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(71) Applicant: **NOVARTIS AG** [CH/CH]; Lichtstrasse 35,
4056 Basel (CH).

(72) Inventor: **SANCHEZ, JR., Robert Joseph**; 1158 Village
Drive, Oceanside, California 92057 (US).

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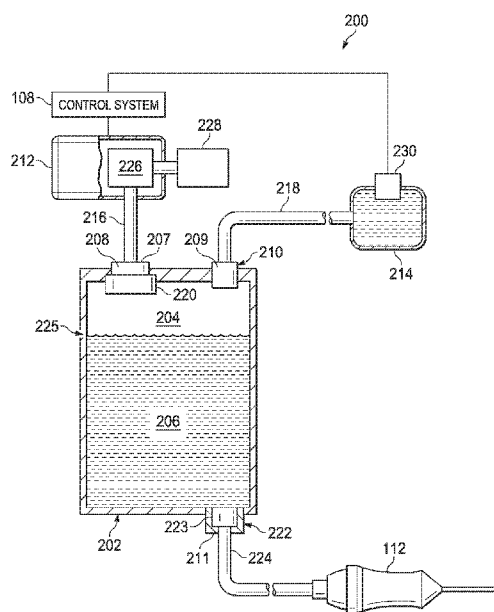


Fig. 2

(57) Abstract: A fluid delivery system (200) includes a pressure source (212) capable of producing both positive and negative fluid pressure, a fluid infusion line (224), and a first fluid storage container (202). The first fluid storage container includes a chamber (204), a fluid outflow port (222) that is connectable to the fluid infusion line to provide fluid communication between the chamber and the fluid infusion line, a pressure inlet (208) that is connectable to the pressure source, and a filter (220) disposed between the pressure inlet and the chamber. The fluid delivery system further includes a control system (108) configured to cause the fluid pressure source to apply both negative pressure and positive pressure.

FLUID STORAGE CONTAINER DEGASSING SYSTEMS AND METHODS

TECHNICAL FIELD

[0001] The present disclosure is directed to methods and systems for performing ophthalmic surgical procedures, and more particularly, to methods and systems for providing pressurized fluid for infusion into a patient's eye.

BACKGROUND

[0002] Fluids are typically injected into a patient's eye during an ophthalmic surgery in order to maintain the intraocular pressure of the eye at an acceptable level. Some ophthalmic surgical systems provide such fluid from a bag placed under physical pressure by an actuator mechanism. The actuator mechanism squeezes the bag to push fluid out of the bag and into an infusion line. The infusion line provides fluid communication between the bag and the ophthalmic surgical tool that injects the fluid into the patient's eye. Some ophthalmic surgical systems provide such fluid through use of a bottle. Typically, the bottle has an infusion outflow port at the bottom of the bottle, which can be connected to the fluid infusion line. The bottle also has a pressure inlet at the top of the bottle. The pressure inlet is connected to a pressurized fluid source such as a pressurized gas. When the pressurized gas is injected into the bottle, it pushes fluid out of the infusion outflow port. In some examples, the fluid is pushed into a cassette chamber. In some examples, the fluid is pushed into the fluid infusion line.

[0003] The ophthalmic surgical systems that provide fluid infusion, among other functions, typically do so through use of a fluid delivery system integrated with a console. For example, the fluid delivery system for an ophthalmic surgical system may include a space for placing the bag or bottle while the bag or bottle is connected to the fluid delivery system. In some cases, the bags or bottles may come packaged with the infusion fluid therein. However, such fluid is not typically degassed. In other words, there may be gas bubbles within the infusion fluid or gas that is dissolved into the infusion fluid. An infusion fluid that is not degassed may introduce gas bubbles into the patient's eye during the infusion process. Such gas bubbles may

obscure an operator's vision during the ophthalmic surgical operation being performed.

SUMMARY

[0004] According to one example, a fluid delivery system includes a pressure source capable of producing both positive and negative fluid pressure, a fluid infusion line, and a first fluid storage container. The first fluid storage container includes a chamber, a fluid outflow port that is connectable to the fluid infusion line to provide fluid communication between the chamber and the fluid infusion line, a pressure inlet that is connectable to the pressure source, and a filter disposed between the pressure inlet and the chamber. The fluid delivery system further includes a control system configured to cause the fluid pressure source to apply both negative pressure and positive pressure.

[0005] A method includes connecting a pressure source of a fluid delivery system to a pressure inlet of a fluid storage container, the pressure inlet comprising a filter that allows gas to pass therethrough, connecting a fluid infusion line of the fluid delivery system to a fluid outflow port of the fluid storage container, and applying a negative pressure to the fluid storage container to degas a liquid within the fluid storage container.

[0006] A fluid delivery system includes a pressure source capable of producing both positive and negative fluid pressure, a fluid infusion line, a fluid source, and a first fluid storage container. The first fluid storage container includes a first fluid storage chamber, a first infusion outflow port that is connectable to the fluid infusion line, a first fluid inflow port that is connectable to the fluid source, and a first pressure inlet that is connectable to the fluid pressure source, the first pressure inlet comprising a first filter. The fluid delivery system further includes a control system configured to fill the fluid storage chamber with infusion fluid for a first period of time and cause the fluid pressure source to apply a negative pressure to the first fluid storage container for a second period of time following the first period of time.

[0007] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory in nature and are intended to provide an understanding of the present disclosure without limiting the scope of the present disclosure. In that regard, additional aspects, features, and advantages of the present disclosure will be apparent to one skilled in the art from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings illustrate embodiments of the devices and methods disclosed herein and together with the description, serve to explain the principles of the present disclosure.

[0009] Fig. 1 is a diagram showing an illustrative ophthalmic surgical system that includes a fluid delivery system.

[0010] Fig. 2 is a diagram showing an illustrative fluid delivery system with a fluid storage container.

[0011] Fig. 3 is a diagram showing an illustrative fluid delivery system with dual fluid storage containers.

[0012] Fig. 4 is a flowchart showing an illustrative process for providing fluid through the fluid delivery system with two fluid storage containers.

[0013] Fig. 5A is a diagram showing an illustrative fluid delivery bag capable of being degassed before infusion.

[0014] Fig. 5B is a diagram showing another illustrative fluid delivery bag capable of being degassed before infusion.

[0015] Fig. 6 is a flowchart showing an illustrative method for degassing fluid before infusion into a patient's eye.

