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(54) FOOD SURFACE SANITATION TUNNEL

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(52) **U.S. Cl.** **426/335**; 426/241

(57) **ABSTRACT**

This invention is a modular, adjustable, easy to maintain, portable or fixed food sanitation tunnel, comprising an enclosing means for subjecting food to sanitizers including UV light, ozone, hydroperoxides, superoxides and hydroxyl radicals, and a method for using the system. The enclosing means includes one or more UV radiation sources and one or more target rods located within a tunnel, such as a c-shaped shell. The UV radiation sources are preferably UV light sources that emit UV light of approximately 185 to 254 nm. The target rods are approximately up to 0-30% titanium dioxide, up to 0-30% silver and up to 0-30% copper, by weight. The system may include a mister for the efficient production of hydroxyl radicals by the UV light sources. Parts of the system are easily removable for cleaning and for maintenance. Also, in an alternative embodiment, the tunnel is located on a frame, and the frame is on wheels.

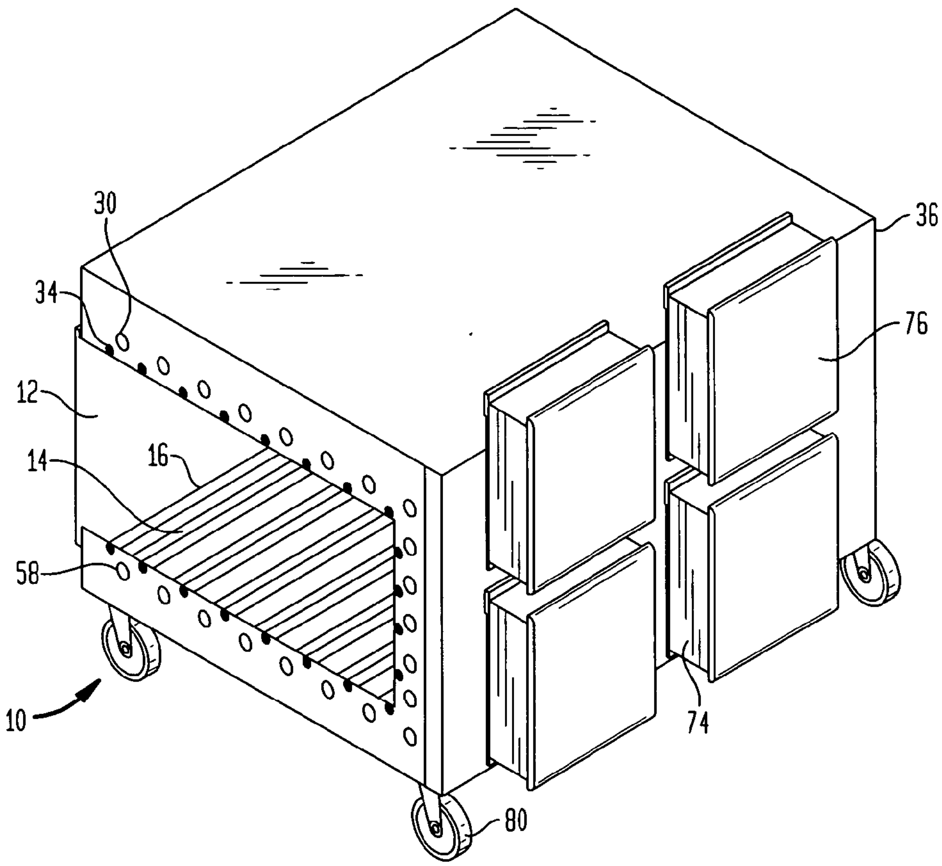


FIG. 1

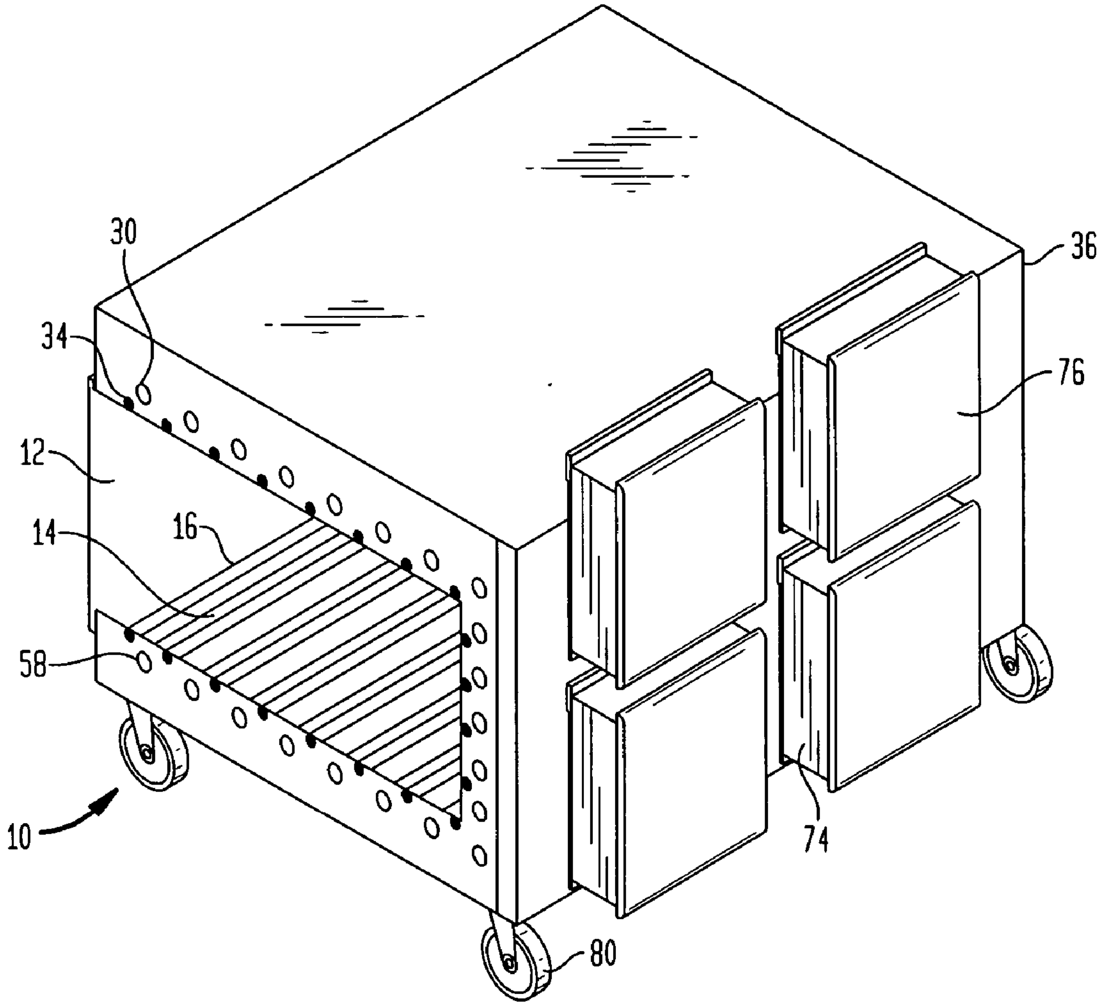


FIG. 2

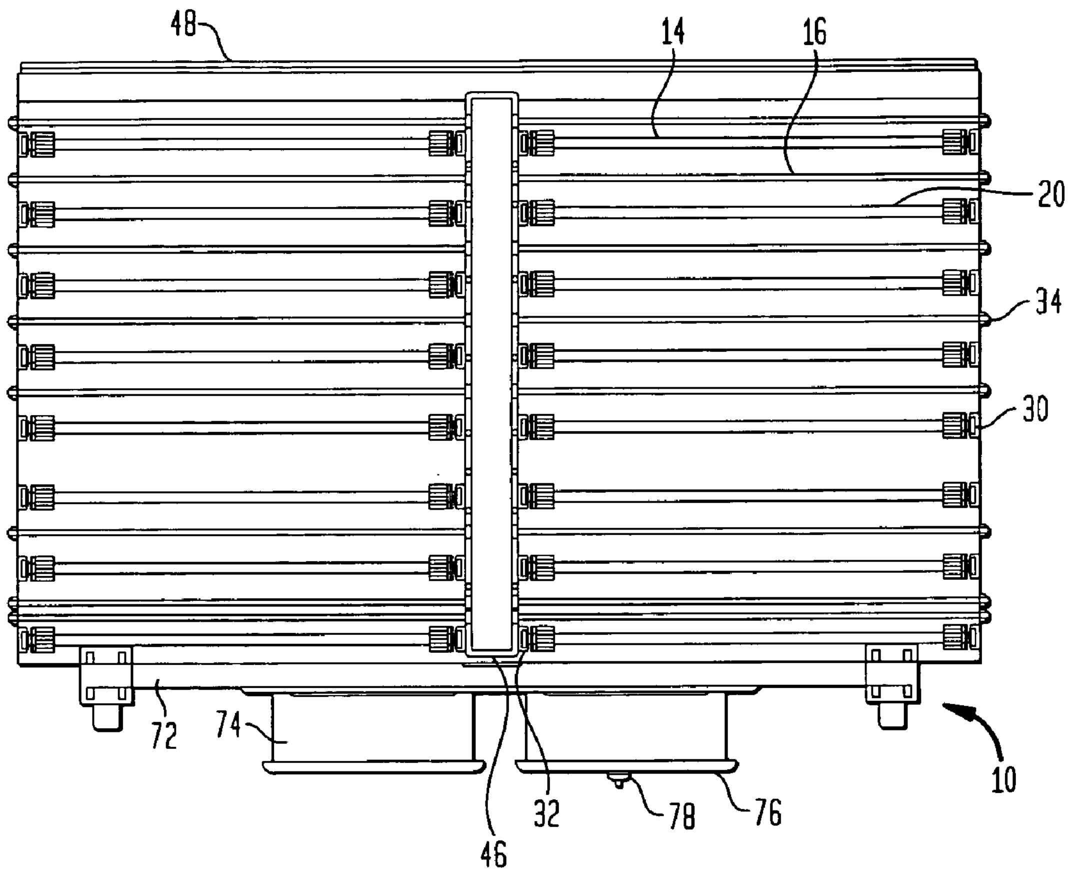


