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(71) Applicant (for all designated States except US): **SIGMA-ALDRICH CO.** [US/US]; 3050 Spruce St., St. Louis, MO 63103 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **RIEBENSTAHL, Hubert** [DE/DE]; Siebenburgenweg 04, D-89555 Steinheim (DE).

(74) Agent: **PANKA, Brian, G.**; Harneess, Dickey & Pierce, P.L.C., 7700 Bonhomme, Suite 400, St. Louis, MO 63105 (US).

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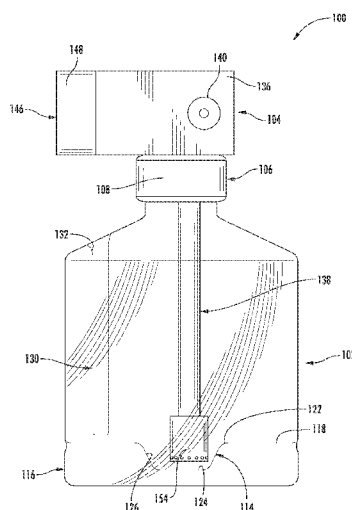


FIG. 2

(57) Abstract: A vapor product delivery assembly (100) is operable to retrieve vapor product from liquid. The delivery assembly (100) generally includes a glass container (102) configured to retain the liquid, and a valve assembly (104) configured to be coupled to the glass container (102) to introduce carrier gas into the liquid in the glass container (102). A sparging tube (138) of the valve assembly extends at least partly into the glass container (102) and into a recessed portion (114) defined in a bottom of the glass container (102). As such, the sparging tube (138) introduces the carrier gas into the liquid in the glass container (102) at a location in the recessed portion (114) in the bottom of the glass container (102).

VAPOR PRODUCT DELIVERY ASSEMBLIES AND RELATED METHODS

Cross-Reference to Related Application

[0001] This application claims priority to U.S. Patent Application Serial No. 61/300,646, a provisional patent application filed on 2 February 2010. The disclosure of U.S. Patent Application Serial No. 61/300,646 is incorporated herein by reference in its entirety.

Field

[0002] The present disclosure relates to delivery assemblies, and more particularly to vapor product delivery assemblies for use in withdrawing vapor products from liquids disposed within glass containers of the vapor product delivery assemblies, and related methods.

Background

[0003] This section provides background information related to the present disclosure which is not necessarily prior art.

[0004] In the semiconductor industry, electronic devices are often produced by means of a chemical vapor deposition (CVD) process. A liquid or solid precursor is supplied in a bubbler through which a carrier gas, such as nitrogen or hydrogen, may be bubbled via a dip pipe so that the gas becomes saturated with the precursor. The carrier gas/precursor vapor mixture is then passed at a controlled rate into an epitaxial reactor. Such systems are used in the production of both silicon and compound semiconductors. It is important that the concentration of the chemical in the vapor phase be extremely stable. Channeling and non-uniform surfaces provided by conventional single-use type bubblers can lead to variable vaporization of the precursors, causing fluctuations in the gas/precursor concentrations. Such fluctuations are adverse to the deposition process.

Summary

[0005] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0006] Example embodiments of the present disclosure generally relate to assemblies for retrieving vapor product from liquid. In one example embodiment, an assembly generally includes a container formed from glass and configured to retain liquid within the container, and a gas inlet disposed at least partly within the container and configured to introduce carrier gas into liquid within the container. The container includes a recessed portion defined in a bottom of the container. The gas inlet extends at least partly into the recessed portion of the container such that carrier gas can be introduced by the gas inlet into liquid positioned within the recessed portion of the container.

[0007] In another example embodiment, a vapor product delivery assembly generally includes a glass container configured to retain liquid within the container and a valve assembly configured to be coupled to the glass container. The glass container is transparent such that liquid within the glass container can be viewed from outside the glass container, and includes a recessed portion defined in a bottom of the glass container. The valve assembly is operable to introduce carrier gas into the glass container for use in retrieving vapor product from liquid within the container. The valve assembly generally includes a housing, a sparging tube coupled to the housing, and a diffuser coupled to an end portion of the sparging tube. The diffuser is positionable at least partly within the recessed portion of the container when the valve assembly is coupled to the glass container such that carrier gas can be introduced by the diffuser into liquid positioned within the recessed portion of the container.

[0008] Example embodiments of the present disclosure also generally relate to methods for retrieving vapor product from liquid. In one example embodiment, a method generally includes collecting liquid within a recessed portion defined in a bottom of a transparent glass container; sparging carrier gas into the liquid collected within the recessed portion in the bottom of the transparent glass container through a sparging tube disposed at least partly within said recessed portion; and retrieving vapor product from the liquid via the carrier gas.

[0009] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this

summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

Drawings

[0010] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0011] FIG. 1 is a perspective view of an example embodiment of a vapor product delivery assembly including one or more aspects of the present disclosure;

[0012] FIG. 2 is a side elevation view of the vapor product delivery assembly of FIG. 1;

[0013] FIG. 3 is a perspective view of a glass container of the vapor product delivery assembly of FIG. 1;

[0014] FIG. 4 is a section view of the glass container of FIG. 3 taken in a plane include line 4–4 in FIG. 3;

[0015] FIG. 5 is a section view of the glass container of FIG. 3 taken in a plane include line 5–5 in FIG. 3;

[0016] FIG. 6 is a perspective view of a valve structure of the vapor product delivery assembly of FIG. 1;

[0017] FIG. 7 is a front elevation view of the valve structure of FIG. 6;

[0018] FIG. 8 is a top plan view of the valve structure of FIG. 6; and

[0019] FIG. 9 is a bottom plan view of the valve structure of FIG. 6 with a sparging tube and a diffuser removed from the valve structure.

[0020] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

Detailed Description

[0021] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0022] Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific

components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

[0023] The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a", "an" and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

[0024] When an element or layer is referred to as being "on", "engaged to", "connected to" or "coupled to" another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to", "directly connected to" or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0025] Although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should

not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

[0026] Spatially relative terms, such as "inner," "outer," "beneath", "below", "lower", "above", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0027] With reference now to the drawings, FIGS. 1-9 illustrate an example embodiment of a delivery assembly 100 (e.g., a bubbler assembly, etc.) including one or more aspects of the present disclosure. The example delivery assembly 100 is configured (e.g., sized, shaped, constructed, etc.) to hold liquid, as desired, and retrieve vapor products from the liquid, for example, for subsequent use in vapor deposition processes (e.g., in semiconductor manufacture operations, etc.). The example delivery assembly 100 can provide generally consistent concentrations of vapor products for use in the vapor deposition processes at generally low volumes of liquid in the delivery assemblies.

[0028] As shown in FIGS. 1 and 2, the delivery assembly 100 generally includes a container 102 and a valve assembly 104 configured to be coupled to the container 102. The container 102 is configured to receive and hold (or retain) liquid therein (as well as vapor products formed by the liquid). The valve assembly 104 is configured to control flow of carrier gas into the

container 102 to retrieve vapor products from the liquid in the container 102, and to control flow of the vapor products retrieved by the carrier gas out of the container 102. Any suitable carrier gas may be used with the example delivery assembly 100 within the scope of the present disclosure, including, for example, nitrogen, hydrogen, etc.

[0029] A connector 106 is provided to couple the valve assembly 104 to the container 102. The connector 106 is configured to releasably, removably, etc. couple the valve assembly 104 to the container 102 and support the valve assembly 104 generally above the container 102. The illustrated connector 106 includes a union nut 108 fixedly coupled (e.g., press fit, overmolded, etc.) to the valve assembly 104. The union nut 108 includes interior threads (not shown) configured to be screwed onto a correspondingly threaded collar 112 of the container 102 (see, FIGS. 3 and 4). Once coupled to the container 102, the valve assembly 104 may be uncoupled from the container 102 by, for example, unscrewing the connector 106 from the threaded collar 112 of the container 102. An O-ring (not shown) may be included within the connector 106 to help seal the connection of the valve assembly 104 to the container 102 (and the connector 106 of the valve assembly 104 to the threaded collar 112 of the container 102). In other exemplary embodiments, delivery assemblies may include valve assemblies configured to be coupled (e.g., releasably, removably, etc. coupled) to containers with, for example, quick release connectors, press-fit connectors, friction fit connectors, etc.

