas in need of advance oxidation treatment (AOT).

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Advanced Oxidation Technology (AOT) processes for treatment of liquids, gases and surfaces such as applying hydrogen peroxide (H_2O_2), ozone, electron beam, UV light etc. are well known. A wide variety of organic contaminants and noxious species of biological origin can be oxidized by AOT. AOT of organic pollutants usually involves hydroxyl radicals as active intermediates, although biological systems may be inactivated by active excited states produced upon direct or indirect light absorption (photosensitization). Photocatalytic oxidations using metal oxides such as TiO_2 for decontamination have drawn considerable interest in the last decade for the purpose of cleaning surfaces, water and air.

It is well known that addition of H_2O_2 to suspension of TiO_2 in water, may improve the photocatalytic oxidation efficiency. This results from the conversion of TiO_2 electrons to OH radicals, thus increasing the yield of $\cdot\text{OH}$ by both retarding electron- $\cdot\text{OH}$ (or hole) recombination and supplying additional $\cdot\text{OH}$ radicals by the reduction of H_2O_2 . (Upon accepting an electron the H_2O_2 molecule dissociates into $\cdot\text{OH}$ radical and hydroxyl ion (OH^-)).

Although many AOT seem to be highly promising for practical applications, the combination of yields, process rates and cost require improvement of processes efficiency, stability and reproducibility. It is widely accepted that without such optimization, commercialization of the promising technological principles will not be forthcoming. More specifically, substantial resources have been assigned to try and locate materials and techniques for improving the geometrical utilization efficiencies in conventional advanced oxidation and photocatalytic reactors.

The present invention concerns the combination of UV light with other advanced oxidation processes, applying, for example, 266 nm laser UV light at relatively long distances or at hidden volumes and surfaces.

Furthermore, attempts to use materials such as HGFS (High Grade Fused Silica) SFS (Synthetic Fused Silica) or other thin film techniques as light guides often foul as these often get clogged or can be covered by colloidal deposit and hard water mineral deposits causing hot spots and deterioration of optical performance.

Such deterioration does not occur using the methodology of the present invention as it is the UVJET boundaries (water/air) which are used to reflect light within the jet stream itself making a virtual reactor type, not hindered by conventional material limitations.

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Furthermore, the water jet involves continuous renewal of the liquid/air interface and therefore contamination and foul of the surface is minimized. Furthermore, research and commercialization works conducted to date in the arena of advanced oxidation and photocatalysis often use UV lamps requiring optical elements, which are themselves subject to damage threshold and deterioration of optical performance after prolonged use, or wherein the energy density is high. The method of the present invention surpasses these limitations by inserting high power pulsed sub microsecond UV laser light into the venturi suction point on the water projection means such that no conventional optical lenses or optical elements are needed. This increases the energy, which can be coupled to a single platform and remove damage threshold limitation.

An oxidizer such as H₂O₂ and/or photocatalyst materials such as TiO₂, ZnO, ITO (XXdelete ITO) and other semi-conducting metal particles or suspension can be added to the real time flowing liquid waveguide prior to, during, or after or in combination to the launching of the UVJET stream into air, or wherein directionally applying said UVJET stream onto a predetermined surface target site. This allows the methodology of the present invention to activate or initiate the oxidation or photocatalytic processes within the jet stream, or (better) at the tip of the jet stream for surface or volume treatment. Light can be introduced into the jet or be projected externally at specific point along the jet stream. When UV laser pulses are introduced (sub-microsecond pulsed UV laser beams for example) to the flowing jet stream bouncing and reflecting within the jet stream by total internal reflection TIR due to refractive index of liquid being higher than that of the surroundings.

As a result of the refractive index profile thus created, UV pulsed laser light undergoes multiple reflections within the jet stream, which contain the oxidizers or photocatalyst materials, and thus within the angular limitation for the coupling and delivery or guiding of light therein, the method of the present invention provides a unique geometrical utilization using no hardware type reactor vessel, eliminating head - loss associated with conventional reactor types and eliminating the need to search for appropriate reflecting coating which does not exist sufficiently efficient for such deep UV wavelength of light, such that ensures appropriate absorption by oxidizers, semi conductor metal oxides.

Therefore the method of the present invention does not suffer from the limitations of conventional light guide systems, when applying AOT is considered. It can be utilized for delivery, initiation and triggering both advanced oxidation processes, and photocatalysis

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on a single platform wherein no hardware reactor type is needed and the boundaries of the jet eliminates the need to develop reflecting coating for the deep UV substantially reducing the capital cost and periodical maintenance and replacements associated with conventional methods. The present invention may indeed be suitable for using both Advanced Oxidation materials and photocatalytic processes together in line with the unique platform in which geometrical utilization is increased as long as angular optical orientation (such as jet stream angular orientation compared with the coupled/delivered light throughout) is maintained.

The inner walls of the jet are preferably coated with at least one layer or thin film of semi conductor metal oxides such as TiO₂, ZnO, ITO in order to ensure no bio-film growth may accumulate, or for ensuring the biocompatibility and cleanliness of the water projection means at all times. More specifically, such coating or film once exposed to the pulsed laser light reflecting through the jet (before it is launched into air or surface) will produce electron holes and subsequent free radical formation having extremely short life times. These free radical species (i.e. such as hydroxyl radicals) are potent ensuring the surface of the inner walls of the water projection means are remaining clean and sterilized at all times during continuous operation. This will ensure continuous industrialized operation without the need to stop operation for cleaning procedures such as conventional CIP procedures in wide variety of industries.

An additional preferred mode for use of the UVJET is wherein 20ns, 80MHz laser beam is coupled to the venturi suction input on the water projection means (UVJET) and wherein the jet is washing, disinfecting, cleaning and dissolving, mineralizing and oxidizing noxious species which may contaminate five gallon water or flavored water jugs (20 liters jugs). An additional preferred mode for utilization of the UVJET is wherein washing and filling and sterilization is occurring simultaneously in order to streamline current water production techniques and to provide a continuum of quality assurance process using the UVJET devices according to the methodology of the present invention.

An additional environmentally friendly preferred embodiment of the present invention is wherein the UVJET stream is conducting electrical current or the jet stream or water projection means may be semi conducting or said water projection means or jet stream it is producing is super conducting or dielectric or any combination thereof. A further suitable mode for interoperability and interconnectivity featuring valuable mechanism in which the UVJET of the present invention may be adapted to suit different applications in bottled

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water industries, biomedical, bio-phonic and environmental or agricultural applications. In the latter (agricultural, biomedical) specially adapted suspensions or mix (i.e. multi components water based suspensions) are passed through the jet stream in order to perform photochemical processes such as sterilization, disinfection, advanced oxidation, mineralization, cleaning and washing, dissociation and excitation, triggering of photo reactive species, or fluorescent species or quenching or completing dangerous organo-phosphorous species in a single action or plurality of washing sequences or combinations programmable for the purpose of treating human skin, decontaminating it (from biological/chemical contaminants), or for treating larger metropolitan surface area in need of washing and simultaneously sterilizing or oxidizing the contamination into more innocuous, more manageable forms. More specifically, the methodology of the present invention is used for performing both oxidation and sterilization simultaneously, on the same single technological platform. More specifically treatment of chemical and biological species may be achieved using the methodology of the present invention. This is achieved using the principles of internal reflection within the jet stream to trigger photosensitive species, singlet oxygen species, oxidizers such as H_2O_2 and utilization of semi conducting metals such as TiO_2 photo catalyst. The use of TiO_2 photo catalyst and similar materials may assist in keeping the inner surfaces of the water projection means clear, clean, sterilized and free of bio-film formation as free radical species are formed on the surface upon absorption of photons having sufficient electron volts (about 3.4 eV for strong effect/absorption of the photo catalyst) to create electron pair holes on said inner surface. More specifically a hybrid combination is proposed for achieving higher efficiencies wherein both: oxidizer species such as H_2O_2 and photo catalyst such as TiO_2 are used together synchronously or simultaneously. Such preferred embodiment may be suitable for deep cleaning actions or for removal of already formed thick layers of noxious species of biological origin, and/or chemical contamination compounded volumes.

The method of the present invention may include variable use of electrical current conducted along the body of the water projection means, peak power of UV light (sub-microsecond to achieve/maximize peak powers) conducted along the jet stream and through the water projection means and combination applied to the external body or geometry of the jet stream (i.e. along the air or gas surrounding the jet stream, refractive index of about 1.00).