FIG. 3

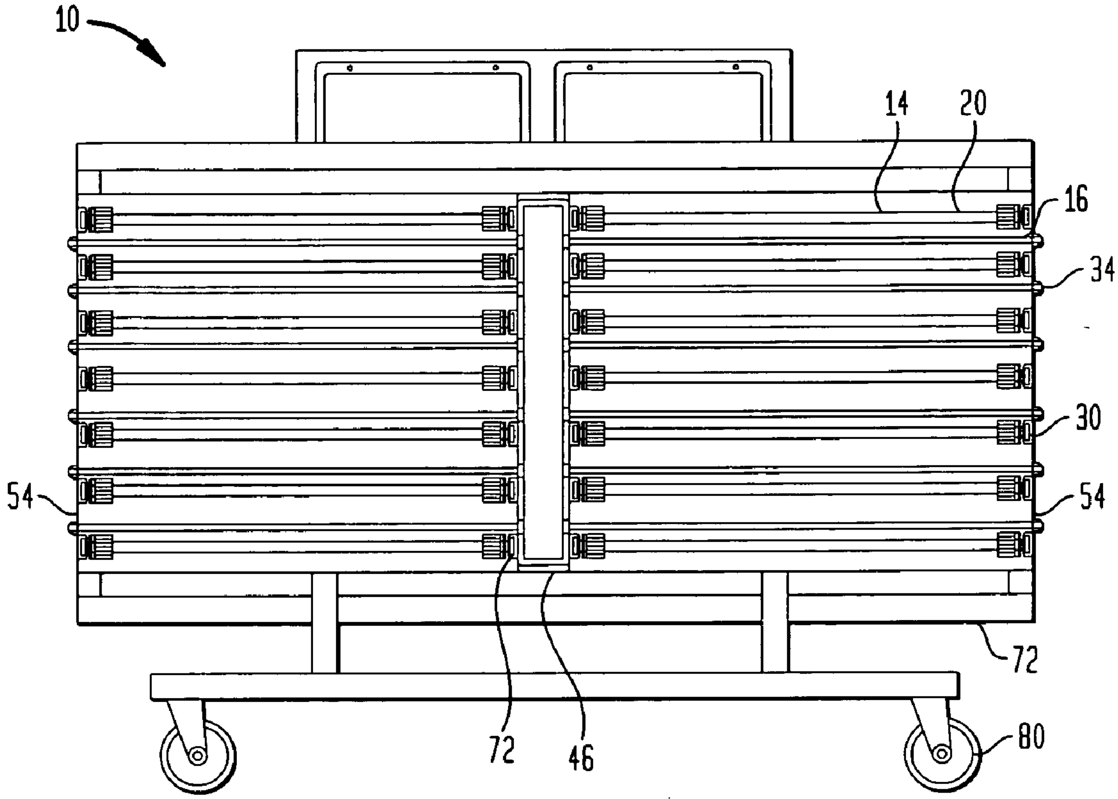


FIG. 4

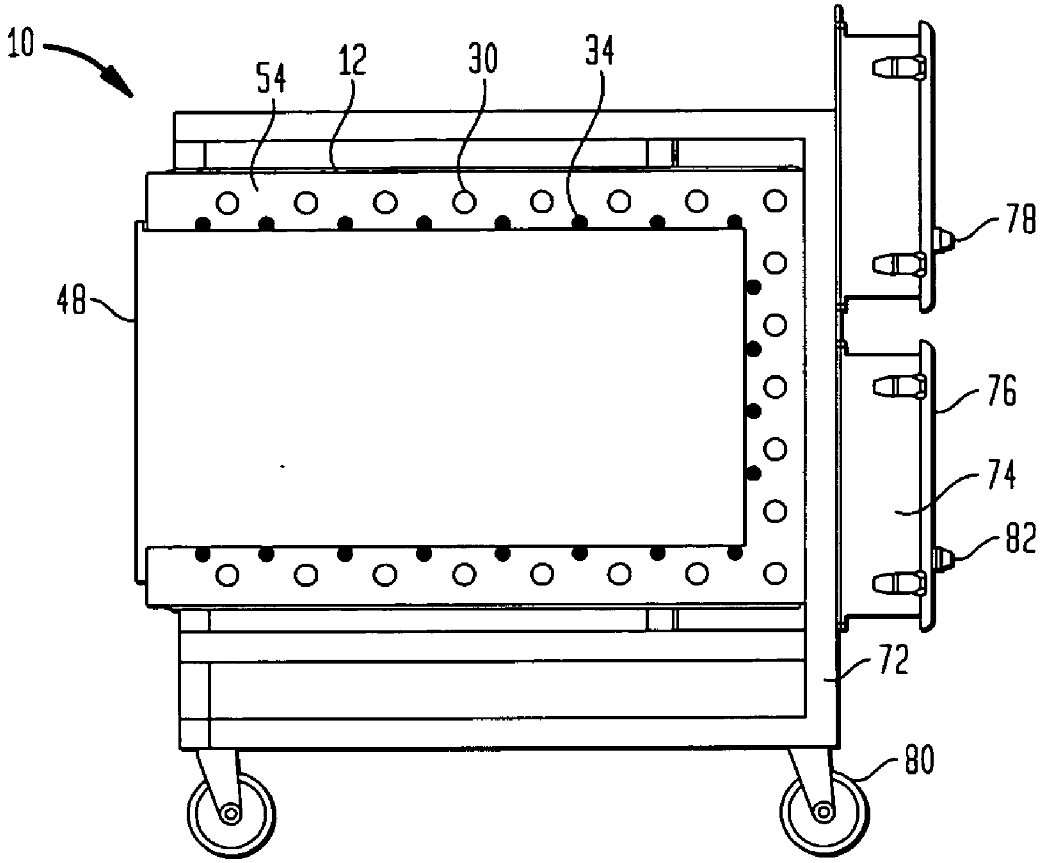


FIG. 5

FIG. 6A

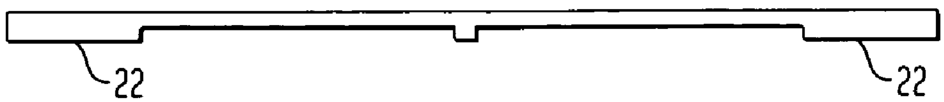


FIG. 6B

FIG. 7

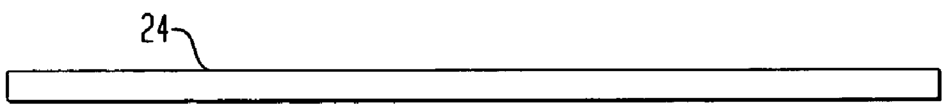


FIG. 8

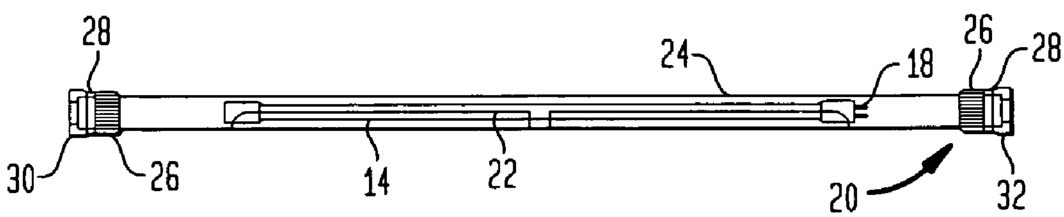


FIG. 9

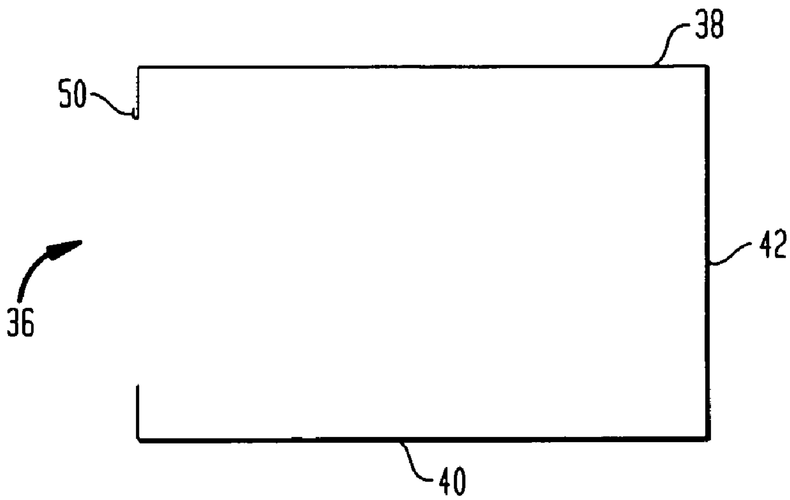


FIG. 10

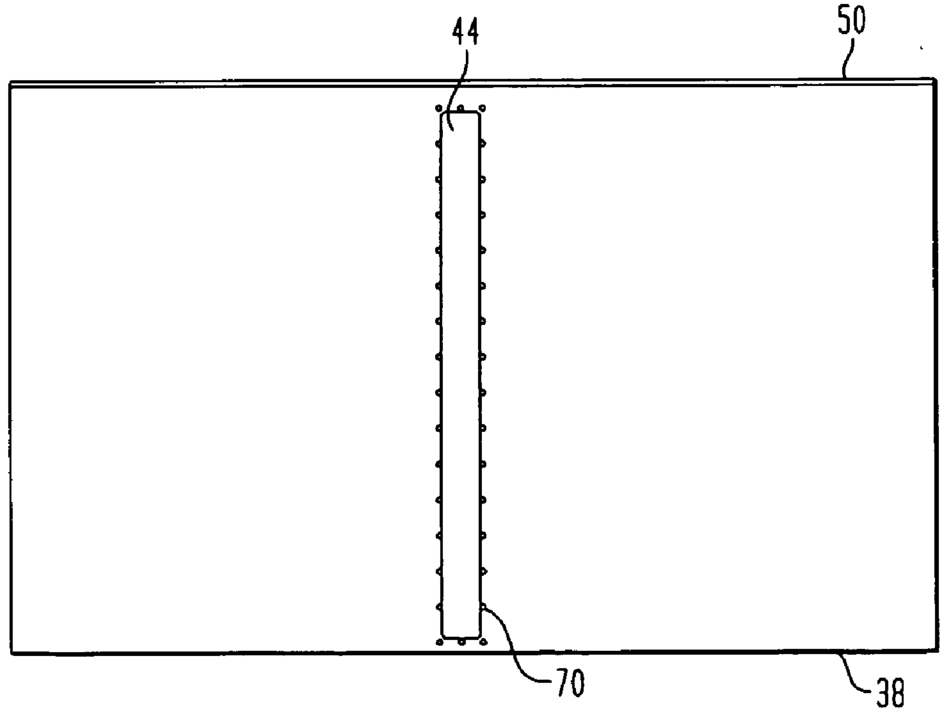


FIG. 11

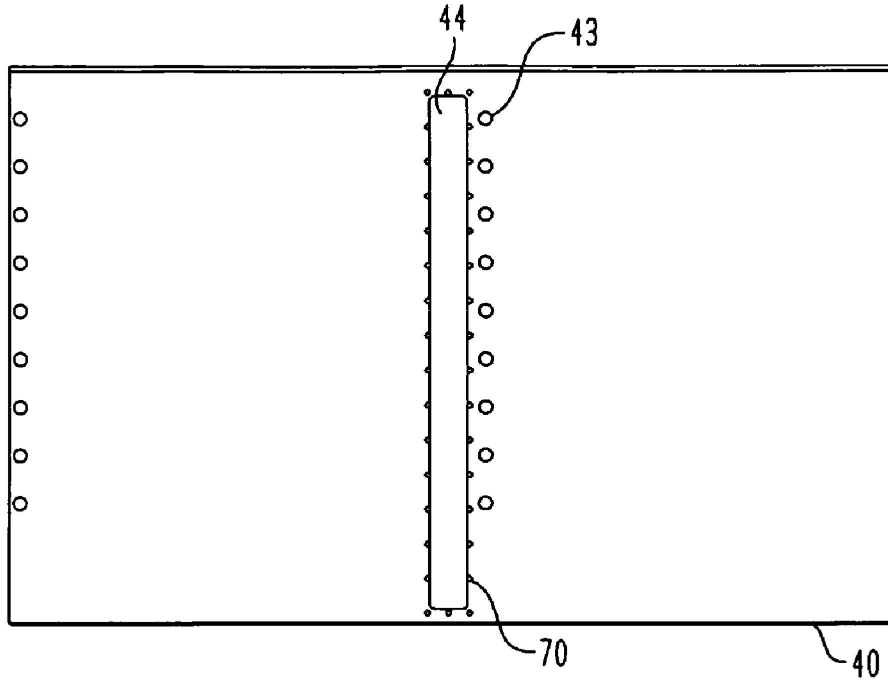


FIG. 12

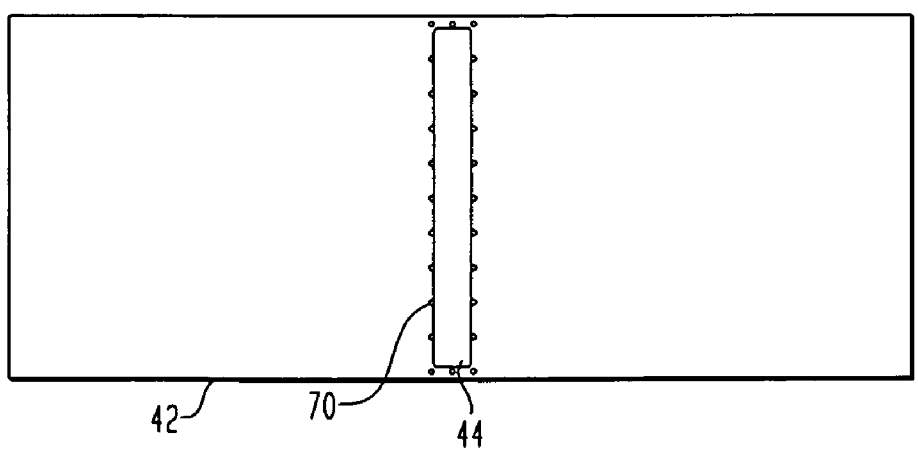


FIG. 13A

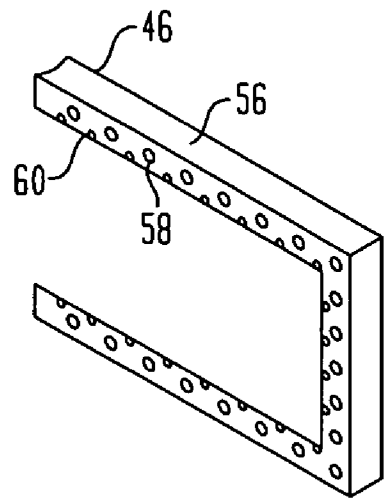


FIG. 13B

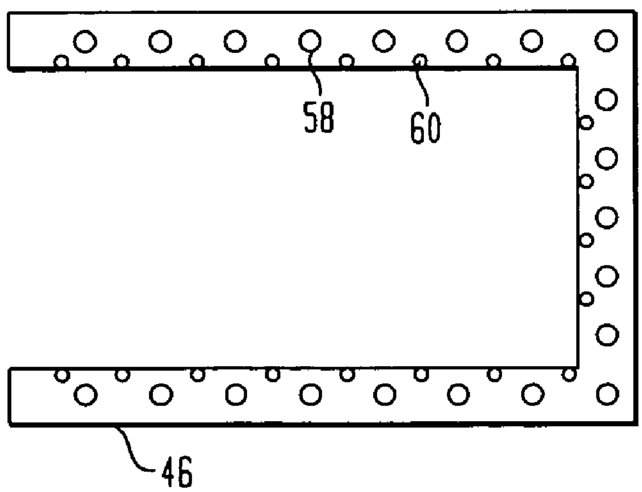


FIG. 13C

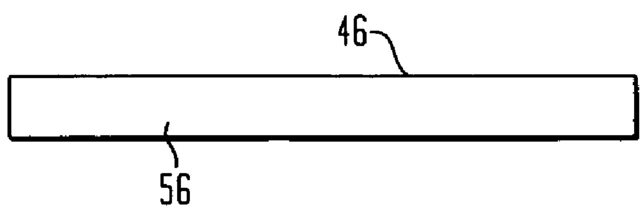


FIG. 14A

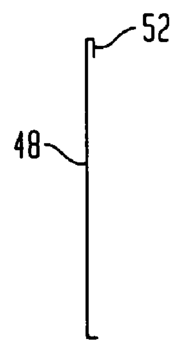


FIG. 14B

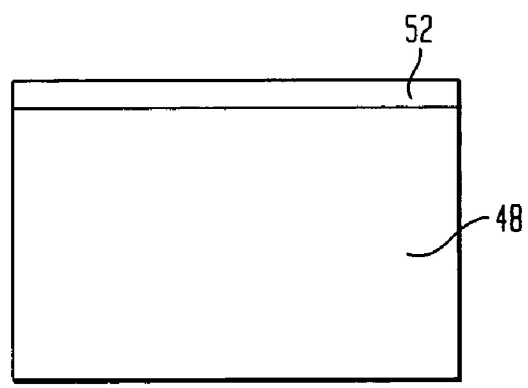


FIG. 15

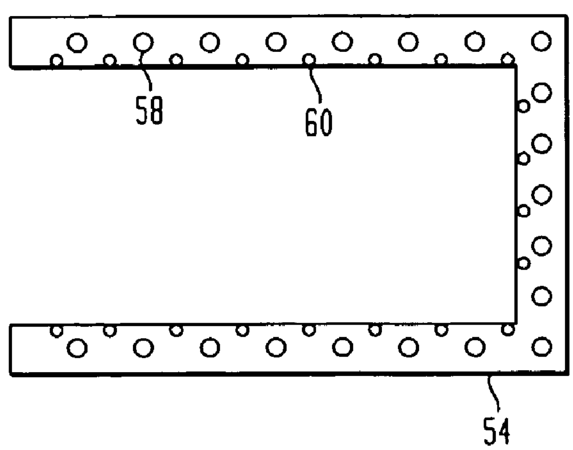


FIG. 16

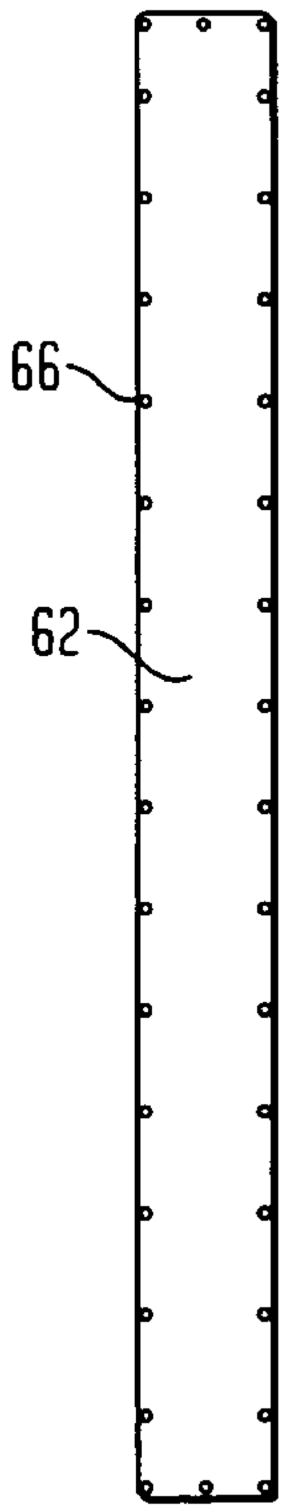


FIG. 17

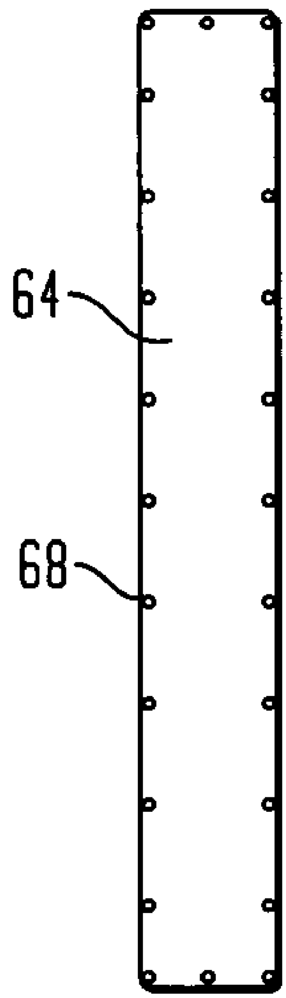


FIG. 18A

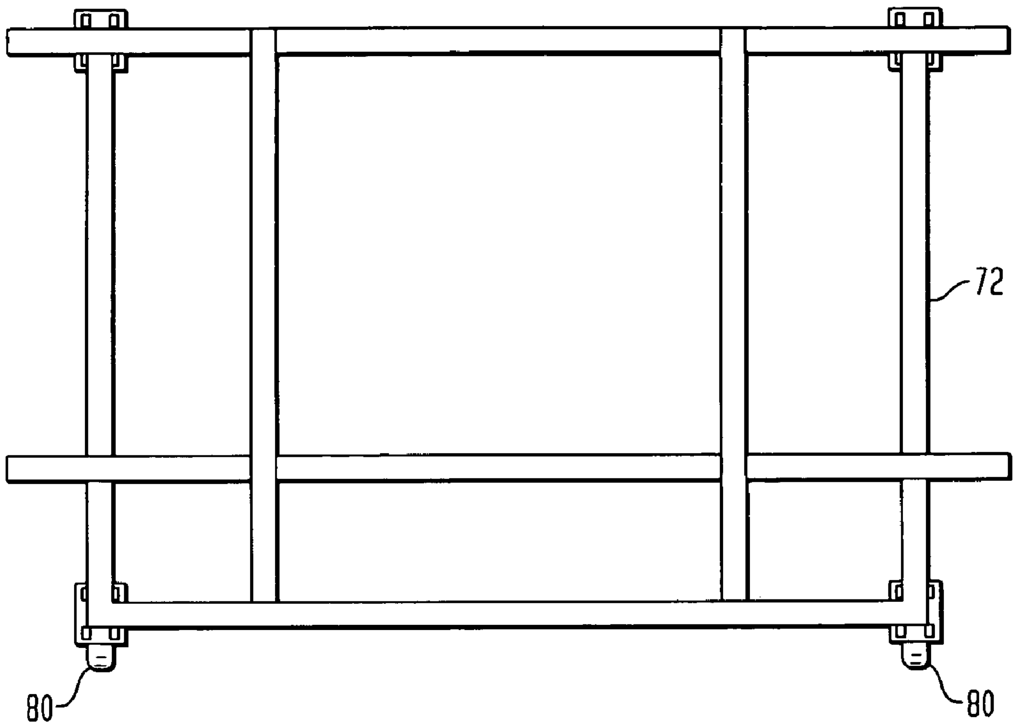


FIG. 18B

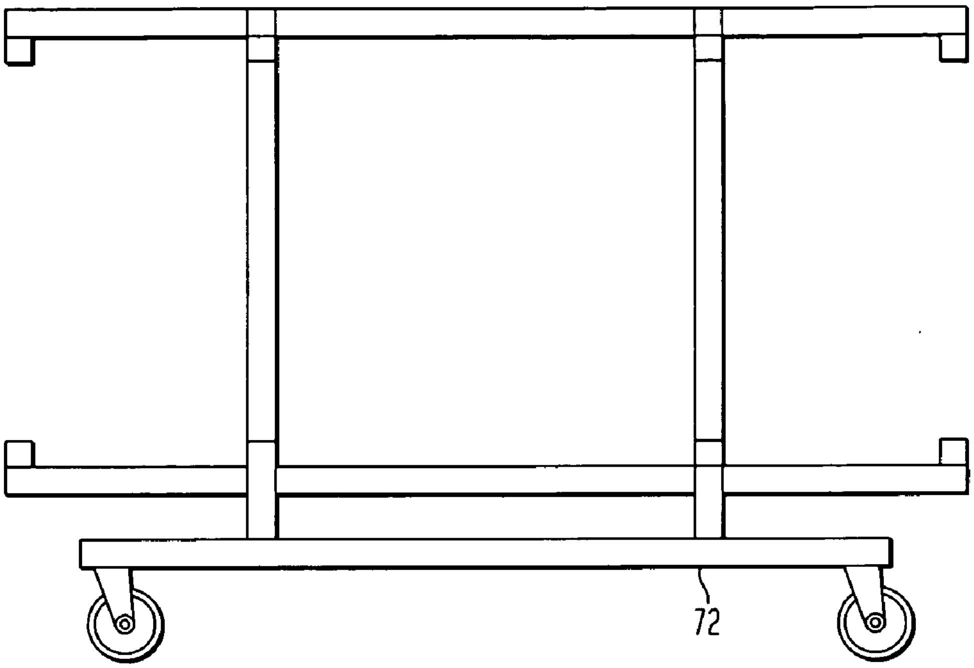


FIG. 18C

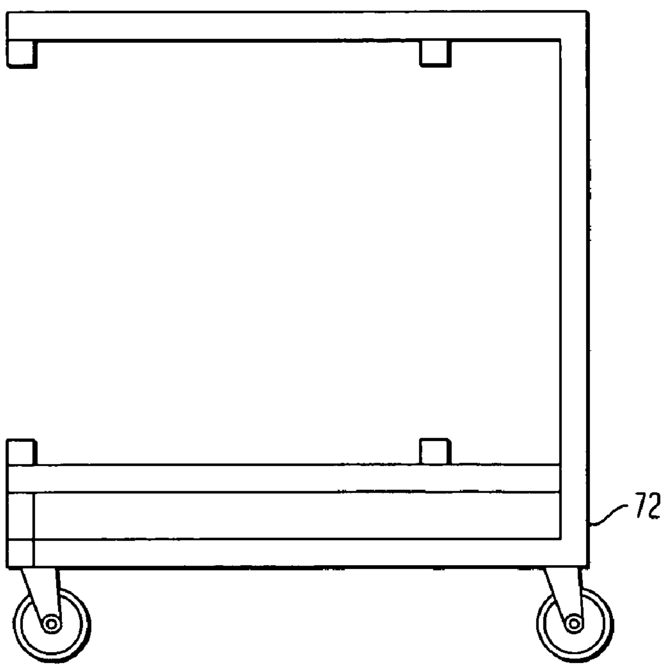


FIG. 19

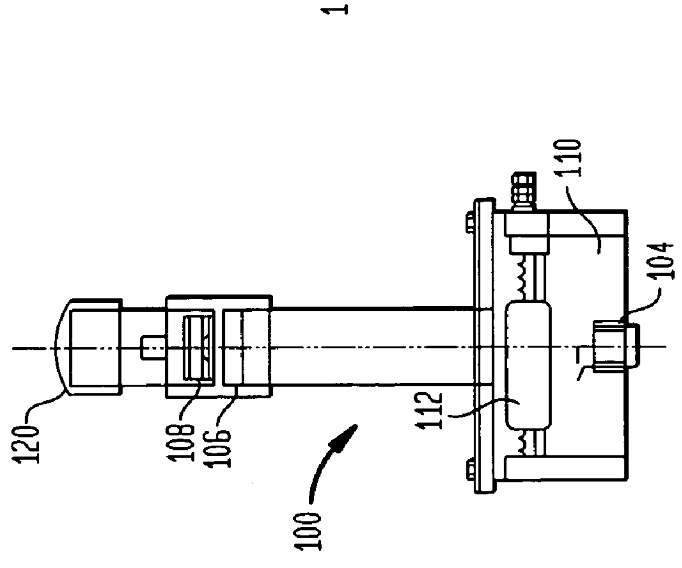


FIG. 20

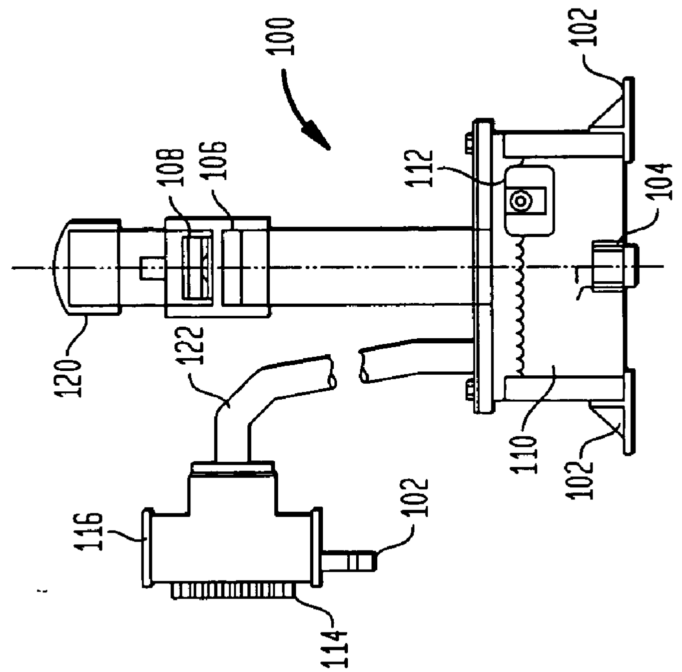
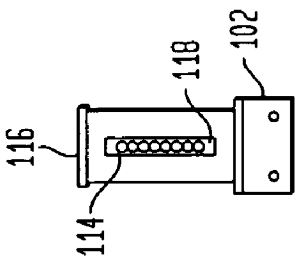


FIG. 21



FOOD SURFACE SANITATION TUNNEL