DETAILED DESCRIPTION

[0016] For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the embodiments illustrated in the

drawings, and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is intended. Any alterations and further modifications to the described devices, instruments, methods, and any further application of the principles of the present disclosure are fully contemplated as would normally occur to one skilled in the art to which the disclosure relates. In particular, it is fully contemplated that the features, components, and/or steps described with respect to one embodiment may be combined with the features, components, and/or steps described with respect to other embodiments of the present disclosure. For simplicity, in some instances the same reference numbers are used throughout the drawings to refer to the same or like parts.

[0017] The present disclosure is directed to a fluid delivery system and a fluid storage container adapted to degas a fluid within a fluid storage container before that fluid is infused into the patient's eye. According to some examples, the fluid storage container includes an infusion outflow port and a pressure inlet. The pressure inlet includes a filter such as a semi-permeable membrane. Before the fluid is infused into the patient's eye, a vacuum is applied through the filter. The filter prevents the liquid infusion fluid from exiting the bag, while permitting passage of gas bubbles through the filter. In this manner, the infusion fluid can be degassed before it is infused into the patient's eye. The fluid delivery system and fluid storage container will be described in further detail below.

[0018] Fig. 1 is a diagram showing an illustrative ophthalmic surgical system 100. According to the present example, the ophthalmic surgical system 100 includes a surgical console 102 and an ophthalmic surgical tool 112. The ophthalmic surgical tool 112 is in fluid communication with the console 102 through a fluid infusion line 114. The surgical console 102 includes a display screen 104 and a fluid delivery system 110. In one implementation, the surgical console 102 is configured to be mobile and may be used by a user, such as a health care provider, to perform ophthalmic surgical procedures. The surgical console 102 may also include a control system 108 that may be configured to process, receive, and store data to perform various functions associated with the ophthalmic surgical tool 112.

[0019] The display screen 104 may communicate information to the user, and in some implementations, may show data relating to system operation and performance

during a surgical procedure. In some examples, the display screen 104 is a touchscreen that allows the operator to interact with the surgical console 102 through a graphical user interface.

[0020] The fluid delivery system 110 may include a cassette 106 that is removably insertable into the fluid delivery system 100. In some examples, the cassette 106 may include components of the fluid delivery system 110 that may come into contact with patient fluids and tissue. Specifically, the cassette 106 may include a fluid storage container and the fluid infusion line 114. In some examples, the cassette 106 may include components of other systems such as an aspiration system (not shown).

[0021] Fig. 2 is a diagram showing an illustrative fluid delivery system 200 with a fluid storage container 202. The fluid delivery system 200 may correspond to the fluid delivery system 110 described above. According to the present example, the fluid delivery system 200 includes a pressure source 212 having a pump 226, a fluid source 214, and a fluid infusion line 224. The fluid storage container 202 includes a fluid chamber 204 for storing infusion fluid 206, a pressure inlet 208 with a filter 220, a fluid inflow port 210, and a fluid outflow port 222.

[0022] As described above, the fluid delivery system 200 may utilize a cassette (e.g. 106, Fig. 1) that is insertable into the surgical console (e.g. 102, Fig. 1). The cassette may include the fluid storage container 202 and the fluid infusion line 224. The cassette may be structurally configured such that, when inserted into the console, the fluid inflow port 210 and pressure inlet 208 are appropriately connected to the fluid source 214 and the pressure source 212, respectively.

[0023] The pressure source 212 may be a compressor or pump that is integrated into the surgical console (e.g., 102, Fig. 1). In some examples, the pressure source 212 may be provided by a machine (e.g., a pump) separate from the console that is connectable to the surgical console through a pressure line. In either case, the pressure source 212 is connectable to the pressure inlet 208 of the fluid storage container 202 through the pressure line 216, such as a conduit. The pressure line 216 provides fluid communication between the pressure inlet 208 and the pressure source 212.

[0024] The pressure source 212 is configured to apply both positive and negative pressure relative to atmospheric pressure to the fluid storage container 202 through the pressure inlet 208. Specifically, the pressure source 212 is adapted to apply a negative pressure (i.e., a vacuum) to the fluid storage container 202 to degas the infusion fluid 206 stored therein. The pressure source 212 is also adapted to apply positive pressure to push the infusion fluid 206 out of the fluid storage container 202, through the fluid infusion line 224 and into a patient's eye.

[0025] In some examples, including the exemplary implementation in Fig. 2, the pressure source 212 utilizes a Venturi pump 226 to apply negative pressure to the fluid storage container. In some examples, to apply a vacuum to the pressure inlet 208, the pressure source causes a fluid to flow from the pressure source 212, through the Venturi pump 226, and to a muffler 228. The Venturi pump 226 includes a narrower portion of tubing. Because speed increases through the narrow portion, pressure drops, thereby creating a vacuum. In this manner, the pressure source 212 can apply negative pressure to the pressure inlet 208. Other types of pumps for providing a vacuum may be used as well.

[0026] While the exemplary implementation in Fig. 2 uses a single interface between the container 202 and the pressure source 212, other implementations include two separate pressure interfaces; one for having positive pressure applied and one for having negative pressure applied. In such a case, two separate pressure lines may connect the two pressure interfaces to the pressure source 212. In some cases, the pressure source that provides a positive pressure may be a separate piece of machinery than the pressure source that provides a negative pressure. In other words, there may be two separate pressure sources; one for providing positive pressure and one for providing negative pressure. For example, a pump may provide vacuum or negative pressure and a compressor may provide positive pressure.

[0027] The fluid source 214 provides an infusion fluid to the fluid storage container 202. The infusion fluid may be, for example, a balanced salt solution (BSS). The infusion fluid may be provided to the fluid storage container 202 in any of a variety of manners. In one example, the fluid source 214 may include a fluid tank that is sized to hold a substantially larger quantity of fluid than the fluid storage container 202. Such a fluid tank may then be used to fill the fluid storage container

202 with the infusion fluid as needed. In some examples, the fluid source 214 may be a fluid tank that is external to the surgical console 102. In either case, the fluid storage container 202 is connectable to the fluid source 214 through a fluid line 218. The fluid line 218 thus provides fluid communication between the fluid source 214 and the fluid inflow interface 210 of the fluid storage container 202.

[0028] Still referring to Fig. 2, the chamber 204 of the fluid storage container 202 is filled with an infusion fluid 206. In some examples, the chamber 204 may be sized such that the amount of fluid within the chamber 206 is generally sufficient for a single surgical procedure. In some examples, however, the chamber 204 may be sized to hold a smaller quantity of infusion fluid. In such a case, the chamber 204 may be refilled during a surgical procedure.

