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(72) Inventor; and
(71) Applicant : **MUNGER, Kewel** [US/US]; 786 Road 188, Delano, CA 93215 (US).

(74) Agent: **HANKIN, Marc, E.**; Hankin Patent Law, APC, 12400 Wilshire Boulevard, Suite 1265, Los Angeles, CA 90025 (US).

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(54) Title: DISINFECTING, STERILIZING, AND PACKAGING READY-TO-EAT PRODUCE

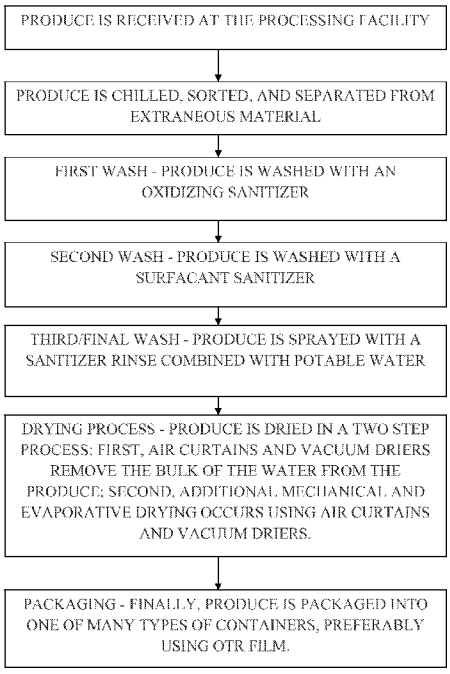


FIG. 1

(57) Abstract: This invention generally relates to a method for efficiently disinfecting, sterilizing, and packaging produce so that it is Ready-To-Eat by a consumer. The claimed method removes dirt, soil, pathogens, and renders produce with a longer shelf life. The claimed method is a multi-step sanitizing process that is designed to not cause bruising or other physical harm to produce. Ultimately, this method yields produce disinfected, packaged, and ready-for-sale on the market shelf.

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DISINFECTING, STERILIZING, AND PACKAGING READY-TO-EAT PRODUCE

FIELD OF INVENTION

[0001] This invention generally relates to a method using a produce preparation device for efficiently disinfecting, sterilizing, and packaging a quantity of produce, such as fruits and vegetables, intended for consumption by humans. Particularly, the present invention concerns a three-step method of sanitizing produce, followed by a drying and packaging procedure that yields packaged, ready-to-eat produce. This entire process is achieved with minimal physical harm or bruising to the produce.

BACKGROUND

[0002] Fresh produce is an essential part of the human diet. It provides many nutrients necessary to ideal health. However, the modern fast-paced lifestyle of many people has decreased consumption of such fresh produce, in favor of unhealthy, processed foods. This has created a need for fresh, safe, and readily available produce.

[0003] In recent years, there has been an increasing global trend towards the production of produce that is packaged and "Ready-to-Eat" ("RTE") without requiring further preparation by the consumer. Prior to being displayed at market, produce must be washed, and sanitized. Dust, pesticides, and biological contamination must be removed or the produce will spoil or not be of market quality. Further, if certain biological contaminants remain on the produce – serious illness or death might result from consuming the contaminated produce.

[0004] Scientists have attempted to improve the chemicals and methods used to minimize the harmful impact on the produce and to extend the shelf life of fresh-cut or fresh-picked produce. One such scientist, Dr. John Lopes, conducted extensive research on extending the shelf life of RTE produce. Dr. Lopes revolutionized the food disinfecting and sterilizing industry in the 1990s by inventing PRO-SAN®. The PRO-SAN® formula is disclosed in U.S. Patent Nos. 5,143,720 and 5,280,042 (collectively "the PRO-SAN® Patents"). Specifically, PRO-SAN® is an anionic surfactant and acid anionic sanitizer in one. PRO-SAN® is also an effective sanitizing agent. PRO-SAN® is an FDA-approved composition made from Generally Recognized as Safe ("GRAS") ingredients that have excellent antimicrobial activity against gram positive and gram negative bacteria, including the common-on-food pathogens *E. Coli, Staph. aureus, and salmonella.* For example, research conducted on Tomatoes and Serrano Peppers,

applying PRO-SAN® resulted in there being up to a 3 Log reduction in *salmonella* on tomatoes, and up to a 4.1 Log reduction in *salmonella* on Serrano Peppers. PRO-SAN® was so effective that it was used by NASA's Food Technology Commercial Space Center so that astronauts would not get food poisoning in space.

[0005] Dr. John Lopes has conducted extensive research and has several patents on produce washes including PRO-SAN®, but the PRO-SAN® patents have not disclosed or claimed a process or method that uses PRO-SAN® to maximize efficiency of disinfecting and sanitizing produce.

[0006] For years, the produce industry has been using some form of oxidizer sanitizer, such as chlorine dioxide, to kill bacteria, viruses, fungi, and other microbes without affecting taste, odor, or appearance of food. This minimal impact makes it an ideal disinfectant for RTE produce. By killing such microbes, the fresh-cut or fresh-picked produce spoils less quickly, appears fresher on the market shelf, and has a longer shelf life. Research has shown that chlorine alone can produce 1- to 2-log reduction in Microbial counts, which translates to about a one week shelf life for the fresh-cut or fresh-picked produce. A one-week shelf life is shorter than ideal and recent advances, including the present invention, extend this time-period.

[0007] The use of PRO-SAN® and an oxidizer sanitizer together has a synergistic effect not previously known in the art. Together, they increase the shelf life of produce up to 3 times that of either chemical alone.

[0008] Regarding methods to pass a product through sanitation and ultimately dry and package the product, U.S. Patent No. 5,809,739, issued to Eno ("Eno"), discloses a system for sterilizing cartons where each carton is sprayed with a sterilization formula of hydrogen peroxide, dried, and then packaged. The Eno reference discloses an extremely limited method, wherein a series of cartons traveling along a conveyor belt are irradiated in order to sterilize the carton's surfaces. Importantly, Eno fails to disclose or suggest a method for sterilizing produce that requires special handling and care so that the produce does not bruise, puncture, or spoil during the process.

[0009] Regarding a conveyor system that also helps to dry produce, by removing moisture from produce using suction dryers, U.S. Patent No. 5,924, 217, issued to Peeters ("Peeters"), discloses a water permeable conveyer belt for such a purpose. Peeters' water permeable converyor belt, however, requires shaking the produce, and in some embodiments, rotating the produce to complete the drying process effectively. Movements like those disclosed in Peeters are likely to

cause bruising or other mechanical harm to the produce, thereby decreasing the shelf life and salability of the produce.

[0010] Additionally, a limited number of methods of sanitizing produce using PRO-SAN® are currently available, however they are very limited in scope. For example, U.S. Patent Nos. 6,557,568, issued to Murch ("Murch"), 5,932,527, issued to Roselle ("Roselle"), and 5,639,466, issued to Ford ("Ford"), each disclose such a method. Murch merely discloses a method of sanitizing the food by keeping the PRO-SAN® solution on the produce for at least about five minutes. Roselle discloses a method wherein the solution that sanitizes the food, also removes a waxy buildup and maintains a basic pH level that is greater than 9.5. Ford discloses a method to sanitize and package moisture-rich foods, like meats, wherein the main concern is controlling the food's natural lactic acid. The PRO-SAN® sprayed on the packaged food slows spoiling, while leaving a layer of water on the food. However, none of these methods disclose a stepwise sanitizing process involving a plurality of sanitizing agents. Further, these patents fail to disclose a method that prevents mechanical damage to produce, which increases the food safety and effectiveness of the sanitizing agents. Additionally, each of these references fails to disclose a proper sanitization of RTE produce and leaves a distinct opening in the art for such an invention.

[0011] Thus, there is a long felt need in the art for a method of disinfecting and sanitizing produce that does not cause mechanical harm to the produce, which yields packaged, Ready-To-Eat, fresh looking, and safe-to-eat produce.

