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(54) METHOD AND APPARATUS FOR DRAINING A WORK PIECE DURING FINISHING

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(57) **ABSTRACT**

A method of processing a work piece having an enclosure. The method comprises inserting a siphon into the enclosure, submerging the work piece in an immersion tank, removing the work piece from the tank, and draining liquid from the enclosure through the siphon. Inserting can include positioning at least a portion of a short leg of the siphon in the enclosure of the work piece. Preferably, draining includes directing liquid back into the immersion tank. After draining, the work piece can be moved to a second workstation and/or the siphon can be withdrawn from the enclosure. The method can be performed using a finishing system comprising a primary carrier, a work piece suspended from the primary carrier and defining an enclosure, and a siphon positioned in the enclosure. Preferably, the work piece is suspended above an immersion tank. The siphon can be positioned to direct fluid toward the immersion tank.

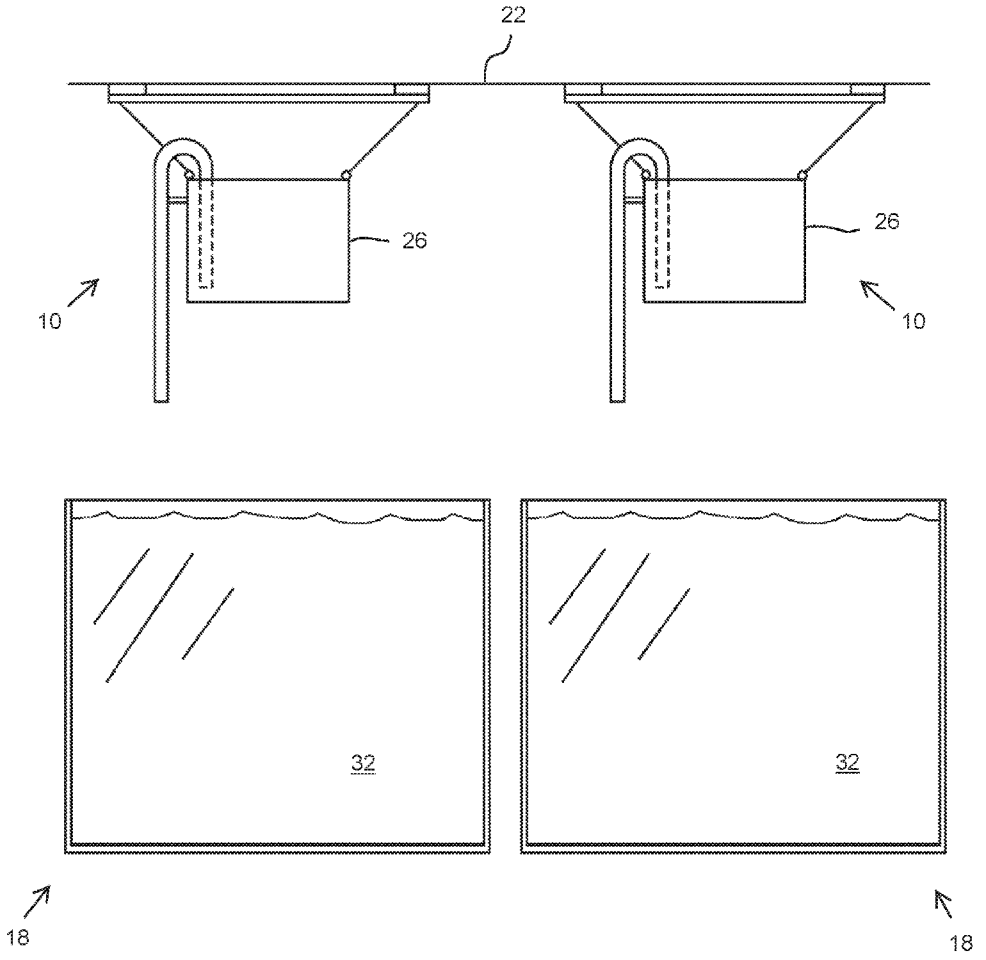


FIG. 1

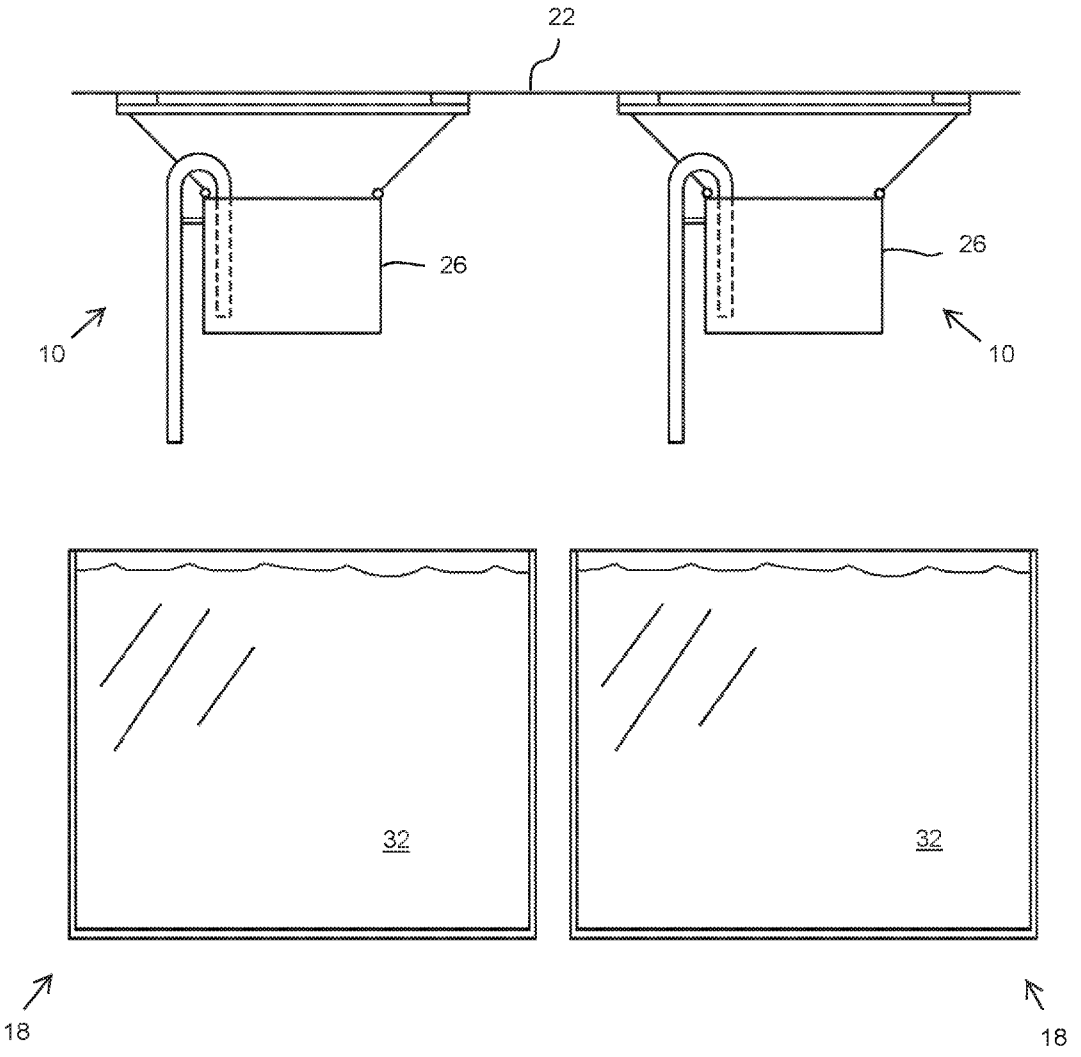


FIG. 2

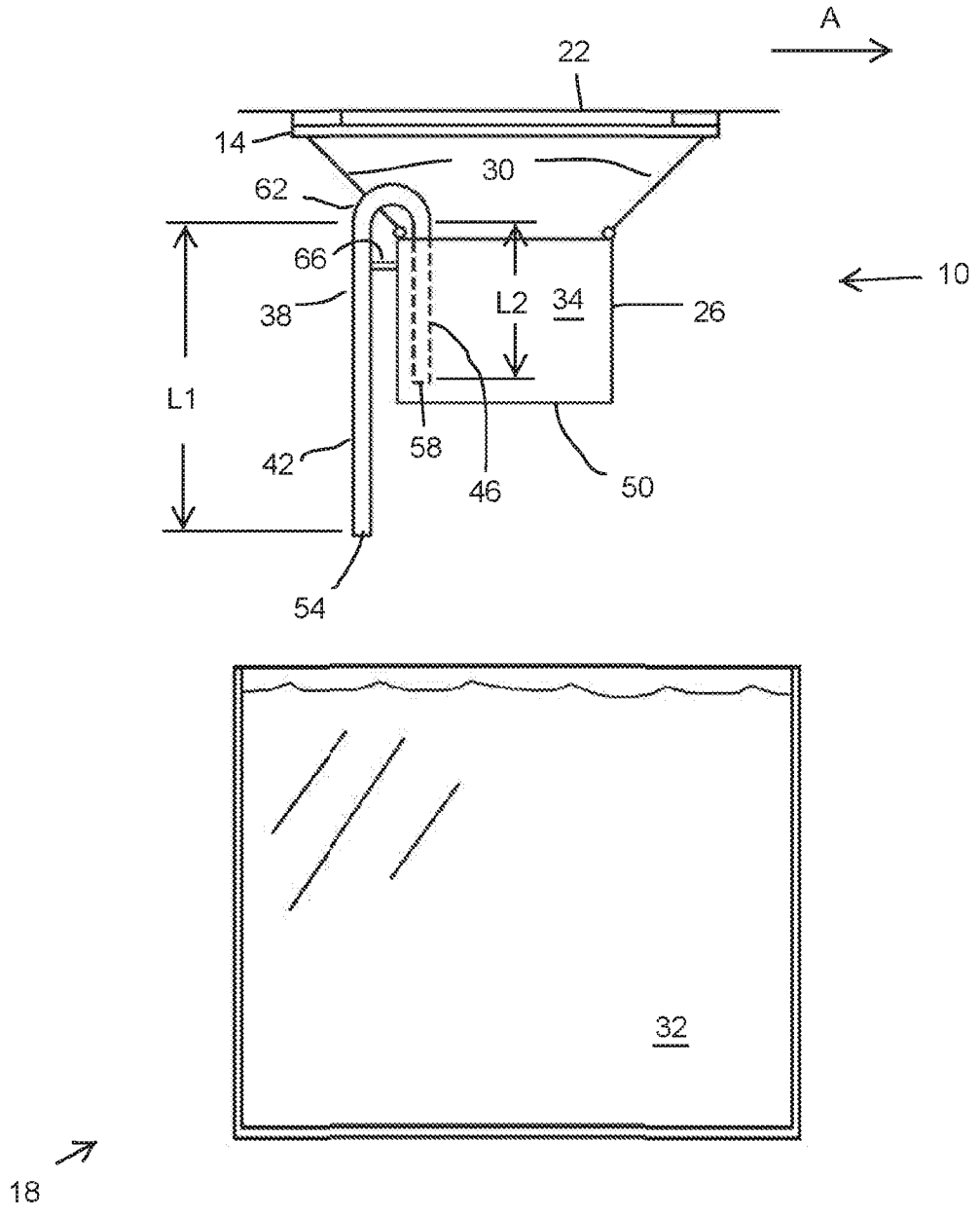


FIG. 3

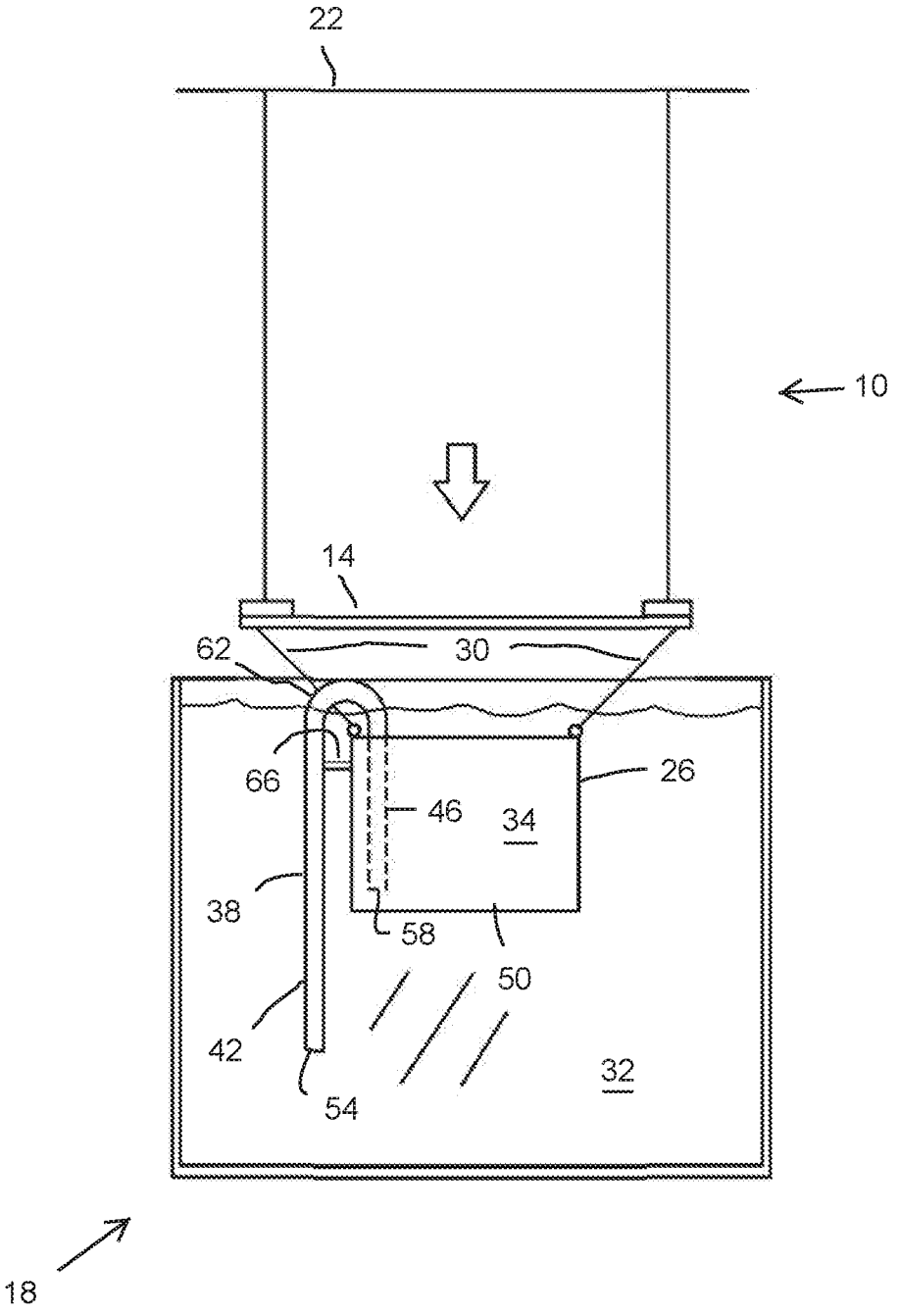


FIG. 4

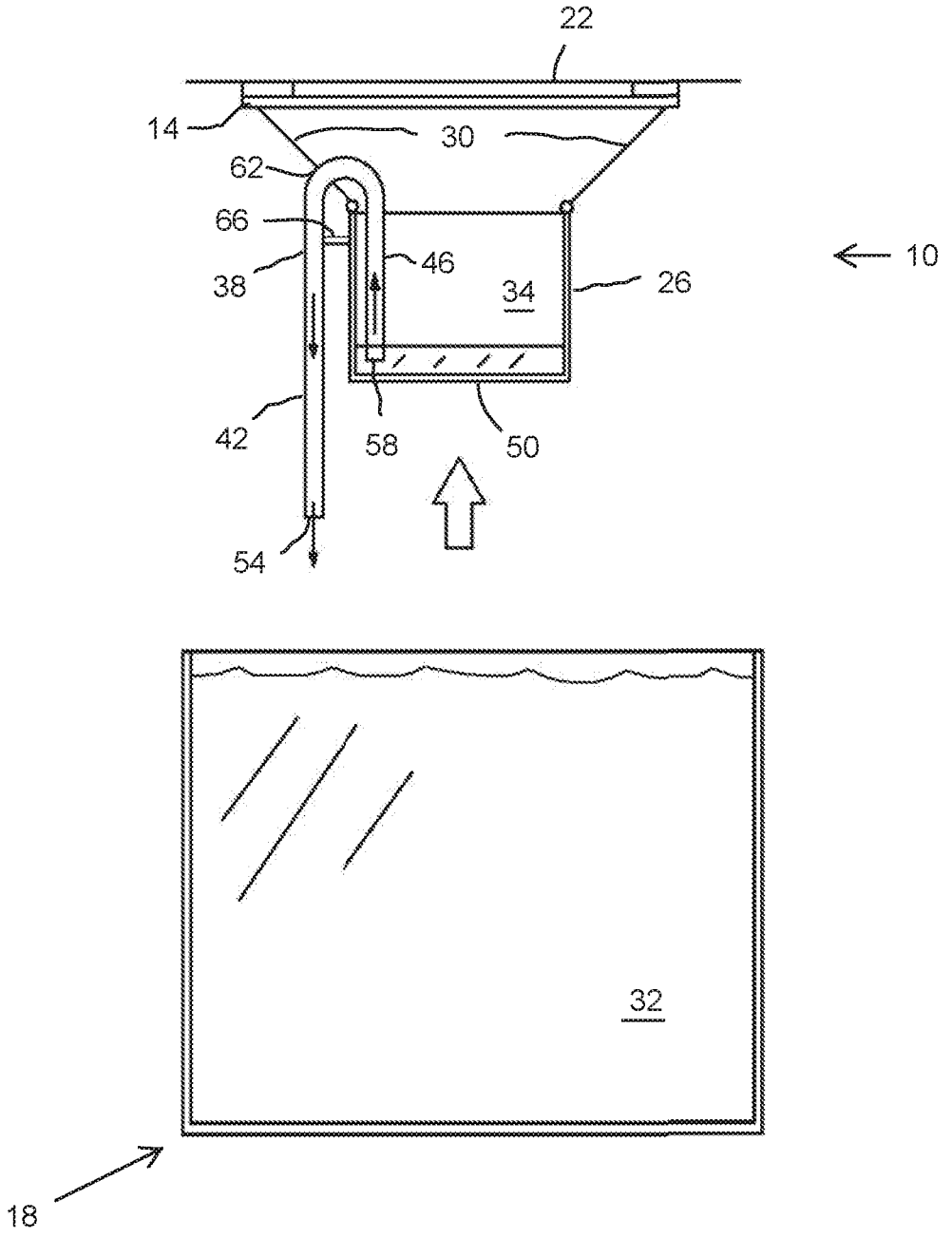
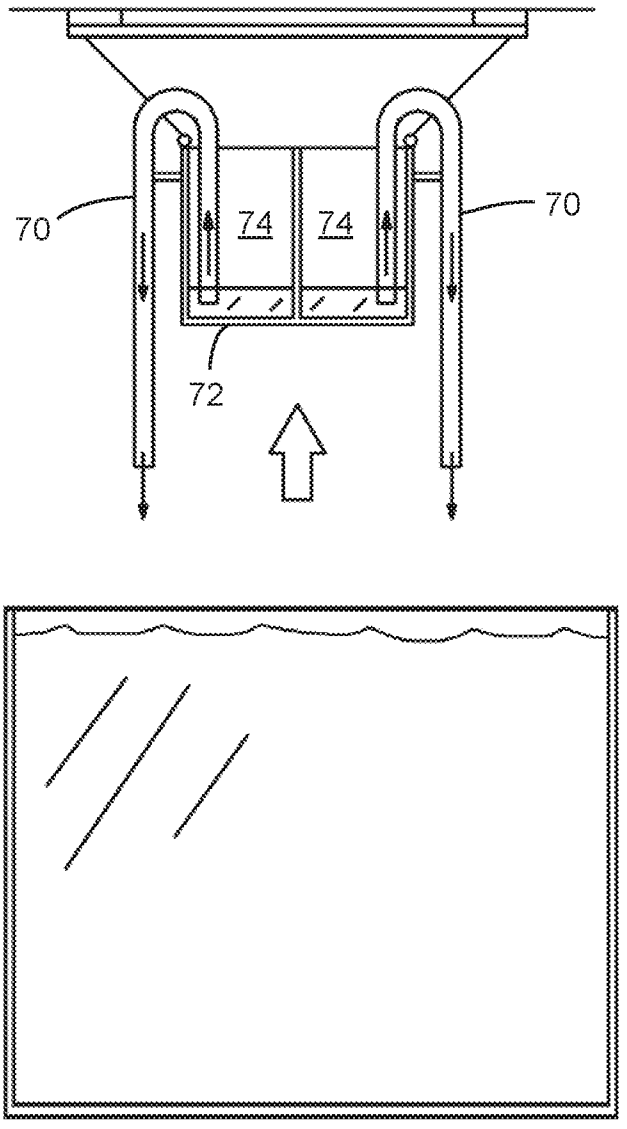