A preferred mode for operation of devices using the methodology of the present invention is wherein additional pulsed laser beams are inserted, superimposed, or projected into or

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onto the jet stream externally from air, or gas. Once these pulsed beams are entering the jet stream from an adequate angle to minimize optical losses (Fresnel reflections and rayleigh scattering type losses) then higher energy density zones are formed within the UVJET streams increasing or decreasing the rates in which predetermined photochemical process are been pursued.

The flowing liquid light guide may contain bubbles for diffusing the light therein, or for reducing the active liquid medium volume to be treated in a predetermined path length optically, or for a specific jet stream length or volume or combinations. More specifically, bubbles may be inserted or added to the flowing liquid wave guide in order to reduce actual treated volume and increase diffusion of the light therein. More specifically said bubbles may be already designed such that they add or subtract from photolytic, or photocatalytic or combination upon interaction with the light prior to the light entering the jet stream, or prior to the light beams entering the water projection means, or after the light is reflecting through the jet stream or any combination thereof. The use of bubbles may include singlet oxygen, hydrogen, nitrogen or any preferred gas having composition or properties appropriate to achieve the desired photolytic, photocatalytic or advanced oxidation processes according to the method of the present invention.

A single laser station may be coupled to a plurality of waveguides (solid state harness of fibers, multi tailed, such as HGFS/SFS/PCF types). This embodiment has a specific advantages as a plurality or set or array of UVJET may be linked via optical fibers such that at the filling point there is 100% electrical safety, yet aseptic filling operation would not have to be disturbed for special CIP procedures or for cleaning or disinfection procedures (i.e. automatic cleaning procedures in almost all agro-food production sites). This unique utilization mode provides a substantial reduction on the periodical maintenance and replacement required for smooth 24/365 industrialized operation.

Light from at least one high peak power, high intensity, high repetition rate laser engine may be coupled directly to a plurality or set or array of UVJET, or visijet, or Ex-rayjet (according to the methodology of the present invention) for surpassing the damage threshold of conventional optical fibers enabling direct coupling of high power pulsed UV laser beams in an array of filling nozzles (i.e. array of UVJET). This will eliminate the need to use conventional heat based pasteurization processes requiring heavy investment in infrastructure and lengthy and expensive preparation and utility support means. The UVJET of the present invention provides an evolutionary step reducing substantially the

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foot print associated with conventional systems or sterilization and aseptic filling, while providing energy conscious design to maximize production throughput while minimizing operational and maintenance procedures.

In contradistinction to the known treatment processes of the kinds specified, the UVJET devices using the method of the present invention provide no damage to the sensitive components present in flavored water or other sensitive liquid which passes through it. For example, while other treatment methodologies using heat or chemicals strongly effect the components in multi components mix or beverage often effecting negatively the flavor, freshness and texture of the liquid to be treated thus reducing its overall quality and shelf life, the UVJET according to the methodology of the present invention provides a capable platform which does not interfere with the delicate and often sensitive components present in flavored beverages, pharmaceutical preparation, biomedical and environmental protection applications. Rather, the technique of the present invention does not cause molecular migration, organoleptic migration and leaves the treated surfaces or volume passed through the water projection means intact. Due to the ability to lock reflecting pulsed laser beam within the jet stream in motion, thermal aberration of treated surface are minimized (the pulse of light is enclosed within the jet stream of water for example during the filling of mineral or flavored water bottles or five gallon jugs). More specifically the jet stream also cools any thermal dynamics caused by the interaction of the peak power of light onto a predetermined surface (i.e. for example: when washing and disinfecting packaged water products for the bottled water industries).

A 10 W average power, pulsed diode pumped UV laser engine may be coupled to at least one UVJET water projection means and multi photon absorption processes occur within the jet stream having energy of more than one mJ per cm^2 . A pulse repetition rate into the jet stream or into the water projection means may be between 10Hz to about 250Hz. The pulse repetition rates may be between 5KHz to about 80MHz. A single laser engine may be used for driving a plurality or set or arrays of UVJET water projection means. A wavelength may be chosen from the effective wavelength range in photochemistry, from between 266nm to about 1000nm. Several frequencies of light may be used sequentially or in unison or serially to suit different application and reaction rates according to the method of the present invention. Photocatalytic, photolytic or advanced oxidation processes may be used wherein the wavelength of the delivered light (within the jet stream) is about 266nm. For polishing and final photo treatment, the wavelength used is preferably about 355nm in the UV region of the EMR spectrum. The UVJET may be used

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for treating water intake from municipality, or the UVJET may process spring water or aquifer water, or drinking water into/out of distribution pipe networks, or the UVJET may be utilized for aseptic filling, replacing conventional heat based pasteurization, or the UVJET may be used to wash and disinfect inner surfaces of five gallon water or beverage jugs, or the UVJET may assist in washing and decontamination of NBC procedures and cleaning and disinfection of human skin or metropolitan surface area.

The spectrum delivered in the jet stream may be of the visible range, NIR (Near Infra Red) range, the far infra red, or combination for optimizing a specific application. Conventional fiber optics may be used to drive an array of UVJET for the purpose of facilitating aseptic filling, washing and sterilization simultaneously on the same platform. The UVJET may be used in a sub-miniaturized version to open pluck formation in the main aorta, or in a specific artery or vein or blood vessel (i.e. within small and large blood vessels or veins). For biomedical applications, the UVJET is used to dissolve tumors, and unwanted restenosis or residues using a preferred UPW (Ultra Pure Water) based suspension and photo reactive or photo catalytic components. In addition, for specific treatment using the methodology of the present invention it will be beneficial to use singlet oxygen or any type of oxidizer in order to produce predetermined specific radical species or to provide adequate photolytic dissociation power to cause a specific photochemical interaction, or reaction rate or combination to suit a predetermined specific application (for example: Bottled water and, Biomedical, bio-photonics, defense, environmental protection applications and so forth). The liquid carrying electromagnetic radiation may be a medical preparation, suspension or multi-component mix or solution.

The water projection means may be made out of biocompatible metals, polymer, or organo elastomer. The water projection means may be made out of glass or crystal, which is especially beneficial when scaling down the UVJET according to the methodology of the present invention. Such sub-miniaturized version of the UVJET may be especially beneficial in biomedical domain such as for dentistry and periodontology applications, cleaning the inner cavity space of the tooth, or for removing plaque formation from tooth and arteries using photocatalysis processes using the UVJET real time liquid waveguide according to the present invention.

The present invention may utilize phenton/phenton processes, wherein oxidizer is added to the flowing liquid waveguide (i.e. to the liquid which conducts light throughout). A preferred mode for using such processes as the phenton/phenton process is wherein the

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laser used is a multi line laser, or wherein several lasers or a single laser harmonically or frequency doubled is utilized. A predetermined specific wavelength of light may be reflected within the jet stream, while the same wavelength or a different wavelength is projected into the jet stream externally so as to suit a specific application or reaction rate within available limitations.

A scale up of the UVJET may be used for treatment of wastewater, water reclamation or for treatment of agro-food production waste discharge. An array of jets (i.e. UVJET showers) may be angularly positioned such that they form showers for washing and disinfection and for advanced oxidation processes treating humans, or machine interfaces which have been contaminated. The laser engine may be a Nd:Yag laser engine using THG, FHG, THG (Second Harmonic Generation, Fourth Harmonic Generation, Third harmonic Generation), wherein its pulse repetition rate is reduced to augment the power per pulse delivered through the UVJET, or arrays of UVJET operating serially, sequentially, or in parallel or in any programmable combination. Taser engine's pulse repetition rates may be increased so as to reach MHz, or GHz class. This may involve using a quasi-CW mode, or mode locked lasers or electrical discharge lasers, or plasma pumped lasers, or electron beam pumped excimers. Selection of the specific laser engine for any preferred embodiment of the present invention will depend on the specific application for which treatment is required.

For opening drains and for unblocking clogging, the UVJET may operate using direct pulsed UV laser projection into the water projection means. Light may be guided into the UVJET using conventional solid state optical fibers, or photonic band-gapped fibers, or photonic band-gapped crystals or combination thereof. The jet stream may be surrounded with compressed air or gas so as to be able to add components to the jet stream or in order to maximize optical efficiencies using the UVJET of the present invention.