BACKGROUND OF INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to the simultaneous sanitation of several food surfaces and more particularly pertains to industrial modular, compact, efficient systems and devices for sanitizing foods during processing and packaging, especially those processed on assembly lines. The present invention also relates to foods sanitized by such systems and devices.

[0003] 2. Description of Related Art

[0004] Food sanitation is a growing concern in the world. More and more aggressive disease-causing agents are discovered every year. In addition, an increasing number of people are made ill each year by eating contaminated foods. Also, the numbers of foods linked to food-caused illnesses continues to increase. Nonetheless, the desire for safer foods is higher than ever. In fact, more and more state and federal jurisdictions are requiring that businesses use the most efficacious food safety and sanitation practices.

[0005] Efficient use of modern sanitization techniques decreases the cost of applying them. These savings, when passed to the consumer, mean the consumers spend less on the processed foods. Also, efficient sanitizing techniques can allow more food to be processed in a smaller amount of space. Thus, smaller facilities may compete with larger ones, thereby increasing competition between processors and lowering prices to consumers. In addition, facilities that use less-safe processing techniques may be easily retrofit to install an efficient apparatus. Furthermore, modularity in a sanitizing system or device makes it easy to manufacture and easy to replace parts.

[0006] Sanitizing radiation allows a highly controllable application of organism-killing radiation to foods and food additives. The use of sanitizing radiation in the food industry in general is well known in the prior art, and has been used in a variety of forms, including gamma ray radiation, ultraviolet (UV) light and infrared radiation.

[0007] For example, it is well known that gamma radiation and UV radiation has been used in some countries for the sterilization of spices and animal feeds. However, over-use of ultraviolet radiation may cause undesirable chemical reactions with a food or food additive, which can cause the food or food additive to obtain undesirable flavors or textures. Also, various vitamins and proteins may be altered or destroyed through being subjected to too much radiation, reducing the food value of the treated product.

[0008] Traditional methods of irradiating foods processed or packaged in assembly line manner use an unnecessary amount of radiation, as well as space, in a food processing facility. Furthermore, they fail to take full advantage of the combined use of ozone, UV light, hydroperoxides, superoxides and hydroxyl radicals in the sanitization process. For example, U.S. Pat. No. 6,150,663 to Rosenthal teaches a system incorporating an irradiation system using radiation, and only radiation, to sanitize food. Rosenthal also teaches vibration of the food to optimize radiation exposure to all of the food surfaces. The entire system is inefficient and ineffective, as irradiation alone may not properly sanitize food, and there is no sanitization of more than one side at the same time. In addition, if there were a slight fold on the food surface, the shaded food surface would never be sanitized. However, ozone, hydroperoxides, superoxides and hydroxyl radical ions are able to get beneath a fold and sanitize a folded over food surface. Furthermore, hydroperoxides, superoxides, ozone and hydroxyl radical ions, when used together, reduce the amount of radiation needed thereby decreasing radiation damage to food. Also, if the food were prepackaged so that vibration would topple the packaging, then the Rosenthal process would be contraindicated.