FIG. 5



METHOD AND APPARATUS FOR DRAINING A WORK PIECE DURING FINISHING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Priority is hereby claimed to U.S. provisional patent application No. 62/094,784 filed on Dec. 19, 2014, the entirely of which is incorporated herein by reference.

BACKGROUND

[0002] The present invention relates to finishing systems and processes for manufactured parts, and more particularly to carriers for transporting manufactured parts through a finishing process and methods relating to the same. For example, a finishing process can include a painting or an electroplating process whereby manufactured parts are immersed in a dip tank full of fluids. The shape of complex parts (e.g., containers and automotive parts) can introduce difficulty in ensuring full drainage of fluid from the parts after removal from a dip tank.

[0003] To facilitate drainage of dip tank fluid from a part, parts are often provided with drain holes formed in the part. These drain holes are typically provided solely to facilitate drainage of fluids from the part, and are often otherwise undesirable. Without drain holes, complex and costly machines must be utilized to ensure good coverage of and drainage of fluid from complex parts. Without such measures, a significant amount of liquid may be lost from the dip tank during the process, which increases processing time and cost due to stoppages, re-filling, and treatment or disposal, and may also negatively affect downstream portions of the finishing process.

SUMMARY

[0004] The present invention provides a method and apparatus of processing a work piece having an enclosure through a workstation having an immersion tank with liquid. The method comprises inserting (e.g., attaching) a siphon at least partially into the enclosure of the work piece, submerging at least a portion of the work piece (e.g., the entire work piece) in the immersion tank to thereby cause the liquid in the immersion tank to at least partially fill the siphon and the enclosure in the work piece, removing (e.g., lifting) the work piece from the immersion tank, and draining liquid from the enclosure through the siphon. In one embodiment, the siphon includes a short leg and a long leg, and inserting includes positioning at least a portion of the short leg in the enclosure of the work piece. Preferably, draining includes directing liquid from the siphon back into the immersion tank.

[0005] If desired, after draining, the method can include moving the work piece to a second workstation. The second workstation can include any additional manufacturing process, such as dipping the work piece into a second immersion tank with a second liquid. After draining, the siphon can be withdrawn from the enclosure.

[0006] The method can be performed using a finishing system comprising a primary carrier, a work piece suspended from the primary carrier and defining an enclosure, and a siphon having an inlet end positioned in the enclosure. When used to perform the above-referenced method, the finishing system further includes a workstation having an immersion tank, and the work piece is suspended above the immersion tank. Preferably, the siphon is positioned to direct fluid from the enclosure toward the immersion tank. An attachment means can be provided to secure the siphon to the work piece.

[0007] The finishing system can also include a second workstation and a conveyor positioned to move the work piece to the second workstation. As noted above in connection with the method, the second workstation can include a second workstation having a second immersion tank. In the event that the work piece defines two enclosures, two siphons can be provided, one for each enclosure.

[0008] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a side view of a carrier assembly for moving a work piece between two workstations and embodying the present invention.

[0010] FIG. **2** is a side view of the carrier assembly of FIG. **1** at a single workstation.

[0011] FIG. **3** is a side view of the carrier assembly of FIG. **2** with a work piece lowered into an immersion tank.