The UVJET may be stationary positioned for performing aseptic filling procedures in the water industries, additionally the UVJET may be mobile in order to provide swift response to disaster areas, and for treatment or decontamination of human skin or metropolitan areas in the event of biological or chemical terrorist attack. The UVJET may be also utilized to wash vehicles, working surfaces and key building installation providing automatic treatment for both biological and chemical eventualities.

Light from the laser may pass through an acoustic-optical shutter prior to entering the UVJET water projection means. An acoustic-optical modulator may be used before or

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after the pulsed laser beams have entered the water projection means such that the spectral distribution over a predetermined volume over a predetermined surface area (i.e. the dose, or dosimeter value for a specific treatment application), over a predetermined period of time is optimized and may be calculated against specie specific concentration or type of contaminants calibration standards using the method of the present invention.

The jet stream may contain at least one fluorescent component or phosphorous components or photo reactive or photosensitive components for performing treatment or for spectroscopic data acquisition aimed at monitoring the processes of the UVJET according to the methodology of the present invention.

Semi conductive and/or metal particles may be present in the jet stream for performing photo catalysis on surface or volume application such as cleaning of medical instruments, disinfection and cleaning procedures of industrial food processing, decontamination processes and sterilization processes according to the method of the present invention.

For photochemistry, such an effect as photon localization occurring in liquid, or surfaces been treated, or both of them may be utilized.

Fig. 2 illustrates how the technique of the present invention can be used for washing and disinfection/sterilization noxious species on the surface of instruments, fruits, in medical, agricultural, industrial, and domestic cleaning, and purification application. In the present example, a device **17** of the present invention (the so-called “water projector”) is directly coupled to the inside of a container **19**. The device **17** is constructed generally similar to the above-described device **100**, and its outlet is inserted into an inlet opening **25** of the container **19**. Water stream enters the device through its water inlet **26** while UV pulsed laser light enter through the device light entrance **18**. The water stream with the UV light exit together in a common trajectory **24**, which is directed either manually or automatically (by means of a production line robot controlling the device) to wash with the water and with the UV light locked within the water streams the entire inner surface of the container, thus hitting noxious species, such as **20, 22, 23**, washing them out while eliminating them by means of the UV disinfecting light. The water then may be gathered and recycled by pumping it into the device for further washing sequences. During its flow along the jet the water self disinfecting by the UV, continues. The same small amount of water thus may be utilized, until turbidity is recognized either by human eye or by automatic controlling system, then it may be mixed with fresh water, or be replaced.

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The water projecting device may comprise a needle for the insertion of catalysts such as H_2O_2 , TiO_2 into the jet stream at the right point (plasma point, focusing, or collimated trajectory of pulsed laser UV light beams).

Reference is now made to **Figs. 3A and 3B** illustrating the use of the technique of the present invention for aseptic filling or for quality assurance and for industrialized photochemical processing. Here, a system **300** of the present invention comprises at least one radiation unit **70** having a high intensity pulsed sub-microsecond laser generating UV light beams, generally at **71**, a multi-tail optical waveguide harness **72** composed of a plurality of optical waveguides (fibers) - five such waveguides **73(a-e)** being shown in the present example, and a corresponding plurality of hollow aerobic, non toxic, water projection devices **74** of the present invention. The device **74** is a conduit or chamber (having integral conductive, dielectric, semi conductive or super conductive link) having at least one inlet associated with the respective waveguide and an outlet launcher **75**. Laser light **71** is thus split by the unit **72** into a respective number of light components (of various or identical energies) coupled to the plurality of waveguides **73**, respectively. The light component from each waveguide enters the respective water projecting device **74**, where the propagating light is coupled with the flow of an appropriate liquid medium and the light-liquid stream is output at the outlet **75** as a UVJET stream **76** to flow through air (or another gas) environment **77** around the jet stream. This environment **77** has a refractive index lower than that of the jet stream **76** thus enabling the effective (with minimal losses) propagation of the UV light component towards a target - a bottle **79** to be filled with or to be washed by the respective liquid. The UVJET-stream is appropriately aligned with an inlet opening **78** of the bottle. Upon entering the bottle, the UV radiation accesses the inner walls **80** of the bottle thus effecting a predetermined photochemical processing on species **81** located inside the bottle. The inner surface of the UVJET may be coated by a layer of photo catalytic compounds to ensure and maximize biocompatibility and ensure that no bio-film formation will accumulate. Additionally, the UVJET water projection device may be constructed from an already biocompatible materials not requiring photo catalytic action to remain clean or biocompatible at all times.

The present invention provides for creating an array of real time flowing liquid waveguides for aseptic filling or for quality assurance using photochemistry. As shown in **Fig. 3B**, at least one radiation unit is provided having a high intensity pulsed sub-microsecond UV laser source **84** that produces a UV light beam **86**. The latter is deflected by a stirring mirror or beam deflector, or prism **87**, **88**, **89** so as to synchronously direct the beams to

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the inlets **92** of hollow aerobic, non toxic, water projection means **95**, **94**, **92** of the present invention, where the beams are coupled with liquid streams and are output through outlet launchers towards a conduit or chamber **98** which is a bottle being filled aseptically (the bottled inner surface are being disinfected while said bottle is simultaneously being filled. The bottle **98** is accommodated on a carousel **99** associated with an array or set of UVJET according to the method of there present invention.

Fig. 4 illustrates a cross sectional view of a device **119** of the present invention for photochemical treatment through a jet stream of light transmitting liquid. The device **400** is configured as a liquid jet stream launcher having a liquid inlet **121** for receiving liquid from a liquid supply means (not illustrated); a liquid projection outlet **122** in liquid communication with the inlet **121**; a light radiation inlet (entrance opening) **120** positioned in an appropriate orientation relatively to the outlet **122** for directing a beam of light into the liquid flow such that the beam of light is being guided within a liquid jet stream projected from the liquid projection outlet **122**, locked within along the trajectory of the jet towards a target site. In this specific example, the device further comprises a wall bracket **123** useful for anchoring the device to either stationary or adjustable support. Thus, appropriate liquid enters the device via the inlet **121** and is forced towards a flow stabilizer portion **126** through a spherical groove **127** while performing venturi hydrodynamic - pneumatic differential pressure between the liquid path (through the flow stabilizer portion **126**) and the light/air passage **124**. An air suction operation is performed wherein air entering via the light radiation entrance opening **120** is sucked and mixed into the flowing liquid, thus increasing the diffusion of light within the jet. The inner surface **129** of a hydrodynamic nozzle **128** may be coated with a photo catalytic coating in order to prevent sedimentation during long period use.

Fig. 5 schematically illustrates a hydrodynamic nozzle **100** suitable to be used in the device of the present invention for projecting a liquid jet stream **101** having a trajectory **104** which terminates on a target site **109** surface. A light beam **103** is being guided inside the jet stream **101**, and internally refracted several times along the jet trajectory, however, locked inside and tracing its path until reaching a vicinity **108** of the target site. This is due to the refractive index of the liquid that is greater than the refractive index of the surrounding air **102**, and from the refractive index of another surrounding gas (e.g. Argon) **105** (that may be dispersed according to various treatment types in order to enhance the refractive profile). When the jet stream with the light beam hits the target site **109** surface, the liquid is already purified due to the photochemical effects that occur during its flow

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through the air, however, the target site surface also becomes purified around, as pointed out by the arrow icons **106** and **107**. This is due to the scattering of light reflected all around between the droplets and micro droplets created from the jet while hitting the surface.

The following are experimental results obtained with the technique of the present invention, consisting of two disinfecting procedures performed according to the following parameters.

Example 1: refers to disinfecting a contamination of the species *Bacillus Subtilis*. The following conditions were used: initial concentration - $3.9 \cdot 10^5$ cfu/ml; laser parameters - 250mw average power, 15KHz pulse frequency, 30ns pulse duration; water jet flow-rate - 500ml/sec

Treatment Duration (sec)	Water jet treatment (without UV) No. of bacteria (cfu/ml)	Water jet + UV treatment No. of bacteria (cfu/ml)
0	$3.6 \cdot 10^5$	$3.6 \cdot 10^5$
1	$6.9 \cdot 10^4$	$1.8 \cdot 10^2$
3	$4.0 \cdot 10^2$	$2.5 \cdot 10^1$

Example 2: refers to disinfecting a contamination of the species *Aspergillus Niger*. The following conditions were used: initial concentration - $2.1 \cdot 10^5$ cfu/ml; laser parameters - 250mw average power, pulsed 15KHz, 30ns pulse duration; water jet flow-rate - 500ml/sec.

