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Published: without international search report and to be republished upon receipt of that report

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Title: STATIC INVENTOR FOR 360 DEGREE DISINFECTION OF WORKPIECES

Abstract: A disinfection system is disclosed. A first conveyor (23) passes workpieces (22) through a first UV radiation unit (14) for partial disinfection and then passes the workpieces (22) to a static inverter (16) that inverts the workpieces (22). The partially disinfected workpieces (22) fall from the inverter (16) to a second conveyor (18) in an inverted position with portions of the partially disinfected workpieces (22) that previously rested on the first conveyor (12) now being exposed upward. The second conveyor (18) passes the inverted, partially disinfected workpieces (22) through a second UV radiation unit (20) to disinfect the remaining portions of the workpieces (22), providing for 360 degree disinfection of the workpieces (22).
Static inverter for 360 degree disinfection of workpieces

This application claims the benefit of U.S. Provisional Application Ser. No. 60/441,932, filed on January 21, 2003, the disclosure of which is incorporated herein by reference.

Background of the Invention

The present invention relates to disinfection using ultraviolet (UV) lighting or radiation, and more particularly, to 360° disinfection of products carried on a conveyor belt or line.

It is known to treat food products and surfaces associated with food processing with UV radiation to remove microbial contamination. It is also known to position a UV lamp over a conveyor belt or line to treat products passing under the lamp. One problem with this approach is that the bottom portion of the product that rests on the conveyor is not treated by the overhead lamp, leaving a potentially large area untreated. U.S. Patent No. 6,132,784 attempts to address this problem by positioning powered rollers, rather than a belt, under the UV lamp and rotating the product (such as apples) under the lamp for more complete UV treatment. This offers some advantages, but many if not most products one might wish to treat using UV radiation are not well suited for rotation under a UV lamp using such powered rollers. This is particularly true of large objects, particularly elongate objects such as meat logs and rolls of material such as rolls of packaging materials. U.S. Patent Nos. 4,877,964 and 5,958,336 attempt to address the problem of treating the undersides of workpieces on a conveyor by using spaced, powered rollers and positioning UV lamps or bulbs below or between the spaced, powered rollers. Also, U.S. Patent No. 5,597,597 attempts to address the problem of treating the undersides of workpieces on a conveyor by using a mesh conveyor. The disclosures of U.S. Patent Nos. 4,877,964, 5,597,597, 5,958,336, and 6,132,784 are incorporated herein by reference. Similarly, these systems offer some advantages but still undesirably add to the cost and complexity of the system and provide somewhat limited efficiency and effectiveness in treating the undersides of workpieces.

Summary of the Invention

It is therefore an object of the present invention to provide a method and apparatus that provides for 360 degree treatment of workpieces being carried by conveyors.
It is a further object of the present invention to provide a method and apparatus of the above type in which the treatment is disinfection using UV radiation.

It is a further object of the present invention to provide a method and apparatus of the above type that is of simple, rugged construction and provides reliable, predictable results.

It is a still further object of the present invention to provide a method and apparatus of the above type that is particularly well suited for use in connection with pliant, elongate objects.

It is a still further object of the present invention to provide a method and apparatus of the above type that is particularly well suited for use in connection with food products such as meat, fish, poultry, fruits, and vegetables, and in connection with surfaces associated with foods and food processing.

It is a still further object of the present invention to provide a method and apparatus of the above type that is particularly well suited for use in connection with meat logs and similar elongate cuts of meats, fish, and poultry.

It is a still further object of the present invention to provide a method and apparatus of the above type that is particularly well suited for use in connection with packaging, films, and containers.

It is a still further object of the present invention to provide a method and apparatus of the above type that is particularly well suited for use in connection with elongate rolls of packaging films and materials.

Toward the fulfillment of these and other objects and advantages, a disinfection system is disclosed. A first conveyor passes workpieces through a first UV radiation unit for partial disinfection and then passes the workpieces to a static inverter that inverts the workpieces. The partially disinfected workpieces fall from the inverter to a second conveyor in an inverted position with portions of the partially disinfected workpieces that previously rested on the first conveyor now being exposed upward. The second conveyor passes the inverted, partially disinfected workpieces through a second UV radiation unit to disinfect the remaining portions of the workpieces, providing for 360 degree disinfection of the workpieces.