[0012] FIG. **4** is a side view of the carrier assembly of FIG. **2** with the work piece removed from and held above the immersion tank, so that liquid flows from the work piece through a drainage siphon back into the immersion tank.

[0013] FIG. **5** is a side view of a different work piece after removal from an immersion tank.

DETAILED DESCRIPTION

[0014] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the accompanying drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0015] A finishing system is illustrated in FIGS. **1-4**. The finishing system includes a conveyor **22**, a carrier assembly **10**, and a plurality of workstations **18**. The carrier assembly includes a primary carrier or load bar **14** configured to be transported between the workstations **18** (FIG. **1**) by the conveyor **22** as part of a conveyor system. Each workstation **18** is designed to perform a different manufacturing process, such as dipping, painting, drying, drilling, or attaching another component. In the carrier assembly of FIG. **1**, both of the workstations involve dipping.

[0016] The load bar **14** can be a rigid structure that is coupled to the conveyor **22** for traveling along the conveyor **22** between work stations **18**. A work piece **26** is supported below the conveyor **22** by the load bar **14**. The work piece **26** is coupled to lower ends of one or more hangers or brackets **30**, and the load bar **14** is coupled to upper ends of the hangers **30** such that the work piece **26** is configured to hang from the load bar **14**. The hangers **30** can be pivotally coupled to the load bar **14** and the work piece **26**, and can also be rigid members, such as beams, rods, poles, shafts or bars, in some constructions. However, in other constructions, the hangers **30** can be flexible members such as chains, cables and ropes, etc. But the work piece **26** may be supported by the conveyor **22** in any manner with or without any additional structure via any convenient connection points on the load bar **14**, and the work piece **26**. In alternate constructions, additional structure, such as a skid may be coupled to the hangers **30** and

connected to the load bar **14** by any connection points to carry the work piece **26**, and the work piece **26** can be directly or indirectly fastened to the skid. Regardless of whether the carrier assembly **10** includes a skid or additional structure, the work piece **26** is configured to move along with the load bar **14** via the conveyor **22**.

[0017] Though the conveyor system shown in FIG. **1-3** illustrates only a single carrier assembly **10**, the conveyor system may include any number of carrier assemblies **10**. The conveyor **22** can be part of any overhead conveyor system between the plurality of work stations **18**. Further, the conveyor system can be adapted accordingly so it moves in any suitable direction. In particular, the conveyor **22** transports the plurality of carrier assemblies **10** between the plurality of work stations **18**. The work stations **18** may include finishing stations, such as an electroplating immersion tank **32** for submerging the work piece **26** into an electro-coating liquid, as illustrated in FIGS. **1-3**. In order to coat the work piece **26** at the finishing station, the work piece **26** is at least partially submerged in the immersion tank **32** and then removed. Depending upon the type of coating, the liquid in the tanks and the work piece **26** to be coated may be oppositely electrically charged to promote adhesion. However, the work stations **18** are not limited to such an example, and can include one or more of electro-coating, autodeposition coating, powder coating, liquid spray painting, cleaning, chemical etching, pre-treatment, and heat treating operations. Additionally, the work stations **18** can also include other types of equipment, such as an oven or drying station, a paint spray station, a cleaning station and the like.

[0018] The work piece **26** is illustrated as a box or case forming an enclosure, but may be of almost any shape, and particularly a shape that forms an enclosure **34** that retains liquid when the work piece **26** is removed from the immersion tank **32**. Although some conveyor systems are equipped with complex manipulation capability, the conveyor **22** illustrated is only equipped to lower and raise the work piece **26** without tilting and rotation capability. Thus, the illustrated work piece **26** orientation required for good coverage leads to unavoidable liquid retention upon removal from the immersion tank **32**. In other constructions, the conveyor **22** and/or the carrier assembly **10** may enable tilting of the work piece **26** to enhance liquid coverage in the immersion tank **32**, but the tilting capability is often not sufficient to empty the liquid from the enclosure **34** in the work piece **26**. Thus, a drainage siphon **38** is further provided for removing the liquid that is retained by the enclosure of the work piece **26** after the work piece **26** is removed from the immersion tank **32**.

[0019] The drainage siphon **38** is illustrated as a tube that includes a long leg **42** and a short leg **46** that are in fluid communication. The short leg **46** is positioned inside the enclosure **34** adjacent a bottom of the enclosure **34** and generally near a location where the liquid tends to be retained. The long leg **42** is positioned exterior to the enclosure **34** and the work piece **26**, substantially below a bottom side **50** of the work piece **26**, so that an outlet **54** defined by a distal end of the long leg **42** is lower than an inlet **58** defined by a distal end of the short leg **46**. Due to the gravitational potential energy difference between the liquid in the enclosure **34** and the outlet **54**, the liquid will be siphoned from the enclosure **34** of the work piece **26** by the inlet **58** of the drainage siphon **38**. The liquid is then discharged by the outlet **54** of the drainage siphon **38**, thereby removing most of the liquid retained by the enclosure **34** of the work piece **26**. The long leg **46** is arranged to direct the liquid through the outlet **54** of the drainage siphon **38** back into the immersion tank **32**. However, in other constructions the liquid may be discharged to another container or location.

