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Campbell-Brown et al.

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(54) **VENT PATH FOR A LIQUID CONTAINER**

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(22) Filed: **Sep. 25, 2012**

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Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/US2012/029608, filed on Mar. 19, 2012.

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B41J 2/175 (2006.01)
B41J 2/14 (2006.01)

(52) **U.S. Cl.**
USPC **347/86**; 347/49

(58) **Field of Classification Search**
USPC 347/7, 49, 85, 86, 87
See application file for complete search history.

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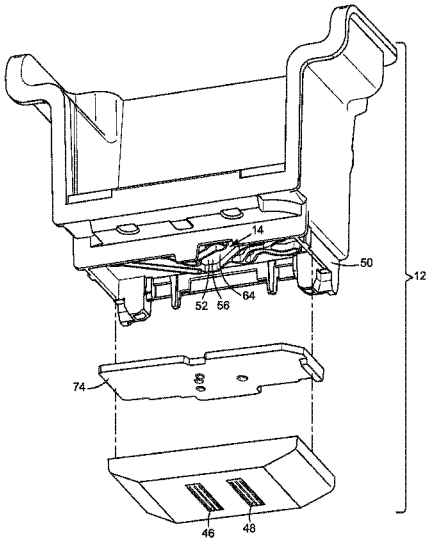
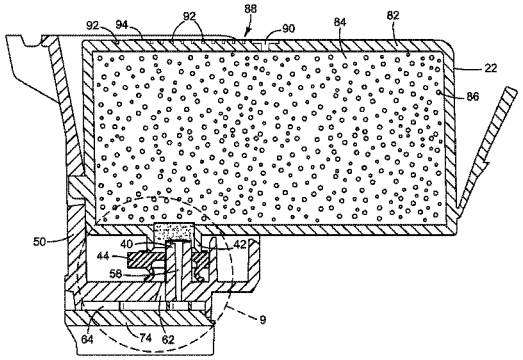
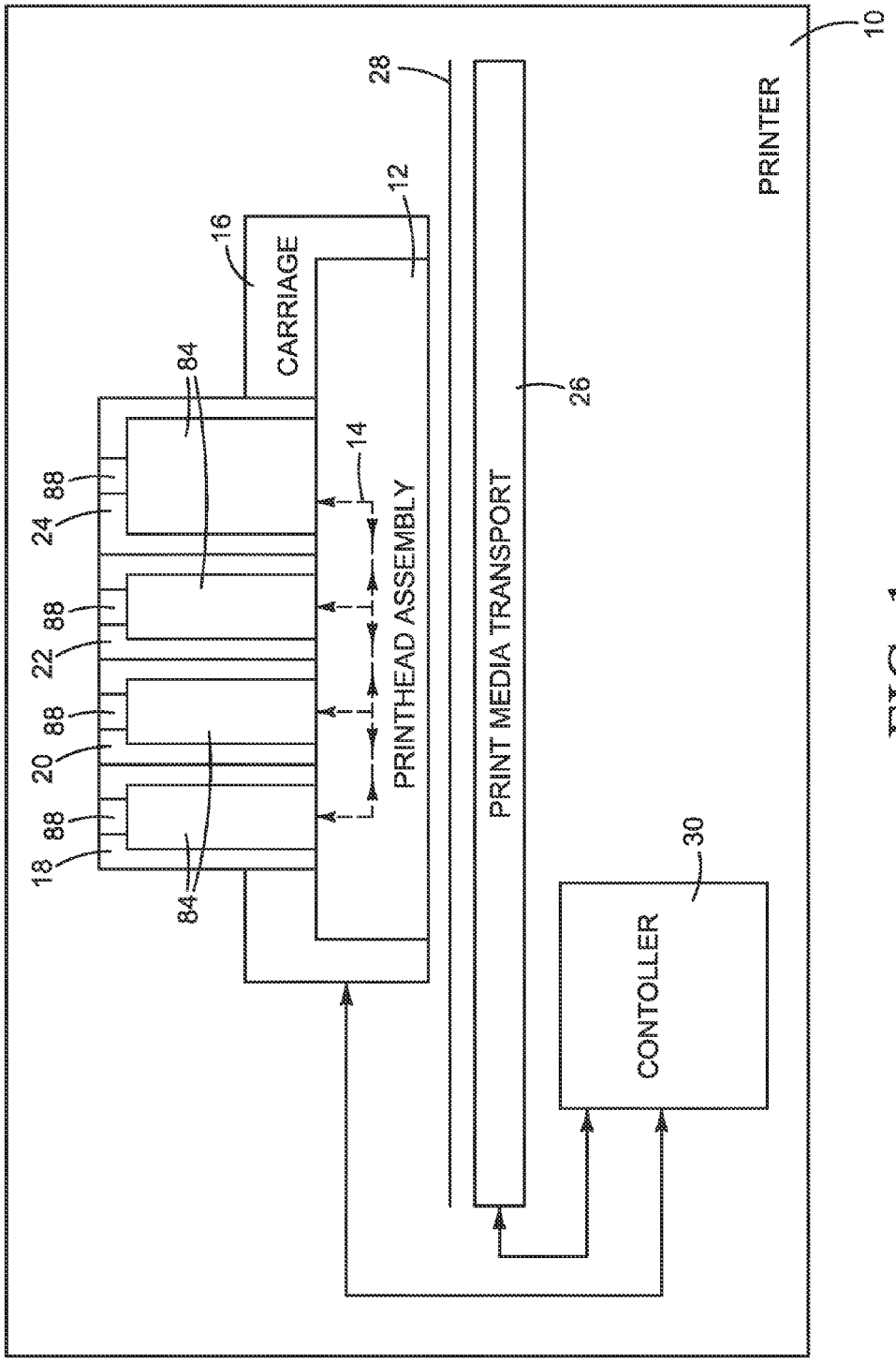
(57) **ABSTRACT**

In one example, a structure for supporting a printhead includes: a substrate having a first side and a second side; multiple inlets each protruding from the first side of the substrate through which liquids may be introduced into the structure from the outlets of liquid containers that can be attached to the structure; multiple openings through the substrate from the first side to the second side, each opening positioned near one of the inlets at a location exposed to the outlet of a corresponding one of the containers when the container is attached to the structure; and an air channel on the second side of the substrate connecting each of one or more of the openings to another opening.

15 Claims, 12 Drawing Sheets






PRINTER
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CARRIAGE
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PRINTHEAD ASSEMBLY
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PRINT MEDIA TRANSPORT
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CONTOLLER