**Brief Description of the Drawings**

The above brief description, as well as further objects, features and advantages of the
present invention will be more fully appreciated by reference to the following detailed description of the presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is an overhead perspective view of a system of the present invention;

FIGS. 2-5 are side elevation views of a portion of a system of the present invention showing conveyors moving a workpiece past a static inverter;

FIG. 6 is a side elevation view of an alternate embodiment of a static inverter used in practicing the present invention;

FIG 7 is an overhead view of a portion of a system of the present invention showing a preferred embodiment of a static inverter used in practicing the present invention;

FIG. 8 is a side elevation view of a preferred embodiment of a static inverter used in practicing the present invention; and

FIG. 9 is an end elevation view of a preferred embodiment of a static inverter used in practicing the present invention.

**Detailed Description of the Preferred Embodiment**

Referring to Fig. 1, the reference numeral 10 refers in general to a disinfection system of the present invention. The system 10 comprises a first conveyor 12, a first treatment unit 14, a static inverter 16, a second conveyor 18, and a second treatment unit 20. The system 10 is used to treat or disinfect workpieces 22.

The first and second conveyors 12 and 18 may take any number of different forms and may be selected from among most any conventional conveyors known in the art, including but not limited to those using belts, chains, rollers, or the like to move workpieces. As seen in Fig. 1, the longitudinal axes of the first and second conveyors 12 and 18 are preferably not aligned. Instead, the second conveyor 18 is slightly offset. Although the first and second conveyors 12 and 18 are depicted as being substantially parallel, this is not required, and any number of different alignments may be used. As best seen in Figs. 2-6, the second conveyor 18 is also disposed lower than the first conveyor 12, with the downstream end of the first conveyor 12 slightly overlapping the upstream end of the second conveyor 18. Although this alignment is preferred, it is understood that the conveyors 12 and 18 may be at the same level and that the ends need not overlap.
The first and second treatment units 14 and 20 are preferably radiation sources and are more preferably UV radiation units. UV radiation units are widely known in the art and typically include a bank of UV bulbs in a protective housing that supports the UV bulbs in close proximity to workpieces passing along an adjacent conveyor, protects the UV bulbs, and Shields users and the outside surrounding environment from the radiation emitted by the bulbs. The UV radiation units 14 and 20 may take any number of forms, shapes, sizes, and configurations. Each UV radiation unit 14 and 20 may be as simple as a single UV bulb or may take the form of most any conventional UV radiation unit known in the art.

The static inverter or chute 16 is preferably stainless steel and is preferably rigidly affixed slightly above the first conveyor 12 near the downstream end of the conveyor 12. An upstream portion of the inverter 16 is disposed upstream of the downstream end of the first conveyor 12, and a downstream portion of the inverter 16 is disposed downstream of the upstream end of the second conveyor 18. The upstream end of the inverter 16 is substantially planar and is aligned substantially parallel with and in close proximity to the surface of the first conveyor 12 that carries the workpieces 22. Middle and downstream portions of the inverter 16 are helical or somewhat helical or spiral in shape and have a concave inner surface. Referring to Fig. 6, in one embodiment, the concave inner surface also has one or more grooves or tracks 24 running longitudinally therein.

Figs. 7-9 depict a preferred embodiment of the diverter 16. In this embodiment, the diverter 16 is positioned downstream of the first conveyor 12 and above the second conveyor 18. The diverter is of relatively simple construction, having a guide member 19, such as ½ inch stainless steel rod, and a substantially planar member 21, such as a 10-gauge stainless steel plate. The rod 19 is aligned substantially horizontally, substantially perpendicular to the discharge end of the first conveyor 12. The plate 21 is affixed to the rod 19, with the line of intersection between the rod 19 and plate 21 being substantially horizontal, and with the plate 21 sloping or angling downward away from the rod 19. The inverter 16 may take any number of different shapes, sizes, and configurations. It is also understood that the inverter 16 need not be stationary or static and that the inverter 16 may include moving parts, including but not limited to powered and un-powered rollers, belts, and chains. It is also understood that the inverter 16 may be aligned and positioned in any number of ways relative to conveyors 12 and 18 and, for example, need not have overlapping portions.