[0020] When the work piece **26** and drainage siphon **38** are initially submerged in the liquid in the immersion tank **32**, liquid enters the outlet **54** of the drainage siphon **38** and the inlet **58** of the drainage siphon **38** as liquid enters the enclosure **34**. This entry of fluid into both ends of the siphon can result in the formation of an air bubble near a pipe bend **62** between the long leg **42** and the short leg **46**.

[0021] Upon lifting the work piece from the tank, the siphon will cause liquid in the work piece to flow into the inlet **58** and flow out of the outlet **54**. Specifically, the weight of the liquid in the long leg **42** is greater than the weight of the liquid in the short leg **46**, and thus liquid will flow through the long leg **42** towards the outlet **54**. The liquid from the enclosure **34** initially pulls any air bubble out through outlet **54**, after which the liquid continues to flow from the enclosure **34** to the immersion tank **32** through the drainage siphon **38**. Due to the pressure decrease from the inlet **58** to the top of the drainage siphon **38**, which is below atmospheric pressure, the liquid is lifted through the short leg **46**, from the enclosure **34** up to the pipe bend **62** where the liquid can then fall, due to gravity, through the long leg **42**, and be discharged out the outlet **54**. The liquid continues to be removed from the enclosure **34** by the drainage siphon **38** until most liquid is removed from the enclosure **34**, or the liquid level in the immersion tank **32** is at the same height as the liquid level in the enclosure **34**.

[0022] The drainage siphon **38** is illustrated as a rigid tube having a rigid 180-degree pipe bend **62** fluidly connecting the short leg **46** and the long leg **42** to orient the long leg **42** downward so that the outlet **54** is below the inlet **46** of the drainage siphon **38**. In other constructions the drainage siphon **38** may be a flexible conduit configured to have the outlet **54** beneath the inlet **58**. In the illustrated construction a length L**1** of the long leg **42** is approximately twice as long as a length L**2** of the short leg **46**. In other constructions the length L**1** of the long leg **42** may instead be three times longer than the length L**2** of the short leg **46**, or any other amount longer. The length L**1** of the long leg **42** is preferably long enough that the outlet **54** is positioned below a bottom of the enclosure **34** so that all water stored in the enclosure is removed. The length L**2** of the short leg **46** is long enough that it extends to the bottom of the enclosure **34**. Alternatively, in other constructions, the long leg **42** of the drainage siphon **38** may be telescopic or collapsible so that the length L**1** of the long leg **42** can be variably increased or decreased as necessary. The short leg **46** may also be independently telescopic, or expandable and collapsible. Further, the long leg **42** and the short leg **46** may also both be independently telescopic. If the drainage siphon **38** is a flexible conduit it may also be expandable and configurable to properly direct liquid flow.

[0023] In the illustrated construction, the drainage siphon **38** is coupled to an inside and/or outside surface of the work piece **26** by an attachment means in the form of a bracket **66** or fastener. Additionally, brazing, welding, permanent or removable fasteners, and the like may be used in combination with or without the bracket **66** and/or fastener to couple the drainage siphon **38** to the work piece **26**. Examples of fasteners that can be used (with or without a bracket) to attach the drainage siphon **38** to the work piece **26** include without limitation a clip, clamp, elastic element, permanent magnet, electromagnet, cable tie, clasp, hook, cord, adhesive, hook-

and-loop strips or any other suitable component, or combination of components. The drainage siphon **38** can be permanently or releasably attached to the work piece **26** by a bracket **66** and/or a fastener as disclosed herein. Alternatively, the drainage siphon **38** can hang from the work piece without any additional attachment means. The drainage siphon **38** may also be frictionally fit to an integral component of the work piece **26**, or alternatively, the drainage siphon **38** may be integrally formed as part of the work piece **26**. However, in further constructions, the drainage siphon **38** may not be coupled to the work piece **26** at all, and may instead hand from the work piece or be coupled to the carrier assembly **10**, or integrated therewith, such that the drainage siphon **38** is not supported by the work piece **26**. In such constructions, the drainage siphon **38** may be maintained out of contact with the surfaces of the work piece **26**, thus preventing any interference with the surface treatment that coupling the drainage siphon **38** directly to the work piece **26** may produce during submersion in the immersion tank **32**. In some constructions where the drainage siphon **38** is coupled to the work piece **26**, the point of contact may be a preselected portion of the work piece **26** not designated or required to receive the coating or other finishing. The drainage siphon **38** may be attached to the work piece **26** or the carrier assembly **10** prior to the work piece **26** being loaded onto the conveyor system. Alternatively, the drainage siphon **38** may be attached to the work piece **26** or carrier assembly **10** at any point during the process.