SUMMARY OF THE INVENTION

[0012] To minimize the limitations in the cited references, and to minimize other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a three-step produce washing, sanitizing, and disinfecting method, achieved by a produce preparation device, followed by a drying and packaging wherein the produce is disinfected, sterilized, dried and packaged. This entire method is achieved with minimal to no mechanical damage to the produce, which prevents premature degradation of the produce. The method involves the produce being chilled and sorted upon arrival at the processing facility, going through specific washes for specific periods of time, and, finally, being dried and packaged.

[0013] The present invention discloses a method for disinfecting, sterilizing, drying and packaging produce. The preferred embodiment comprises the following steps: first wash, second

wash, third and final rinse, drying, and packaging. Importantly this method is achieved with little bruising or scarring to the produce.

[0014] A number of optional configurations can be made of the presently claimed method. For example, the number of washes need not be fixed at three. For further example, the first wash can be one of many oxidizer sanitizers available on the market. Additionally, the chemical used in the first wash may, in certain embodiments, be exchanged with the chemical solution in the second wash.

[0015] In the preferred embodiment, the produce is blueberries. The produce can be another similar produce that needs disinfecting and sterilizing before being consumed by the public.

[0016] The process begins when the produce is received at the processing facility and immediately cooled. The produce is sorted by color and quality and all extraneous materials are removed. There are two ideal temperature ranges at which the entire process should occur. There is the "cool" temperature range of approximately 50-55 degrees Fahrenheit (10-12.78 degrees Celsius). The preferred process temperature, however, is the "colder" range of approximately 34 to 40 degrees Fahrenheit (1.1-4.4 degrees Celsius). To maintain freshness of the produce, it is important that the temperatures in the processing facility do not deviate below freezing (0.0 degrees Celsius) or above 40 degrees Fahrenheit (4.4 degrees Celsius) for any substantial period of time.

[0017] To have the greatest efficacy and quality of sanitizing, the present invention preferably includes a three-step sanitizing and disinfecting wash process. Each sanitizing and disinfecting wash step may be followed by a chilled, filtered-water rinse, but preferably the rinse step is the third step is a final rinse which includes chilled potable water. After the sanitizing and disinfecting is complete, the produce will be dried using air curtains, vacuums, and other drying devices known in the art to effectively dry produce. Importantly, none of the driers increases the temperature of the produce, which prevents or greatly limits damage to the internal flesh of the fruit or vegetable being dried. Subsequently, the produce will be packaged in containers and be sold as RTE.

[0018] Each wash may be applied using a washing process with jetted Jacuzzi action, continuously sprayed by a plurality of jets. This is the ideal method of applying the final sanitizer and chilled potable water rinse to the produce. Each wash is, preferentially, a sanitizing agent selected from classes of substances generally regarded as safe ("GRAS") or which have

been ascribed secondary food additive status as those terms are defined by the United States Food and Drug Administration in 21 C.F.R. §§ 178, 182, and 184. The selected washes should, and preferably do, have properties similar to chlorine dioxide or PRO-SAN®.

[0019] Subsequent to all of the washes and water rinse, the produce is dried. The drying procedure should be one that maintains the quality and integrity of the produce.

[0020] In one embodiment, the produce is dried using air curtains, vacuum dryers, air knives, or other similar drying methods that quickly and effectively dry large amounts of produce without bruising, scratching, or otherwise harming the produce and without contaminating the produce with pathogens. Controlling the humidity during the drying process is an additional way to encourage evaporative drying.

[0021] Subsequently, the produce is packaged in a protective tray, box, bowl, cup, gel package, bag, clamshell, or any other type of packaging known in the art to provide physical protection to the produce to limit or prevent damage while shipping. In a preferred embodiment, the packaging is sealed with Oxygen Transmission Rate ("OTR") film or similar covering that will keep the produce contained within the packaging means. OTR film is used to achieve the target concentration of oxygen inside of the package to promote shelf-life and shelf-appearance. The preferred in-package concentrations of oxygen and carbon dioxide are 4% and 14% respectively.

[0022] In a preferred embodiment, after packaging, the produce is shipped and sold at or below 40 degrees Fahrenheit (4.4 degrees Celsius), but above freezing. This temperature maintains a fresh appearance, inhibits microbial growth, and maximizes the shelf-life of the produce.

[0023] In one embodiment, the produce passes through the process via one or more conveyor belts or other similar moving platform that will efficiently move the produce through the washing, drying and packaging phases. Alternatively, other mechanical or human means can be used to move the produce through the process without deviating from the scope of the invention.

[0024] It is an object of the present invention is to overcome limitations in the prior art.

[0025] It is another object of the invention to increase the shelf-life of produce, improve the presence of produce on the market shelf, protect consumers from foodborne pathogens, and provide an environmentally friendly method of sanitizing and disinfecting farm fresh produce.

[0026] The present invention improves the shelf life and chemical stability of fresh, packaged produce, such as blueberries, by sanitizing and packaging the blueberries safely and efficiently. In some instances, the shelf life of these, for example, fresh blueberries, has lasted at least 40

days based on microbial, physical, and sensory analysis. Under similar testing conditions, when input berries were of a lower initial quality, that is, soft with lots of scarring, the shelf life of these blueberries has been at least 21 days, which is still 3 times longer than if they had been cleaned with Chlorine Dioxide alone. As discussed above, the research conducted on tomatoes and Serrano peppers concluded that PRO-SAN® had up to 3 Log reduction in tomatoes for Salmonella and up to 4.1 Log reduction in Serrano peppers for Salmonella. The present method greatly increases the shelf life of produce and improves the marketability of produce.

[0027] One embodiment of the invention is a produce washing method comprising the following steps: providing a plurality of produce; providing a produce preparation device; loading the plurality of produce into the produce preparation device; wherein the produce preparation device is comprised of a first wash portion, a second wash portion, a third wash portion, and a drying portion; washing the produce in a first wash by the first washing portion of the produce preparation device; washing the produce in a second wash by the second washing portion of the produce preparation device; washing the produce in a third wash/rinse by the third washing portion of the produce preparation device; drying the produce by the drying portion of the preparation device; packaging the produce; and wherein the washed, dried, and packaged produce is ready to eat.

[0028] Preferably, the produce is moved within the produce preparation device via one or more conveyor belts. Preferably, the conveyor belts are water-permeable and do not cause mechanical damage to the produce. The first wash, preferably, comprises an oxidizer sanitizer wash. Preferably, the oxidizer sanitizer is chlorine dioxide. Preferably, the second wash comprises a surfactant sanitizer wash. Preferably, the surfactant sanitizer wash is comprised of PRO-SAN®.

[0029] Alternatively, the first wash may comprise a surfactant sanitizer wash. Preferably, the surfactant sanitizer wash is comprised of PRO-SAN®. Preferably, the second wash comprises and oxidizer sanitizer wash. Typically, the oxidizer sanitizer is chlorine dioxide.

[0030] For both of the above alternatives, the third wash preferably comprises a PRO-SAN® Final Rinse wash combined with a potable water rinse. Preferably, the drying portion is comprised of one or more vacuums and one or more air-curtain driers. Preferably, the packaging is comprised of a protective container made of polypropylene and the polypropylene packaging is preferably covered with an Oxygen Transmission Rate film.

[0031] Another embodiment is a method of washing produce comprising the steps: providing a plurality of produce; providing a produce preparation device; sorting the produce by color and quality; lowering a temperature of the plurality of produce to 1.1-4.4 degrees Celsius; loading the plurality of produce into the produce preparation device; wherein the produce preparation device is comprised of a first wash portion, a second wash portion, a third wash portion, and a drying portion; washing the produce in a first wash by the first washing portion of the produce preparation device; washing the produce in a second wash by the second washing portion of the produce preparation device; washing the produce in a third wash/rinse by the third washing portion of the produce preparation device; drying the produce by the drying portion of the preparation device; wherein the drying portion is comprised of one or more vacuums and one or more air-curtain driers; packaging the produce; wherein the packaging is comprised of a protective container made of polypropylene; wherein the polypropylene packaging is covered with an Oxygen Transmission Rate film; and wherein the washed, dried, and packaged produce is ready to eat. Preferably, the produce is moved within the produce preparation device via conveyor belts, which are preferably water-permeable and do not cause mechanical damage to the produce. Preferably, the first wash comprises an oxidizer sanitizer wash, the second wash comprises a surfactant sanitizer wash, and the third wash comprises a PRO-SAN® Final Rinse wash combined with a potable water rinse. Preferably, the oxidizer sanitizer is chlorine dioxide, and the surfactant sanitizer wash is comprised of PRO-SAN®. Preferably, the PRO-SAN® is at 0.78% (1 oz./gal), the PRO-SAN® bathes the produce for 2.0 to 3.5 minutes, the PRO-SAN® Final Rinse is 0.2% (0.25 oz/gal), and the potable water from the potable water rinse of the third wash is 1.1-4.4 degrees Celsius.