[0029] The pressure inlet 208 may include a pressure interface 207 that allows the pressure inlet 208 to connect with the pressure line 216 such that a fluid-tight seal is formed. The pressure interface 207 may be a selectively attachable interface, such as a quick disconnect fitting or other interface. In some embodiments, the pressure interface 207 is a Luer fitting. The pressure inlet 208 allows fluid communication between the chamber 204 and the pressure source 212. According to the present example, the pressure inlet 208 includes the filter 220. The filter 220 is structurally configured to allow gaseous fluid to pass therethrough and prevent liquid fluid from passing therethrough. Thus, when a vacuum, such as negative pressure, is applied to the pressure inlet 208, the gas within the chamber 204 and gas bubbles within the infusion fluid 206 can be pulled through the filter 220. But, the infusion fluid 206 (i.e., BSS) is maintained within the fluid storage container and not pulled through the filter 220.

[0030] The fluid inflow port 210 includes an interface 209 that allows the fluid inflow port 210 to connect to the fluid line 218 such that a fluid-tight seal is formed. The interface 209 may be a selectively attachable interface, such as a quick disconnect fitting or other interface. In some embodiments, the interface 209 is a Luer fitting. The fluid line 218 provides fluid communication between the fluid source 214 and the fluid inflow port 210. The fluid inflow port 210 allows fluid communication between the chamber 204 and the fluid line 218. In some examples, the fluid inflow port 210

may include a one-way valve that allows fluid to flow into the chamber 204 but prevents fluid from flowing out of the chamber 204.

[0031] The fluid outflow port 222 includes an interface 211 that allows the fluid outflow port 222 to connect to the fluid infusion line 224 such that a fluid-tight seal is formed. The fluid outflow port 222 thus provides fluid communication between the chamber 204 and the fluid infusion line 224. The fluid infusion line 224 provides fluid communication between the fluid outflow port 222 and the ophthalmic surgical tool 112 that injects the infusion fluid into the patient's eye. In some examples, the fluid outflow port 222 may include a one-way valve that allows fluid to flow out of the chamber 204 but prevents fluid from flowing into the chamber 204. The fluid outflow port 222 may also include a stop valve 223 or check valve to selectively prevent or allow fluid from flowing through the fluid outflow port 222.

[0032] During operation of the fluid delivery system, the control system (e.g. 108, Fig. 1) may manage the various components to direct fluid as desired. For example, after the cassette is inserted into the surgical console 102, the chamber 204 may be empty. Thus, the control system 108 may operate a pump 230 to cause the fluid from the fluid source 214 to be pumped into the chamber 204 to fill the chamber. During this time, the stop valve 223 of the fluid outflow port 222 may be closed so as to prevent fluid from flowing out of the fluid outflow port 222. In some examples, the infusion fluid 206 may be pumped into the chamber 204 until the fluid level reaches a certain threshold level 225 that is lower than the top of the chamber 204.

[0033] After the chamber 204 has been appropriately filled with infusion fluid 206, the control system 108 may apply a negative pressure to the pressure inlet 208 through use of the pressure source 212 and the pump 226. The negative pressure, or vacuum, that is applied can degas the infusion fluid 206 stored within the chamber 204. In other words, gas bubbles within the infusion fluid solution may be removed from the infusion fluid solution.

[0034] After the infusion fluid 206 has been degassed, the solution may be ready for infusion into the patient's eye. The control system 108 may thus apply positive pressure to the pressure inlet 208. During this time, the stop valve 223 of the fluid outflow port 222 may be open so as to allow fluid flow therethrough. The positive

pressure at the pressure inlet 208 causes the infusion fluid to be pushed out of the chamber 204, into the fluid infusion line 224, through the ophthalmic surgical tool 112, and into the patient's eye. The magnitude of the positive pressure may be controlled so as to provide the desired flow rate of infusion fluid 206 to the patient's eye.

[0035] The control system 108 may include a processor and a memory. The memory may store machine readable instructions that when executed by the processor, cause the control system 108 to perform various tasks. For example, the control system 108 may send control signals to the pressure source 212 and the fluid source 214. Such control signals may activate either the pressure source 212 or the fluid source 214 to behave as desired at designated points in time. For example, the control system 108 may cause the fluid source 214 to fill the fluid storage container 202 with fluid 206. Then, the control system 108 may cause the pressure source 212 to apply a negative pressure to degas the fluid 206 within the fluid storage container 202. The control system 108 may then cause the pressure source 212 to apply positive pressure to the fluid storage container 202 to push the fluid 206 out of the fluid storage container 202.

[0036] Fig. 3 is a diagram showing an illustrative fluid delivery system 300 with dual fluid storage containers 202, 302. Like the first fluid storage container 202, the second fluid storage container 302 includes a chamber 304 adapted to hold a quantity of fluid 306, a pressure inlet 308 with a filter 320, a fluid inflow port 310, and a fluid outflow port 322. In this example, however, the fluid line 218 includes a switch valve 318 that allows fluid from the fluid source 214 to be directed to either the first fluid storage container 202 or the second fluid storage container 302. Similarly, the fluid infusion line 224 includes a switch valve 324 that allows fluid from either the first fluid storage container 202 or the second fluid storage container 302 to be directed to the ophthalmic surgical tool 112.

[0037] According to the present example, the pressure lines 301, 303 connect the pressure source to the pressure inlets 208, 308 of the fluid storage containers 202, 302 through a switch valve 316. The first pressure line 301 may be used for applying positive pressure and the second pressure line 303 may be used for applying negative

pressure. Thus, positive pressure may be applied to one fluid storage container while negative pressure is applied to the other and vice versa.

[0038] Fig. 4 is a flowchart showing an illustrative process 400 for providing fluid through the fluid delivery system 300 that includes the two fluid storage containers 202, 302. Steps performed on the first fluid storage container 202 are shown in the left column 402 and the steps performed on the second fluid storage container 302 are shown in the right column 404. Reference numeral 406 identifies a starting point in time, where the first fluid storage container 202 is filled with infusion fluid and the second fluid storage container 302 is empty.

[0039] Between points in time identified by the reference numerals 406 and 408, at step 412, infusion fluid is pushed out of the first fluid storage container 202 by applying positive pressure to the pressure inlet 208 of the first fluid storage container 202. Meanwhile, steps 414 and 416 are performed on the second fluid storage container 302. At step 414, the second fluid storage container 302 is filled with infusion fluid. After the second fluid storage container 302 is appropriately filled, at step 416, the infusion fluid solution within the second fluid storage container 302 is degassed by applying a negative pressure to the pressure inlet 308 of the second fluid storage container 302.