[0030] With additional reference to FIGS. 3-5, the container 102 is generally cylindrical in shape and includes a generally open-mouth construction defined by the collar 112 of the container 102. The open-mount construction allows liquid to be added to the container 102 in preparation for use, and allows the valve assembly 104 to be readily coupled to the container 102 in fluidic communication with the container 102. A uniform, generally cylindrical interior space is defined within the container 102 for holding the liquid in the container 102 (e.g., during transport of the delivery assembly 100, during operation of the delivery assembly 100, etc.). In other example embodiments, delivery assemblies may include containers having constructions other than open-mouth constructions, containers having shapes

other than cylindrical, and/or containers having interior spaces with shapes other than cylindrical.

[0031] The container 102 is formed from glass (e.g., from any suitable glass, etc.) to thereby provide a generally inert construction for the container 102 suitable for use, for example, with corrosive liquids. For example, the glass container 102 offers a generally robust medium configured to inhibit corrosion of the container 102 that may be caused by corrosive liquids in the container 102. This glass construction can thus help preserve integrity of the container 102 (e.g., against becoming structurally weakened as a result of corrosive activity, etc.) and purity of vapor products retrieved from liquids in the container 102 (e.g., against contamination caused by corrosion of the container 102, etc.). Corrosive liquids may include, but are not limited to, trans-1,2-trichloroethylene (ClCH=CCl_2), phosphorus oxychloride (POCl_3), carbon tetrachloride (CCl_4), carbon tetrabromide (CBr_4) solutions, halides, other corrosive liquids, etc. within the scope of the present disclosure.

[0032] The glass container 102 also provides a generally transparent medium such that liquids in the container 102 are visible from outside the container 102. This allows users to see through the container 102 and monitor liquid (e.g., liquid level, etc.) in the container 102 without separate use of liquid level sensors, etc. As such, the illustrated embodiment does not include a liquid level sensor to monitor liquid (e.g., liquid level, etc.) in the glass container 102. In other example embodiments, however, delivery assemblies may include liquid level sensors to monitor fluid in containers.

[0033] The container 102 includes a recessed portion 114 (e.g., a sump, an opening, a cutout, a reservoir, a hollowed-out portion, etc.) defined in a bottom 116 of the container 102. The recessed portion 114 is centrally located in the bottom 116 of the illustrated container 102 and is configured to collect liquid in the recessed portion 114. More particularly, the recessed portion 114 is configured to direct liquid into the recessed portion 114 as liquid in the container 102 is depleted and liquid level in the container 102 decreases (e.g., during operation of the delivery assembly 100, etc.). In addition, a surface 118 of the bottom 116 of the container 102 may be sloped generally toward the recessed portion 114 to further direct liquid to the recessed portion 114. Thus, the location and/or shape of the recessed portion

114 can help facilitate flow of liquid from the interior space of the container 102 (and from the bottom 116 of the container 102 surrounding the recessed portion 114) into the recessed portion 114. This will be described in more detail hereinafter.

[0034] In the illustrated embodiment, the recessed portion 114 defines a generally conical shape. Upper and lower regions 122 and 124 of the recessed portion 114 are generally circular in shape. The upper region 122 of the recessed portion 114 (located generally coplanar with the bottom's surface 118) is generally larger than the lower region 124 of the recessed portion 114 (e.g., a floor portion, etc. located generally below the upper region 122) such that a diameter dimension of the upper region 122 is larger than a diameter dimension of the lower region 124. The lower region 124 of the recessed portion 114 can be viewed as defining an intermediate surface generally below the bottom's surface 118. Side portions 126 of the recessed portion 114 slope generally inwardly from the upper region 122 toward the lower region 124 of the recessed portion 114 thereby giving the recessed portion 114 its generally conical shape. As such, the illustrated recessed portion 114 can be viewed as defining a generally circular footprint in the bottom 116 of the container 102. The bottom 116 of the illustrated container 102 is generally hollow in structure. In other example embodiments, however, delivery assemblies may include containers having generally solid bottoms formed from glass. In still other example embodiments, delivery assemblies may include containers having recessed portions located and/or shaped differently than disclosed herein, for example, recessed portions located toward peripheries of the containers and/or recessed portions defining square footprints, oval footprints, etc.

[0035] With continued reference to FIGS. 1-5, the container 102 also includes a generally elongate, cylindrical chamber 130 extending into (and generally disposed within) the interior space of the container 102. The chamber 130 is configured to allow, for example, a thermometer, etc. to be inserted into the chamber 130 through an upper opening 132 of the chamber 130 to measure temperature of liquid in the container 102. As such, a temperature of liquid in the container 102 can be obtained without directly accessing the liquid (e.g., without removing the valve assembly 104 from the

container 102, etc.). In the illustrated embodiment, the chamber 130 is a glass chamber 130 formed generally monolithically (or uniformly) with the container 102. With this construction, the chamber 130 is generally sealed from any liquid in the container 102 so that liquid in the container 102 will not flow into the chamber 130. In other example embodiments, delivery assemblies may include containers having chambers with shapes other than elongate and cylindrical and/or chambers formed differently than disclosed herein.

[0036] With reference now to FIGS. 6-9, the valve assembly 104 of the illustrated delivery assembly 100 generally includes the connector 106, a generally square-shaped housing 136 (also termed, a valve block, a body, etc.), and a sparging tube 138 (broadly, a gas inlet) (e.g., a dipleg, etc.). The sparging tube 138 is in fluidic communication with the valve assembly 104 such that carrier gas received by the valve assembly 104 can flow through the housing 136 and to the sparging tube 138 for delivery, for example, into the container 102.

[0037] Inlet and outlet valve structures 140 and 142 (e.g., fittings, etc.) are coupled to the housing 136. In the illustrated embodiment, the inlet and outlet valve structures 140 and 142 are coupled to upper ports (not shown) of the housing 136 on generally opposite side portions of the housing 136. The inlet valve structure 140 facilitates connection of a carrier gas supply line (not shown) to the valve assembly 104 for introducing carrier gas to the valve assembly 104 and for supplying (and/or dispensing) carrier gas to the container 102 via the sparging tube 138 (when the valve assembly 104 is coupled to the container 102). And, the outlet valve structure 142 facilitates connection of a vapor product transfer line (not shown) to the valve assembly 104 for receiving vapor product retrieved by the carrier gas out of the container 102 (via a lower vapor product port 144 (broadly, a receiving port) of the housing 136 (FIG. 9)) and for transporting vapor product from the valve assembly 104 (when the valve assembly 104 is coupled to the container 102). In other example embodiments, delivery assemblies may include valve assemblies having more than two valve structures and/or valve structures located differently than disclosed herein.

[0038] A valve spool 146 is disposed at least partly within the housing 136 and is movable (e.g., axially slidable, etc.) relative to the housing

136 to control movement of carrier gas and vapor products through the housing 136. An actuator 148 coupled to the valve spool 146 can be operated to move the valve spool 146 within the housing 136. In particular, the actuator 148 is operable to selectively open the valve spool 146 to allow the carrier gas and vapor products to flow through the valve assembly 104 (and the housing 136), and to selectively close the valve spool 146 to inhibit the carrier gas and vapor products from flowing through the valve assembly 104 (and the housing 136). The actuator 148 may include, for example, internal threads that receive corresponding external threads of the valve spool 146 so that rotation of the actuator 148 causes the valve spool 146 to move axially (e.g., slide, etc.) within the housing 136. Counterclockwise rotation could move the valve spool 146 to its open position, and clockwise rotation could move the valve spool 146 to its closed position (or vice versa). In other example embodiments, delivery assemblies may include valve assemblies having more than one valve spool and/or valve spools operable differently than disclosed herein.