[0032] These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] Fig. 1 is an illustration of a functional flow block diagram that shows one embodiment of the method of disinfecting, sanitizing, and packaging produce.

[0034] Fig. 2 is a perspective view of one embodiment of the device used in the first wash.

[0035] Fig. 3 is a perspective view of one embodiment of the device used in the second wash.

[0036] Fig. 4 is a perspective view of one embodiment of the device used in the third and final wash.

[0037] Fig. 5 is a perspective view of one embodiment of the device used in the first part of the produce drying step and shows the use of air curtains and vacuum dryers.

[0038] Fig. 6 is a perspective view of one embodiment of the device used in the second stage of the produce drying.

[0039] Fig. 7 is a perspective view of one embodiment of the device used in the packaging of the produce.

DETAILED DESCRIPTION OF THE INVENTION

[0040] In the following detailed description of various embodiments of the invention, numerous specific details are set forth in order to provide a thorough understanding of various aspects of one or more embodiments of the invention. However, one or more embodiments of the invention may be practiced without some or all of these specific details. In other instances, well-known methods, procedures, and/or components have not been described in detail so as not to unnecessarily obscure aspects of embodiments of the invention.

[0041] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present invention. Accordingly, the screen shot figures, and the detailed descriptions thereof, are to be regarded as illustrative in nature and not restrictive. Also, the reference or non-reference to a particular embodiment of the invention shall not be interpreted to limit the scope of the invention.

[0042] In the following description, certain terminology is used to describe certain features of one or more embodiments of the invention. For instance, the term "wash" refers to applying water or some other liquid, often a cleaner, sanitizer, or disinfectant, to a product. Washing can occur through spraying, soaking, dipping, rubbing, bathing, or scrubbing the product in the liquid. "Wash" may also mean a jetted-Jacuzzi action wherein sprinklers spray a quantity of liquid on the produce. The term "bath" involves completely or substantially submerging the produce in the liquid in which the produce is taking a "bath." The period of contact time for a bath varies, and the preferred timings are provided when relevant. The term "produce" refers to

fruits and vegetables, including, but not limited to: blueberries; blackberries; raspberries; strawberries; grapes; cranberries; tomatoes; plums; apples; or other similar produce that can benefit from being disinfected and sanitized before it is sold to a consumer. The produce that would go through this process and machine can be classified in the RTE category of produce. The term "extraneous materials" refers to dirt, rocks, leaves, stems, pesticides, chemicals or other similar materials such that its nature is apparent in farming produce, but its presence in a RTE product is undesirable and deleterious. The term "mechanical harm" refers to bruising, scarring, discoloration, or any other physical damage caused to produce as a result of the bumping or moving related to the sanitizing, washing, drying, packaging, or shipping processes

[0043] Fig. 1 is an illustration of a functional flow block diagram that shows one embodiment of the method of disinfecting, sanitizing, and packaging produce. **Fig. 1** shows a flow chart describing each of the preferred steps of one embodiment of the present invention. In the first step **10** the produce is received at the packing facility. After it is received, the produce is chilled, sorted, and separated from extraneous materials **11**. Produce is sorted based on features that, depending on the type of produce, increase the likelihood that the produce will remain of the highest quality. For example, in one embodiment, blueberries are sorted by color, size, and physical qualities such as external damage and overall appearance. This initial sorting involves choosing produce that is will be sanitized and packed with the highest quality results. In the preferred embodiment, the produce is initially chilled to 34 to 40 degrees Fahrenheit (1.1-4.4 degrees Celsius). The packing facility is chilled to either the "cool" range of 50-55 degrees Fahrenheit (10-12.78 degrees Celsius) or the "cold" range of 34-40 degrees Fahrenheit (1.1-4.4 degrees Celsius). After this initial sorting and chilling, the produce goes through its first wash **12**. In one embodiment, an oxidizer sanitizer is used at the first wash.. The produce next goes through a second wash **13**, this time, for example, the produce is cleaned with a surfactant sanitizer. Continuing through the process, the produce is subjected to its final wash **14**, which in one embodiment is a spray applied sanitizer rinse. The produce is then subjected to a two stage drying, **15** and **16**, using a variety of mechanical and evaporative drying techniques designed to prevent harm to the produce. Finally, the produce is packaged, **17**, in an appropriate container for RTE produce.

[0044] Fig. 2 is a perspective view of one embodiment of the device used in the first wash. **Fig. 2** shows a perspective view of one possible embodiment of a device to achieve the first wash as

shown in **12** in Fig. 1. The produce enters the first cleaning trough **200**, at intake incline **205**. High quality pipes **210** and **215** provide the first wash cleaning solution. In one embodiment this may be an oxidizer sanitizer. In the preferred embodiment, chlorine dioxide is used for the first wash. This wash should have 1.2 to 2.2 minutes of contact time with the produce. The preferred concentration of Chlorine Dioxide is 0.8 to 3.0 parts per million (PPM). The substrate for the Chlorine Dioxide is filtered water. Next, the produce travels along the trough from intake position **205** to a completed first wash position at **225**. Ventilation pipe **220** provides another access point and prevents blockages from occurring under the shower hood **230**. Legs **235** provide stability to the entire first wash process and control access to the produce and keep it is above ground level. Drain **240** provides for easy cleaning of the process room if an overflow or spill occurs.

[0045] Fig. 3 is a perspective view of one embodiment of the device used in the second wash. **Fig. 3** shows a perspective view of one possible embodiment of a process to complete the second wash **13**. In one embodiment, the produce is received from **225** to second wash intake **305**. In the preferred embodiment (as pictured in **Figs. 4** and **5**), produce is moved from step to step on a special water permeable conveyor belt that prevents damage to delicate produce. High quality pipes **310** and **315** provide several possibilities for supplying the second wash to the produce in trough **300**. The preferred sanitizing agent used in the second wash step is a surfactant sanitizer. In the preferred embodiment, PRO-SAN® at 0.78% (1 oz./gal) is used to bathe the produce. Concentration is monitored by measuring of the pH of the PRO-SAN® solution and should remain between 2.4 and 2.8. The contact time of this second wash with the produce should be 2.0 to 3.5 minutes, in order to maximize the sanitization effect. Overflow prevention gap **330** drains second wash cleaner and soap bubbles into trough **320** to prevent overflow. Legs **335** provide stability to the entire second was process and control access to the produce and keep it above ground level. Drain **340** provides for easy and sanitary cleaning of the process room if an overflow or spill occurs.

[0046] Fig. 4 shows a perspective view of one embodiment of a process to complete the third wash **14**. Produce is, by either a washing or a conveyor belt, moved to intake location **405** from the preceding wash stage. Here produce travels from intake location **405** to pre-drying location **425**. In Fig. 4, the produce is shown traveling from right to left, this is not intended to effect the scope of the disclosed subject matter. In the illustrated embodiment, produce moves on a slow

moving water permeable conveyor belt **430**. An alternate embodiment would permit the conveyor belt to be a plurality of belts working in line with transitions between each unique belt. The benefit of both of these embodiments is that they prevent mechanical harm from damaging the skin, peal, or external layer of the produce. The processing table **400** and conveyor belt **430** are preferably wide enough so that produce can rest at a single layer and still be effectively processed. Next, produce passes under the washing of a plurality of sprinklers **410** and **415** attached to spray bar **409**. In one embodiment, sprinklers **410** spray PRO-SAN® Final Rinse. The preferred concentration of PRO-SAN® Final Rinse is 0.2% (0.25 oz/gal). Concentration is monitored by observing a pH between 2.4-2.8. In one embodiment, sprinklers **415** spray potable water chilled at the preferred temperature of 34 to 40 degrees Fahrenheit (1.1-4.4 degrees Celsius). While the number of sprinklers can vary, the preferred number is 10 sprinklers to make certain that the entire produce line has contact with the final sanitizing solution. Finally the produce passes to the pre-drying location **425** in preparation for passing under air curtain **520** and vacuum driers **530**. At this stage, produce has been thoroughly sanitized without any mechanical harm, discoloration, or other negative effects on the produce.