[0024] A process of conveying one or more work pieces **26** through a finishing process can include the following steps. First, the work piece **26** is connected to the conveyor **22** by the hangers **30**. If not pre-attached, the drainage siphon **38** is provided in communication with the enclosure **34** of the work piece **26**. The conveyor **22** is operated to transport the work piece **26** to a work station **18**. The conveyor **22** may transport the work piece **26** directly into the work station **18** along the primary direction of travel A, or may first transport the work piece **26** to a position above the work station **18** (e.g., in the case of an immersion tank holding an electrocoating liquid). A vertical drive may lower the carrier assembly **10** from the conveyor **22** so that the work piece **26** is lowered into the work station **18**. The vertical drive can include any suitable system for producing the required vertical travel (e.g., motor, or hydraulic cylinders). Alternately, the conveyor **22** may follow a path that descends to allow the work piece **26** to descend into the work station **18**. The work piece **26** can be lowered while traveling along the conveyor **22** or after stopping at a position along the conveyor **22** corresponding to the desired work station **18**. In the case where the work station **18** includes an immersion tank **32** containing an electro-coating liquid, the work piece **26** and the drainage siphon **38** are lowered into the immersion tank **32** so that at least a portion of the work piece **26** is submerged within the immersion tank **32** (FIG. **2**). While the work piece **26** is submerged, the liquid coats the work piece **26** and also flows into the enclosure **34** of the work piece **26**. Once the work piece **26** is coated thoroughly by the liquid, which may include one or more minor oscillations, the work piece **26** and the drainage siphon **38** are removed from the immersion tank **32** (FIG. **3**). The liquid then flows from the enclosure **34** of the work piece **26** back into the immersion tank **32** via the drainage siphon **38**. Once most of the liquid is removed from the enclosure **34** of the work piece **26**, the work piece **26** is transported via the conveyor **22** to another work station **18** or to an unloading area of the conveyor system. Once the work piece **26** is unloaded, the drainage siphon **38** may be removed and reused with another work piece **26** on the same or different carrier assembly **10** in the conveyor system.

[0025] The system and method described herein are applicable for any number of work stations **18**. In some constructions, the carrier assembly **10** may include and support more than one work piece **26** each having a drainage siphon **38** for removing liquid from an enclosure. Additionally, referring to FIG. **5**, more than one drainage siphon **70** may be used in conjunction with the same work piece **72** to accommodate a plurality of fluidly separate enclosures **74**, or to increase the speed at which liquid is removed from the work piece **72**.

1. A method of processing a work piece having an enclosure through a workstation having an immersion tank with liquid, the method comprising:

inserting a siphon at least partially into the enclosure of the work piece;

submerging at least a portion of the work piece in the immersion tank to thereby cause the liquid in the immersion tank to at least partially fill the siphon and the enclosure in the work piece;

removing the work piece from the immersion tank; and

draining liquid from the enclosure through the siphon.

2. A method as claimed in claim **1**, wherein inserting includes attaching the siphon to the work piece.

3. A method as claimed in claim **1**, wherein the siphon includes a short leg and a long leg, and wherein inserting includes positioning at least a portion of the short leg in the enclosure of the work piece.

4. A method as claimed in claim **1**, wherein submerging includes submerging the entire work piece in the liquid.

5. A method as claimed in claim **1**, wherein removing includes lifting the work piece out of the immersion tank.

6. A method as claimed in claim **1**, wherein draining includes directing liquid from the siphon back into the immersion tank.

7. A method as claimed in claim **1**, further comprising, between inserting and submerging, positioning the work piece above the immersion tank.

8. A method as claimed in claim **1**, further comprising, after draining, moving the work piece to a second workstation.

9. A method as claimed in claim **8**, wherein the second workstation includes a second immersion tank with a second liquid.

10. A method as claimed in claim **1**, further comprising, after draining, withdrawing the siphon from the enclosure.

11. A method as claimed in claim **1**, further comprising removably attaching the siphon to the work piece by either or both of a bracket and a fastener.

12. A finishing system comprising:

a primary carrier;

a work piece suspended from the primary carrier, the work piece defining an enclosure; and

a siphon having an inlet end positioned in the enclosure.

13. A finishing system as claimed in claim **12**, further comprising a workstation having an immersion tank, the work piece being suspended above the immersion tank.

14. A finishing system as claimed in claim **13**, wherein the siphon is positioned to direct fluid from the enclosure toward the immersion tank.

15. A finishing system as claimed in claim **13**, further comprising:

a second workstation; and

a conveyor positioned to move the work piece to the second workstation.

16. A finishing system as claimed in claim **15**, wherein the second workstation comprises a second immersion tank.

17. A finishing system as claimed in claim **12**, wherein the work piece defines two enclosures, and wherein the siphon comprises two siphons, each siphon having an inlet end positioned in one of the two enclosures.

18. A finishing system as claimed in claim **12**, further comprising an attachment means for securing the siphon to the work piece.

19. A finishing system as claimed in claim **12**, further comprising either or both of a bracket and a fastener positioned to couple the work piece to the siphon.

20. The finishing system as claimed in claim **19**, wherein the bracket or fastener is releasably coupled to the work piece.

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