[0009] Thus, there is a need for a portable modular system that sanitizes more than one food surface simultaneously. There is also a need for a system that uses the sanitizing combination of radiation, ozone, hydroperoxides, superoxides and hydroxyl radicals, or one that makes it easy to apply or manufacture economically. There is also a lack of such a sanitizing system that may be retrofit into an existing assembly system. There is no system designed with modularity in mind, to suit different processes properly, or to provide easy manufacture or replacement of component parts. There is no system wherein the radiation, ozone, hydroperoxides, superoxides and hydroxyl radicals are optimized for food treatment. There is no system that efficiently utilizes sanitizing radiation, ozone, hydroperoxides, superoxides and hydroxyl radicals to sanitize processed and/or prepackaged foods. There is no system which adds regulated amounts of moisture to the enclosing sanitizing system to improve the efficiency of the formation of hydroperoxides, superoxides and hydroxyl radicals in sanitizing food. There is no such. system that is easy to assemble, adjust, transport, clean, maintain and disassemble. There is no system using sanitizing radiation, ozone, hydroperoxides, superoxides and hydroxyl radicals that is adjustable on a frame with wheels, or that uses sanitizers on more than one side simultaneously. In other words, there is no system that takes advantage of the sanitizing and free-moving characteristics of a combination of radiation with ozone, hydroperoxides, superoxides and hydroxyl radicals to improve sanitization beyond what mere radiation can perform.

SUMMARY OF INVENTION

[0010] The present invention is a modular, adjustable, portable, easy to maintain food sanitation tunnel system, having an enclosing means for simultaneously subjecting food on at least two sides to sanitizers including UV light, ozone, and plasma including hydroperoxides, superoxides and hydroxyl radicals. The enclosing means has one or more UV light sources and one or more target rods in optical proximity to the UV light sources. The UV radiation sources emit UV light of approximately 185 to 254 nm. In an alternative embodiment, the enclosing means further comprises drainage holes through a bottom surface.

[0011] In another embodiment, the target rods comprise up to approximately 0-30% titanium dioxide, up to 0-30% silver and up to 0-30% copper, by weight. In yet another embodiment, the system includes a mister for adding an optimized amount of mist in proximity to the target rods for the efficient production of hydroxyl radicals. In still another embodiment, hydroxyl radicals are generated in part from the moisture in the ambient air in the proximity of the target rods.

[0012] In yet another embodiment, a door at least partially encircles the food within a space defined by the enclosing means. The door is removably attached to an overhang of the enclosing means. In still another embodiment, the system includes an electrical box attached to the exterior of the enclosing means, and the electrical box has a removable cover plate.

[0013] In another embodiment, the enclosing means is C-shaped. In yet another embodiment, the system has alternating UV light sources and target rods. In still another embodiment, the enclosing means is approximately 46 inches in width. In yet still another embodiment, the target rods are of modular construction.

[0014] In yet another embodiment, the UV light source is located within an assembly. In another embodiment, the assembly includes a reflector tube and a shield, and the assembly is of modular construction. In still another embodiment, the target rods and the assemblies are easy to manufacture, maintain and replace.

[0015] In yet still another embodiment, the system includes a rigid frame for the enclosing means, and a self-contained adjustable conveyor. In another embodiment, the system includes a ballast housing and a control box located on the frame, and the frame has wheels.

[0016] In yet another embodiment, the UV light sources and the target rods surround the food in a rectangular or triangular shape. In still another embodiment, the frame is adaptable to allow the enclosing means to be optimally located in relation to the food.

[0017] In still another embodiment, the invention is a food sanitation tunnel, comprising means for subjecting food to sanitizing radiation, means for subjecting food to ozone and means for subjecting food to a sanitizing plasma, whereby the food is subjected to the radiation, the ozone and the plasma generally simultaneously. In yet another embodiment, the means for subjecting food to sanitizing radiation, the means for subjecting food to ozone and the means for subjecting food to sanitizing plasma includes one or more sanitizing radiation sources located in an assembly and one or more target rods in optical proximity to the assemblies. In yet still another embodiment, the assemblies and the target rods are modular in construction, easy-to-clean and easy-to-maintain. In addition, the tunnel is generally portable. The assemblies and target rods are in generally triangular orientation, a c-shaped configuration, or other preferred orientation.

[0018] In still another embodiment, the tunnel includes an enclosing structure, and a door is removably attached to an upper portion of the enclosing structure.

[0019] In yet another embodiment, the invention is a method for sanitizing food comprising the exposing of a food surface within an enclosure simultaneously to UV light, ozone, and sanitizing plasma. In another embodiment, the invention is the food sanitized by the method above.

[0020] It is an object of this invention to provide a portable modular system that sanitizes more than one side of a food surface simultaneously.

[0021] It is another object of this invention to provide a modular system makes utilization of the sanitizing combination of radiation, ozone, hydroperoxide, superoxide and hydroxyl radicals easy to apply or manufacture economically, or to fit into an existing system.

[0022] It is still another object of the invention to provide a system designed with modularity in mind, and to provide easy manufacture or replacement of component parts.

[0023] It is yet another object of the invention to provide a system wherein the radiation, ozone, hydroperoxide, superoxide and hydroxyl radicals are combined and optimized for food treatment.

[0024] It is yet still another object of the invention to provide a system that efficiently utilizes sanitizing radiation, ozone, hydroperoxide, superoxide and hydroxyl radicals to sanitize processed and/or prepackaged foods during processing and packaging.

[0025] It is still another object of the invention to provide a system which adds moisture to the sanitizing system to improve the efficiency of the formation of a sanitizing plasma for sanitizing food.

[0026] It is yet another object of the invention to provide a system that is easy to assemble, adjust, transport, clean, maintain and disassemble.

[0027] It is still another object of the invention to provide a system using sanitizing radiation, ozone, hydroperoxide, superoxide and hydroxyl radicals that is adjustable on a frame.

[0028] It is yet still another object of the invention to provide a system that takes advantage of the sanitizing and free-moving characteristics of the combination of sanitizing radiation, ozone, hydroperoxide, superoxide and hydroxyl radicals to improve sanitization beyond what mere radiation can perform.

[0029] In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with particular reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0030] FIG. **1** is a front perspective view of the preferred embodiment of the invention.

[0031] FIG. **2** is a cut away top view of the preferred embodiment of the invention, revealing the UV light sources.

[0032] FIG. **3** is a front elevation view of the preferred embodiment of the invention, without the optional door.

[0033] FIG. **4** is a side elevation view of the preferred embodiment of the invention.

[0034] FIG. **5** is a side elevation view of a UV light source of the invention.

[0035] FIG. **6**A is a side elevation view of a reflecting tube of the invention.

[0036] FIG. **6**B is an end elevation view of a reflecting tube of the invention.

[0037] FIG. **7** is a side elevation view of a shield of the invention.

[0038] FIG. **8** is a side elevation view of a UV light assembly of the invention.

[0039] FIG. **9** is a side elevation view of the shell of the invention.

[0040] FIG. **10** is a top plan view of the top section of the shell of the invention.

[0041] FIG. **11** is a top plan view of the bottom section of the shell of the invention.

[0042] FIG. **12** is a top plan view of the side section of the shell of the invention.

[0043] FIG. **13**A is a perspective view of the center box of the invention.

[0044] FIG. **13**B is a side elevation view of the center box of the invention.

[0045] FIG. **13**C is an end elevation view of the center box of the invention.

[0046] FIG. **14**A is a side elevation view of a door for the shell of the invention.

[0047] FIG. **14**B is a front elevation view of a door for the shell of the invention.

[0048] FIG. **15** is a side elevation view of an endpiece for the shell of the invention.

[0049] FIG. **16** is a side elevation view of a cover plate for the top and bottom concave portions of the center box of the invention.

[0050] FIG. **17** is a side elevation view of a cover plate for the side concave portion of the center box of the invention.

[0051] FIG. **18**A is a top plan view of a frame for the invention.

[0052] FIG. **18**B is a side elevation view of a frame for the invention.

[0053] FIG. **18**C is an end elevation view of a frame for the invention.

[0054] FIG. **19** is a front elevation view of the mister used in an alternative embodiment of the invention.

[0055] FIG. **20** is a side elevation view of the mister used in an alternative embodiment of the invention.

[0056] FIG. **21** is a detailed view of the mist header used in an alternative embodiment of the invention.