Treatment Duration (sec)	Water jet treatment (without UV) No. of bacteria (cfu/ml)	Water jet + UV treatment No. of bacteria (cfu/ml)
0	$3.3 \cdot 10^3$	$3.3 \cdot 10^3$
1	$5.2 \cdot 10^2$	$1.6 \cdot 10^2$
3	$8.0 \cdot 10^1$	$1.1 \cdot 10^1$

In both examples, contamination has been preformed on empty, unused bottles. It was done on-site, using the following protocol:

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1. Known stock suspension of bacteria were reduced to contamination concentration as referenced in the tables per each individual specie;
2. 10 ml per container have been used for infection, shaken thoroughly in bottle until uniformly distributed, so that bacteria will reach all surfaces of containers. Access liquid disposed properly.
3. Containers were dried over-night at 34C oven, and then capped with sterile caps.
Contamination were preformed shortly before the demonstration.

The data in the tables refer to the following three disinfecting runs performed per each bacteria species:

- (i) positive control per each strain, without treatment;
- (ii) treatment by washing cycles of water jet without UV;
- (iii) treatment by washing cycles of water jet with UV thereby delivered.

All tests have been preformed with 2 repeats (to account for statistical variations).

The data in tables 1 and 2 represents the average values of each run.

Sampling of bottles has been preformed using the following protocol :

1. 50ml saline has been poured into treated containers, each container than capped with sterile cap;
2. Capped containers have been shaken so that all surface of the container will be sampled;
3. Sampled liquid has been poured into sterile collection containers;
4. Incubation and plate counting of the bacteria have been performed using standard procedures.

Those skilled in the art will readily appreciate that various modifications and changes can be applied to the embodiments of the invention hereinbefore exemplified without departing from the scope defined in and by the appended claims.

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CLAIMS:

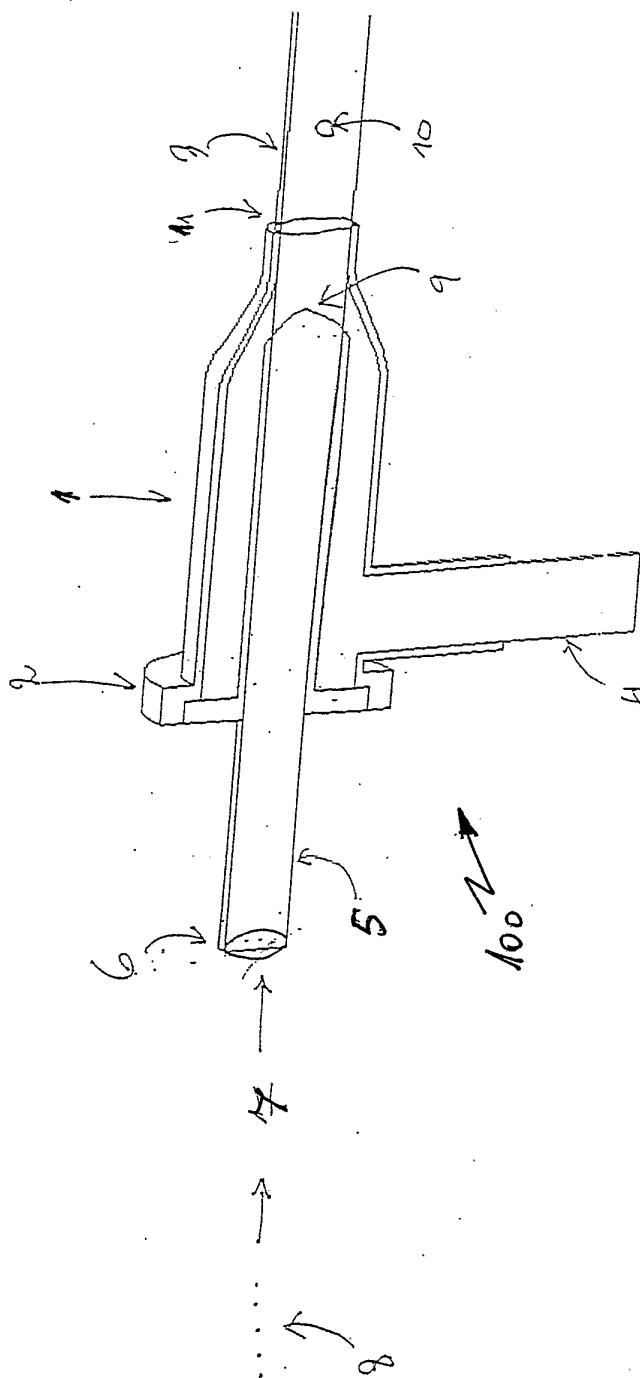
1. A method for affecting at least one chemical or mechanical property of a target site, the method comprising;
 - (a) providing a stream of liquid having a predetermined flow rate towards a contact with the target site;
 - (b) providing UV-radiation having predetermined parameters in terms of power, wavelength, duty cycle and repetition rate;
 - (c) directing said UV-radiation within said stream of liquid along a trajectory of said stream;
 - (d) maintaining said stream in contact with said target site for a time period and under conditions sufficient for affecting said at least one chemical or mechanical property.
2. The method of Claim 1, wherein the liquid stream is free-space flowing along at least one portion of its trajectory.
3. The method of Claim 1, wherein the target site is an item or a substance suspected as afflicted by noxious biological or chemical species.
4. The method of Claim 1, wherein the target site is selected from pre-filled containers, filled containers, surfaces, humans, mammals, vehicles, medical instrumentation, conveyors, conveyor belts, foods, fruits, vegetables, salads.
5. The method of Claim 1, wherein said UV-radiation is generated by a laser source.
6. The method of Claim 5, wherein said laser source is a high-frequency pulsed laser.
7. The method of Claim 5 or 6, wherein said laser source is a high-intensity pulsed laser.
8. The method of any one of Claims 5 to 7, wherein said laser source is a pulsed 266nm laser.
9. The method of any one of Claims 5 to 7, wherein said laser source is a pulsed 355nm laser.

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10. The method of any one of Claim 5 to 9, wherein said laser source is a high intensity sub-microsecond pulsed laser.
11. The method of Claim 1, wherein the at least one chemical or mechanical change applies to at least 50 percent of particle type or microorganism species predetermined as a subject for having the change.
12. The method of Claim 1, wherein said UV radiation carried by the stream of liquid performs disinfection of said liquid on its way to the target site.
13. The method of Claim 1, further comprising recycling the liquid by gathering it from the vicinity of the target site and returning it towards another contact with a target site.
14. The method of Claim 1, further comprising recycling the liquid by gathering it from the vicinity of the target site and returning it towards another contact with a target site, wherein the liquid is disinfected on its way to the target site by means of the UV-radiation carried by the liquid stream.
15. The method of Claim 1, comprising: coupling output from at least one UV-radiation unit to an inlet of a water projecting means and feeding the liquid stream into said water projection means under venturi pressure.
16. A device for supplying a liquid stream carrying UV-radiation to a target site, the device comprising at least one pipe-like member having an inlet means for receiving the stream of liquid and the UV radiation under venturi pressure, and an outlet means for outputting said liquid stream carrying the UV radiation.
17. The device of Claim 16, wherein said inlet means comprises a first inlet opening for receiving a beam of UV radiation; and a second inlet opening for receiving the liquid stream.
18. The device of Claim 16, comprising a UV radiation source operable to generate at least one beam of UV radiation, a beam splitting assembly accommodated in the optical path of the generated UV radiation and operable to split the generated UV radiation beam into an array of UV components; an array of the pipe-like members each associated with the corresponding one of the UV components.