The workpieces 22 are preferably elongate and pliant. It is preferred that the
workpiece 22 be of sufficient length so that a portion of the workpiece remains in contact with at least one of the conveyors 12 or 18 as the workpiece 22 passes the inverter 16. If a workpiece 22 is too short, it may lose the driving force supplied by contact with one of the conveyors 12 and 18 and may become stuck on the inverter 16. If the workpiece 22 is too stiff, it may be prone to slide laterally off the inverter 16 without inverting. If the workpiece 22 is too limp or flaccid, it will be difficult for the first conveyor 12 to drive it onto and through the inverter 16. While the system 10 is particularly well suited for use in connection with workpieces 22 such as meat logs, similar elongate cuts of meat, fish, and poultry, and elongate rolls of packaging films and materials, the system 10 may of course be used in connection with any of a wide variety of objects that may be conveyed by conveyors 12 and 18. For example, the workpieces 22 need not be elongate, need not be pliant, and may include food and non-food items.

Referring to Fig. 1, in operation, a plurality of untreated workpieces 22a are placed on the first conveyor 12, and the first conveyor 12 moves the untreated workpieces 22a to and through UV radiation unit 14. UV radiation unit 14 disinfects upper portions of the workpieces 22b, as indicated by cross-hatching 26, but leaves lower portions of the workpieces 22b untreated, as indicated by the absence of cross-hatching.

Conveyor 12 then moves and drives the partially treated workpieces 22b to and through the static inverter 16. As best seen in Figs. 2 through 5, conveyor 12 initially drives the front end of the partially treated workpiece 22b up and onto the substantially planar upstream portion of the inverter 16. Conveyor 12 then begins to drive the front end of the workpiece 22b into the concave, helical portion of the inverter 16. As this happens, the inverter 16 lifts and twists the front end of the workpiece 22b, rotating one side of the workpiece 22b up and over the other side of the workpiece 22b, thereby inverting the front end of the workpiece 22b. Friction provided by the portion of the workpiece 22b that still rests on the first conveyor 12, along with the concave inner surface of the inverter 16, help to keep the workpiece 22b moving longitudinally through the inverter 16 without significant lateral sliding downward across the upwardly sloping inner surface of the inverter 16. This helps the inverter 16 to lift and flip or invert the workpiece 22b rather than allowing the workpiece 22b to simply slip off the inverter 16 with the disinfected portion of the workpiece 22b still facing largely upward. The grooves or tracks 26, if used, also help deter such lateral sliding.
As the conveyor 12 continues to drive the workpiece 22b into and through the inverter 16, gravity eventually pulls the inverted front portion of the workpiece 22b downward, out of the concave, helical portion of the inverter 16 so that the partially treated, inverted front portion of the workpiece 22b falls to the second conveyor 18. At this point, the second conveyor 18 begins to assist in pulling the workpiece 22b through and from the inverter 16, with the disinfected portion 26 of the workpiece 22b resting on the second conveyor 18 and the untreated portion exposed upward. The operation of the preferred embodiment depicted in Figs. 7-9 is substantially identical, with the exception of the precise motions of the workpieces 22 as the workpieces are passed through inverter 16. In the preferred embodiment, the diverter 16 relies more heavily on gravity to invert the workpieces 22.

The second conveyor 18 then moves the inverted, partially disinfected workpiece 22b to and through UV radiation unit 20, and UV radiation unit 20 disinfects the previously untreated portion of the workpiece 22b with the portion disinfected by UV radiation unit 20 being indicated by cross-hatching 28. Quite often there will be overlap such that some portions disinfected or irradiated by unit 14 will also be disinfected or irradiated by unit 20.

In this manner, the system 10 allows for 360 degree disinfection of workpieces carried by conveyors 12 and 18. The sizing of the radiation units 14 and 20 and the speed of the conveyors 12 and 18 are selected in part based upon the time of radiation exposure needed to obtain the level of disinfection desired.

Other modifications, changes and substitutions are intended in the foregoing, and in some instances, some features of the invention will be employed without a corresponding use of other features. For example, while the preferred embodiment discussed above relates primarily to the use of a static inverter 16 in the UV disinfection of food and surfaces associated with food processing, it is understood that the static inverter 16 of the present invention will have any number of different uses, many of which may have nothing to do with irradiation, food, or surfaces associated with food. Similarly, while the treatment discussed in the preferred embodiment dealt with disinfection using UV radiation, it is understood that the system 10 may be used in connection with any number of different kinds or types of treatments, including but not limited such widely varying treatments as painting, washing, battering, seasoning, drying, and countless other treatments. Further, any number of different treatment or radiation units 14 and 20 may be used. For example, a single radiation unit may be used rather than using two, with the inverter 16 being disposed inside the single
radiation unit. Further still, any number of conveyors may be used, including a single conveyor. It is understood that the inverter 16 may take any number of different shapes, sizes, and configurations. It is also understood that the inverter need not be static. It is of course understood that all quantitative information is given by way of example only and is not intended to limit the scope of the present invention.
What is claimed is:

1. A method, comprising:
   (a) providing a first portion of a treatment to a workpiece on a first conveyor, said treatment being selected from the group consisting of irradiating, painting, washing, battering, seasoning, and drying;
   (b) after step (a), at least partially inverting said workpiece; and
   (c) providing a second portion of said treatment to said at least partially inverted workpiece on a second conveyor.