FIG. 1

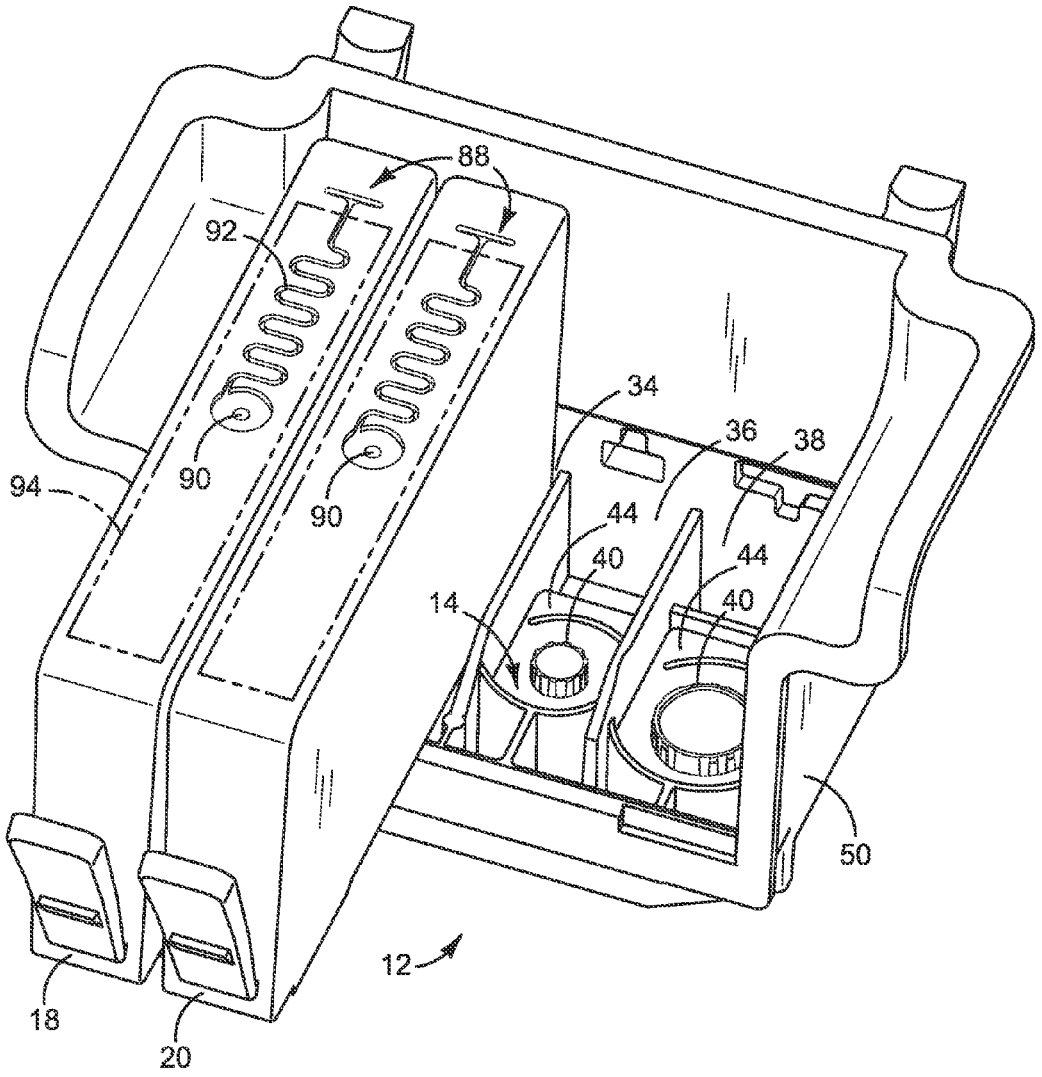

FIG. 2

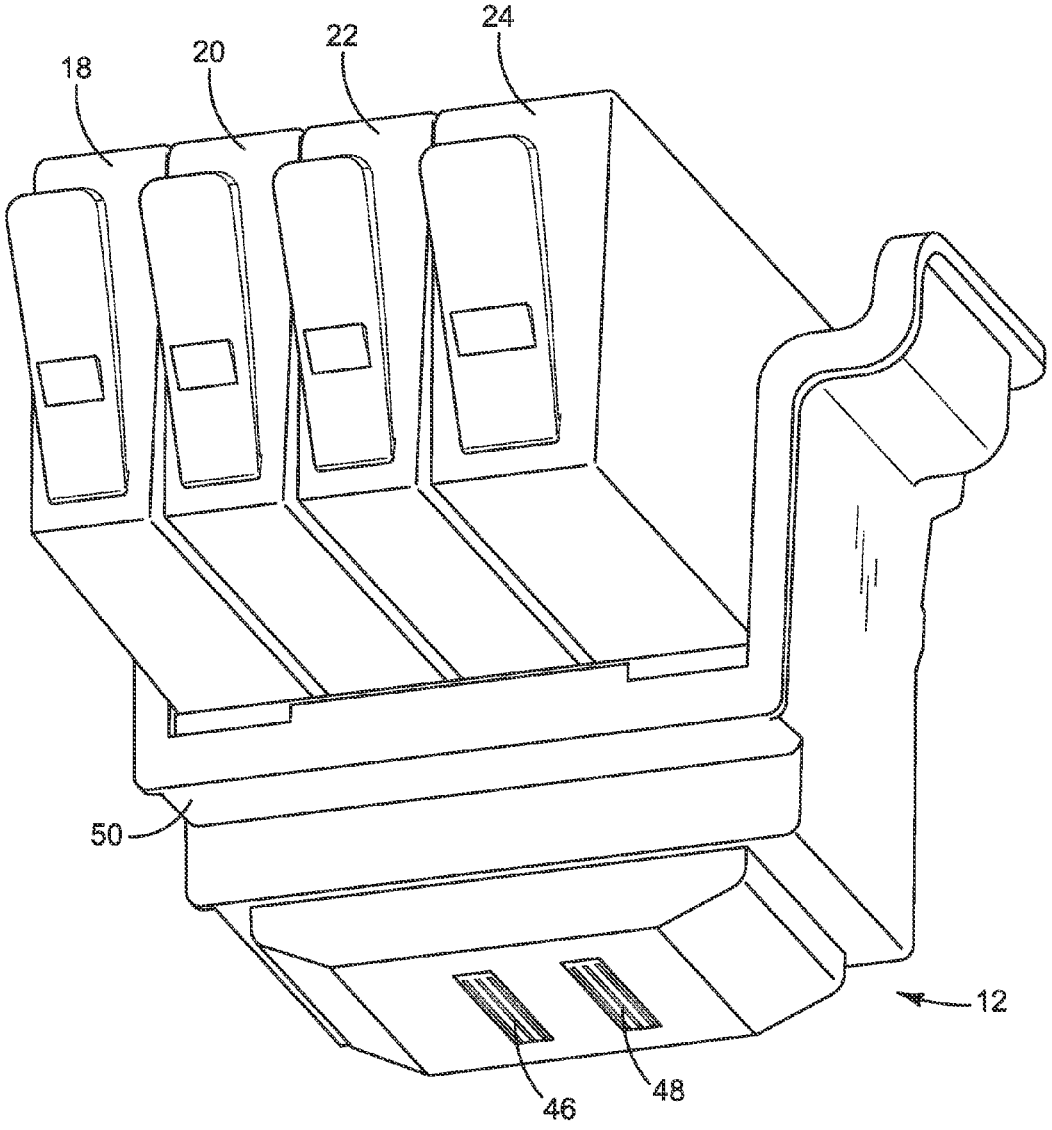

FIG. 3

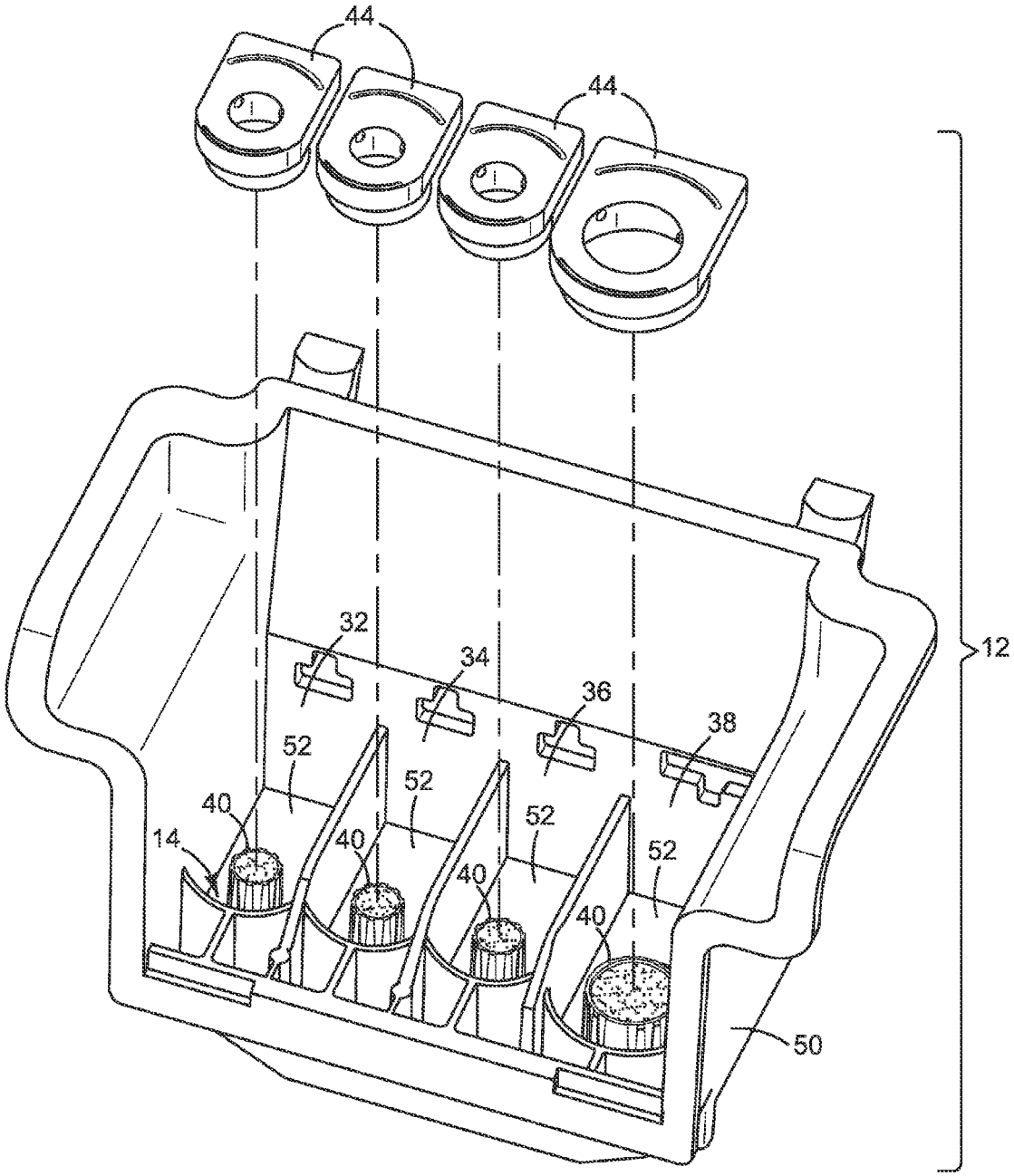