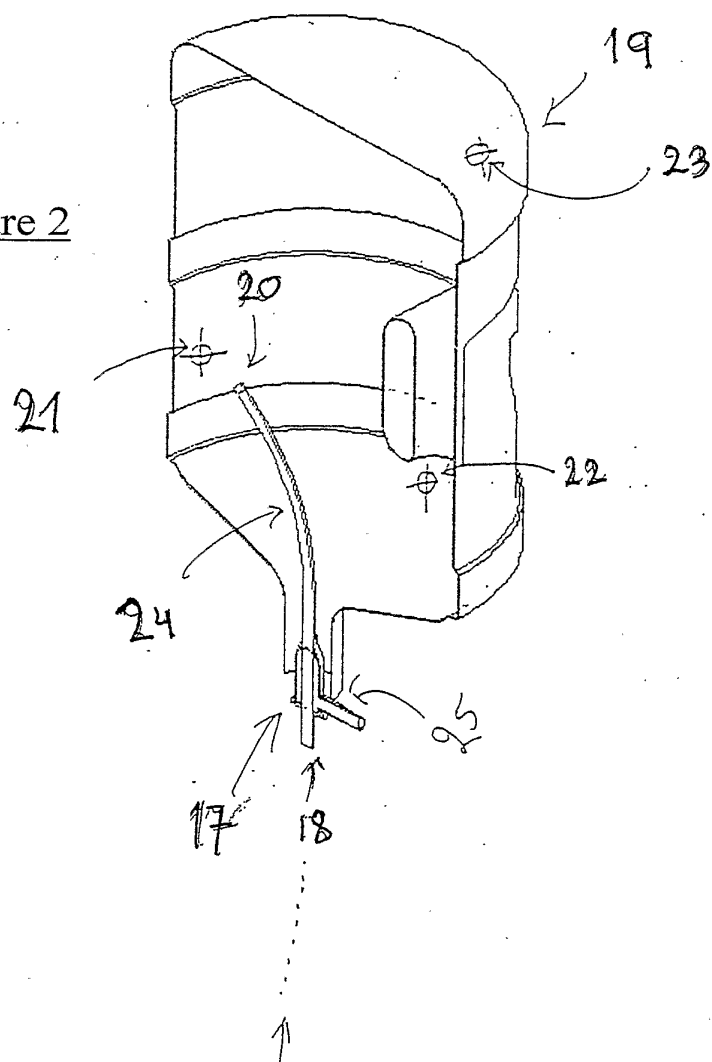
1/5

Figure 1

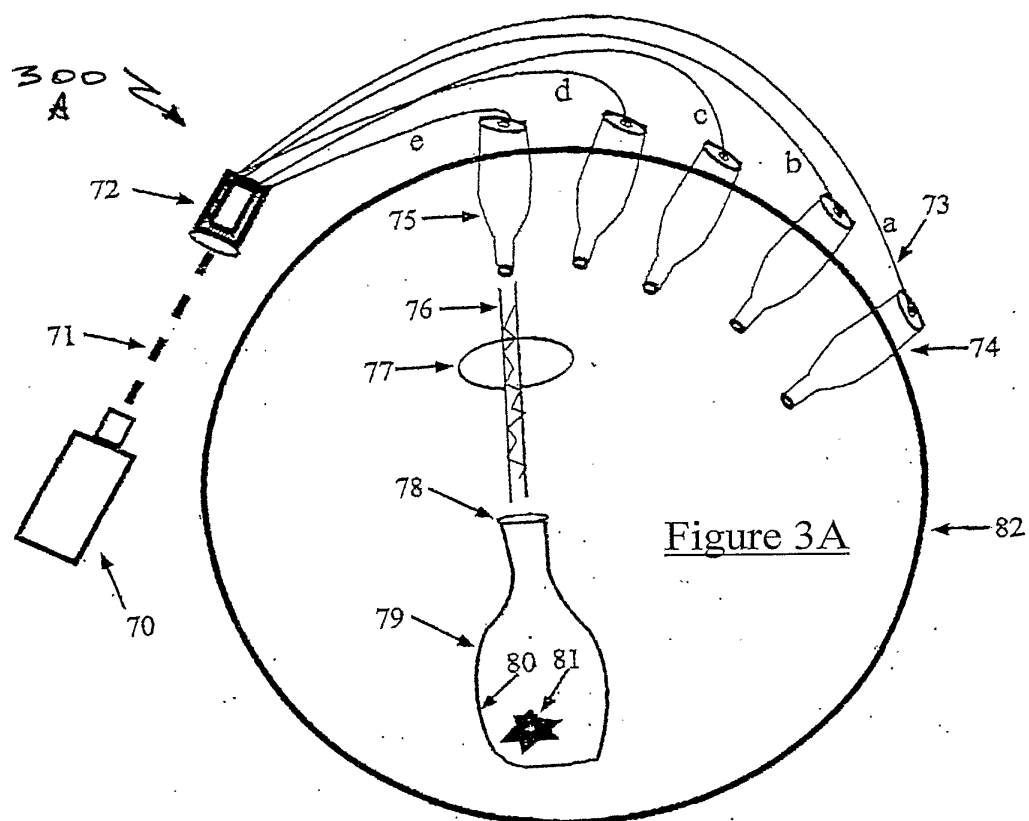
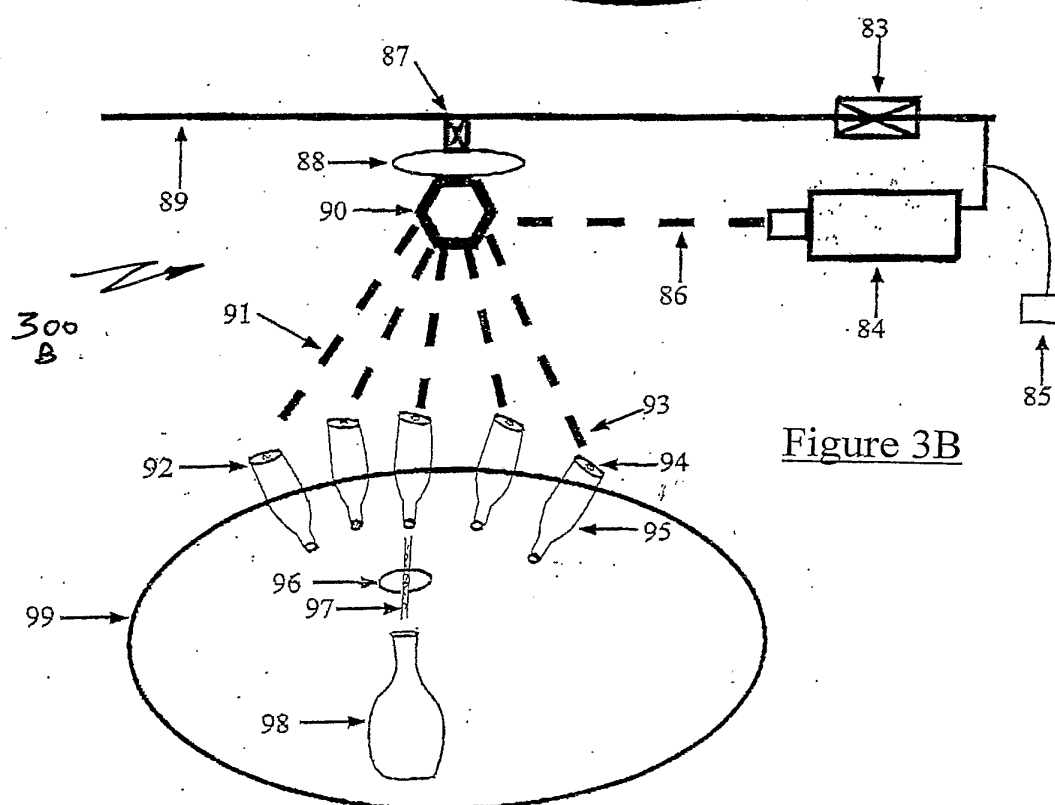