[0039] The sparging tube 138 is coupled to the housing 136 at a lower carrier gas port 152 of the housing 136 (FIG. 9), for example, via a threaded connection, etc. This allows carrier gas to flow from the lower carrier gas port 152 into the sparging tube 138 for ultimate discharge into the container 102 (when the valve assembly 104 is coupled to the container 102). The sparging tube 138 includes a diffuser 154 at a lower end portion of the sparging tube 138. In the illustrated embodiment, the diffuser 154 is coupled to the lower end portion of the sparging tube 138, for example, via a threaded connection. The diffuser 154 may include any suitable diffuser 154 within the scope of the present disclosure operable, for example, to deliver, inject, etc. bubbles of carrier gas into liquid for use in retrieving vapor products from the liquid, etc.

[0040] The sparging tube 138 is configured to extend into the interior space of the container 102 (through the collar 112 of the container 102) when the valve assembly 104 is coupled to the container 102 (see, FIGS. 1 and 2). This positions, disposes, etc. the lower end portion of the sparging tube 138, and more particularly the diffuser 154 coupled thereto, at least partly in the recessed portion 114 of the container 102 (closely adjacent the intermediate surface of the recessed portion's lower region 124). Here, the

diffuser 154 may be at least partly submerged with liquid positioned in the recessed portion 114 of the container 102. As such, the sparging tube 138 and diffuser 154 can introduce, inject, etc. carrier gas into the container 102 generally in the recessed portion 114 of the container 102 (and into liquid positioned in the recessed portion 114 of the container 102). In the illustrated embodiment, the sparging tube 138 (and diffuser 154) is positioned slightly off-center in the recessed portion 114 of the container 102 (e.g., in a radially off-set position in the recessed portion 114 of the container 102). However, the sparging tube 138 (and diffuser 154) may be positioned generally centrally (e.g., radially, etc.) in the recessed portion 114 of the container 102 within the scope of the present disclosure) (e.g., the location of the recessed portion 114 in the container 102 can be adjusted to accommodate the sparging tube 138 (and diffuser 154) so that the sparging tube 138 (and diffuser 154) are generally centrally located in the recessed portion 114; the location of the sparging tube 138 (and diffuser 154) can be adjusted to accommodate the recessed portion 114 so that the sparging tube 138 (and diffuser 154) are generally centrally located in the recessed portion 114, etc.).

[0041] The valve assembly 104 of the illustrated embodiment is preferably made from an inert substance having a high resistance to chemical reaction and a low level of metals and other extractable contaminants. In one example embodiment, a valve assembly 104 may include components molded from materials comprising fully fluorinated polymers, such as PFA, TFE, PTFE, FEP, ETFE, or the like.

[0042] Operation of the illustrated delivery assembly 100 will now be described to deliver vapor products to a reactor site, in gas phase, for subsequent use at the reactor site (e.g., via a carrier gas for subsequent use in a vapor deposition process, etc.). The delivery assembly 100 is initially prepared for operation by filling the container 102 with desired liquid for producing vapor products suitable for the subsequent use. After the container 102 is filled with liquid (e.g., filled with liquid to a desired level, etc.), the valve assembly 104 is coupled to (e.g., threaded onto, etc.) the container 102 via the connector 106. As shown in FIGS. 1 and 2, this positions the lower ports 144 and 152 of the housing 136 generally within the container 102 and locates the sparging tube 138 (and more particularly, the diffuser 154) at least

partly in the recessed portion 114 defined in the bottom 116 of the container 102. The prepared delivery assembly 100 can then be transported to the reactor site for subsequent use.

[0043] At the reactor site, a carrier gas supply line (not shown) can be coupled to the inlet valve structure 140 of the valve assembly 104 for supplying carrier gas to the container 102 (via the sparging tube 138 and diffuser 154). And, a product transfer line (not shown) can be coupled to the outlet valve structure 142 of the valve assembly 104 for receiving vapor product retrieved by the carrier gas out of the container 102. The actuator 148 of the valve spool 146 may then be selectively operated to move the valve spool 146 between its open position and its closed position. Moving the valve spool 146 to its open position allows carrier gas to flow from a carrier gas supply (via the carrier gas supply line) into and through the housing 136, and into the recessed portion 114 of the container 102 via the sparging tube 138 and diffuser 154. The carrier gas passes through the liquid in the container 102 and promotes transfer/transition of liquid into the gas phase, thereby saturating the carrier gas. The carrier gas (i.e., the carrier gas bubbles formed by the diffuser 154) thus vaporizes the liquid in the container 102. And, the carrier gas and vaporized product from the liquid then flow out of the container 102 through the housing 136 (via the lower carrier gas port 152 and the outlet valve structure 142) for delivery to the reactor site. Temperature of the liquid in the container 102 may be monitored through the chamber 130 as desired (e.g., with a thermometer, etc.). And, levels of liquid in the container 102 can be monitored by viewing the level of the liquid through the transparent glass container 102.

[0044] As previously described, the recessed portion 114 of the illustrated container 102 is configured to collect liquid in the recessed portion 114. Thus, during operation of the delivery assembly 100 as the liquid in the container 102 dissipates (i.e., as it vaporizes in the carrier gas bubbles injected into the container 102), the recessed portion 114 directs the remaining liquid in the container 102 into the recessed portion 114. This provides a generally consistent volume of liquid in the recessed portion 114 into which the sparging tube 138 and diffuser 154 can inject carrier gas during operation (as the diffuser 154 is disposed at least partly in the recessed

portion 114 of the container 102). The recessed portion 114 also allows the sparging tube 138 and diffuser 154 to be positioned generally deeper in the liquid in the container 102. This provides a longer path length for the carrier gas bubbles to move through the liquid in the container 102 (i.e., between the location where the carrier gas is injected into the liquid in the recessed portion 114 of the container 102 and the surface of the liquid in the container 102). As such, saturation efficiency of the carrier gas injected into the liquid may be improved, and concentrations of vapor product provided by the delivery assembly 100 to the reactor site may be generally consistent. Moreover, duration of use of the illustrated delivery assembly 100 may be extended as larger volumes of liquid in the containers may be utilized (and residues in the delivery assembly 100 may be reduced).

[0045] In another example embodiment, a delivery assembly generally includes a container and a valve assembly configured to be coupled to the container. The container is formed from glass and includes a generally conical-shaped recessed portion formed in a bottom of the container. The container also includes an elongate, tubular chamber monolithically formed in a generally upper portion of the container (and extending into an interior space of the container).

[0046] In this embodiment, the glass forming the container has a thickness of about 3 millimeters and the glass forming the chamber has a thickness of about 1.5 millimeters. The container has a diameter dimension of about 130 millimeters and a height dimension of about 130 millimeters. As such, a volume of the container is about 1,725 milliliter. A bottom of the container has a thickness of about 24 millimeters, and the recessed portion defined in the bottom of the container has a depth dimension of about 15 millimeters. A generally circular upper region of the recessed portion has a diameter dimension of about 36 millimeters, and a generally circular lower region (or floor portion) of the recessed portion has a diameter dimension of about 30 millimeters. The chamber has a length dimension of about 100 millimeters, and a diameter dimension of about 12 millimeters.

[0047] Also in this embodiment, operation of the delivery assembly may be effective for delivering generally constant concentrations of vapor

product from liquid in the container at liquid volumes of less than about 100 milliliters (e.g., at liquid volumes as low as about 15 milliliters, etc.).