FIG. 4

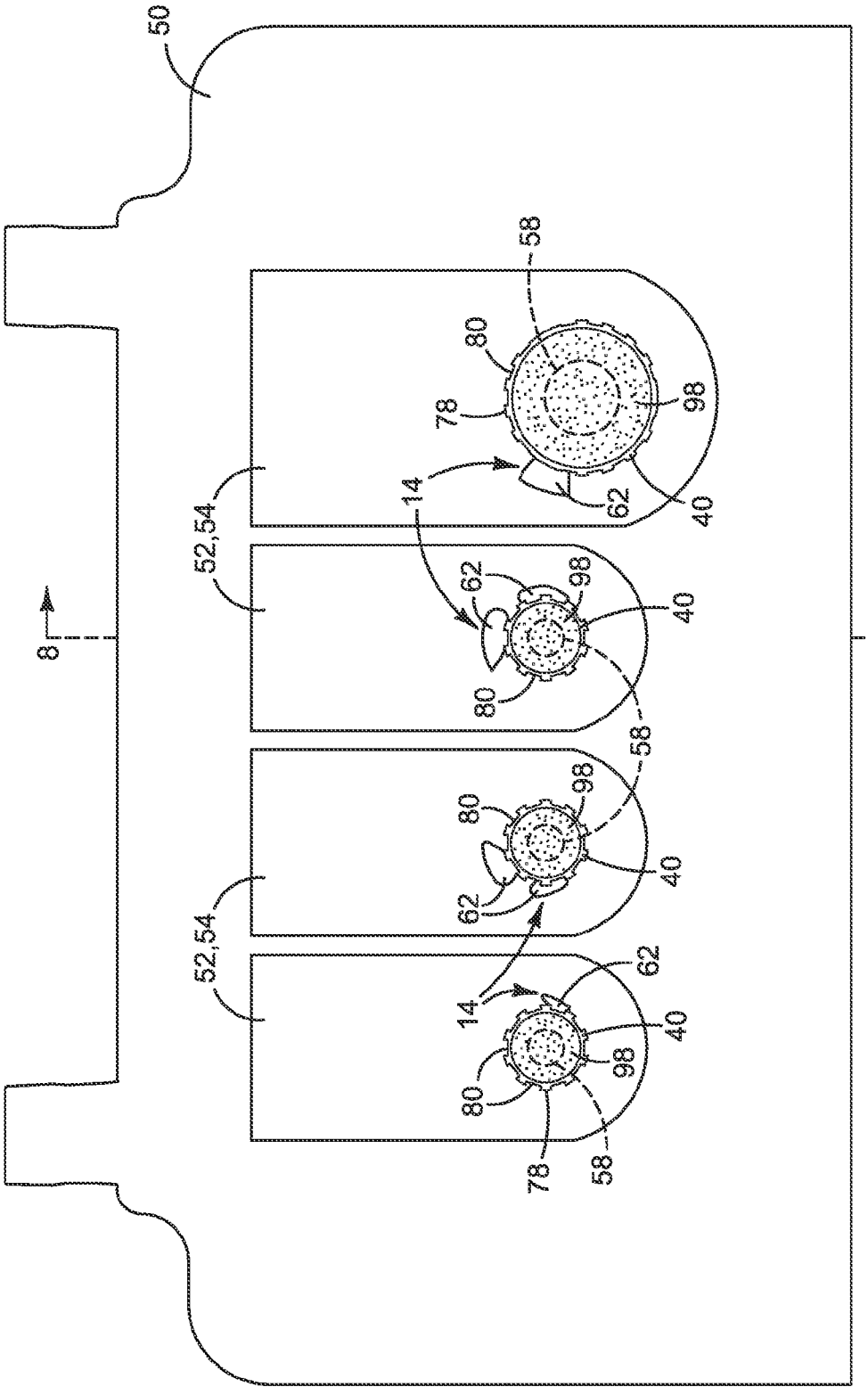
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FIG. 5