2/5

Figure 2



3/5



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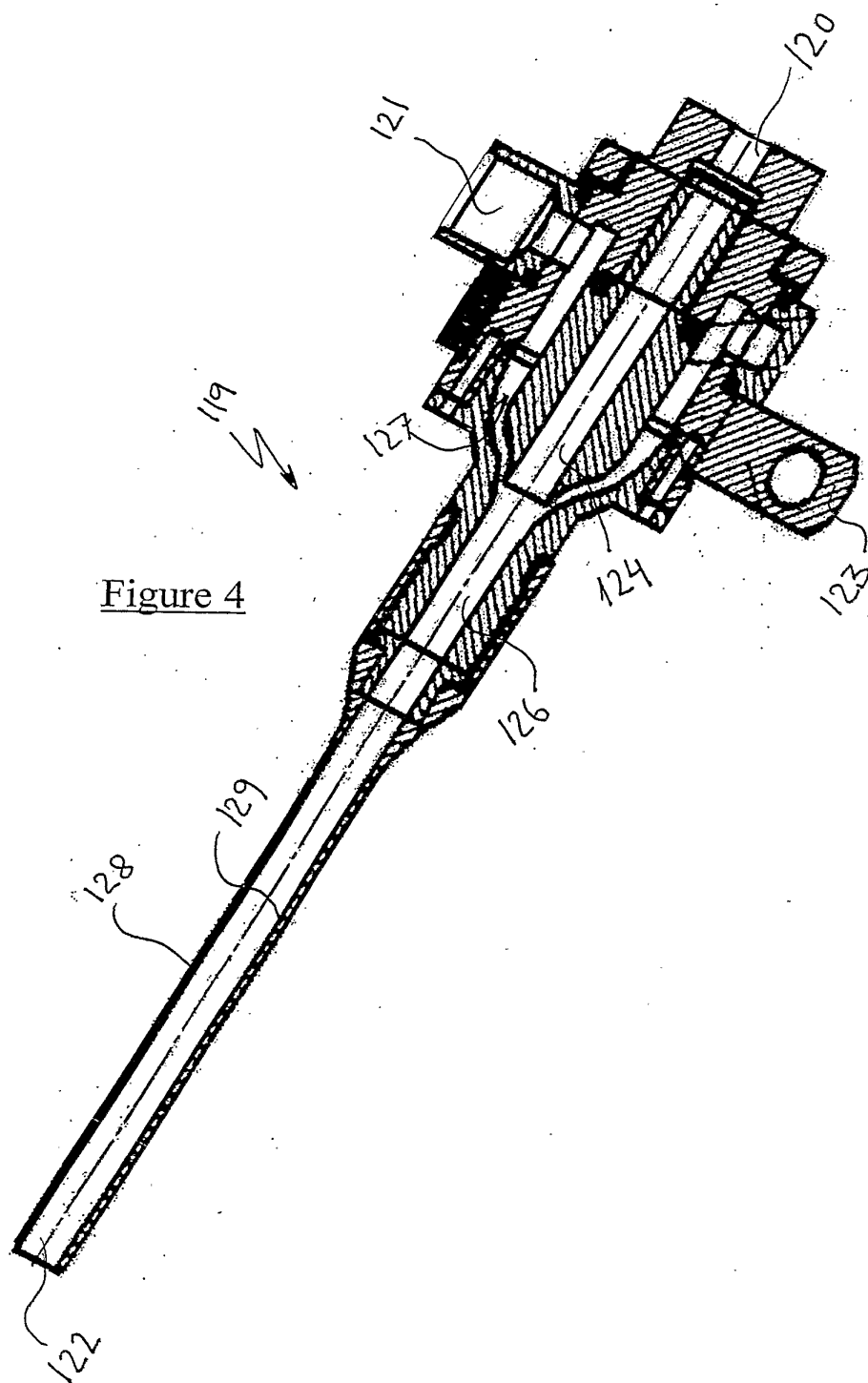
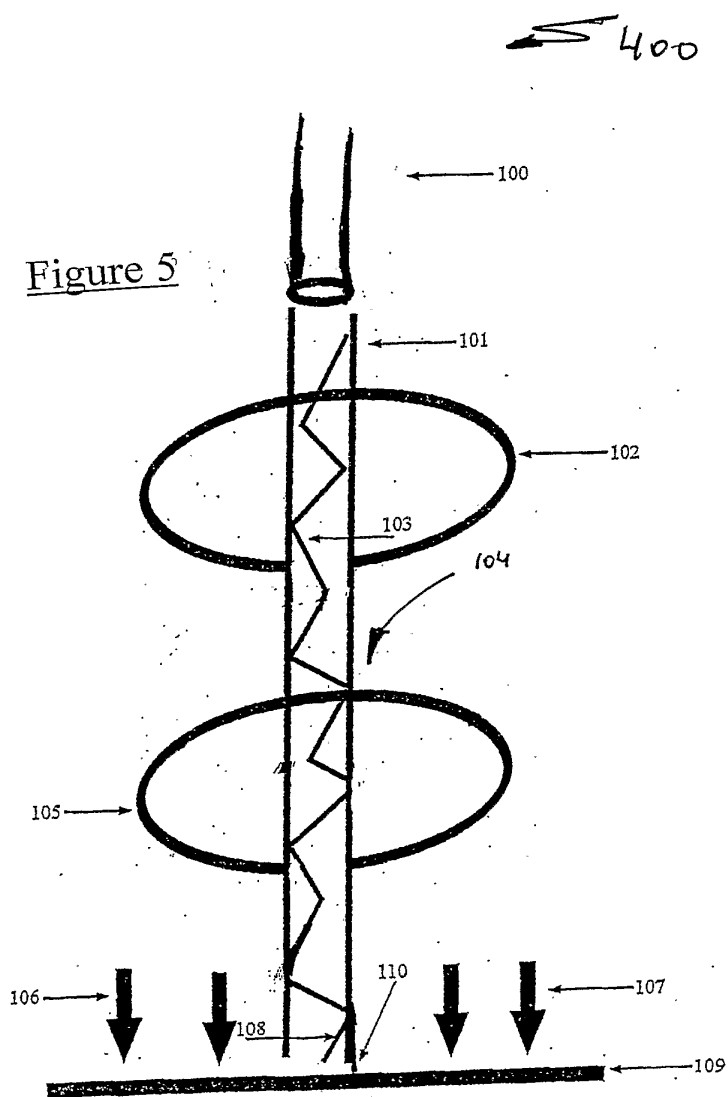


Figure 4

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 03/00621

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61L2/10 A23L3/28 B67C7/00 G02B6/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61L A23L B67C B65B G02B A61B A61C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 264 055 A (BARKER GEORGE E) 2 August 1966 (1966-08-02) column 1, line 12-42 column 2, line 13-37 column 3, line 59 -column 5, line 15; examples ----	1-4, 11-17
X	WO 00 32520 A (BRUCKER FRANZ ;KOEHL MICHAEL (DE); LIESKE VOLKER (DE); FRAUNHOFER) 8 June 2000 (2000-06-08) page 2, line 22 -page 6, line 6; claims 4-7,19-25 ----	1-4,11, 12,15
X	DE 43 07 204 A (UNIV SCHILLER JENA) 15 September 1994 (1994-09-15) column 2, line 7 -column 4, line 55; figures ----- -/--	1-12,16, 17

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents:

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

E earlier document but published on or after the international filing date

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

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

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

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

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

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

G document member of the same patent family

Date of the actual completion of the international search

31 October 2003

Date of mailing of the international search report

10/11/2003

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 03/00621

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 816 145 A (GOUDY JR PAUL R) 28 March 1989 (1989-03-28) column 2, line 3-68 column 8, line 65 -column 9, line 15; figures 11,12 -----	1-12,16, 17
X	US 4 749 126 A (BRULS G J C L ET AL) 7 June 1988 (1988-06-07) cited in the application column 1, line 46 -column 2, line 13 column 2, line 56 -column 3, line 12; figures -----	16,17

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 03/00621

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 1-15 (partially)
because they relate to subject matter not required to be searched by this Authority, namely:
see FURTHER INFORMATION sheet PCT/ISA/210
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.1

Claims Nos.: 1-15 (partially)

Claims 1-15 relate to a method "for affecting at least one chemical or mechanical property of a target site", i.e. to a method of treatment of a target site. According to the present application, said target site includes human, mammal or animal body (see p. 6, 3th par., p. 16, 1st par., p. 21, 2nd par.-p. 22, 1st par., p. 23, 1st par., p. 26, 4th par., p. 27, 1st and 2nd par., p. 29, 2nd par., p. 30, 1st par., p. 40, last par., p. 41, last par., p. 48 and 49, claim 4). In particular, it is specified that the claimed method can be used in surgery, therapy and diagnostic for in vivo applications. According to Rule 39.1(iv) PCT in combination with Article 17(2)(a)(i) PCT, such methods of treatment in vivo are not to be searched. Therefore, the in vivo applications of the claimed method were excluded from the search of method claims 1-15.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 03/00621