[0048] In other example embodiments, delivery assemblies generally include containers and valve assemblies configured to be coupled to the containers. In these example embodiments, the containers may include containers as described herein (e.g., container 102, etc.). And, the valve assemblies may include valve assemblies such as those described in U.S. Patent No. 7,431,049 and PCT Application No. PCT/US09/053587, both of which are incorporated herein by reference.

[0049] Specific dimensions and/or values disclosed herein are exemplary in nature and do not limit the scope of the present disclosure.

[0050] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the invention, and all such modifications are intended to be included within the scope of the invention.

Claims

What is claimed is:

1. An assembly for retrieving vapor product from liquid, the assembly comprising:

a container formed from glass and configured to retain liquid within the container; and

a gas inlet disposed at least partly within the container and configured to introduce carrier gas into liquid within the container;

wherein the container includes a recessed portion defined in a bottom of the container; and

wherein the gas inlet extends at least partly into the recessed portion of the container such that carrier gas can be introduced by the gas inlet into liquid positioned within the recessed portion of the container.

2. The assembly of claim 1, wherein the container is transparent such that liquid within the container can be viewed from outside the container.

3. The assembly of claim 1, wherein the container includes a chamber disposed within the container and sealed from liquid within the container for measuring temperature of liquid within the container.

4. The assembly of claim 1, wherein the gas inlet includes a sparging tube and a diffuser coupled to the sparging tube, and wherein the diffuser extends at least partly into the recessed portion of the container such that carrier gas can be introduced by the diffuser into liquid positioned within the recessed portion of the container.

5. The assembly of any one of claims 1-4, further comprising a valve assembly configured to be coupled to the container, wherein the gas inlet is coupled to the valve assembly, and wherein the valve assembly is operable to introduce carrier gas into the container through the gas inlet for use in retrieving vapor product from liquid within the container.

6. The assembly of claim 5, wherein the valve assembly includes a receiving port configured to receive vapor product from the container.

7. The assembly of claim 6, wherein the valve assembly includes a first fluid port operable to introduce carrier gas to the valve assembly and a second fluid port operable to transport vapor product from the valve assembly.

8. The assembly of claim 7, wherein the valve assembly includes a valve spool moveable relative to the valve assembly to control movement through the valve assembly of carrier gas introduced to the valve assembly and a vapor product retrieved by the carrier gas.

9. The assembly of claim 5, wherein the gas inlet is centrally located in the recessed portion of the container.

10. The assembly of claim 5, wherein the gas inlet is located in a radially off-set position in the recessed portion of the container.

11. The assembly of any one of claims 1-4, further comprising trans-1,2-trichloroethylene disposed within the container.

12. The assembly of any one of claims 1-4, further comprising phosphorus oxychloride disposed within the container.

13. The assembly of any one of claims 1-4, wherein the recessed portion of the glass container defines a generally conical shape in the bottom of the container.

14. The assembly of any one of claims 1-4, wherein the recessed portion of the glass container defines a generally circular footprint in the bottom of the container.

15. The assembly of any one of claims 1-4, wherein the recessed portion includes a generally circular-shaped floor portion having a diameter dimension of about thirty millimeters.

16. A vapor product delivery assembly for retrieving vapor product from liquid, the assembly comprising:

a glass container configured to retain liquid within the container, the glass container being transparent such that liquid within the glass container can be viewed from outside the glass container; and

a valve assembly configured to be coupled to the glass container and operable to introduce carrier gas into the glass container for use in retrieving vapor product from liquid within the container;

wherein the glass container includes a recessed portion defined in a bottom of the glass container; and

wherein the valve assembly includes a housing, a sparging tube coupled to the housing, and a diffuser coupled to an end portion of the sparging tube, the diffuser being positionable at least partly within the recessed portion of the container when the valve assembly is coupled to the glass container such that carrier gas can be introduced by the diffuser into liquid positioned within the recessed portion of the container.

17. The vapor product delivery assembly of claim 16, wherein the container includes a chamber disposed within the container and sealed from liquid within the container for measuring temperature of liquid within the container.

18. The vapor product delivery assembly of claim 16, wherein the valve assembly includes a receiving port defined in the housing of the valve assembly, the receiving port configured to receive vapor product retrieved from liquid within the container.

19. The vapor product delivery assembly of claim 16, wherein the valve assembly includes:

a first fluid port operable to introduce carrier gas to the valve assembly;

a second fluid port operable to transport vapor product from the valve assembly; and

a valve spool moveable relative to the housing to control movement through the housing of carrier gas introduced to the housing and a vapor product retrieved by the carrier gas.

20. The vapor product delivery assembly of any one of claims 16-19, wherein the diffuser is centrally positionable in the recessed portion of the container.

21. The vapor product delivery assembly of any one of claims 16-19, wherein the diffuser is positionable in a radially off-set location in the recessed portion of the container.

22. The vapor product delivery assembly of any one of claims 16-19, further comprising trans-1,2-trichloroethylene disposed within the container.

23. The vapor product delivery assembly of any one of claims 16-19, further comprising phosphorus oxychloride disposed within the container.

24. The vapor product delivery assembly of any one of claims 16-19, wherein the recessed portion of the glass container defines a generally conical shape in the bottom of the container.

25. The vapor product delivery assembly of any one of claims 16-19, wherein the recessed portion of the glass container defines a generally circular footprint in the bottom of the container.

26. The vapor product delivery assembly of any one of claims 16-19, wherein the recessed portion includes a generally circular-shaped floor portion having a diameter dimension of about thirty millimeters.

27. The vapor product delivery assembly of any one of claims 16-19, wherein the valve assembly is coupled to the glass container.

28. A method for retrieving vapor product from liquid, the method comprising:

collecting liquid within a recessed portion defined in a bottom of a transparent glass container;

sparging carrier gas into the liquid collected within the recessed portion in the bottom of the transparent glass container through a sparging tube disposed at least partly within said recessed portion; and

retrieving vapor product from the liquid via the carrier gas.

29. The method of claim 28, further comprising monitoring temperature of the liquid within the container through a chamber disposed within the transparent glass container and sealed from the liquid within the transparent glass container.

30. The method of claim 28, further comprising monitoring level of the liquid within the container by viewing the level of the liquid through the transparent glass container.

31. The method of claim 28, wherein sparging carrier gas includes sparging carrier gas into a radially central location in the liquid collected within the recessed portion in the bottom of the transparent glass container.

32. The method of claim 28, wherein sparging carrier gas includes sparging carrier gas into a radially offset location in the liquid collected within the recessed portion in the bottom of the transparent glass container.

33. The method of any one of claims 28-32, wherein the liquid is trans-1,2-trichloroethylene.

34. The method of any one of claims 28-32, wherein the liquid is phosphorus oxychloride.

35. The method of any one of claims 28-32, wherein the recessed portion of the transparent glass container defines a generally conical shape in the bottom of the transparent glass container.

36. The method of any one of claims 28-32, wherein the recessed portion of the transparent glass container defines a generally circular footprint in the bottom of the transparent glass container.

37. The method of any one of claims 28-32, wherein the recessed portion includes a generally circular-shaped floor portion having a diameter dimension of about thirty millimeters.