[0040] At the point in time 408, after the fluid in the first fluid storage container 202 falls below a minimum fluid level, the process 400 switches. Specifically, between time points 408 and 410, at step 422, infusion fluid is pushed out of the second fluid storage container 302 by applying positive pressure to the pressure inlet 308. Meanwhile, steps 418 and 420 are performed on the first fluid storage container 202. At step 418, the first fluid storage container 202 is filled with infusion fluid. After the first fluid storage container 202 is appropriately filled, at step 420, the infusion fluid solution within the first fluid storage container 202 is degassed by applying a negative pressure to the pressure inlet 208 of the first fluid storage container 202.

[0041] At time point 410, the first fluid storage container 202 is filled with degassed fluid and the second fluid storage container 302 is empty. The process 400 may continue by switching between the fluid storage containers 202, 302 as described

above. Specifically, while infusion fluid is being pressurized out of one fluid storage container, the other fluid storage container is being filled and degassed. Thus, a steady flow of degassed infusion fluid can be provided to the patient's eye.

[0042] Figs. 5A and 5B are diagrams showing illustrative fluid delivery bags capable of being degassed before infusion. The fluid delivery bags may store an infusion fluid. The bags may be flexible so that when squeezed, the infusion fluid within is pressed out of the bag and into the patient's eye. For example, some surgical consoles (e.g., 102, Fig. 1) may include an actuator mechanism that squeezes a bag filled with fluid in order to provide pressurized infusion fluid into the patient's eye.

[0043] Fig. 5A illustrates an example in which the degassing interface 504 is at a top 501 of a bag 500. In the present example, the bag 500 includes the degassing interface 504 with a filter 506, an interior chamber 502, and a fluid outflow port 510 with an outflow interface 508. The outflow interface 508 may be connectable to a fluid infusion line (e.g., 224, Fig. 2). The degassing interface 504 may be connectable to a pressure source (e.g. 212, Fig. 2) through a pressure line. In this example, the degassing interface 504 includes a filter 506 that may allow gaseous fluids to pass through preventing liquid fluids from passing through. The filter 506 may be, for example, a semipermeable membrane. Thus, when a negative pressure is applied to the degassing interface 504, gas bubbles within the infusion fluid solution may be pulled out of the solution. But, the infusion fluid does not pass through the filter 506. Thus, the infusion fluid solution within the chamber 502 can be degassed.

[0044] Fig. 5B illustrates an example in which the degassing interface 512 is at a bottom 503 of a bag 520. In the present example, the bag 520 includes the degassing interface 512 with a filter 514, and a fluid outflow port 510 with an outflow interface 508. The bag also includes a snorkel 516 that extends into the center portion of the chamber 502. The fluid outflow port 510 may include an annular channel 518 that surrounds the snorkel 516. The outflow interface 508 may be connectable to a fluid infusion line (e.g., 224, Fig. 2). Thus, fluid flowing out of the chamber 502 passes through the annular channel 518, through the outflow interface 508, and into a fluid infusion line. The degassing interface 512 may be connectable to a pressure source (e.g. 212, Fig. 2) through a pressure line. The degassing interface 504 includes a filter 514 that may allow gaseous fluids to pass through preventing liquid fluids from

passing through. The filter 514 may be, for example, a semipermeable membrane. Thus, when a negative pressure is applied to the degassing interface 504, gas bubbles within the infusion fluid solution may be pulled out the solution. Specifically, infusion fluid within the chamber 502 is pulled through the snorkel 516 against the filter 514. But, the infusion fluid is not pulled through the degassing filter 514. Thus, the infusion fluid solution within the chamber 502 can be degassed.

[0045] The snorkel 516 may be any suitable length. For example, the snorkel 516 may be relatively short and extend only a small distance from the bottom 503 of the bag 520. In some examples, the snorkel 516 may be relatively long and extend to a point near the top 501 of the bag 520. In some examples, both degassing interface 504 as illustrated in Fig. 5A and degassing interface 512 as illustrated in Fig. 5B may be included within a single bag.

[0046] Fig. 6 is a flowchart illustrating a method 600 for degassing fluid before infusion into a patient's eye. According to the present example, the method includes a step 602 for connecting a fluid outflow port of a fluid storage container to a fluid infusion line. The fluid infusion line provides fluid communication between the fluid storage container and an ophthalmic surgical tool.

[0047] At a step 604, the pressure inlet of the fluid storage container is connected to a pressure source. The pressure source is capable of applying both positive and negative pressure to the fluid storage container. Additionally, the pressure inlet includes a filter, such as a semipermeable membrane, that allows gas to pass therethrough but prevents liquid from flowing therethrough.

[0048] At a step 606, the pressure source applies negative pressure to the pressure inlet. By applying negative pressure to the pressure inlet, gas within the chamber of the fluid storage container will exit the chamber through the membrane. Additionally, gas bubbles within the infusion fluid solution will exit the chamber. In other words, the infusion fluid solution is degassed. Through use of principles described herein, infusion fluid to be degassed before this injected into the patient's eye. This can help improve the visibility for the operator during a surgical procedure.

[0049] Persons of ordinary skill in the art will appreciate that the embodiments encompassed by the present disclosure are not limited to the particular exemplary

embodiments described above. In that regard, although illustrative embodiments have been shown and described, a wide range of modification, change, and substitution is contemplated in the foregoing disclosure. It is understood that such variations may be made to the foregoing without departing from the scope of the present disclosure. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the present disclosure.

CLAIMS

What is claimed is:

1. A fluid delivery system comprising:
 - a pressure source capable of producing both positive and negative fluid pressure;
 - a fluid infusion line;
 - a first fluid storage container comprising:
 - a chamber;
 - a fluid outflow port in communication with the fluid infusion line to provide fluid communication between the chamber and the fluid infusion line;
 - a pressure inlet in communication with the pressure source; and
 - a filter disposed between the pressure inlet and the chamber; and
 - a control system configured to cause the pressure source to selectively apply both negative pressure and positive pressure.
2. The fluid delivery system of claim 1, further comprising a fluid source in communication with the first fluid storage container.
3. The fluid delivery system of claim 2, wherein the first fluid storage container further comprises a fluid inflow port that is connectable to the fluid source.
4. The fluid delivery system of claim 3, wherein the control system is configured to fill the first fluid storage container with infusion fluid from the fluid source before causing the pressure source to apply negative pressure.
5. The fluid delivery system of claim 2, further comprising a second fluid storage container that includes:
 - a chamber;
 - a fluid outflow port that is connectable to the fluid infusion line to provide fluid communication between the chamber and the fluid infusion line;
 - a fluid inflow port that is connectable to the fluid source;
 - a pressure inlet that is connectable to the pressure source; and

a filter disposed between the pressure inlet of the second fluid storage container and the chamber of the second fluid storage container.