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S4	1	("20140227132").PN.	US-PGPUB; USPAT	OR	OFF	2017/02/23 19:01
S5	1	S4 and (reflecting and photons).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 19:03
S6	1	S4 and (reflecting near photons).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 19:03
S7	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 20:30
S8	109	S7 and (photons and wavelength and (DNA or RNA) and skin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 20:31
S10	78	S7 and (photons and wavelength and (DNA or RNA) and skin and microorganisms)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 20:32
S11	68	S7 and (photons and wavelength and (DNA or RNA) and skin and absorption and microorganisms)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 20:32
S12	92	S7 and (photons and wavelength and (DNA or RNA) and skin and absorption)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2017/02/23 20:32

			IBM_TDB			
S15	37	("20050173652" "5364645" "5933702" "5843374" "20030170151" "5843374" "6165170" "20070045561" "5753106" "6099799" "6235090" "20020177118" "5647890" "6770069" "3672126" "4458153" "4524079" "6063170" "20060188835" "4317041" "20040238344" "20040120850" "20040166018" "6149717" "7326387" "20020089275" "20050118078" "6673137" "20070102280" "20040120846" "5750072" "20030188740" "20050173652" "6160835" "20050186108" "5492676" "5505904" "5993738" "20050205206").PN.	US-PGPUB; USPAT	OR	OFF	2017/02/23 21:08
S16	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 23:57
S17	62	S16 and (photons and wavelength and (DNA or RNA) and skin and microorganism)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/23 23:57
S18	59	S16 and (photons and wavelength and (DNA or RNA) and skin and microorganism and (human or animal or man or people))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 00:39
S19	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 10:11
S20	92	S19 and (photons and wavelength and (DNA or RNA) and skin and (animal or human))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 10:11
S21	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 10:13
S22	59	S21 and (photons and wavelength and	US-PGPUB;	OR	OFF	2017/02/24

		(DNA or RNA) and skin and microorganism and (human or animal or man or people or pet))	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			10:13
S23	98	S19 and (photons and wavelength and (DNA or RNA) and skin and absorption ("232 nm" or "232nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 10:41
S24	5665	(photons and wavelength and (DNA or RNA) and skin and absorption ("232 nm" or "232nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 10:55
S25	4126	(photons and wavelength and (DNA or RNA) and skin and absorption ("232 nm" or "232nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and (destroy or eliminate or decontaminate))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 11:02
S26	3529	(photons and wavelength and (DNA or RNA) and skin and absorption ("232 nm" or "232nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and (destroy or eliminate or decontaminate) and directing and generating and "peak absorption")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 11:04
S48	1	("20140227132").PN.	US-PGPUB; USPAT	OR	OFF	2017/02/24 13:54
S49	1	S48 and (human or animal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 13:54
S50	1	S48 and (skin and (human or animal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 13:55
S51	49	neister-s-edward.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 13:56
S52	1	S51 and (skin and (human or animal)).clm.	US-PGPUB; USPAT; USOCR;	OR	OFF	2017/02/24 13:57

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S53	7	S51 and (skin and (human or animal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 13:57
S54	0	S51 and (photons and wavelength and (DNA or RNA) and "single line wavelengths" and ("232 nm" or "232nm" or "282nm" or "282 nm")) .clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 14:05
S55	4	S51 and (photons and wavelength and (DNA or RNA) and ("232 nm" or "232nm" or "282nm" or "282 nm")) .clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 14:05
S82	1	("20060104859").PN.	US-PGPUB; USPAT	OR	OFF	2017/02/24 14:19
S87	0	S82 and (("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 14:24
S88	0	WO-2004011038-\$did.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 14:57
S89	3	WO-2004011038-\$did.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 14:57
S90	0	S89 and (photons and wavelength and (DNA or RNA) and skin and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 15:02
S91	0	S89 and (photons and wavelength and (DNA or RNA) and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2017/02/24 15:02

			IBM_TDB			
S92	0	S89 and (photons and wavelength and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 15:02
S94	0	S89 and (skin and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 15:03
S95	1	S82 and (photons and wavelength and (DNA or RNA) and skin and absorption and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 15:03
S96	0	(wavelength and (DNA or RNA) and absorption and "chemical bonds" and microgranisms)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 17:20
S97	3168	(wavelength and (DNA or RNA) and absorption and "chemical bonds")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 17:20
S98	1651	(wavelength and (DNA or RNA) and absorption and "chemical bonds" and ultraviolet)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 17:20
S99	14	(wavelength and (DNA or RNA) and absorption and "chemical bonds" and ultraviolet and ("232 nm" or "232nm" or "282nm" or "282 nm"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:15
S100	262	(wavelength and (DNA or RNA) and absorption and ultraviolet and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:31
S101	19	(wavelength and (DNA or RNA) and absorption and "chemical bonds" and ultraviolet and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2017/02/24 18:31

			EPO; JPO; DERWENT; IBM_TDB			
S102	176	(wavelength and (DNA or RNA) and absorption and ultraviolet and ("222 nm" or "222nm" or "282nm" or "282 nm") and (microorganism or microorganisms or bacteria or virus))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:33
S103	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).qpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:57
S104	9	S103 and (photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:57
S105	19944	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).qpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:58
S106	9	S105 and (photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 18:58
S107	49	neister-s-edward.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:01
S108	0	S107 and (photons and wavelength and (DNA or RNA) and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:01
S109	4	S107 and (photons and wavelength and (DNA or RNA) and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:01
S110	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222	US-PGPUB; USPAT;	OR	OFF	2017/02/24 19:13

		nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women)).clm.	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S111	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:14
S112	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:15
S113	1	(photons and wavelength and (DNA or RNA) and skin and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:15
S114	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and destroy).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:16
S115	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:18
S116	1	(photons and wavelength and (DNA or RNA) and skin and peak and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:18
S117	1	(photons and wavelength and (DNA or RNA) and skin and destroy and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:19
S118	1	(photons and wavelength and (DNA or RNA) and skin and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2017/02/24 19:19

			IBM_TDB			
S119	0	(photons and wavelength and (DNA or RNA) and skin and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:19
S120	1	(photons and wavelength and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:20
S121	0	(photons and wavelengths and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:21
S122	1	(photons and "absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:22
S123	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:22
S124	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:24
S125	1	(photons and peak and wavelength and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:25
S126	1	(photons and "chemical bonds" and wavelength and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:25
S127	0	(photons and wavelength and (DNA or RNA) and skin and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2017/02/24 19:26

			EPO; JPO; DERWENT; IBM_TDB			
S128	0	(photons and wavelengths and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm"))).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:26
S129	0	(photons and wavelength and (DNA or RNA) and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm"))).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/02/24 19:26

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S56	2468	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).qpc.	US-PGPUB	OR	OFF	2017/02/24 12:15
S130	2468	(A61L2/10 or A23L3/28 or A23B7/015 or A61L2/0011 or B08B17/00 or A61L9/20).qpc.	US-PGPUB	OR	OFF	2017/02/24 19:03
S131	0	S130 and (photons and wavelength and (DNA or RNA) and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB	OR	OFF	2017/02/24 19:03
S132	5	S130 and (photons and wavelength and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB	OR	OFF	2017/02/24 19:03
S133	5	S130 and (photons and wavelength and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm") and skin)	US-PGPUB	OR	OFF	2017/02/24 19:04
S134	5	S130 and (photons and wavelength and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm") and (human or animal))	US-PGPUB	OR	OFF	2017/02/24 19:04
S135	5	S130 and (photons and wavelength and (DNA or RNA) and "peak absorption" and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB	OR	OFF	2017/02/24 19:04
S136	7	S130 and (photons and wavelength and (DNA or RNA) and ("222 nm" or "222nm" or "282nm" or "282 nm"))	US-PGPUB	OR	OFF	2017/02/24 19:05
S137	0	(photons and wavelength and (DNA or RNA) and "single line wavelengths" and ("222 nm" or "222nm" or "282nm" or "282 nm"))).clm.	US-PGPUB	OR	OFF	2017/02/24 19:05
S138	1	(photons and wavelength and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm"))).clm.	US-PGPUB	OR	OFF	2017/02/24 19:05
S139	1	(photons and wavelength and (DNA or RNA) and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm") and skin).clm.	US-PGPUB	OR	OFF	2017/02/24 19:06
S140	1	(photons and wavelength and (DNA or RNA)	US-	OR	OFF	2017/02/24