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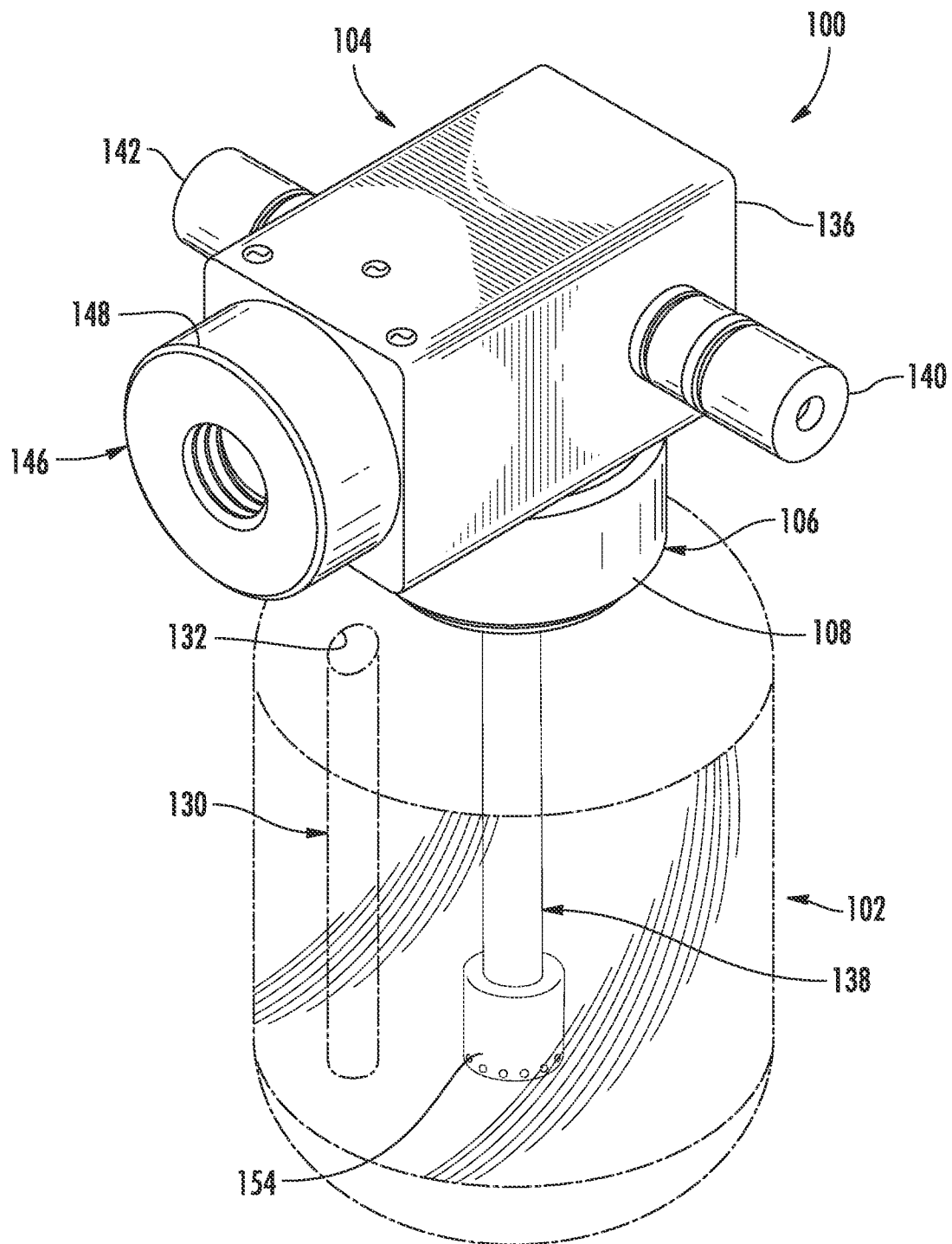


FIG. 1

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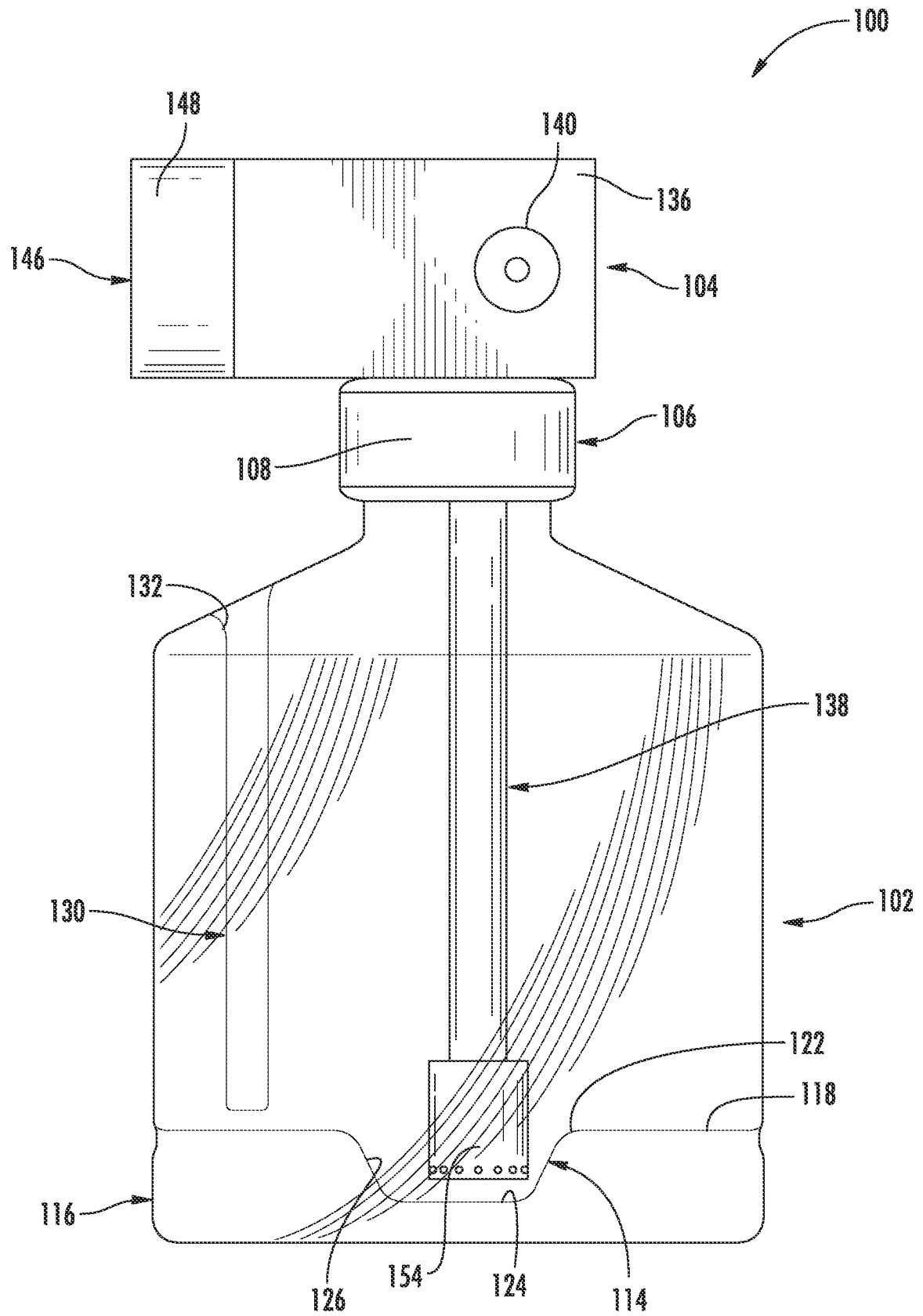