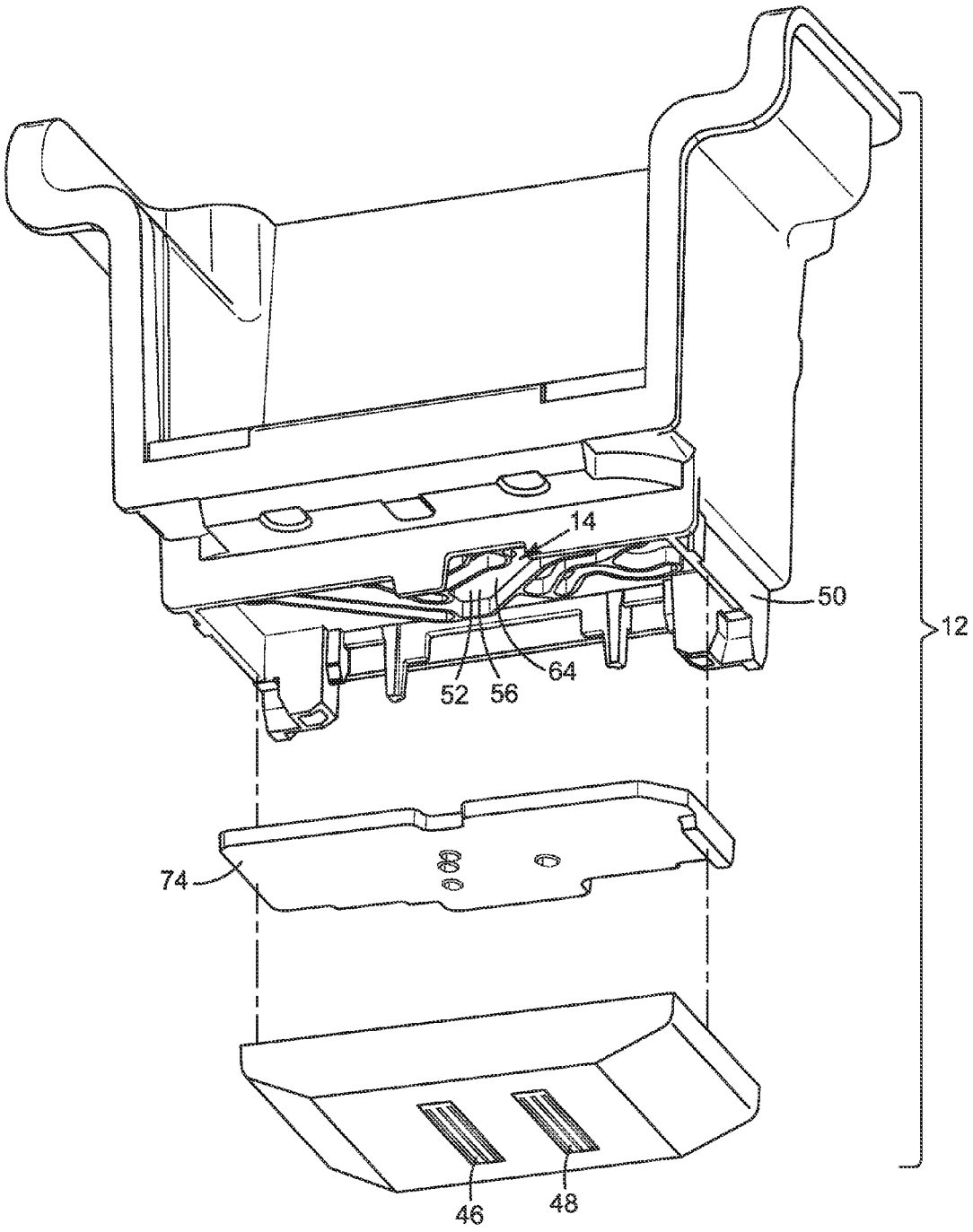


FIG. 6

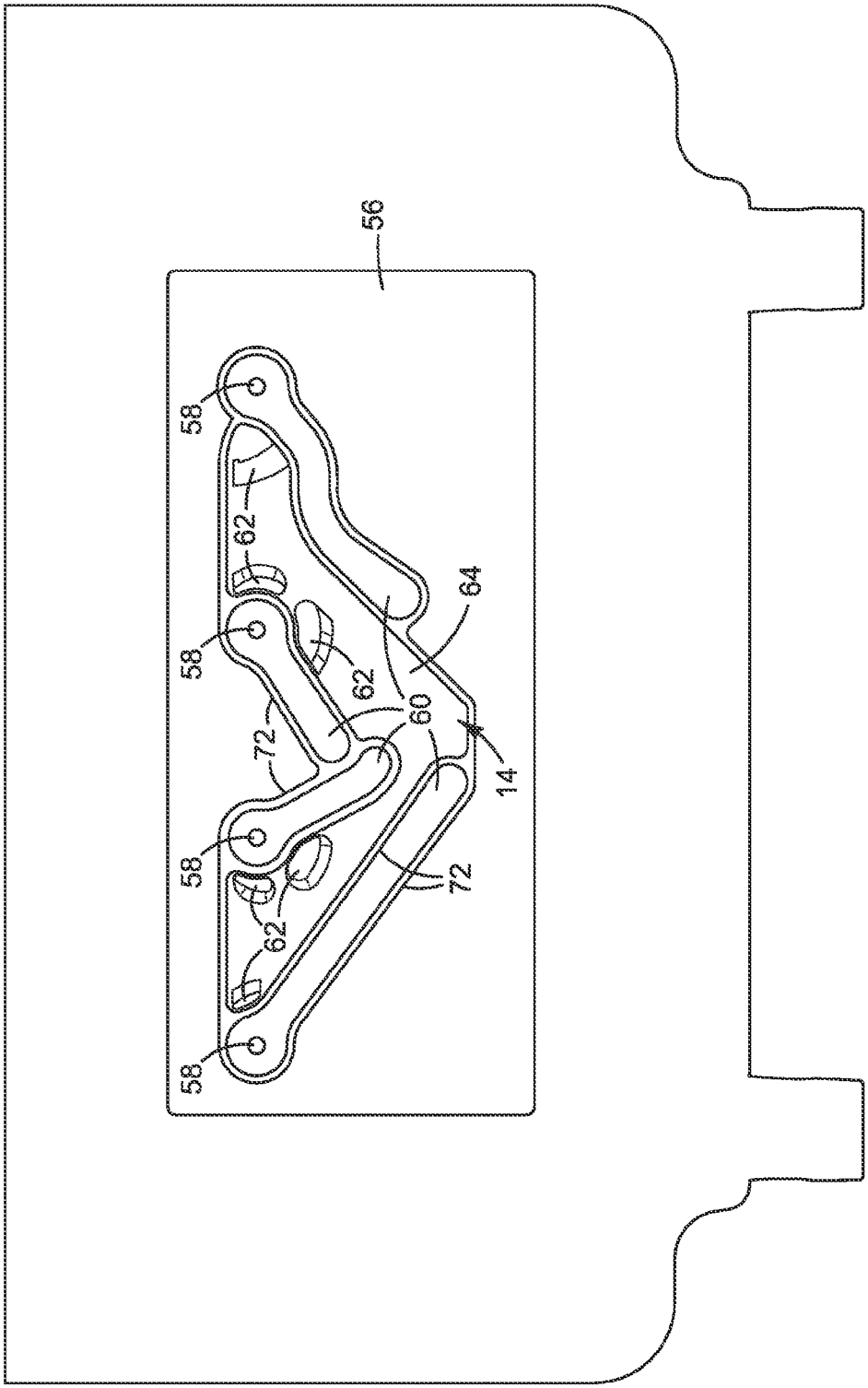


FIG. 7