		and "chemical bonds" and ("222 nm" or "222nm" or "282nm" or "282 nm") and (human or animal)).clm.	PGPUB			19:06
S141	2	(photons and wavelength and (DNA or RNA) and "peak absorption" and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB	OR	OFF	2017/02/24 19:06
S142	3	(photons and wavelength and (DNA or RNA) and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB	OR	OFF	2017/02/24 19:07
S143	3	(photons and wavelength and (DNA or RNA) and skin and absorption ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women)).clm.	US-PGPUB	OR	OFF	2017/02/24 19:07
S144	2	(photons and wavelength and (DNA or RNA) and skin and absorption ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB	OR	OFF	2017/02/24 19:08
S145	2	(photons and wavelength and (DNA or RNA) and skin and absorption ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB	OR	OFF	2017/02/24 19:08
S146	1	(photons and wavelength and (DNA or RNA) and skin and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human) and destroy and directing and generating and "peak absorption").clm.	US-PGPUB	OR	OFF	2017/02/24 19:09
S147	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women) and destroy).clm.	US-PGPUB	OR	OFF	2017/02/24 19:09
S148	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or pet or human or man or people or person or woman or men or women)).clm.	US-PGPUB	OR	OFF	2017/02/24 19:09
S149	1	(photons and wavelength and (DNA or RNA) and skin and absorption and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB	OR	OFF	2017/02/24 19:10
S150	1	(photons and "absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB	OR	OFF	2017/02/24 19:10
S151	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and (animal or human)).clm.	US-PGPUB	OR	OFF	2017/02/24 19:11
S152	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm")).clm.	US-PGPUB	OR	OFF	2017/02/24 19:12

S153	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB	OR	OFF	2017/02/24 19:12
S154	1	(photons and "peak absorption wavelength" and (DNA or RNA) and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB	OR	OFF	2017/02/24 19:12
S155	1	(photons and "peak absorption wavelength" and (DNA or RNA) and skin and (substance or surface) and ("222 nm" or "222nm" or "282nm" or "282 nm") and microorganism).clm.	US-PGPUB	OR	OFF	2017/02/24 19:12

2/ 24/ 2017 7:56:22 PM

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Issue Classification 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD	
	Examiner REGINA M YOO	Art Unit 1799	

CPC						
Symbol					Type	Version
A61L		2		10	F	2013-01-01
A61L		2		0011	I	2013-01-01
A61L		9		20	I	2013-01-01
B08B		17		00	I	2013-01-01
A23B		7		015	I	2013-01-01
A23L		3		28	I	2013-01-01

CPC Combination Sets						
Symbol			Type	Set	Ranking	Version

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/REGINA M YOO/ Primary Examiner.Art Unit 1799	2/24/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	11

Issue Classification 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD	
	Examiner REGINA M YOO	Art Unit 1799	

US ORIGINAL CLASSIFICATION						INTERNATIONAL CLASSIFICATION									
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED				
CROSS REFERENCE(S)															
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)														

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/REGINA M YOO/ Primary Examiner. Art Unit 1799	2/24/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	11

Issue Classification 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17	9	33										
	2	2	18	10	34										
	3	3	19		35										
	4		20		36										
	5		21	12	37										
	6		22	11	38										
	7		23	13	39										
	8		24	14	40										
	9		25	15	41										
	10		26	16	42										
	11	4	27	17	43										
	12	5	28	18	44										
	13	6	29												
	14	7	30												
	15	8	31												
1	16		32												

NONE		Total Claims Allowed:	
(Assistant Examiner)		18	
(Date)			
/REGINA M YOO/		2/24/2017	
Primary Examiner. Art Unit 1799		(Date)	
(Primary Examiner)		O.G. Print Claim(s)	O.G. Print Figure
		1	11

Search Notes 	Application/Control No. 14254957	Applicant(s)/Patent Under Reexamination NEISTER, S. EDWARD
	Examiner REGINA M YOO	Art Unit 1799

CPC- SEARCHED		
Symbol	Date	Examiner
A61L 2/10, 2/0011, 9/20	2/24/2016	RY
A23L 3/28	2/24/2016	RY
A23B 7/015	2/24/2016	RY
B08B 17/00	2/24/2016	RY
UPDATED SEARCH		
A61L 2/10, 2/0011, 9/20	2/24/2017	RY
A23L 3/28	2/24/2017	RY
A23B 7/015	2/24/2017	RY
B08B 17/00	2/24/2017	RY

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
EAST (US-PGPUB, USPAT, USOCR, FPRS, EPO, JPO, DERWENT, IBM_TDB) - See Search History Printout	2/24/2016	RY
EAST - Inventor Search neister-s-edward	2/22/2016	RY
PALM - Inventor Search	2/22/2016	RY
UPDATED SEARCH		
EAST (US-PGPUB, USPAT, USOCR, FPRS, EPO, JPO, DERWENT, IBM_TDB) - See Search History Printout	2/24/2017	RY
EAST and PALM - Inventor Search	2/24/2017	RY
A61L 2/10, 2/0011, 9/20; A23B7/015; A23L3/28; B08B17/00 (see SEARCH HISTORY PRINTOUT)	2/24/2017	RY

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INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
A61L	2/10, 2/0011, 9/20	2/24/2017	RY
A23B	7/015	2/24/2017	RY
A23L	3/28	2/24/2017	RY
B08B	17/00	2/24/2017	RY

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PART B - FEE(S) TRANSMITTAL

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

**LAMBERT & ASSOCIATES
92 STATE STREET
BOSTON, MA 02109-2004**

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	04/17/2014	S. Edward Neister	14-016-EN	7908

TITLE OF INVENTION:

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	Small	\$480	\$0	\$0	\$480	06/12/2017
EXAMINER	ART UNIT	CLASS-SUBCLASS				

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Lambert & Associates

2 Gary E. Lambert

3 David J. Connaughton, Jr.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached.
☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /David J. Connaughton, Jr./

Date 6/9/2017

Typed or printed name David J. Connaughton, Jr.

Registration No. 67275

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal				
Application Number:		14254957		
Filing Date:		17-Apr-2014		
Title of Invention:		METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION		
First Named Inventor/Applicant Name:		S. Edward Neister		
Filer:		Gary Ervery Lambert		
Attorney Docket Number:		14-016-EN		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	480	480

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				480

Electronic Acknowledgement Receipt	
EFS ID:	29443744
Application Number:	14254957
International Application Number:	
Confirmation Number:	7908
Title of Invention:	METHOD AND APPARATUS FOR STERILIZING AND DISINFECTING AIR AND SURFACES AND PROTECTING A ZONE FROM EXTERNAL MICROBIAL CONTAMINATION
First Named Inventor/Applicant Name:	S. Edward Neister
Customer Number:	32118
Filer:	Gary Ervery Lambert
Filer Authorized By:	
Attorney Docket Number:	14-016-EN
Receipt Date:	09-JUN-2017
Filing Date:	17-APR-2014
Time Stamp:	08:55:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$480
RAM confirmation Number	060917INTEFSW08562000
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_Fee_Transmittal_Form-Neister-14-016-EN.pdf	74120	no	2
			310da99b605964f4d19d2d0279a633e812793c0a		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30625	no	2
			a933bc3c8ad38ec32517544b9673cc5e9b6fec45		
Warnings:					
Information:					
Total Files Size (in bytes):			104745		
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					



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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/254,957	07/11/2017	9700642	14-016-EN	7908

32118 7590 06/21/2017
LAMBERT & ASSOCIATES
92 STATE STREET
BOSTON, MA 02109-2004

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 142 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

S. Edward Neister, Dover, NH;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Missouri - Kansas City, MO on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO. 4:21-cv-00345-GAF	DATE FILED 5/17/2021	U.S. DISTRICT COURT Western District of Missouri - Kansas City, MO
PLAINTIFF High Energy Ozone LLC, et al		DEFENDANT Far UV Technologies
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,975,605	3/10/2015	S. Edward Neister
2 9,700,642	7/11/2017	S. Edward Neister
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
 Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

Case 4:21-cv-00345-GAF Document 7 Filed 05/18/21 Page 1 of 1