[0047] Fig. 5 shows a perspective view of one possible embodiment of a process to complete the first stage of produce drying. Produce is moved to the drying intake location **505**. Here produce travels from intake location **505** to second-drying location **525**. In the illustrated embodiment, produce moves on water permeable conveyor belt **530**. The processing table **500** and conveyor belt **530** are to be wide enough so that a single layer of produce can effectively be processed. This helps guarantee that each piece of produce will have proper contact with the washes and drying units. Next, produce passes through a plurality of a variety of driers **520** and **535**. In the illustrated embodiment, an air-curtain **520** is depicted. Air-curtain **520** can be replaced or augmented with an air knife or an air-blade drier. These driers function to remove the excess of water by blowing air over the quantity of produce and driving the excess water through the water permeable conveyor belt **530**. They function at the processing room temperature (which as discussed above is very cool) to prevent raising the temperature of the produce, which might cause harm to the flesh of the produce. Additionally, produce is dried by a plurality of vacuum driers **535**. In a preferred embodiment, there is a plurality of produce driers. The air curtain **520** and vacuum driers **535** function to remove all or substantially all of the water from the berries.

At this stage, produce has been thoroughly sanitized and dried without harm to the color or quality of the produce and is mostly dry.

[0048] **Fig. 6** is a perspective view of one embodiment of the device used in the second stage of the produce drying. **Fig. 6** shows a perspective view of one possible embodiment of a process to complete the drying and transport the produce to the packaging area of the process floor. Produce first passes through a passage way in the wall and into the packaging room where it completes its drying. The packaging room is in a separate temperature controlled room. Next produce passes a plurality of secondary air-curtains **620**, vacuum driers **635**, and/or other drying devices known in the art. These driers provide the final mechanical and evaporative drying of the produce. The completely dry produce continues on the conveyor belt **530**. At end of the conveyor belt **530**, the produce is automatically transitioned to a completely dry conveyor belt **605**. Here the produce travels from the automatic loading position **610** of dry conveyor belt **605** to the packaging machine end **625** of the dry conveyor belt **605**.

[0049] **Fig. 7** is a perspective view of one embodiment of the device used in the packaging of the produce. **Fig. 7** shows a perspective view of one possible embodiment of a process to complete the drying, package the produce, and transport the produce to the boxing area of the process floor. Produce enters the sorting and packaging machine **700** from conveyor belt **630**. The packaging machine fills the containers with the sanitized, washed, and dried produce, and hermetically seals the containers using, preferably, Oxygen Transmission Rate film. Completed packages **720**. The packages may be made of any food quality plastic and in any size made. For example, the packaging can be a protective tray, box, bowl, cup, gel package, bag, clamshell, or any other type of packaging known in the art to provide protection to the produce from damage. The preferred packaging sizing is 1 ounce to 2 pound portions, food-grade polypropylene. The preferred OTR film permits concentrations of 4% O_2 and 14% CO_2. A human technician **710** preferably observes the packaging machine for quality and accuracy in packaging. After passing the quality technician **710**, the produce is sent down shoot **735** and goes to boxing for shipping to market **725**.

[0050] Throughout the entire processing, the produce should be stored at or below 40 degrees Fahrenheit. After processing, the produce should remain at or below 40 degrees Fahrenheit (4.4 degrees Celsius) until it is delivered to the end user.

[0051] Each washing liquid is, preferentially, a sanitizing agent selected from classes of substances generally regarded as safe (GRAS) or which have been ascribed secondary food additive status as those terms are defined by the United States Food and Drug Administration in 21 C.F.R. §§ 178, 182, and 184. The selected washes should have properties similar to chlorine dioxide or PRO-SAN®.

[0052] An important quality of the present invention is the prevention of mechanical harm to the produce. Preventing the produce from harsh treatment and chemicals prevents damage to the skin of the produce and other harm that might cause premature degradation.

[0053] The driers, disclosed above, all use mechanical and evaporative means to remove the rinse water from the produce. Importantly, the driers do not significantly heat the produce to increase the evaporative effect.

[0054] In the preferred embodiment, the entire processing facility is chilled to between 34 and 40 degrees Fahrenheit (1.1-4.4 degrees Celsius). This decreases microbial growth and is the ideal temperature range for disinfectants to function. In an alternative embodiment, the processing room is "cool," chilled to less than 50 degrees Fahrenheit (10-12.78 degrees Celsius). Additionally, the full process, including initial sorting, may be automated to require little to no human contact with the produce, except in final packaging and shipping.

[0055] Other features and advantages are inherent in the produce washing method claimed and disclosed will become apparent to those skilled in the art from the following detailed description and its accompanying drawings.

[0056] Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, other embodiments or versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiments contained herein.

[0057] The foregoing description of the preferred embodiment of the invention has been presented for the purposes of illustration and description. While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the above detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the present invention. Accordingly, the detailed description is to be regarded as illustrative in nature and not restrictive.

Also, although not explicitly recited, one or more embodiments of the invention may be practiced in combination or conjunction with one another. Furthermore, the reference or non-reference to a particular embodiment of the invention shall not be interpreted to limit the scope the invention. It is intended that the scope of the invention not be limited by this detailed description, but by the claims and the equivalents to the claims that are appended hereto.

CLAIMS

What is claimed is:

1. A produce washing method comprising the following steps:
   providing a plurality of produce;
   providing a produce preparation device;
   loading said plurality of produce into said produce preparation device;
   wherein said produce preparation device is comprised of a first washing portion, a second washing portion, a thirding wash portion, and a drying portion;
   washing said produce in a first wash by said first washing portion of said produce preparation device;
   washing said produce in a second wash by said second washing portion of said produce preparation device;
   washing said produce in a third wash by said third washing portion of said produce preparation device;
   drying said produce by said drying portion of said preparation device;
   packaging said produce; and
   wherein said washed, dried, and packaged produce is ready to eat.
2. The produce washing method of Claim 1, wherein said produce is moved within said produce preparation device via one or more conveyor belts.
3. The produce washing method of Claim 2, wherein said one or more conveyor belts are water-permeable and do not cause mechanical damage to said produce.
4. The produce washing method of Claim 3, wherein said first wash comprises an oxidizer sanitizer wash.
5. The produce washing method of Claim 4, where said oxidizer sanitizer is chlorine dioxide.
6. The produce washing method of Claim 4, wherein said second wash comprises a surfactant sanitizer wash.
7. The produce washing method of Claim 6, wherein said surfactant sanitizer wash is comprised of PRO-SAN®.
8. The produce washing method of Claim 3, wherein said first wash comprises a surfactant sanitizer wash.