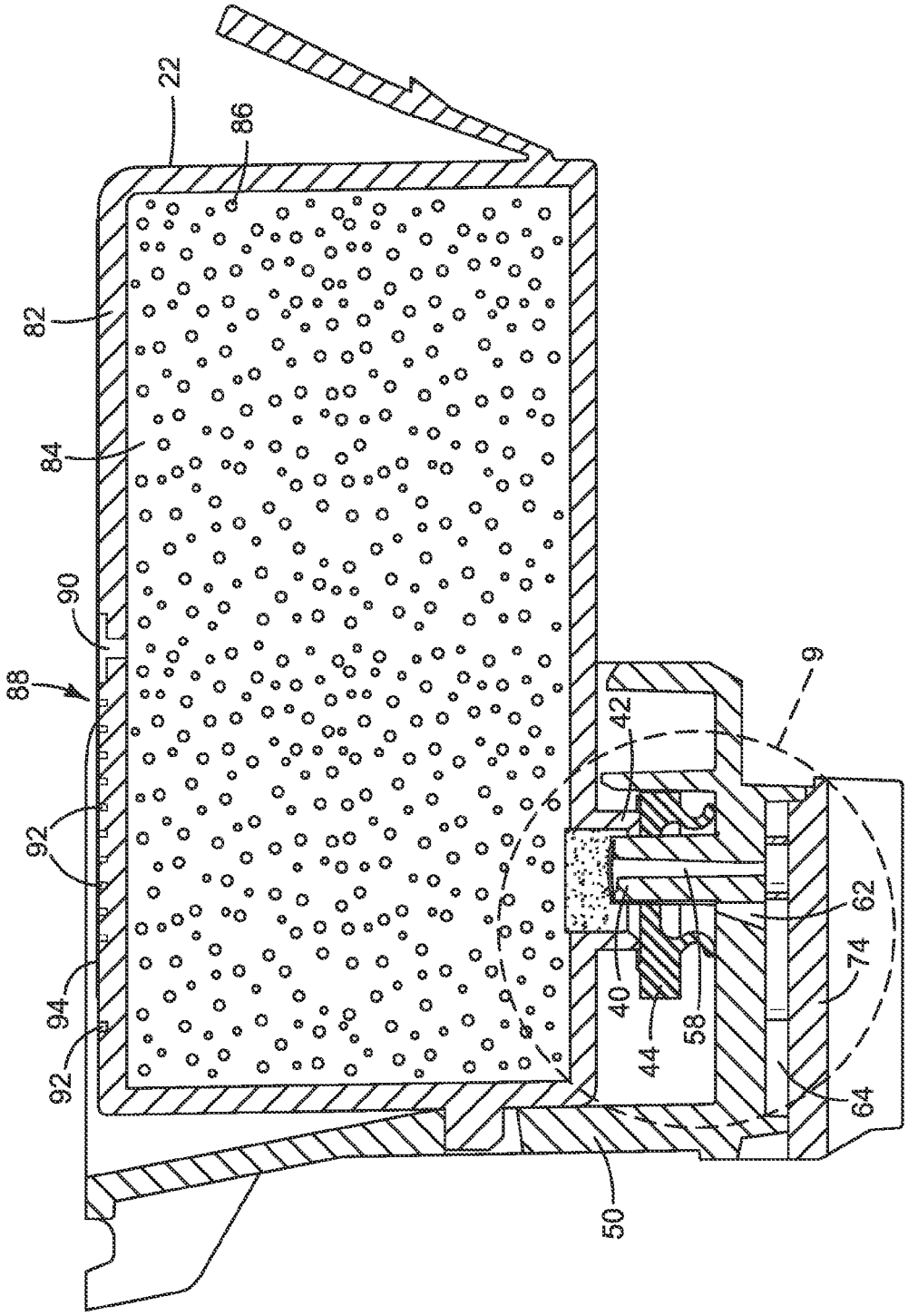


FIG. 8

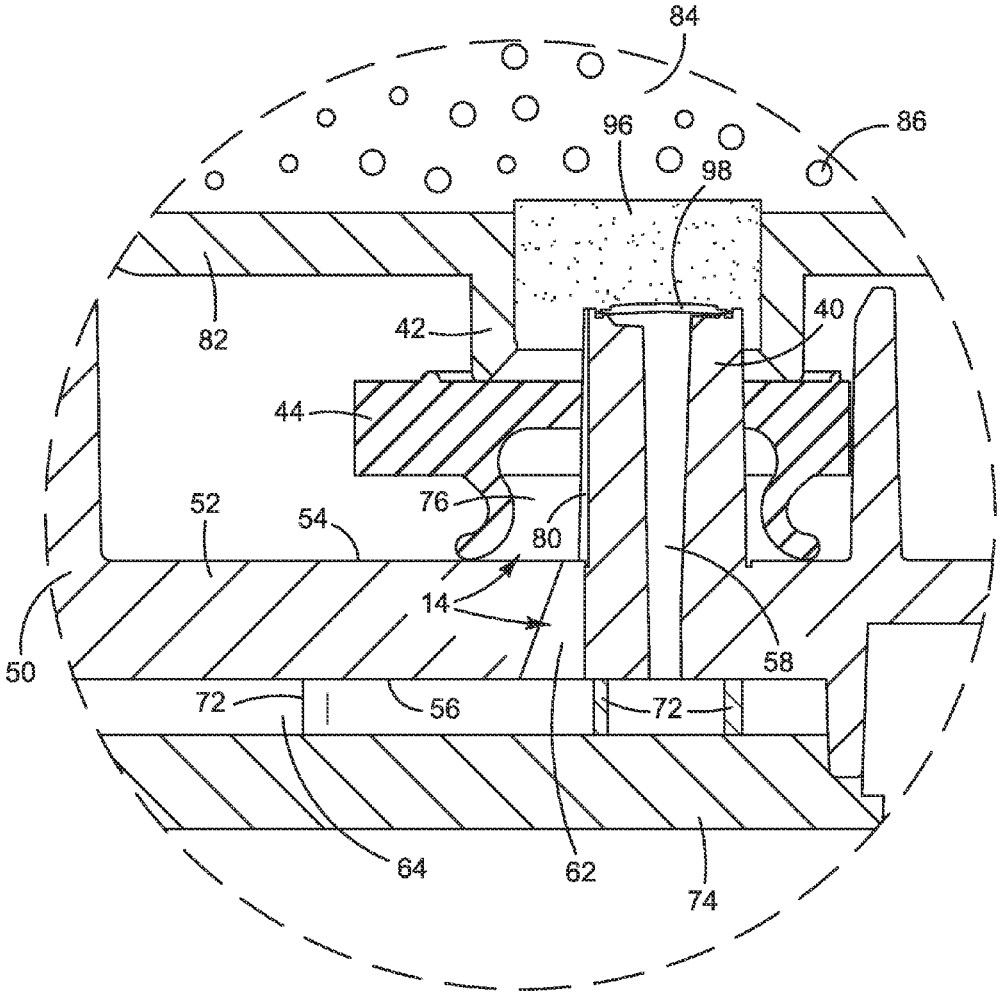
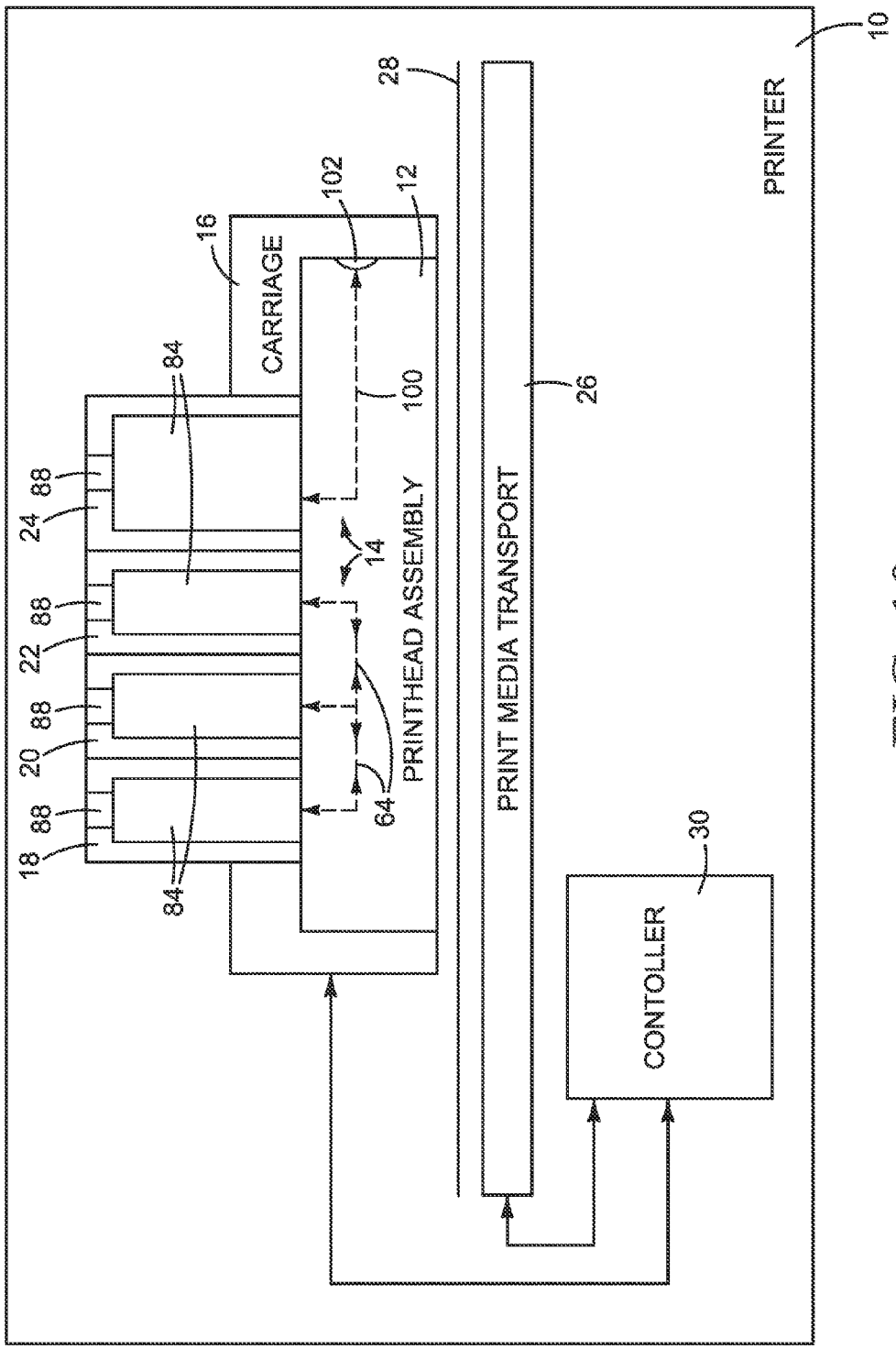