FIG. 2

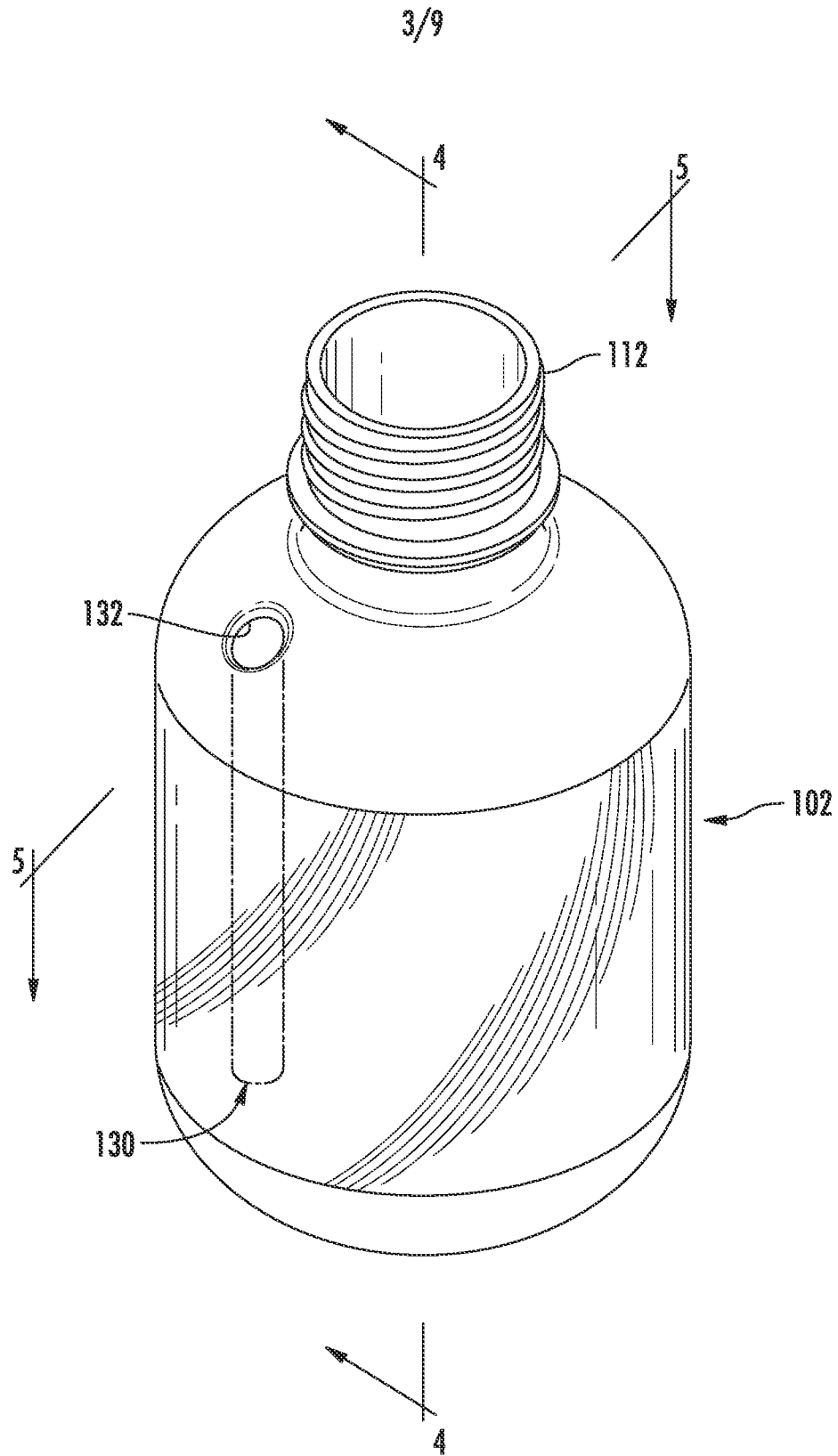


FIG. 3

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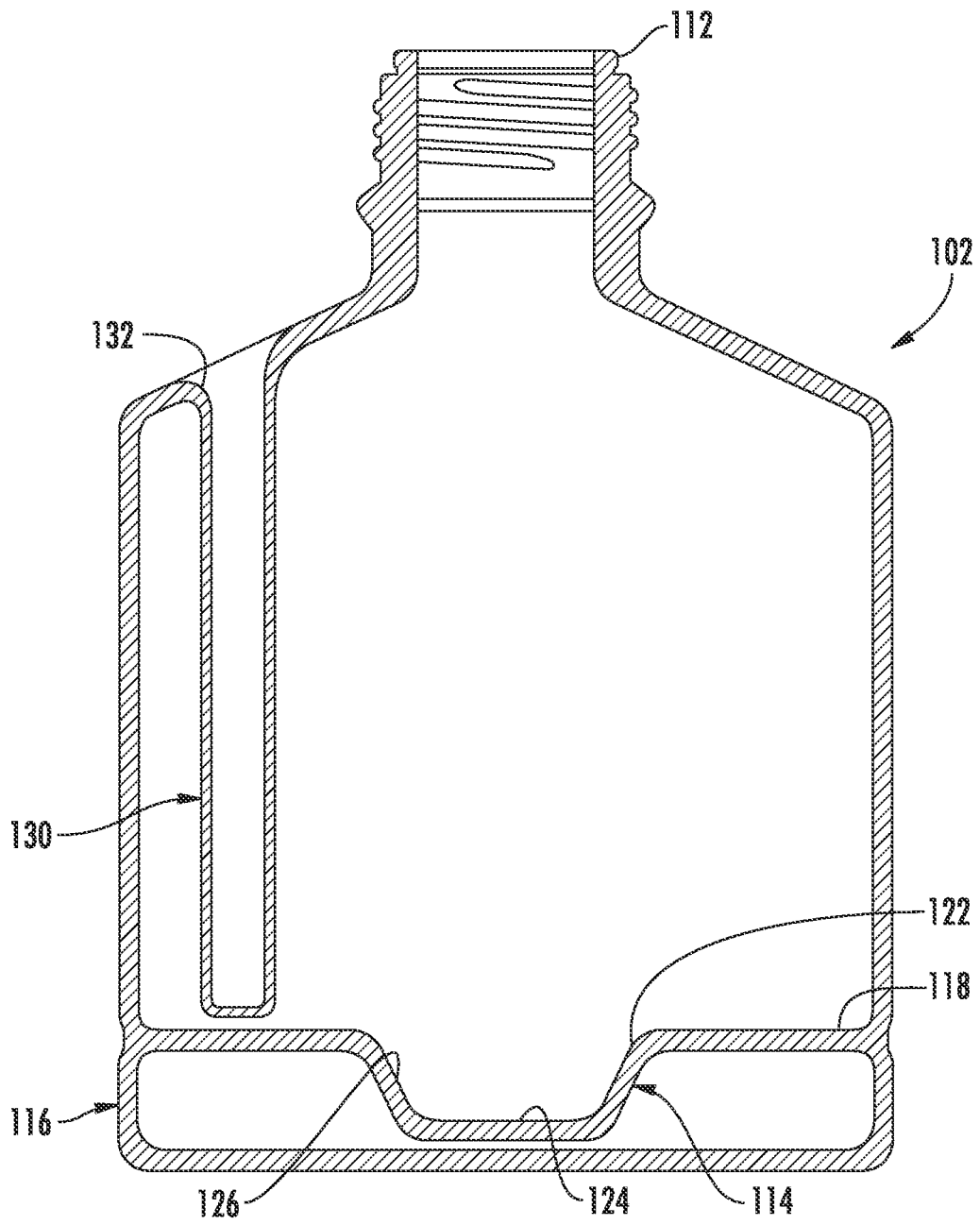