9. The produce washing method of Claim 8, wherein said surfactant sanitizer wash is comprised of PRO-SAN®.
10. The produce washing method of Claim 8, wherein said second wash comprises and oxidizer sanitizer wash.
11. The produce washing method of Claim 10, wherein said oxidizer sanitizer is chlorine dioxide.
12. The produce washing method of Claim 7, wherein said third wash comprises a PRO-SAN® Final Rinse wash combined with a potable water rinse.
13. The produce washing method of Claim 10, wherein said third wash comprises a PRO-SAN® Final Rinse wash combined with a potable water rinse.
14. The produce washing method of Claim 1, wherein said drying portion is comprised of one or more vacuums and one or more air-curtain driers.
15. The produce washing method of Claim 1, wherein said packaging is comprised of a protective container made of polypropylene; and
    wherein said polypropylene packaging is covered with an Oxygen Transmission Rate film.
16. A method of washing produce comprising the steps:
    providing a plurality of produce;
    providing a produce preparation device;
    sorting said produce by color and quality;
    lowering a temperature of said plurality of produce to 1.1-4.4 degrees Celsius;
    loading said plurality of produce into said produce preparation device;
    wherein said produce preparation device is comprised of a first washing portion, a second washing portion, a third washing portion, and a drying portion;
    washing said produce in a first wash by said first washing portion of said produce preparation device;
    washing said produce in a second wash by said second washing portion of said produce preparation device;
    washing said produce in a third wash by said third washing portion of said produce preparation device;
    drying said produce by said drying portion of said preparation device;

wherein said drying portion is comprised of one or more vacuums and one or more air-curtain driers;

packaging said produce;

wherein said packaging is comprised of a protective container made of polypropylene; and

wherein said polypropylene packaging is covered with an Oxygen Transmission Rate film;

wherein said washed, dried, and packaged produce is ready to eat.

17. The method of washing produce of Claim 16,

wherein said produce is moved within said produce preparation device via one or more conveyor belts;

wherein said one or more conveyor belts are water-permeable and do not cause mechanical damage to said produce.

18. The method of washing produce of Claim 17,

wherein said first wash comprises an oxidizer sanitizer wash;

wherein said second wash comprises a surfactant sanitizer wash;

wherein said third wash comprises a PRO-SAN® Final Rinse wash combined with a potable water rinse.

19. The method of washing produce of Claim 18,

where said oxidizer sanitizer is chlorine dioxide;

wherein said surfactant sanitizer wash is comprised of PRO-SAN®.

20. The method of washing produce of Claim 19,

wherein said PRO-SAN® is essentially 0.78% (1 oz./gal);

wherein said PRO-SAN® bathes said produce in the range of 2.0 to 3.5 minutes;

wherein said PRO-SAN® Final Rinse is essentially 0.2% (0.25 oz/gal);

wherein a potable water from said potable water rinse of said third wash is in the range of 1.1-4.4 degrees Celsius.

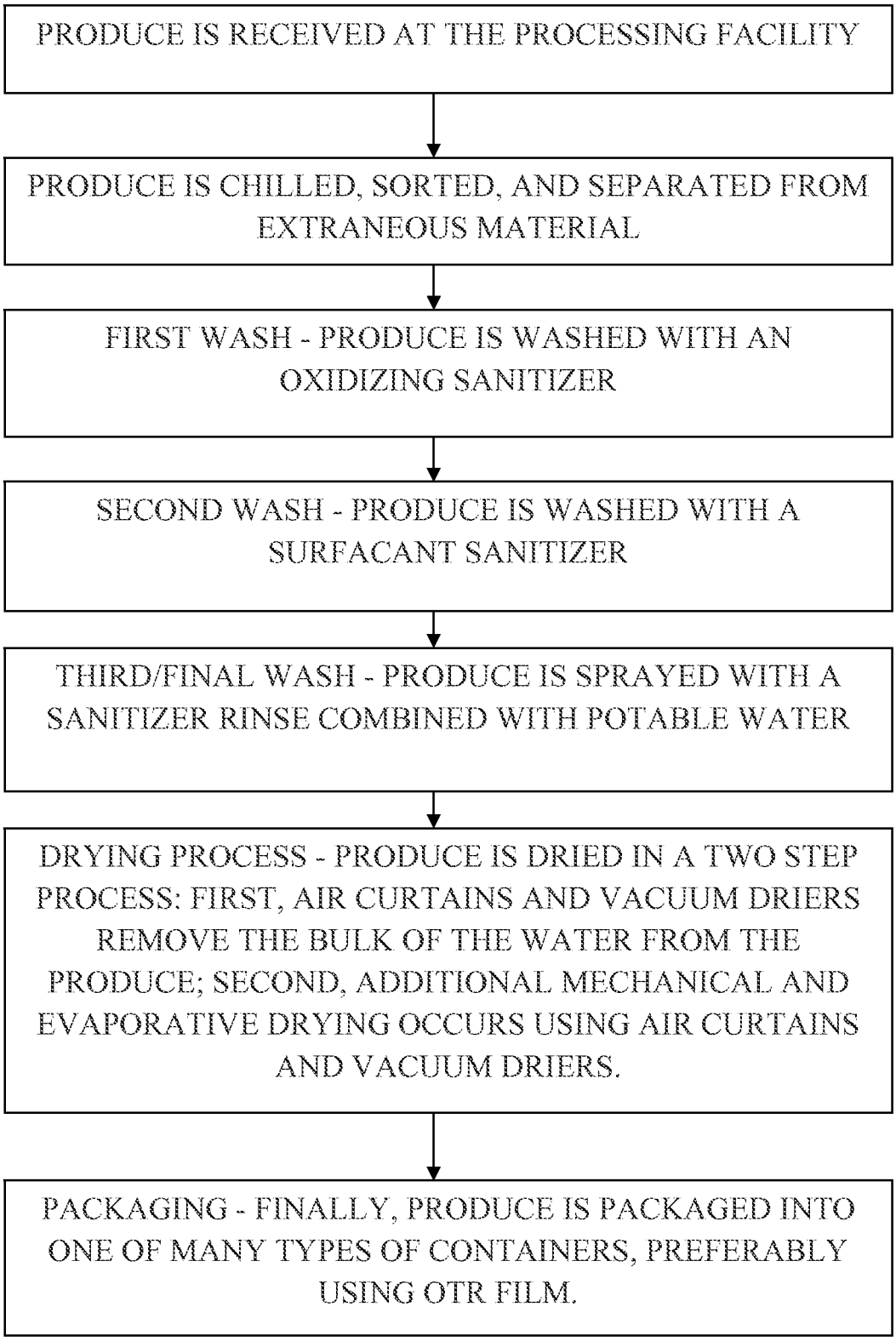

PRODUCE IS RECEIVED AT THE PROCESSING FACILITY
PRODUCE IS CHILLED, SORTED, AND SEPARATED FROM EXTRANEOUS MATERIAL
FIRST WASH - PRODUCE IS WASHED WITH AN OXIDIZING SANITIZER
SECOND WASH - PRODUCE IS WASHED WITH A SURFACANT SANITIZER
THIRD/FINAL WASH - PRODUCE IS SPRAYED WITH A SANITIZER RINSE COMBINED WITH POTABLE WATER
DRYING PROCESS - PRODUCE IS DRIED IN A TWO STEP PROCESS: FIRST, AIR CURTAINS AND VACUUM DRIERS REMOVE THE BULK OF THE WATER FROM THE PRODUCE; SECOND, ADDITIONAL MECHANICAL AND EVAPORATIVE DRYING OCCURS USING AIR CURTAINS AND VACUUM DRIERS.
PACKAGING - FINALLY, PRODUCE IS PACKAGED INTO ONE OF MANY TYPES OF CONTAINERS, PREFERABLY USING OTR FILM.