DETAILED DESCRIPTION

[0057] The present invention is a modular, adjustable, portable, easy to maintain food sanitation tunnel system, shown generally in FIGS. **1-4** at **10**. The system includes an enclosing means of a predetermined geometry, such as a c-shaped tunnel **12** for simultaneously subjecting food on at least two sides to sanitizers including UV light, ozone, and a sanitizing plasma including hydroperoxides, superoxides and hydroxyl radicals. Attached to the inside surface of the tunnel **12** are one or more sanitizing radiation sources, such as UV light sources **14**, and one or more target rods **16** that are located within the tunnel **12** in optical proximity to the UV light sources **14**.

[0058] Preferably the tunnel **12** is made from a rigid, food safe material, such as stainless steel. The tunnel **12** is placed around the food to be sanitized, so that sanitizers touch the food on at least two sides. It is preferred that the food is passed through the tunnel **12** along a conveyor. Where sanitization of the food comes from below the conveyor, it is preferred that the conveyor allow the sanitizers to pass through the conveyor. For example, the conveyor may be a mesh or webbing, or be at least translucent to ionizing radiation, or both.

[0059] The sanitizing radiation sources are preferably generally cylindrical UV light sources **14**, such as low vapor mercury lamps that emit UV light of approximately 185 to 254 nm. However, other sanitizing radiation sources such as medium or high vapor mercury lamps may be used. Thus, both high energy and medium to low energy UV light is preferably used. It is also preferred that the UV light source **14** have its electrical connectors **18** on one end rather than on both ends of the UV lamps **14**, as shown in FIGS. **5** and **8**. This configuration facilitates cleaning of the system **10**, the use of protective conduits for wiring throughout the system, and replacement of the UV light sources. **14**. However, other sanitizing radiation sources in other configurations may be used.

[0060] Also, in the preferred embodiment, the UV light source **14** is located within an assembly **20**, as shown in FIGS. **1-3** and **8**. The assembly **20** makes replacement of the UV light sources **14** easier, acts as a barrier to protect both the UV light source **14** and the food it sanitizes, and reflects UV light to make the UV light source **14** a more efficient sanitizer. The assembly **20** is preferably made as described below.

[0061] Around the UV light source **14** is preferably a generally cylindrical reflector tube **22**, as shown in FIGS. **6**A, **6**B and **8**. The tube **22** has a highly reflective interior surface, so the UV light from the UV light source **14** is reflected onto the food and the vicinity of the target rod **18**. Also, it is preferred that the tube **22** be rigid to help in securing the connection of the UV light source **14** onto the interior of the tunnel **12**. The reflector tube **22** is positioned so that at least some UV light that would otherwise be emitted by the UV light source **14** in a direction away from the food is redirected generally toward the target rod **18**, the air around the food, or the food itself, to optimize the sanitization process. It is also preferred that the reflector tube **22** is of a shape designed so that the UV light source's radiation is not obstructed. In addition, the interior geometry of the reflector tube **22** may be altered to optimize reflection of the UV light onto the target rod **18**, the air around the food, or the food itself. The preferred material for the tube **22** is aluminum; however, other metals may be used, or a reflective coating may be placed on the interior surface of a rigid, generally cylindrical piece.

[0062] Around the UV light source **14** and the reflector tube **22**, fused, is preferably a shield **24**, shown in FIGS. **7** and **8**. The shield **24** protects the food from any material that may possibly fall into the food if the UV light source **14** breaks. Preferably, the shield **24** is a transparent, generally flexible cylinder made from fluorocarbon. However, other equivalent materials may be used.

[0063] In the preferred embodiment, as shown in FIG. **8**, on each end of the shield **24** is an endcap fitting **26**. Each endcap fitting **26** is generally cylindrical and allows each end of the shield **24** to fit at least partway within it. Around each endcap fitting **26** is a means for forming a compressive seal, such as a gasket **28**. On the far end of each endcap fitting **26** is either a closed endcap **30** or an open endcap **32**. These endcaps are illustrated in FIGS. **1-4** and **8**. A closed endcap **30** is preferred for the end of the UV light source **14** that has no electrical connectors **18** to protect the UV light source **14** and is preferably opaque to reduce radiation escaping from the tunnel **12**. An open endcap **32** is preferred for the end of the UV light source **14** that has electrical connectors **18** to provide access to wiring and electronics for the UV light sources **14**. In the preferred embodiment, the endcap fittings **26** and the endcaps **30**, **32** have complementary threads, so that screwing the endcaps **30**, **32** onto the endcap fittings **26** compresses the compressive seal.

[0064] The compressive seal around the assembly **20** helps keep the UV light within the tunnel **12**, and protects the assembly **20** from the outside environment. The rigid reflector tube **22** are preferred to be sufficiently rigid to help provide resistance for screwing the endcaps **30**, **32** onto the endcap fittings **26** in forming the compressive seal. The reflector tube **22** also forms a support for the shield **24** so that the shield **24** does not contact the UV light source **14** during maintenance and cause the UV light source **14** to break.

[0065] Shown in FIGS. **1**,**4**, in optical proximity to the UV light sources **14** and attached to the inner surface of the tunnel **12** is at least one generally cylindrical target rod **16**. The target rods **16** are generally parallel to the UV light sources **14**. The target rod **16** preferably comprises up to approximately up to 0-30% titanium dioxide, up to 0-30% silver and up to 0-30% copper, by weight, and attached to a stainless steel substrate. The number of target rods **16** and UV light sources **14** is dependent upon the amount of sanitization desired as well as the size of the area to be sanitized. As shown in FIGS. **1-4**, the target rods **16** are offset and evenly interspersed between the UV light sources **14**. However, other geometry may be preferred for different sanitization processes, so long as sufficient UV light reaches the target rods **16** to help form the sanitizing plasma.

[0066] As shown in FIGS. **1-4**, target rods **16** are placed within the interior portion of the tunnel **12**, and are held in place by endcaps **34**. Thus, the target rods **16** are like the UV light assemblies **20**, in that both are modular and easily accessible for replacement or maintenance. However, both the UV light assemblies **20** and the target rods **16** alternatively may be hung or secured onto the interior of the tunnel **12** by means not including any endcaps.

[0067] The UV light source itself helps sanitize the food. The UV light also interacts with oxygen to form ozone, which also helps sanitize the food. Moreover, the UV light also interacts with moisture and the target rod **16** to form hydroxyl radicals, superoxides and hyperoxides in a plasma that helps sanitize the food. The UV light generally helps to increase the amount of hydroxyl radicals, superoxides and hydroperoxides. Moisture for use with the target rods **16** may exist naturally in the area of the tunnel **12**.

[0068] Alternatively, moisture may be added by a separate mister **100**, shown in FIGS. **19** and **20**, either attached to or in proximity to the tunnel **12**. The mister is preferably mounted onto the tunnel **12** with a mounting bracket **102**, although it may be situated so that it applies mist toward the food without being attached to the tunnel **12**. Water is preferably excited by an ultrasonic mist former **104**. The mister **100** also preferably includes mist eliminator **106** mesh means for eliminating mist between the means for moving air onto the food, (such as a fan **108**) and the reservoir **110** of water. The output of the fan **108** can be regulated with a flow controller **120**. The level of the reservoir **110** is preferably regulated by a float valve **112**. It is preferred that the material for the mist eliminator **106** is polypropylene or an equivalent material. The mist flows from a flexible tube **122** or equivalent means to a mist outlet **114** The mist outlet **114** means for controlling the amount of mist applied toward the food is also preferred. As detailed in FIG. **21**, it is located on a mist header **116**. Also, an adjustable vent block **118** is used in conjunction with a mist header **116** to control the amount of mist emitted.

[0069] As shown in FIGS. **1** and **9**, in the preferred embodiment, the tunnel **12** comprises a shell **36**, preferably made of an easy to maintain rigid material, such as stainless steel. The shell **36** includes a top portion **38**, a bottom portion **40** and a side portion **42**.

[0070] Preferably the top portion **38**, bottom portion **40** and side portion **42** are separately manufactured in pieces as shown in FIGS. **10-12**, respectively. The portions **38**, **40**, **42** are then joined together, either permanently or temporarily. The preferred method of attachment is welding. In addition, as shown in FIG. **11**, one or more drain holes **43** are drilled through the bottom portion **40**, for any fluids that may drip from the food. It is preferred that the drain holes **43** are approximately one inch in diameter.

[0071] In an alternative embodiment, as shown in FIGS. **14**A and **14**B, a door **48** is attached to the front side of the top portion **38** of the shell **36**. The door **48** may be removably or permanently attached. Moreover, the door **48** may be hingeably attached or removable from the shell **36**. To facilitate attachment of a door **48**, the top portion **40** of the shell **36** may further comprise a lip **50**, so that the door **48** may hang from it by a complementary flange **52**. The door would be superfluous where UV light sources **14** and target rods **16** surround the food.