FIG. 4

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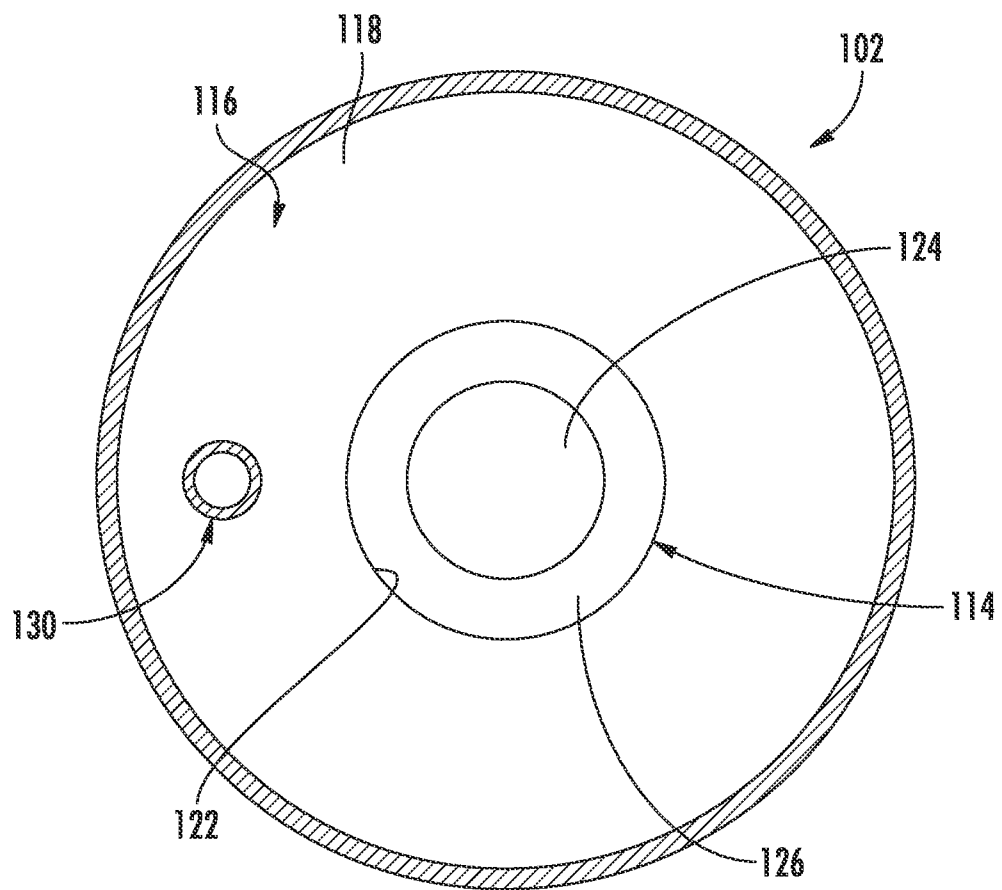


FIG. 5

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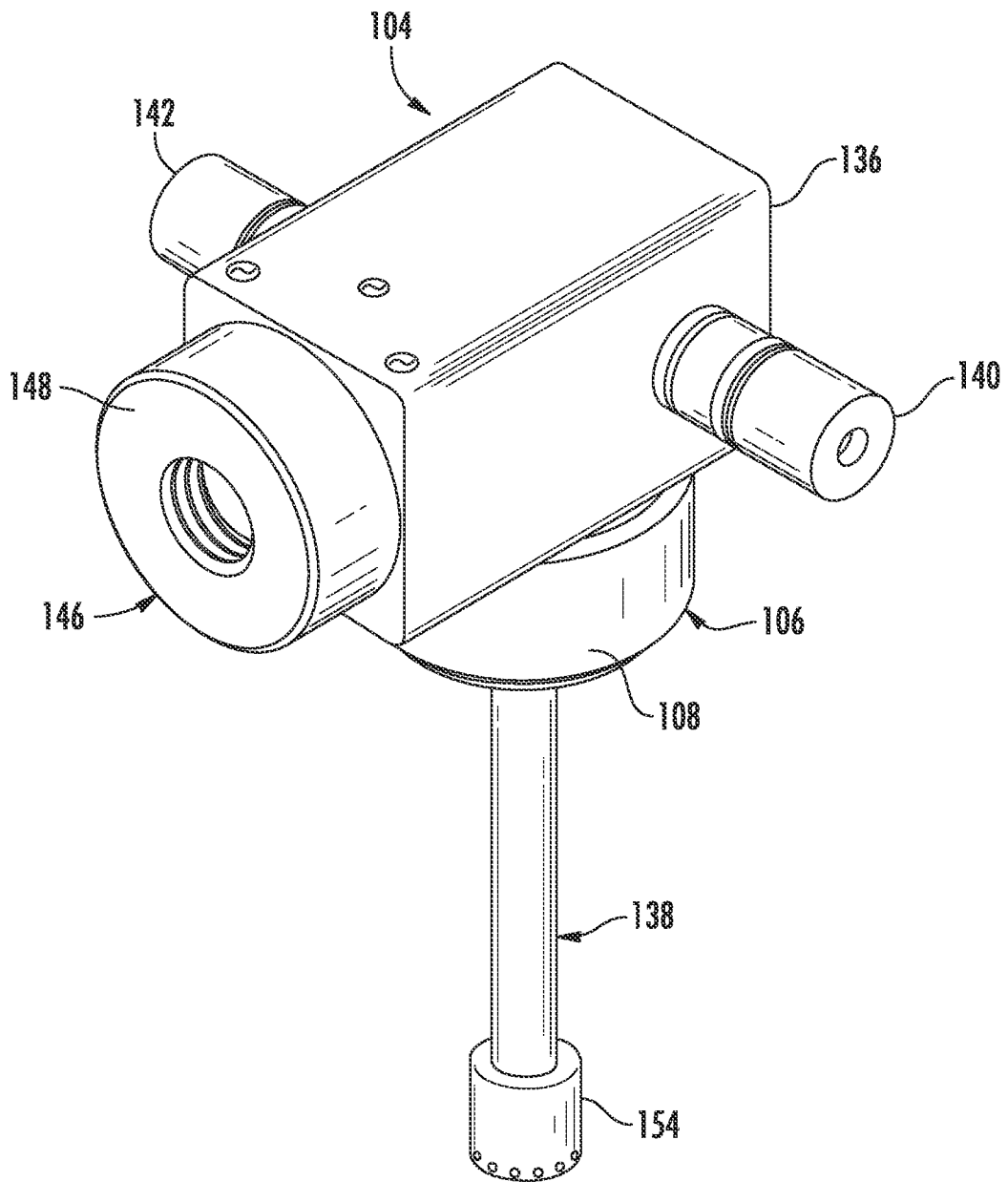


FIG. 6

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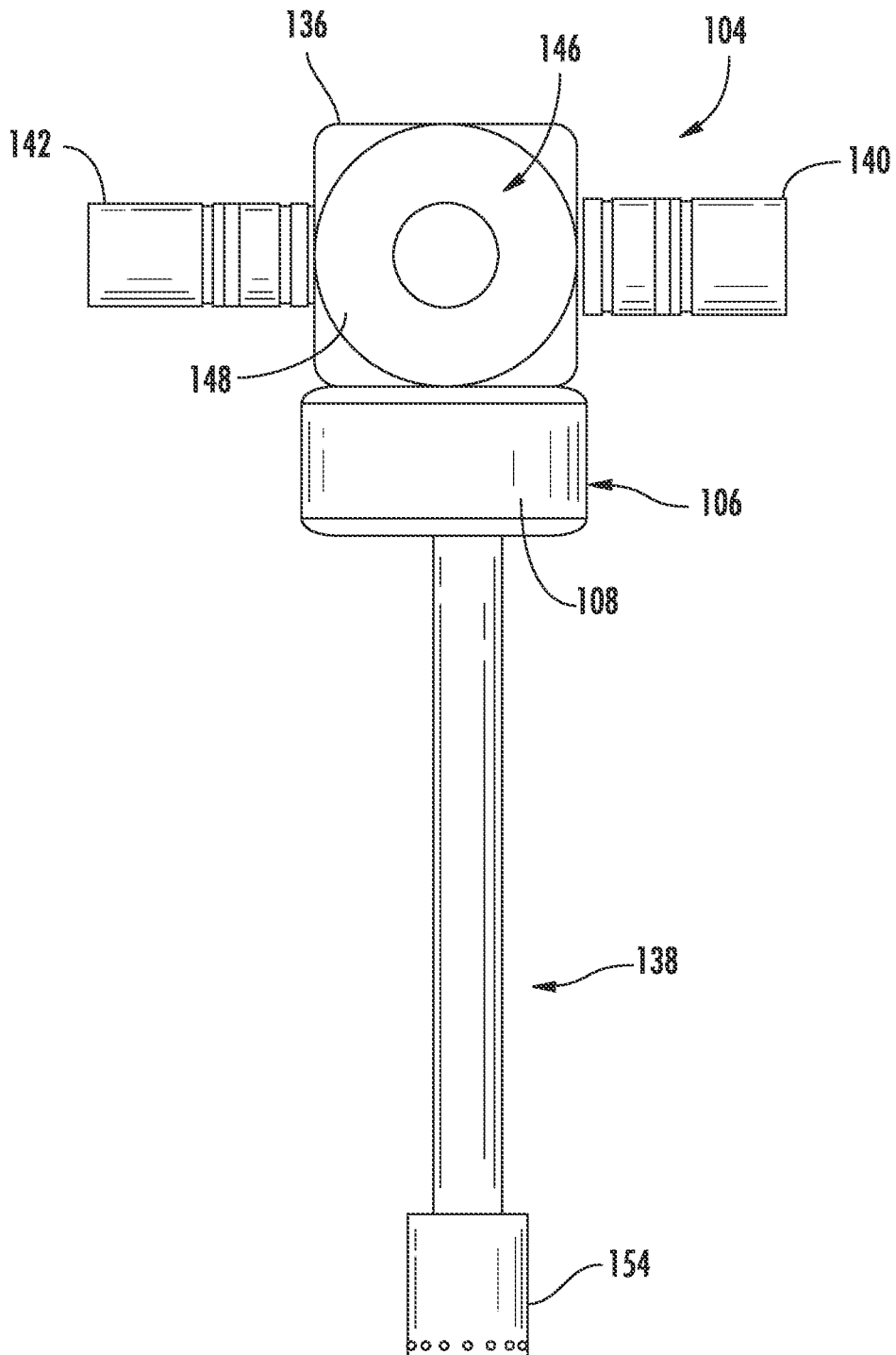