6. The fluid delivery system of claim 5, wherein the control system is configured to apply positive pressure to the first fluid storage container during a period of time, and during the period of time, sequentially cause the second fluid storage container to be filled with infusion fluid and apply a negative pressure to the second fluid storage container.

7. The fluid delivery system of claim 1, wherein the filter comprises a semipermeable membrane.

8. The fluid delivery system of claim 1, wherein the first fluid storage container is within a cassette that is insertable into a surgical console.

9. The fluid delivery system of claim 1, further comprising:
a Venturi pump forming a part of the pressure source; and
a muffler in fluid communication with the Venturi pump.

10. The fluid delivery system of claim 1, wherein the first fluid storage container comprises a bag.

11. The fluid delivery system of claim 10, wherein the pressure inlet is positioned on a top of the bag.

12. The fluid delivery system of claim 10, wherein the pressure inlet is positioned at a bottom of the bag.

13. The fluid delivery system of claim 12, further comprising a snorkel extending from the pressure inlet to a portion of the bag above the pressure inlet.

14. A method comprising:

connecting a pressure source of a fluid delivery system to a pressure inlet of a first fluid storage container, the pressure inlet comprising a filter that allows gas to pass therethrough;

connecting a fluid infusion line of the fluid delivery system to a fluid outflow port of the first fluid storage container; and

applying a negative pressure to the first fluid storage container to degas a liquid within the fluid storage container.

15. The method of claim 14, further comprising, with the pressure source, applying a positive pressure to the first fluid storage container to push fluid out of the first fluid storage container through the fluid outflow port and into the fluid infusion line.

16. The method of claim 14, further comprising:

connecting a fluid inflow port of the first fluid storage container to a fluid source of the fluid delivery system; and

before applying the negative pressure, filling the first fluid storage container with infusion fluid from the fluid source.

17. The method of claim 14, further comprising, pushing fluid out of a second fluid storage container while both filling the first fluid storage container and degassing the fluid in the first fluid storage container.

18. A fluid delivery system comprising:

a pressure source capable of producing both positive and negative fluid pressure;

a fluid infusion line;

a fluid source;

a first fluid storage container comprising:

a first fluid storage chamber;

a first infusion outflow port that is connectable to the fluid infusion line;

a first fluid inflow port that is connectable to the fluid source; and

a first pressure inlet that is connectable to the pressure source, the first pressure inlet comprising a first filter;

a control system configured to fill the first fluid storage chamber with infusion fluid for a first period of time and cause the fluid pressure source to apply a negative pressure to the first fluid storage container for a second period of time following the first period of time.

19. The fluid delivery system of claim 18, further comprising a second fluid storage container that includes:

a second fluid storage chamber;

a second infusion outflow port that is connectable to the fluid infusion line;

a second fluid inflow port connectable to the fluid source; and

a second pressure inlet that is connectable to the pressure source, the second pressure inlet comprising a second filter.

20. The fluid delivery system of claim 19, wherein the control system is further configured to apply a positive pressure to the second fluid storage container during both the first period of time and the second period of time.

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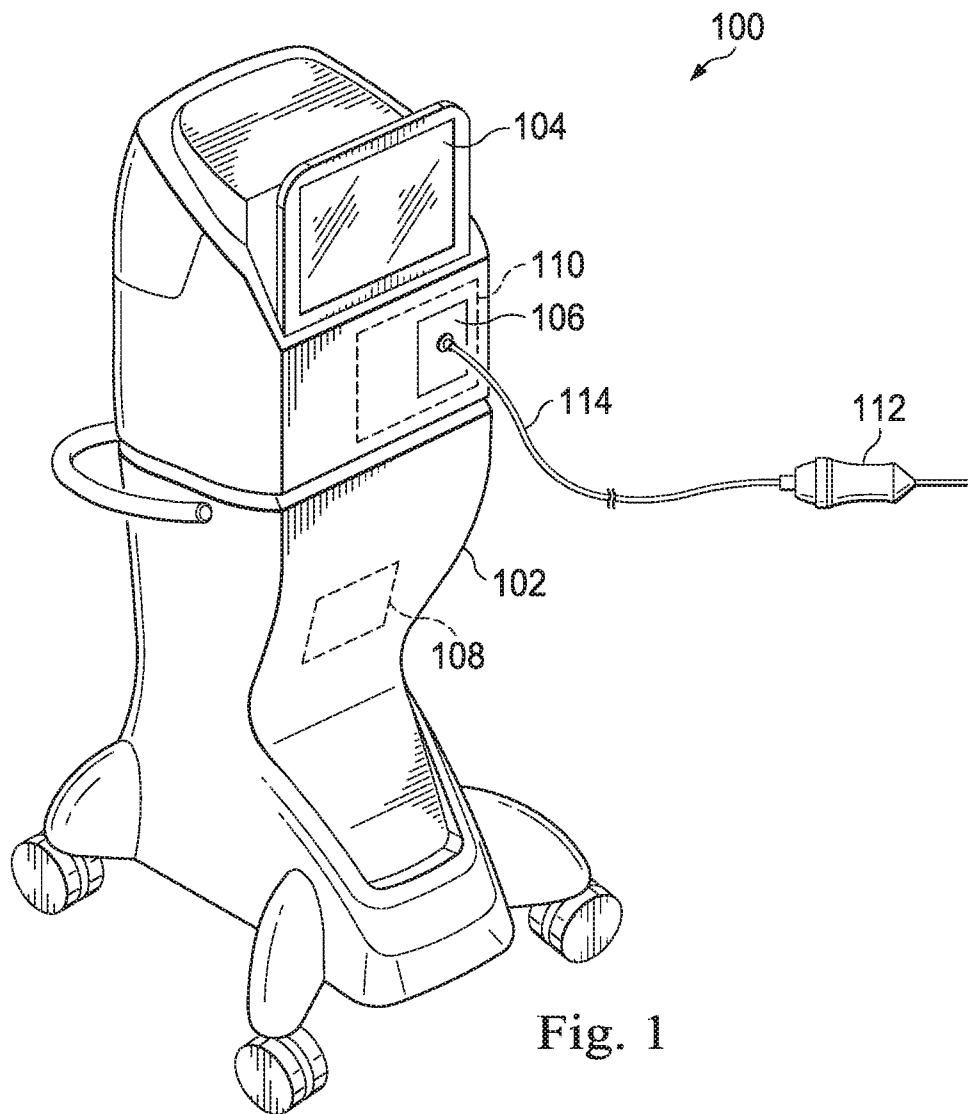