FIG. 1

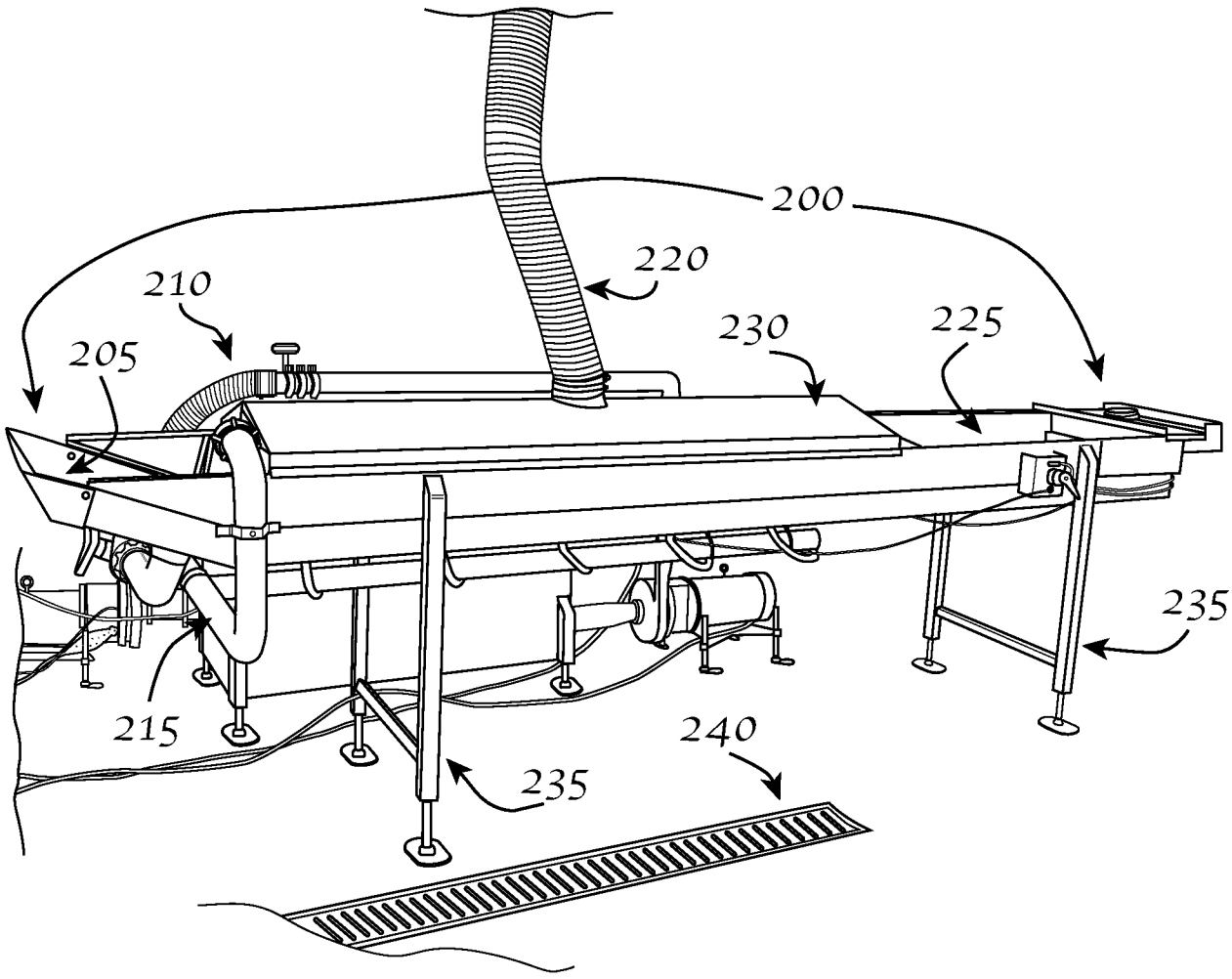


FIG. 2

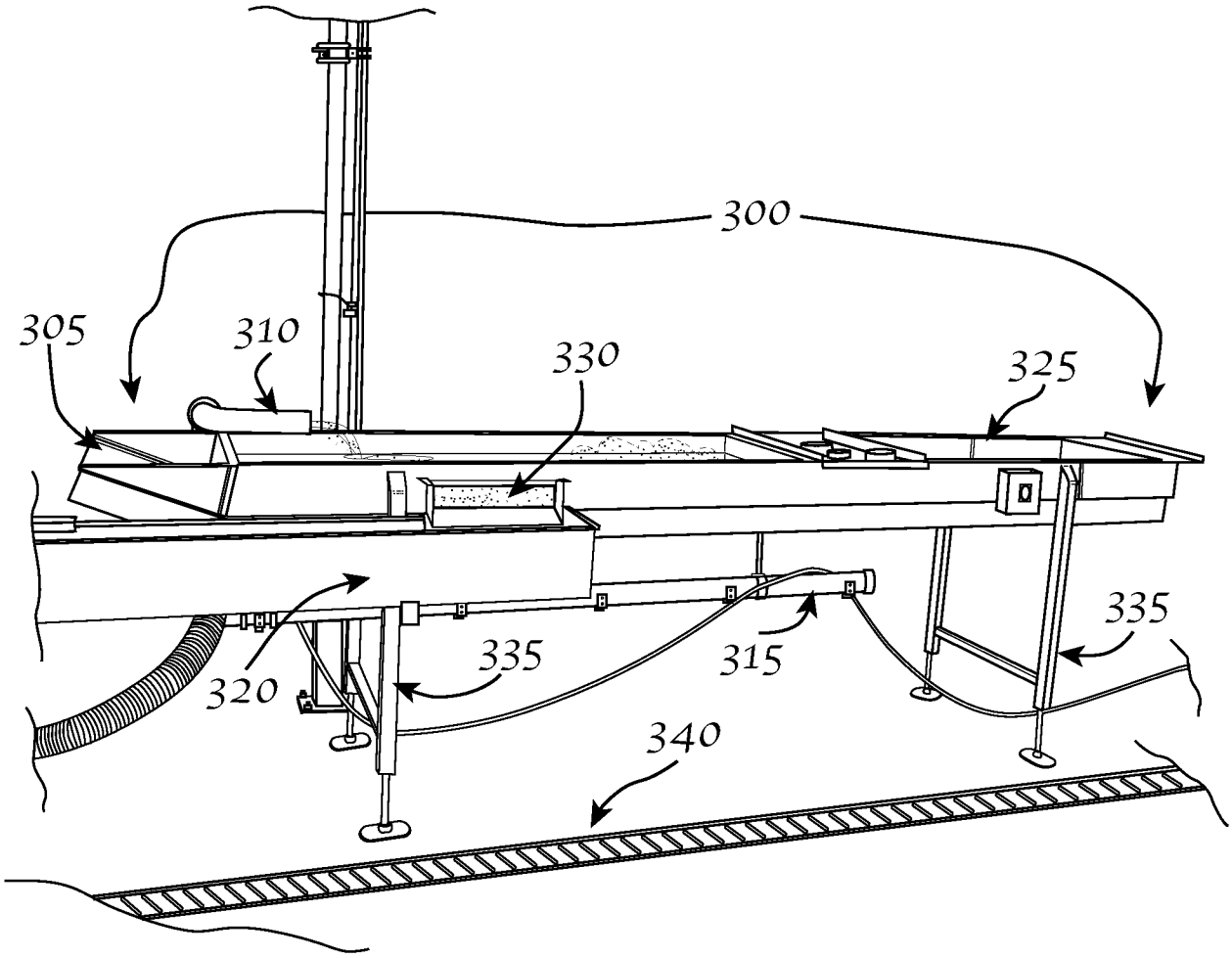


FIG. 3

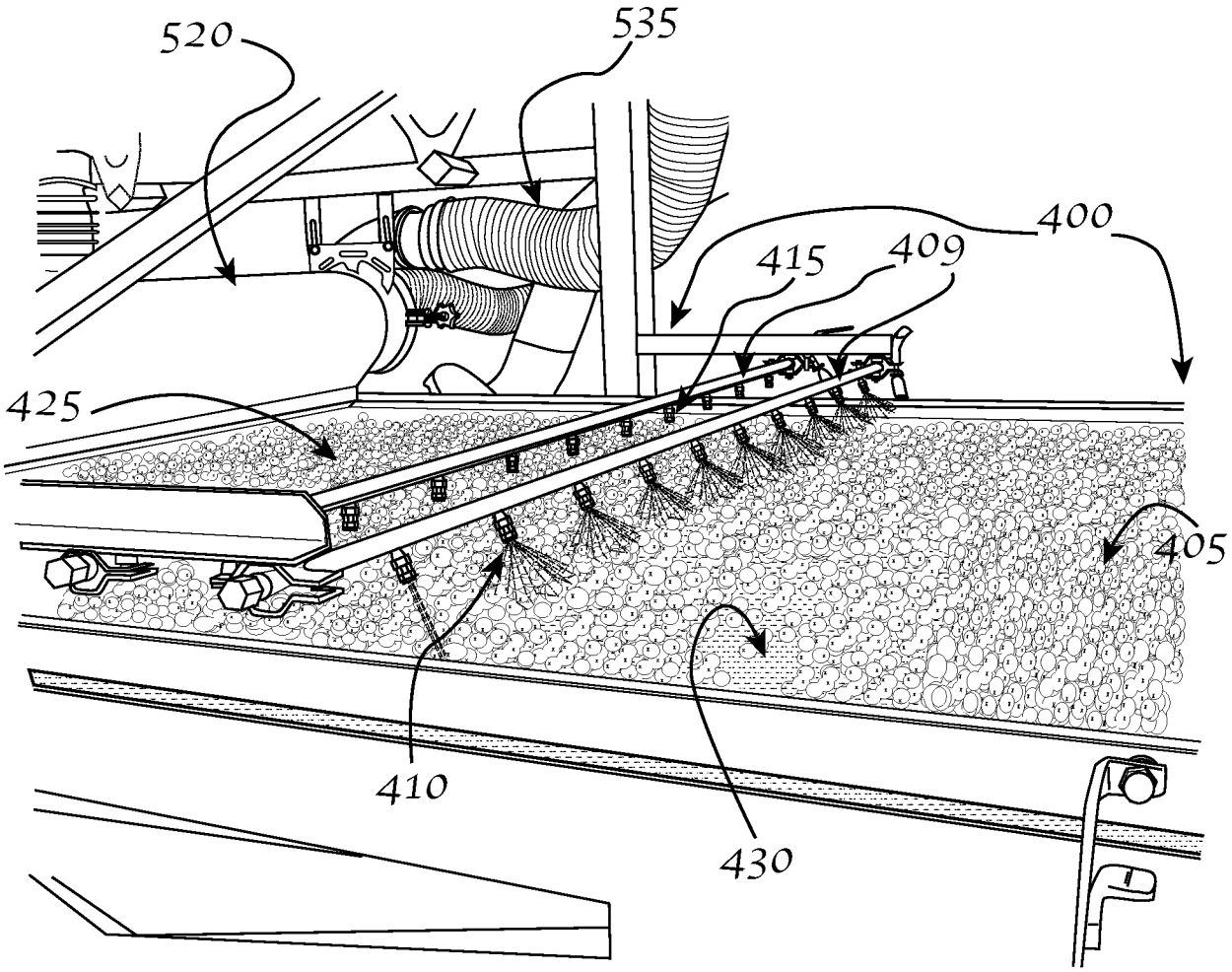


FIG. 4

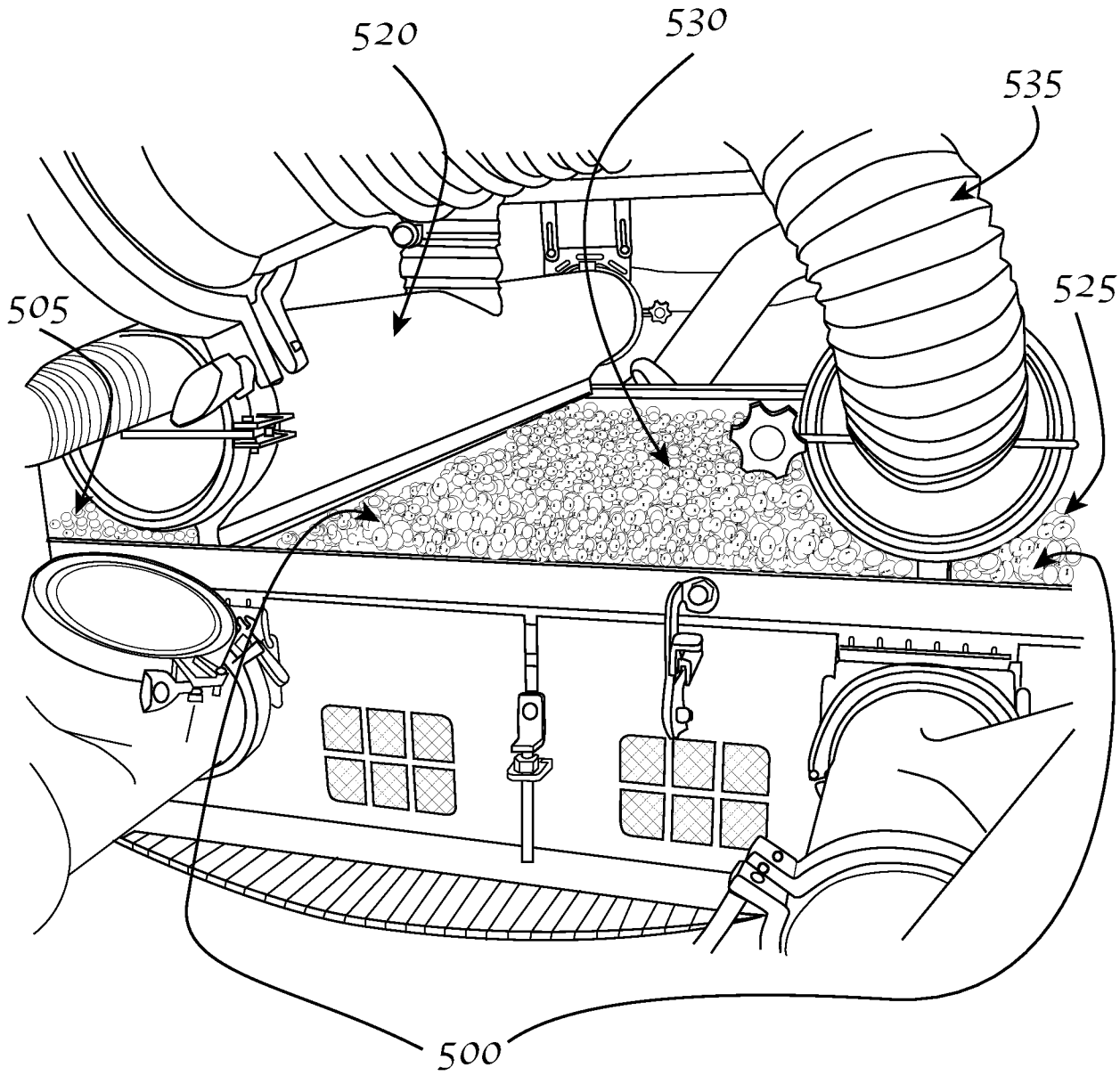


FIG. 5

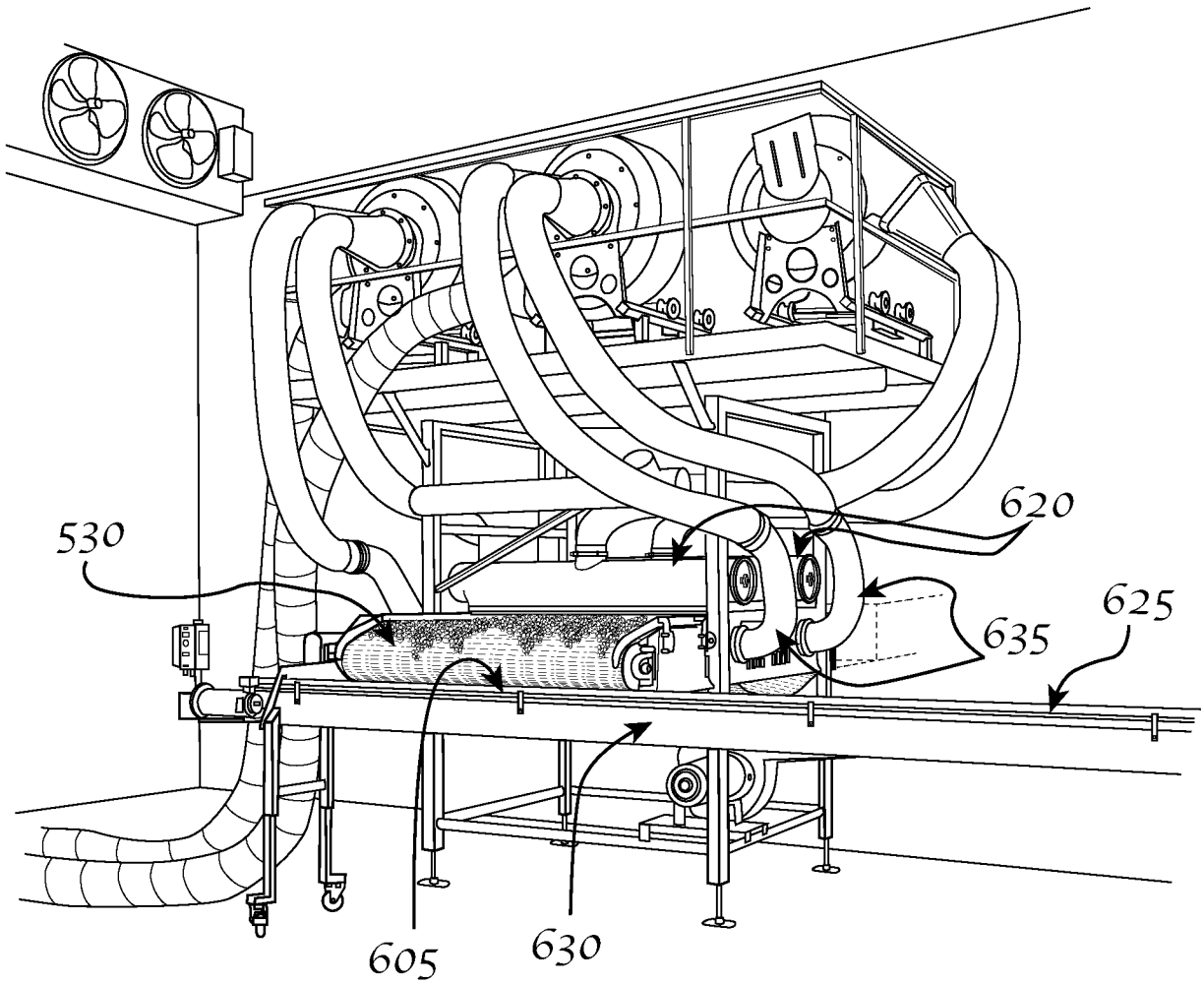


FIG. 6

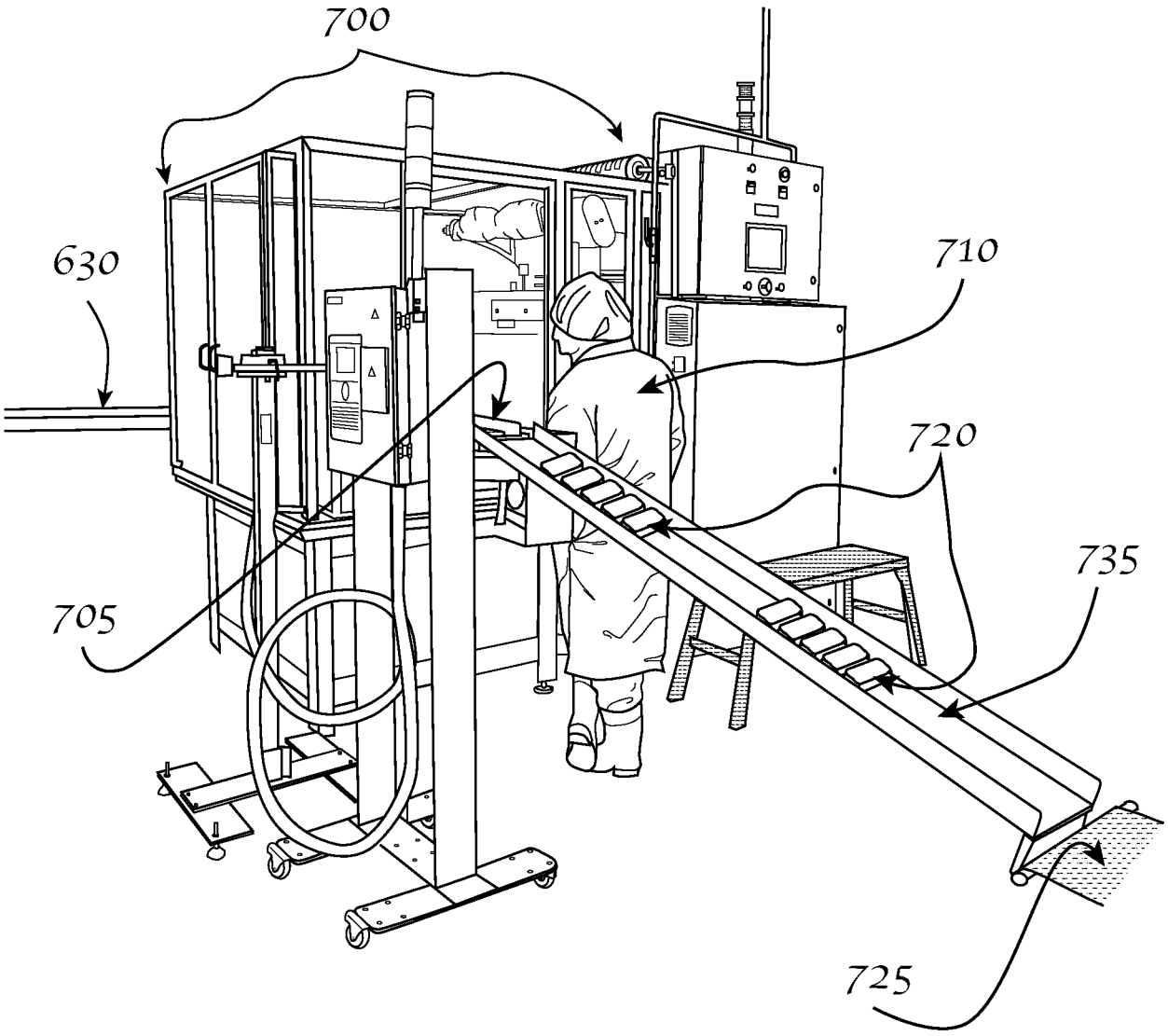


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/56414

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B08B 1/02 (2013.01)
USPC - 134/15
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(8) - B08B 1/02 (2013.01)
USPC - 134/15

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google Scholar; IP.com; ProQuest Dialog; produce, lettuce, salad, greens, triple, wash*, rins*, station*, area, location*, position*, ready eat*, RTE, dries, drying, dried, packag*, bag*, oxidiz*, chlorin*, dioxide