FIG. 9


PRINTER
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CARRIAGE
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PRINT MEDIA TRANSPORT
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PRINTHEAD ASSEMBLY
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CONTOLLER

FIG. 10

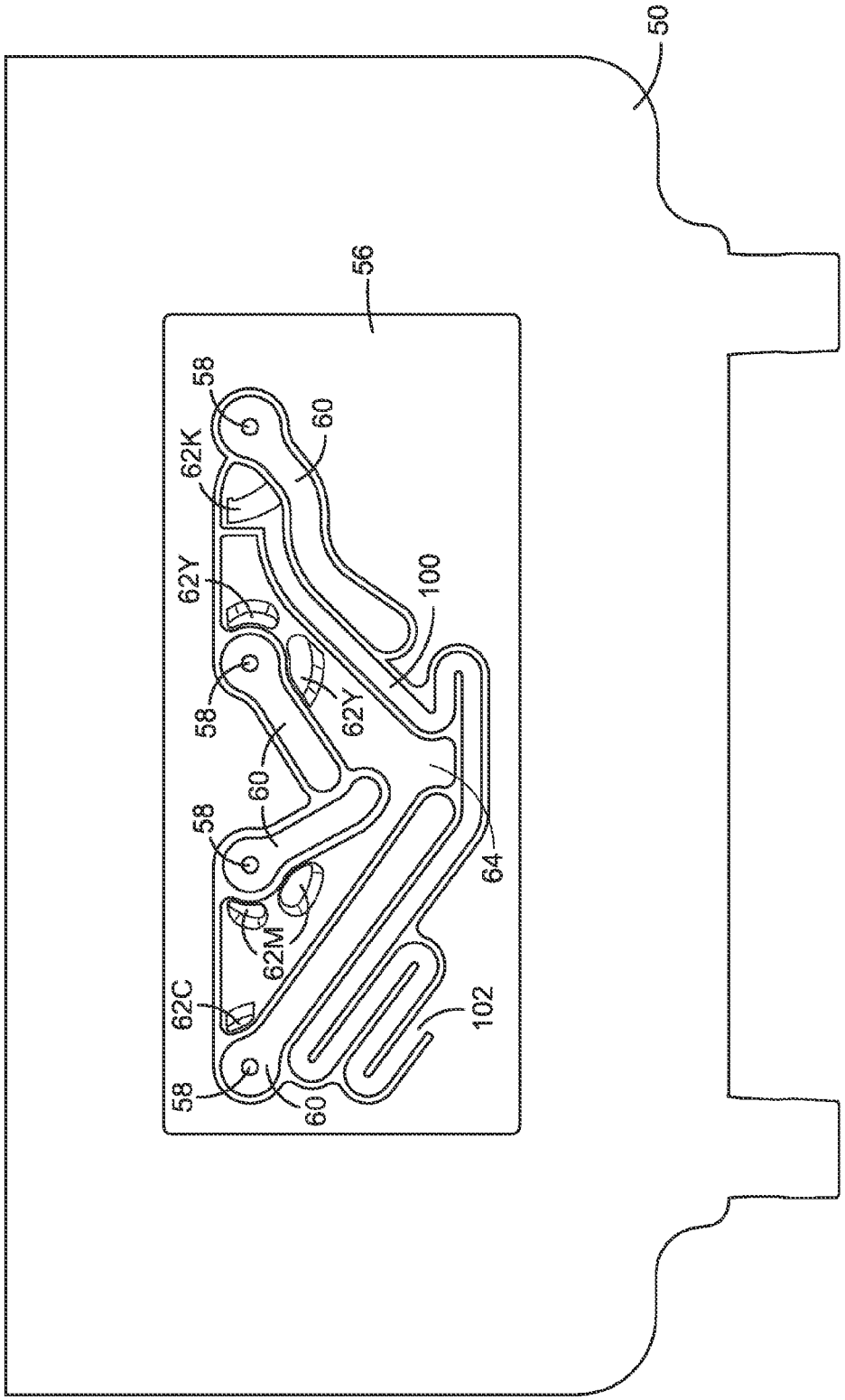

FIG. 11

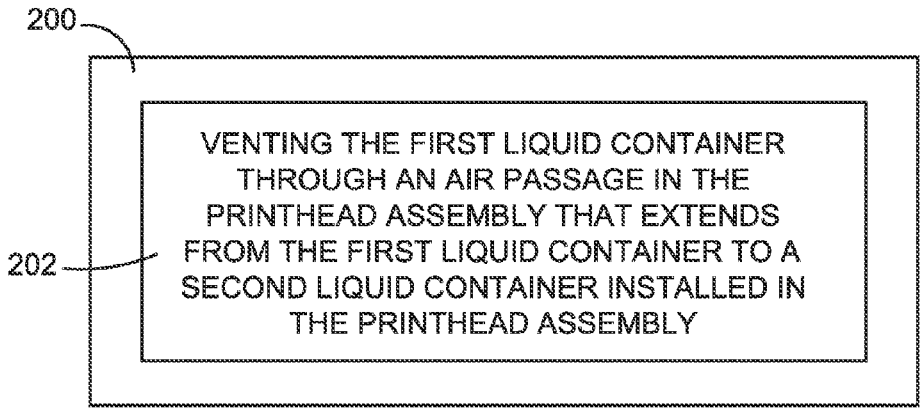

FIG. 12

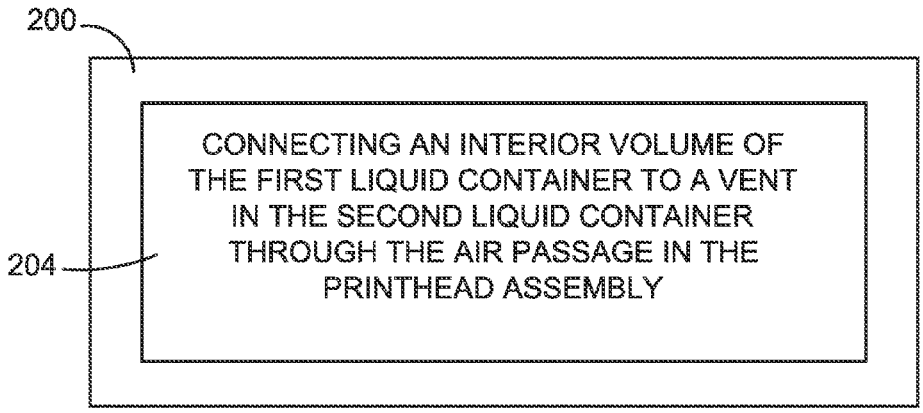

FIG. 13

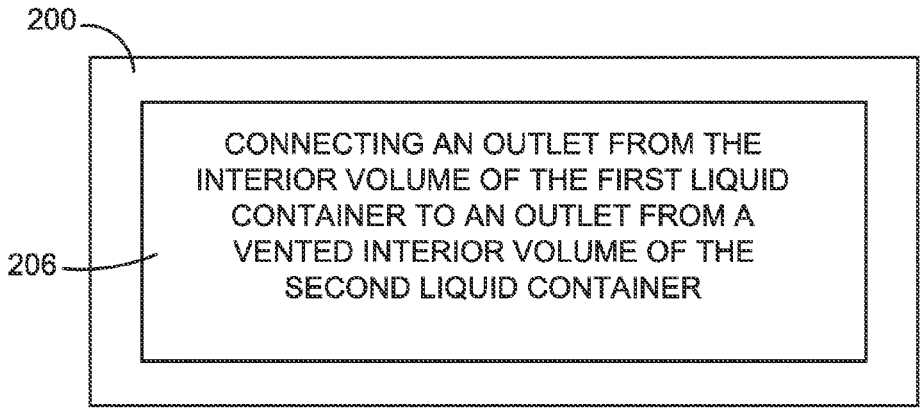

FIG. 14

VENT PATH FOR A LIQUID CONTAINER

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of international patent application number PCT/US2012/029608 filed 19 Mar. 2012 titled Vent Through A Printhead Support Structure.