Fig. 1

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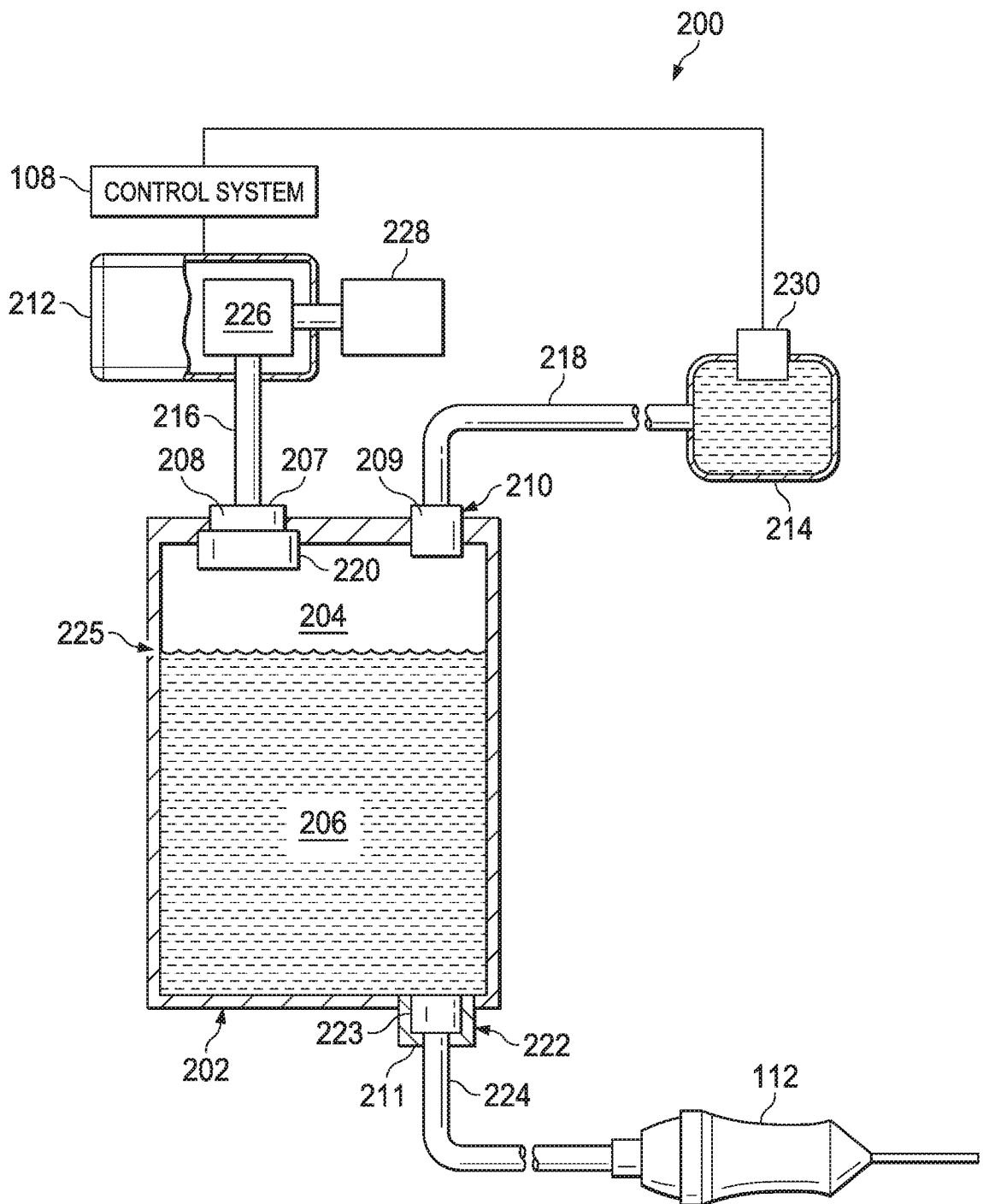


Fig. 2

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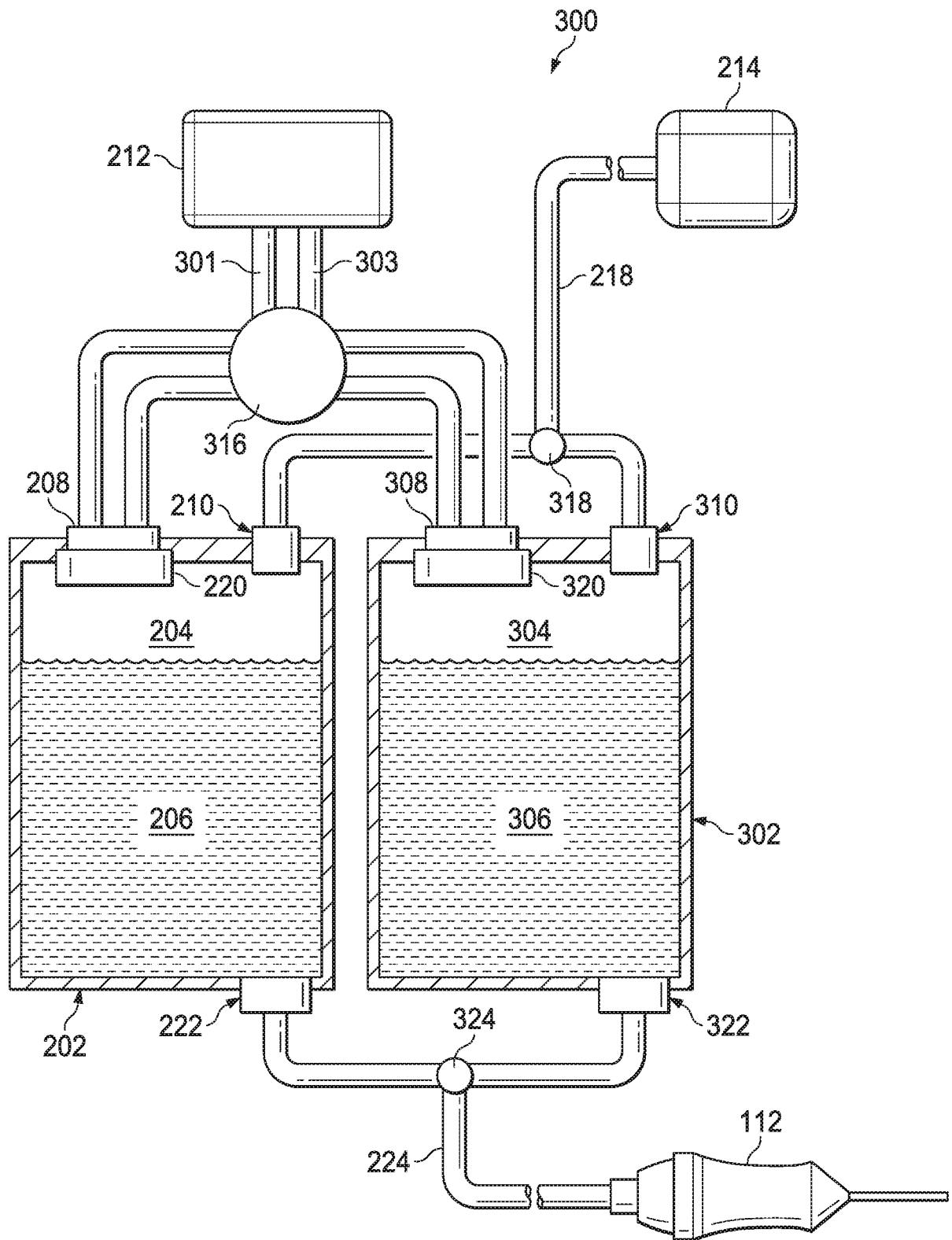