FIG. 7

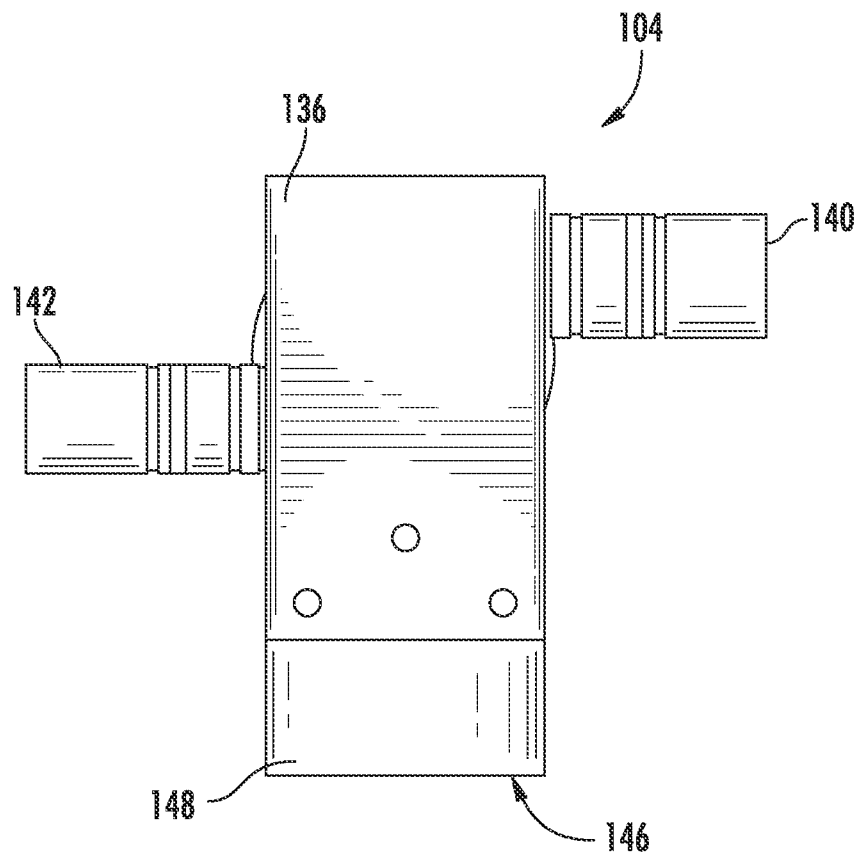


FIG. 8

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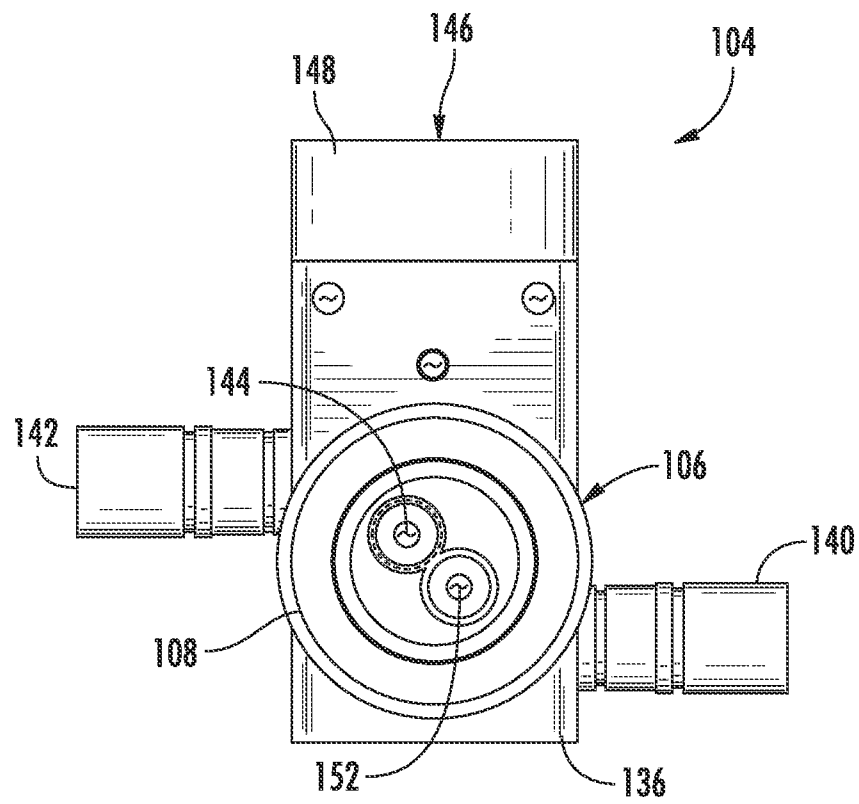


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/022613

A. CLASSIFICATION OF SUBJECT MATTER

INV. B01B1/00

ADD.

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)

B01B B01D C23C H01L

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 09516 A A.D. 1904 (LENNOX ALLISON BELL) 9 March 1905 (1905-03-09) abstract; figures page 9, last paragraph page 10, paragraph 2 -----	1-37
X	US 5 662 838 A (YAMAGUCHI TOORU [JP] ET AL) 2 September 1997 (1997-09-02) abstract; figure 30 column 31, line 57 - line 61 column 32, line 17 - line 55 -----	1,16,28
X	US 5 749 500 A (KRAUS JOEY [US] ET AL) 12 May 1998 (1998-05-12) abstract; figures column 4, line 15 - line 22 ----- -/--	1,16

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

☒ See patent family annex.

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Date of the actual completion of the international search

5 July 2011

Date of mailing of the international search report

12/07/2011

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

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Lapeyrère, Jean

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/022613

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 257 446 B1 (PIKE CHRISTOPHER L [US]) 10 July 2001 (2001-07-10) abstract; figures column 3, line 17 - line 19 -----	1-37

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/022613

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 190409516	A	09-03-1905	NONE	
US 5662838	A	02-09-1997	NONE	
US 5749500	A	12-05-1998	NONE	
US 6257446	B1	10-07-2001	NONE	