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2009/0151749 A1 (LEWIS, DK) 18 June 2009; figure 1; paragraphs [0012], [0020], [0025]-[0027], [0030]	1-19 --- 20
Y --- A	US 2002/0192340 A1 (SWART, SK et al.) 19 December 2002; paragraphs [0011], [0060], [0063], [0066]-[0067], [0176]	1-15, 18-19 --- 20
Y --- A	PRO-SAN Final Rinse. Datasheet [online]. Microcide, Inc, 01 June 2012 [retrieved on 2013-12-20]. Retrieved from the Internet: <URL: https://web.archive.org/web/20120601135005/http://www.microcide.com/product/fruit-and-vegetable-wash-sanitizer/PROSAN-FinalRinse>	7, 9, 12-13, 18-19 --- 20
Y --- A	US 6,195,913 B1 (CANET, JAC et al.) 06 March 2001; abstract; column 4, lines 1-5	14, 16-17, 18-19 --- 20
Y --- A	US 6,004,660 A (TOPOLSKI, AS et al.) 21 December 1999; column 1, lines 5-12; column 4, lines 23-40, 50-60	15-19 --- 20
Y --- A	EP 1 010 368 A1 (PAAIMAANS, GJ et al.) 21 June 2000; paragraphs [0015]-[0016]	16-19 --- 20

☒ Further documents are listed in the continuation of Box C. ☐

* 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 application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 January 2014 (13.01.2014)	30 JAN 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/56414

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	WO 2009/042998 A1 (SCANLIN, LA et al.) 02 April 2009; page 18, lines 10-15; page 19, lines 11-16	16-19 --- 20
Y --- A	US 5,924,217 A (PEETERS, H) 20 July 1999; column 4, lines 35-40	3, 4-14, 16-19 --- 20