Fig. 3

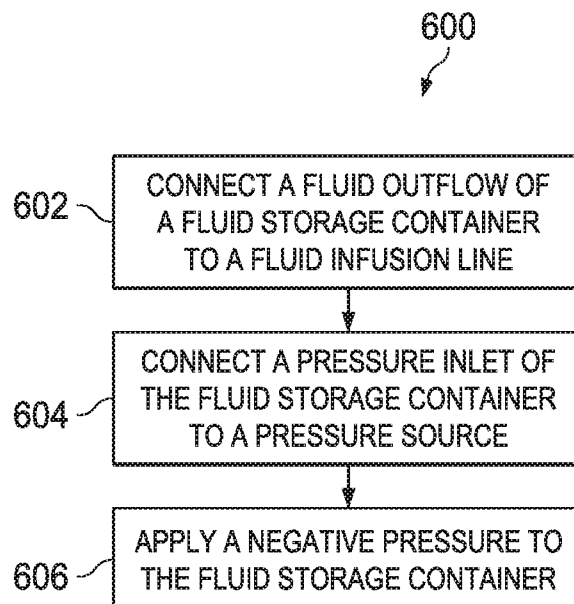
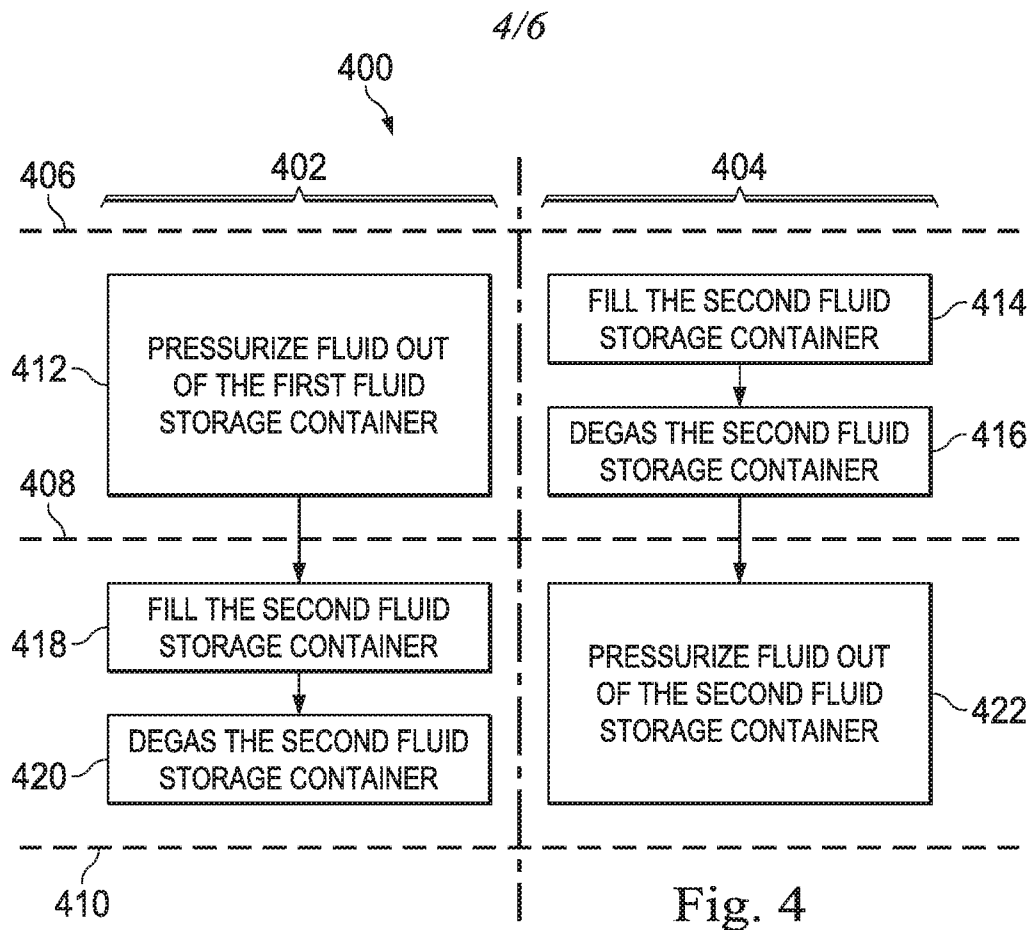