[0072] Attached to the top, bottom, and side portions **38**, **40**, **42** of the shell **36** are means for attaching the UV light sources **14** and target rods **16** to the shell **36** of the tunnel **12**. In the preferred embodiment, as shown in FIGS. **2** and **3**, at least one center box **46** and end pieces **54** are attached to the top, bottom and side portions **38**, **40**, **42** of the shell **36**. The center box **46** is a generally c-shaped member shown generally in FIGS. **13**A-**13**C. It is preferably made from a rigid material, such as stainless steel. It is also preferred that the center box **46** is attached to the shell **36** by welding; however, other means such as screws or rivets may be used. As shown in FIG. **13**A, the back of the center box **46** preferably includes a concave section **56**. Support holes **58** for supporting the UV light sources **14** and their assemblies **20** are drilled through the concave section **56**. Thus, the concave section **56** may serve as a conduit for wiring and electronics for the UV light sources **14**. The holes **58** are preferred to be complementary to the endcap fitting **26** and the open endcap **28** for an assembly **20**, so the assemblies are held in place. In addition, voids **60** for accommodating the target rods **16** are also drilled through the center box **46**. The rods **16** are preferably held in place by having the target rod endcap **34** located on the concave portion **56** of the center box **46**.

[0073] Endpieces **54**, as shown in FIG. **15**, are also preferably attached to the top, middle, and bottom portions **38**, **40**, **42** of the shell **36** by welding. Holes **58** in each endpiece **54** also help support the UV light sources **14** and the associated assemblies **20**. Similarly, voids **60** are drilled through each of the endpieces **54** for supporting target rods **16** by the target rod endcaps **34**. Thus, a target rod **16** and an assembly **20** are supported by both the center box **46** and an endpiece **54**. In an alternative embodiment, a plurality of center boxes **46** may be used within an enlarged shell, and UV light sources **14** and target rods **16** may be supported by two serial center boxes **46**, as well as a center box **46** and an end piece **54**.

[**0074**] It is also preferred that a top and bottom cover plate **62** and a side cover plate **64**, as shown in FIGS. **16** and **17**, are used to help protect elements within the concave portions **56** of the center box **46**, such as wiring and other components. The cover plates **62**, **64** are preferably removably attached by screws inserted in screw holes **66**, **68** through the cover plates **62**, **64** and in holes **70** through each portion of the shell **36**, as shown in FIGS. **10-12**. However, other attachment means, such as rivets or welding, are contemplated. Wiring and other electronics may run through holes in one or more cover plates.

[**0075**] In one embodiment, shown in FIGS. **1-4**, the shell **36** is attached to the upper portion of a rigid frame **72**. The frame **72** alone is separately shown in FIGS. **18**A-**8**C. The tunnel **12** is preferably adjustable vertically and horizontally in relation to the frame **72** to optimize sanitation of the food. Adjustment may be made hydraulically, electronically, or mechanically or by other equivalent means.

[**0076**] It is also preferred that the frame **72** includes one or more generally impermeable but easily accessible control boxes **74**, shown in FIGS. **1-4**. The control box **74** preferably has one or more removable cover panels **76** for access to the circuitry, and an on-off switch **78**. Also, the control box **74** may include a lamp indicator light **82** to show whether power is being sent to the system **10**. It is preferred that the frame **72** and cover panels **76** to the control box **74** and ballast housing are made of an easily cleanable material, such as stainless steel or aluminum.

[**0077**] In an alternative embodiment, the frame **72** is housed on wheels **80**. Preferably, the wheels **80** are able to lock into position so the system **10** is portable yet fixable in a predetermined place.

[**0078**] In addition, while a c-shaped system **10** has been illustrated, other geometries are contemplated. For example, the elements contributing to the sanitization of the system **10** may be circular or triangular in orientation. Moreover, a full rectangular orientation of the elements may be used that does not require any door.

[**0079**] The apparatus sanitized food in accordance with the following procedure.

[**0080**] The food passes through the tunnel. The apparatus uses means for treating the food with UV light including UV-C light. Also, the apparatus treats the air around the food with UV light including UV-C light in the presence of a target to form a first set of chemical species. The apparatus then treats the products of the treated air in the presence of air with UV light including UV-C light to form a second set of chemical species. The first set of chemical species includes ozone, superoxides, and hydroxide radicals. The second set of chemical species includes hydroperoxides. The air to be treated usually includes latent water. However, water may be added to the air being treated by a mister to improve the performance of the apparatus.

[**0081**] In operation, a zone of plasma is created between the target and the UV light. The plasma includes air having hydroxyl radicals, ozone, hydroperoxides and super-oxides. Part of the reason the apparatus is so effective is that the high energy UV light helps create chemical species that have not been created before for food sanitization. Also, the interaction between the new chemical species, the ozone, and the cleansing UV light is synergistic, making a three part cleaning system that is highly effective for food sanitization. In addition, while the UV-C light creates ozone, the lower energy UV light emitted by the UV light source aids in the breakdown of the ozone molecules. Thus, the second chemical species has a higher concentration of hydroperoxides than would normally be formed from the breakdown of ozone without the energy UV light. Therefore, because of the apparatus' sanitizing plasmas, the food requires less exposure to UV light than would otherwise be necessary. Also, the plasma allows sanitization on irregular areas which might otherwise be shaded from UV light or other sanitizing radiation.

[**0082**] The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.

What is claimed is:

1. A modular, adjustable, movable food sanitation tunnel system, comprising:

enclosing means for simultaneously subjecting food on at least two sides of the food to sanitizers including sanitizing radiation and a sanitizing plasma.

2. The system of claim 1, wherein the enclosing means comprises at least one UV light source; and at least one target rod located in optical proximity to the at least one UV light source.

3. The system of claim 1, wherein the enclosing means comprises at least one UV radiation source that emits UV light of approximately 185 to 254 nm.

4. The system of claim 3, wherein the at least one UV radiation source is at least one of a low-vapor mercury UV light source and a high-vapor mercury UV light source.

5. The system of claim 1, wherein the enclosing means comprises means for draining fluid from the food.

6. The system of claim 1, wherein the sanitizers comprise target rods comprising 0-30% titanium dioxide, 0-30% silver and 0-30% copper, by weight.

7. The system of claim 1, wherein the sanitizing plasma comprises at least one of hydroxyl radicals, ozone, hydroperoxides and super-oxides.

8. The system of claim 1, further comprising mister means for providing mist in proximity to the sanitizers for production of the sanitizing plasma.

9. The system of claim 8, wherein the mister means comprises:

ultrasonic means for forming the mist; and

means for directing the mist toward the food.

10. The system of claim 9, wherein the mister means further comprises a mister header for controlling an amount of the mist directed toward the food.

11. The system of claim 2, wherein the sanitizing plasma is generated in part from moisture in the ambient air in proximity of the at least one target rod.

12. The system of claim 1, further comprising a door for a space defined by the enclosing means.

13. The system of claim 1, wherein the enclosing means for subjecting food to sanitizers surrounds the food on four sides.

14. The system of claim 2, wherein UV light sources and target rods are in generally alternating orientation.

15. The system of claim 2, wherein the at least one target rod is of modular construction.

16. The system for claim 2, wherein the at least one UV light source is located within a modular assembly.

17. The system of claim 16, wherein the modular assembly comprises:

a reflector tube, and a shield.

18. The system of claim 1, further comprising an adjustable conveyor for moving food through the system.

19. A food sanitation tunnel, comprising:

means for sanitizing food by generally simultaneously subjecting the food to radiation, ozone, and sanitizing plasma.

20. The tunnel of claim 19, wherein the sanitizing plasma comprises at least one of hydroperoxides, superoxides and hydroxyl radicals.

21. The tunnel of claim 19, wherein the means for sanitizing food comprising at least one sanitizing radiation source located in an assembly; and at least one target rod structure in optical proximity to the assembly.

22. The tunnel of claim 21, wherein the assembly and the target rod structure are modular in construction.

23. The tunnel of claim 19, further comprising an enclosure for the tunnel.

24. The tunnel of claim 23, further comprising a door removably attached to the enclosure.

25. Food sanitized by exposing a surface of the food within an enclosure generally simultaneously to UV light, ozone, and at least one target member for providing superoxides, hydroperoxides, and hydroxyl radicals.

26. Food sanitized by exposing food to radiation, ozone and plasma.

27. The food according to claim 26, wherein the plasma comprises a radical selected from the group consisting of a hydroperoxide, a superoxide, and a hydroxyl.

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