BACKGROUND

In some inkjet printers, the printheads are part of a discrete assembly separate from detachable ink containers in which ink is held in a block of foam or other capillary material. The ink holding chamber in these foam based ink containers is vented to the atmosphere through an opening in the top of the container.

DRAWINGS

FIG. **1** is a block diagram illustrating an inkjet printer with a printhead assembly implementing one example of a new container vent path.

FIGS. **2** and **3** are perspective views illustrating a printhead assembly implementing one example of a new container vent path.

FIG. **4** is an exploded top side perspective view of the printhead assembly of FIGS. **2** and **3**.

FIG. **5** is a top down plan view showing the printhead assembly of FIGS. **2-4** with the tower seals removed to expose air holes in the substrate of the printhead support structure.

FIG. **6** is an exploded bottom side perspective view of the printhead assembly of FIGS. **2-5**.

FIG. **7** is a bottom side plan view of the printhead assembly of FIGS. **2-6** with the manifold cover removed to expose the air channel along the underside of the printhead support structure substrate.

FIG. **8** is a section view of the printhead assembly of FIGS. **2-7** taken along the line **8-8** in FIG. **5** showing a vent path from the ink container outlet through the printhead assembly.

FIG. **9** is a detail view of the vent path shown in FIG. **8**.

FIG. **10** is a block diagram illustrating an inkjet printer with a printhead assembly implementing another example of a new container vent path.

FIG. **11** is a bottom side plan view of a printhead assembly such as that shown in FIGS. **2-5** with the manifold cover removed illustrating one example implementation of the container vent path in the block diagram of FIG. **10**.

FIGS. **12-14** are block diagrams illustrating example methods for venting a liquid container through a printhead assembly.

The same part numbers designate the same or similar parts throughout the figures.

DESCRIPTION

The ink holding chamber in foam based ink containers is vented to the atmosphere through an opening in the top of the container. The container vent opening is sealed during storage and shipment to prevent evaporation from the ink chamber. The container vent is sometimes not functional when the container is installed in a printhead assembly, for example if the user fails to remove the tape sealing the vent or if there is a defect in the vent that prevents air from reaching the ink chamber inside the container. The printer will not print properly with a malfunctioning container vent. A new vent path through the printhead assembly has been developed as an addition to the conventional vent on a detachable ink container. In one example, the new vent path connects each container to the vent on another container so that each container can still supply ink even if the vent on the container malfunctions. This new vent path helps minimize ink vapor losses by providing alternative venting for each container without adding a separate path to the atmosphere.

Although examples of the new vent path are described with reference to ink containers for an inkjet printer, examples are not limited to ink containers, inkjet printers or inkjet printing. Examples of the new vent path might also be implemented in other inkjet type dispensers. The examples shown in the figures and described below, therefore, illustrate but do not limit the invention, which is defined in the Claims following this Description.

As used in this document, "liquid" means a fluid not composed primarily of a gas or gases; and a "printhead" means that part of an inkjet printer or other inkjet type dispenser that dispenses liquid from one or more openings, for example as drops or streams.

FIG. **1** is a block diagram illustrating an inkjet printer **10** with a printhead assembly **12** implementing one example of a new container vent path **14**. FIGS. **2-9** Illustrate in detail one example of a printhead assembly **12** with a vent path **14** such as might be used in the printer shown in FIG. **1**. Referring first to FIG. **1**, printer **10** includes a carriage **16** carrying printhead assembly **12** and detachable ink containers **18**, **20**, **22**, and **24** that supply ink to printhead assembly **12**. Printhead assembly **12** includes one or more printheads through which ink from one or more containers **18-24** is ejected. A print media transport mechanism **26** advances a sheet of paper or other print media **28** past carriage **16** and printhead assembly **12**. A controller **30** is operatively connected to carriage **16**, printhead assembly **12** and media transport **26**. Controller **30** represents generally the programming, processor and associated memory, and the electronic circuitry and other components needed to control the operative elements of printer **10**.

The interior, ink holding chamber **84** of each container **18-24** is vented to the atmosphere through an opening **88** in the respective container **18-24**. Vent path **14** in printhead assembly **12** connects the ink holding chamber **84** in each container **18-24** to the ink holding chamber **84** in each of the other containers **18-24**. Accordingly, because each ink holding chamber **84** is vented through a container opening **88**, vent path **14** provides an alternative vent path for each ink holding chamber **84**. In the example shown, vent path **14** provides the ink holding chamber **84** in each container **18-24** with three alternative vent paths—a vent path **14** to each of the other three container vent openings **88** (through the corresponding ink chamber **84**). Other configurations for vent path **14** are possible. For example, one or more separate vent paths **14** may connect a container ink chamber **84** to fewer than all of the other container vent openings **88** (through the corresponding container ink chamber **84**).

Referring now to FIGS. **2** and **3**, printhead assembly **12** includes bays **32**, **34**, **36**, and **38** for receiving detachable ink containers **18-24**, respectively. (Bay **32** is visible in FIG. **4**.) Only ink containers **18** and **20** are shown installed in printhead assembly **12** in FIG. **2** to better illustrate some features of printhead assembly **12**. Printhead assembly **12** includes ink inlets **40** for receiving ink from a corresponding ink outlet **42** (visible in FIGS. **8** and **9**) on each detachable ink container **18-24**. Each ink inlet **40** is configured as a tower that is surrounded by an annular seal **44** that seals against the bottom of each container outlet when the container is installed in printhead assembly **12**. In the example shown, printhead

assembly **12** includes two printheads **46** and **48**. Ink from color ink containers **18-22**, for example, is ejected from printhead **46** and ink from a black ink container **24** is ejected from printhead **48**.

FIGS. **4** and **5** are exploded top side perspective and plan views, respectively, of printhead assembly **12**. The inlet tower seals **44** are omitted in FIG. **5** to better illustrate vent path **14**. FIGS. **6** and **7** are bottom side perspective and plan views, respectively, of printhead assembly **12**. The printheads **46**, **48** and the manifold cover are omitted in FIG. **7** to better illustrate vent path **14**. FIGS. **8** and **9** are section views showing vent path **14** in more detail.

Referring to FIGS. **4-9**, printhead assembly **12** includes a support structure **50** that supports printheads **46**, **48** and other parts of printhead assembly **12**. Ink inlet towers **40** protrude from a generally planar substrate **52** of support structure **50**. While it is expected that printhead assembly **12** will usually be installed in a printer so that substrate **52** is horizontal during printing operations, as shown in the figures, a horizontal substrate **52** is not required. Indeed, substrate **52** alone or integrated into a printhead assembly **12** might have different orientations during manufacturing, packaging, storing, shipping, and printing. Ink inlet towers **40** protrude from a first side **54** of substrate **52**. Printheads **46**, **48** are mounted to a second side **56** of substrate **52** opposite first side **54**. An ink hole **58** in substrate **52** inside each inlet tower **40** allows ink to flow through each container outlet **42** to printhead **46** or **48** along a corresponding ink channel **60** formed in the second side **56** of substrate **52**.

An air hole **62** in substrate **52** near each inlet tower **40** exposes each container outlet **42** to an air channel **64** formed in the second side **56** of substrate **52**. In the example shown, as best seen in FIG. **7**, air channel **64** is defined by a single enclosed chamber along substrate second side **56** enveloping air holes **62**. Although multiple channels **64** each connecting fewer than all of the air holes **62** might be used, a single channel **64** connecting all air holes **62** maximizes the number of alternate vent paths for each container **18-24**. In the example shown, the walls **72** defining ink channels **60** and air chamber **64** are formed in second side **56** of substrate **52** and closed by a cover **74**. That is to say, three sides of each enclosed space are formed in substrate **52** and the fourth side is formed by cover **74** affixed to substrate **52**. Cover **74** is sometimes called a manifold cover because it helps define the ink distribution manifold formed by ink channels **60** in printhead assembly **12**.