Fig. 6

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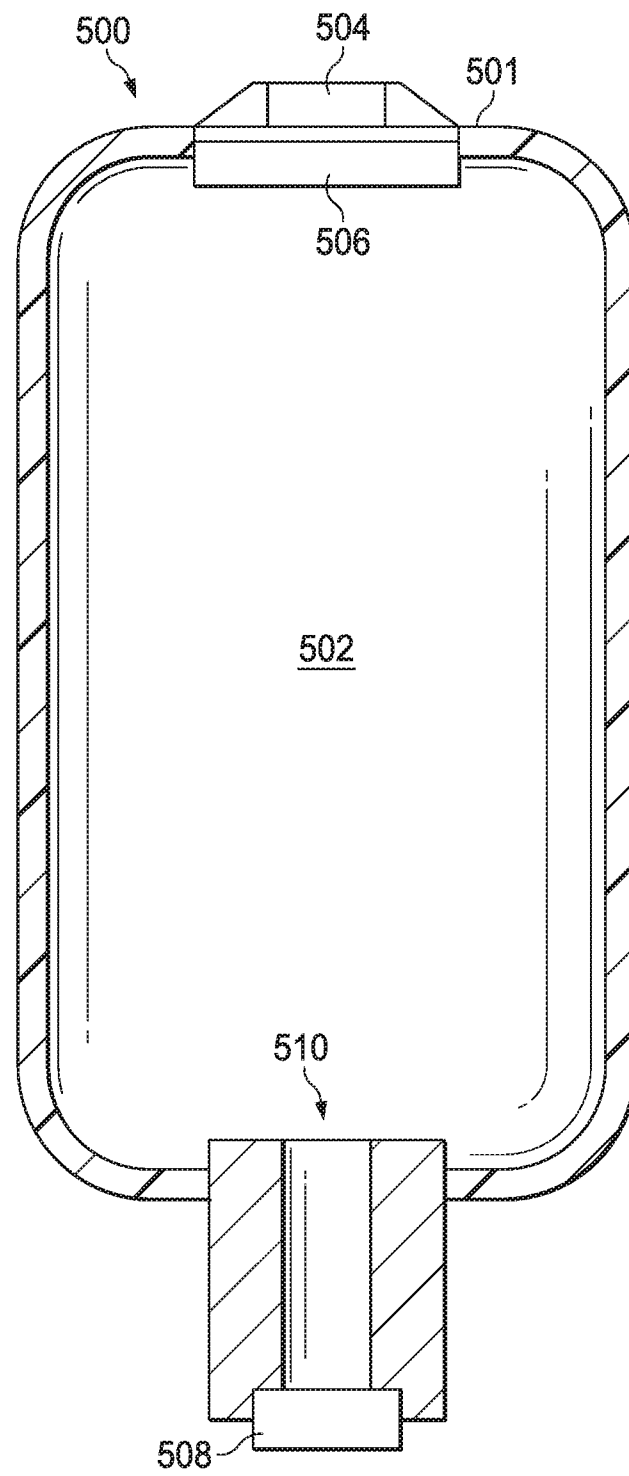


Fig. 5A

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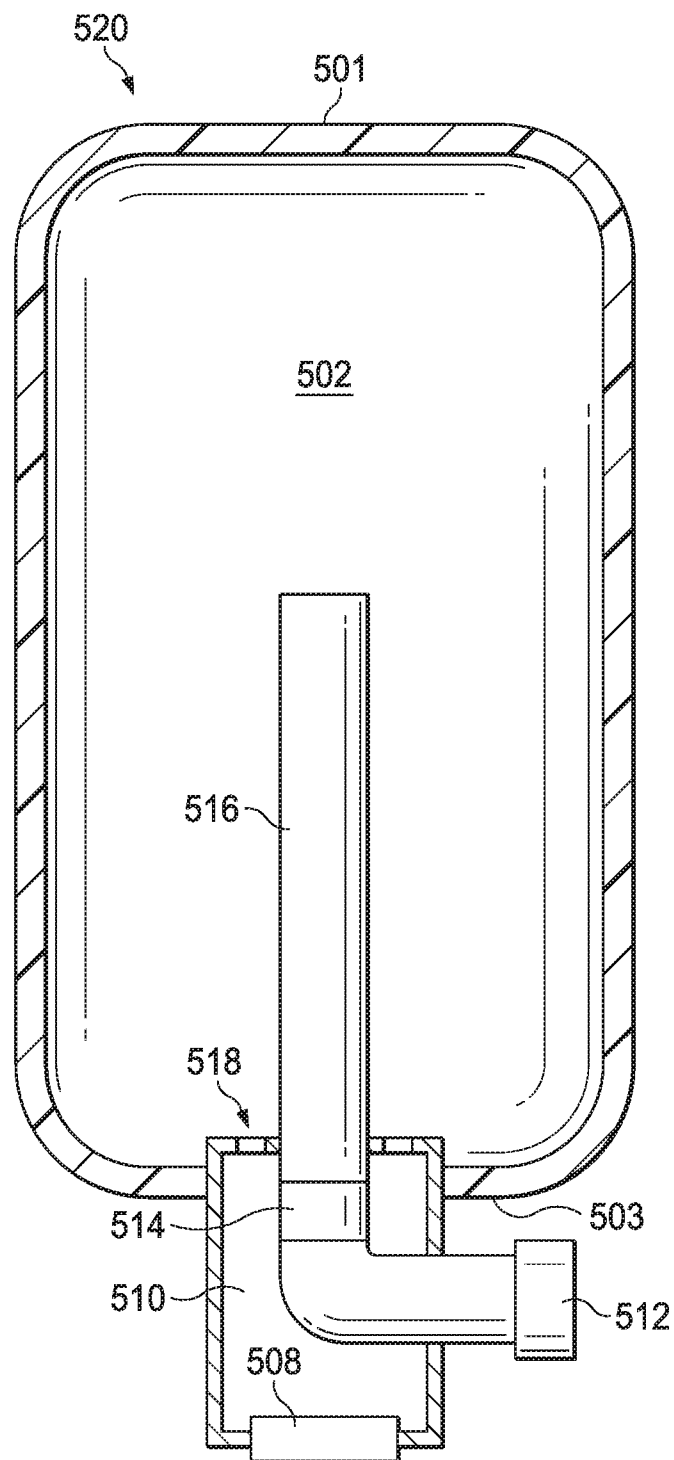


Fig. 5B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051664

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/36
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)
A61M A61F

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/331779 A1 (NYSTROM SIDNEY D [US] ET AL) 30 December 2010 (2010-12-30) paragraphs [0090] - [0099], [0104] - [0105]; figures 6,7a,7b,9 -----	1-20
Y	WO 2013/151904 A1 (OCUJECT LLC [US]) 10 October 2013 (2013-10-10) paragraph [0220] - paragraph [0242] -----	1-20
A	US 2010/030151 A1 (KIRSCH CLAUDIA [US]) 4 February 2010 (2010-02-04) paragraph [0005] -----	1-13



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

12 June 2017

Date of mailing of the international search report

29/06/2017

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

Authorized officer

Skorovs, Peteris

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/051664

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