2. The method of claim 1, wherein said treatment comprises irradiating.

3. The method of claim 1, wherein said treatment comprises irradiating with UV radiation.

4. The method of claim 1, wherein said workpiece comprises an elongate, pliant workpiece.

5. The method of claim 1, wherein step (b) comprises:
   after step (a), passing said workpiece over a static inverter to at least partially invert said workpiece.

6. The method of claim 1, wherein step (b) comprises:
   after step (a), passing said workpiece over a static inverter to at least partially invert said workpiece, said workpiece remaining in contact with at least one of said first conveyor or said second conveyor as said workpiece passes over said static inverter.

7. The method of claim 1, wherein said workpiece is selected from the group consisting of a meat log, an elongate cut of meat, fish, or poultry, or an elongate roll of packaging film or sheet material.

8. The method of claim 1, wherein step (c) comprises:
   providing a second portion of said treatment to said at least partially inverted workpiece on a second conveyor, said second conveyor being offset from said first conveyor so that a longitudinal axis of an upstream end of said second conveyor is not aligned in a vertical plane with a longitudinal axis of a downstream end of said first conveyor.

9. The method of claim 1, wherein step (c) comprises:
   providing a second portion of said treatment to said at least partially inverted
workpiece on a second conveyor, an upstream end of said second conveyor being disposed lower than a downstream end of said first conveyor.

10. A combination, comprising:

a first conveyor having a first width at a downstream end, said first width being measured substantially perpendicular to direction of travel of a workpiece on said first conveyor;
a static inverter disposed near a downstream end of said first conveyor, said static inverter having a second width at an upstream end, said second width being measured substantially perpendicular to direction of travel of said workpiece on said first conveyor, said second width being less than said first width; and
a second conveyor disposed near a downstream end of said static inverter.

11. The combination of claim 10, further comprising a workpiece, said workpiece being of sufficient size to remain in contact with at least one of said first conveyor or said second conveyor as said workpiece passes said static inverter.

12. The combination of claim 10, wherein said static inverter has a third width measured substantially perpendicular to direction of travel of said workpiece on said first conveyor and disposed downstream of said second width, said third width being less than said second width.

13. The combination of claim 12, wherein said static inverter has a fourth width measured substantially perpendicular to direction of travel of said workpiece on said first conveyor, said fourth width being disposed near a downstream end of said static inverter and disposed downstream of said third width, said fourth width being less than said third width.

14. The combination of claim 10, wherein said upstream end of said static inverter has a first side and a second side, said second side being disposed lower than said first side.

15. The combination of claim 10, wherein said static inverter comprises a substantially triangular planar member.

16. The combination of claim 10, further comprising:

a first treatment unit disposed to provide a first portion of a treatment to said workpiece upstream of said static inverter; and
a second treatment unit disposed to provide a second portion of said treatment to
said workpiece downstream of said static inverter.

17. The combination of claim 16, wherein said first and second treatment units comprise UV radiation units.

18. A combination, comprising:

a first conveyor;

a second conveyor;

a chute disposed to receive a workpiece from said first conveyor, to at least partially invert said workpiece, and to pass said at least partially inverted workpiece to said second conveyor;

a first radiation unit disposed to treat said workpiece upstream of said chute; and

a second radiation unit disposed to treat said at least partially inverted workpiece downstream of said chute.

19. The combination of claim 18, wherein said first and second radiation units comprise UV radiation units.

20. The combination of claim 18, wherein said second conveyor is disposed so that a longitudinal axis of an upstream end of said second conveyor is not aligned in a vertical plane with a longitudinal axis of a downstream end of said first conveyor.

21. The combination of claim 18, further comprising a workpiece, said workpiece being of sufficient size to remain in contact with at least one of said first conveyor or said second conveyor as said workpiece passes said chute.