Each ink inlet tower **40** is surrounded by a seal **44**. Referring specifically to FIGS. **8** and **9**, the bottom of each container outlet **42** is pressed into a corresponding seal **44** to make a fluid tight seal that prevents air and ink from escaping between container outlet **42** and printhead assembly inlet **40**. Seal **44** forms an interior cavity **76** surrounding at least part of inlet tower **40**. Air hole **62** opens into cavity **76**. The outer surface **78** of inlet tower **40** is recessed at the location of air hole **62** so that air can move from cavity **76** past seal **44** to container outlet **42**. In the example shown, multiple recesses **80** are formed along outer surface **78** of inlet tower **42** to achieve the desired air flow between cavity **76** and container outlet **42**.

Still referring to FIGS. **8** and **9**, each ink container **18-24** includes a housing **82** that forms an interior chamber **84** for holding ink. For convenience, only ink container **22** shown in FIGS. **8** and **9** is called out in the following description. Ink in chamber **84** is held in foam or other suitable capillary material **86**. A vent **88** on container **22** vents ink chamber **84** to the atmosphere. Vent **88** usually includes an opening **90** in container housing **82** and a small winding channel **92** covered by an adhesive label **94**. (Label **94** is shown in phantom lines on containers **18** and **20** in FIG. **2**.) A wick **96** in container outlet **42** forms the fluidic interface between ink container **22** and printhead assembly **12**. When ink container **22** is installed in printhead assembly **12**, as shown in FIGS. **8** and **9**, wick **96** engages a corresponding inlet tower **40** on printhead assembly **12**, for example through a filter **98**, to establish the operative ink and air connections between ink container **22** and printhead assembly **12**. Thus, vent path **14** allows air flow between ink chambers **84** through air chamber **64** to air holes **62** in substrate **52** to cavities **76** between seals **44** and inlet towers **40**, past inlet towers **40** in recesses **80** to wicks **96** in container outlets **42**.

When container **22** is installed in printhead assembly **12** but not vented correctly through its own vent **88**, the flow of ink from container **22** into printhead assembly **12** during printing and priming can create too high a vacuum inside ink chamber **84**, starving the printheads of ink. Excessive vacuum forms because ink is expelled from container **22** during printing or priming but not enough air to replace the ink can flow into container **22** through a malfunctioning container vent. Vent path **14** through printhead assembly **12** allows air from vents **88** on the other ink containers **18**, **20**, and **24** to pass around and through wick **96** into ink chamber **84** to maintain a correct pressure inside container **22** even if the container **22** vent fails. Air holes **62** in substrate **52** and recesses **80** along inlet tower **40** may be sized and shaped to achieve the desired venting and, where appropriate, to facilitate manufacturing. (Printhead support structure **50** usually will be a molded plastic part.) Multiple smaller air holes **62** around an inlet tower **40**, as shown in FIG. **5**, may be used instead of a single larger hole as necessary or desirable to maintain the rigidity of inlet tower **40** to substrate **52**.

In another example, shown in FIGS. **10** and **11**, vent path **14** through printhead assembly **12** includes two air channels **64** and **100**. First air channel **64** is defined by a single enclosed chamber along substrate second side **56** that envelopes some but not all air holes **62**—air holes **62**C, **62**M, and **62**Y in FIG. **11**. The second air channel **100** vents air hole **62**K (and the corresponding ink container **24**) directly to the atmosphere at outlet **102**, without passing through any of the other air holes **62**C, **62**M, **62**Y. The configuration of vent path **14** in FIGS. **10** and **11** may be used, for example, to help minimize the risk of cross-contamination between different types of ink. It has been observed that ink condensation may form on surfaces exposed to air chamber **64**. If the black ink and the color inks have different chemistries, pigment and dye based inks, for example, a single air channel **64** common to both types of ink might allow black pigment to condense on color dye based ink structures, possibly causing undesirable effects within printhead assembly **12**. Accordingly, a black (K) ink container **24** may benefit from a direct vent channel **100**. Although FIGS. **10** and **11** show a printhead assembly vent path **14** in which three of four ink containers are vented through one another and the fourth ink container is vented directly to the atmosphere, other configurations are possible.

In another example, and referring to the block diagram of FIG. **12**, a method **200** for venting a first ink or other liquid container installed in a printhead assembly includes venting the first liquid container through an air passage in the printhead assembly that extends from the first liquid container to a second liquid container installed in the printhead assembly (block **202**). In one specific implementation shown in FIG. **13**, the venting **202** is performed by connecting an interior volume of the first liquid container to a vent in the second liquid container through the air passage in the printhead assembly (block **204**). In one specific implementation shown

in FIG. **14**, the connecting **204** is performed by connecting an outlet from the interior volume of the first liquid container to an outlet from a vented interior volume of the second liquid container (block **206**).

As noted at the beginning of this Description, the examples shown in the figures and described above illustrate but do not limit the invention. Other examples are possible. Therefore, the foregoing description should not be construed to limit the scope of the invention, which is defined in the following claims.

What is claimed is:

1. A structure for supporting a printhead, comprising:

a substrate having a first side and a second side;

multiple inlets each protruding from the first side of the substrate through which liquids may be introduced into the structure from outlets of liquid containers that can be attached to the structure;

multiple openings through the substrate from the first side to the second side, each opening positioned near one of the inlets at a location exposed to the outlet of a corresponding one of the containers when the container is attached to the structure; and

a first air channel on the second side of the substrate connecting each of one or more of the openings to another opening.

2. The structure of claim **1**, wherein the first air channel comprises a single chamber enveloping the connected openings on the second side of the substrate.

3. The structure of claim **2**, wherein the chamber connects each opening to all of the other openings.

4. The structure of claim **2**, further comprising a second air channel on the second side of the substrate connecting one or more of the openings to the atmosphere without passing through any of the other openings.

5. The structure of claim **1**, further comprising:

a seal surrounding each inlet to seal the outlet of a liquid container against the structure, each seal forming a cavity surrounding the inlet on the first side of the substrate and each opening into a corresponding one of the cavities; and

a gap between the seal and the inlet to allow air to pass between the cavity and a container outlet.

6. The structure of claim **5**, wherein each gap comprises multiple gaps formed by a series of recesses in an outer surface of the inlet at an interface with the seal.

7. A printhead assembly, comprising:

a printhead to dispense liquid; and

a structure supporting the printhead, the structure including:

multiple liquid inlets each to receive liquid from a corresponding one of multiple liquid containers that may be attached to the printhead assembly;

a liquid manifold to distribute liquid from the inlets to the printhead; and

a vent path therein that allows air to pass between first and second liquid containers when the containers are attached to the printhead assembly.

8. The printhead assembly of claim **7**, wherein the vent path also vents a third liquid container directly to the atmosphere without air passing between the third container and another container when the containers are attached to the printhead assembly.

9. The printhead assembly of claim **7**, wherein the vent path extends from an opening into each container when the containers are attached to the printhead assembly to a single, sealed air chamber that connects all of the openings.

10. The printhead assembly of claim **7**, further comprising a substrate having a first side and a second side opposite the first side, and wherein:

each inlet comprises an inlet tower protruding from the first side of the substrate;

the manifold comprises multiple liquid channels along the second side of the substrate, each liquid channel connected to a corresponding inlet tower through a liquid opening in the substrate; and

the vent path comprises multiple air openings through the substrate each near a corresponding inlet tower and a sealed air channel along the second side of the substrate connecting two or more of the air openings.

11. The printhead assembly of claim **10**, wherein the air channel comprises a single air channel connecting each air opening to all of the other air openings.

12. A method of venting a first liquid container installed in a printhead assembly, the method comprising venting the first liquid container through an air passage in the printhead assembly that extends from the first liquid container to a second liquid container installed in the printhead assembly.

13. The method of claim **12**, wherein the venting comprises connecting an interior volume of the first liquid container to a vent in the second liquid container through the air passage in the printhead assembly.

14. The method of claim **13**, wherein the connecting comprises connecting an outlet from the interior volume of the first liquid container to an outlet from a vented interior volume of the second liquid container.

15. The method of claim **12**, further comprising dispensing a liquid from the first container through the printhead assembly while venting the first container through the second container.

* * * * *