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An agency of Industry Canada

CA 2395836 C 2007/12/04

(11)(21) 2 395 836

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2002/08/07

(41) Mise à la disp. pub./Open to Public Insp.: 2004/02/07

(45) Date de délivrance/Issue Date: 2007/12/04

(51) Cl.Int./Int.Cl. *B41J 2/175* (2006.01)

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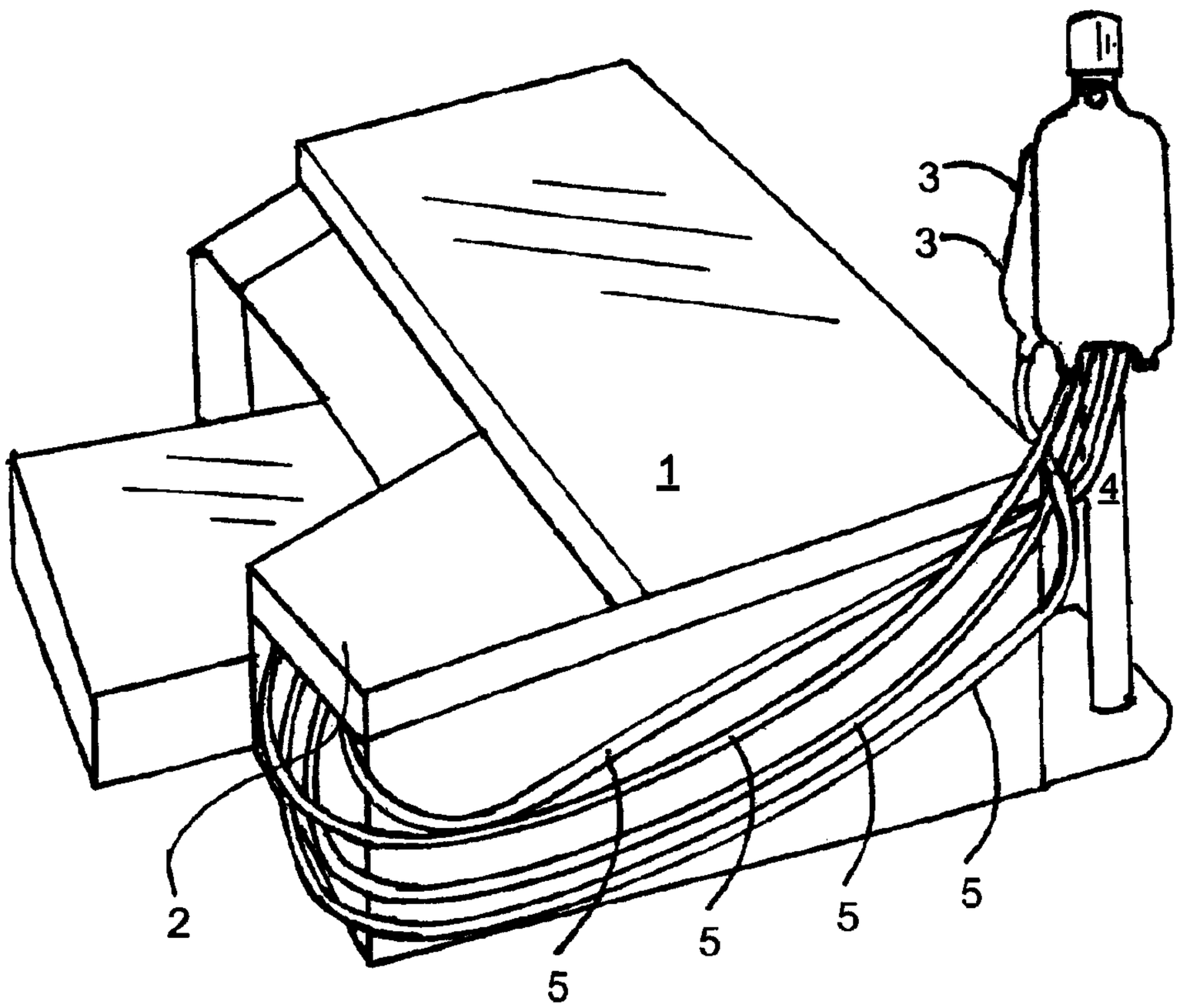
(54) Titre : SYSTEME ETENDU D'ALIMENTATION EN ENCRE POUR IMPRIMANTES A JET D'ENCRE
(54) Title: EXPANDED INK SUPPLY SYSTEM FOR INKJET PRINTERS



(57) Abrégé/Abstract:
An expanded ink supply system for an inkjet printer having a body and a print carriage and print head that moves in relation to a print medium and an ink cartridge inside the printer, the ink cartridge having a first quantity of ink and having an ink fill port, and having an ink container locateable outside the printer body for containing a second quantity of ink, tubing for transferring ink from the ink container to the ink cartridge, the tubing extending out through the ink fill port of the ink cartridge , so that ink in the ink cartridge is supplemented by ink from the ink container.

ABSTRACT OF THE DISCLOSURE

An expanded ink supply system for an inkjet printer having a body and a print carriage and print head that moves in relation to a print medium and an ink cartridge inside the printer, the ink cartridge having a first quantity of ink and having an ink fill port, and having an ink container locateable outside the printer body for containing a second quantity of ink, tubing for transferring ink from the ink container to the ink cartridge, the tubing extending out through the ink fill port of the ink cartridge , so that ink in the ink cartridge is supplemented by ink from the ink container.

EXPANDED INK SUPPLY SYSTEM FOR INKJET PRINTERS

The invention provides an expanded ink supply system for inkjet printers. The expanded ink supply system fluidically supplies an ink cartridge, which is intermittently fluidically connected to an array of movable printheads. Described are various means for creating the necessary pressure to force the ink from the expanded supply to a print cartridge. In one described embodiment, the ink supply is in the form of a bag, placed at a level higher than the ink cartridge, thereby utilizing gravity to force the liquid ink via tubing into the ink cartridge's fill port or alternatively, the cartridge's valve channel. Also described are methods to attach a fitting in the cartridge's fill hole or valve channel and methods for releasing trapped air from the ink supply system.

BACKGROUND OF THE INVENTION

This invention relates to replaceable ink supply systems. More specifically, the present invention relates to expanded ink supply systems for inkjet printers generally comprising an array of detachably mounted print cartridges containing a limited amount of ink and an array of separate print heads mounted on a carriage that reciprocates across a print medium such as paper in an inkjet printer. For the purposes of this invention it is necessary to distinguish between cartridges with printheads that are affixed to a cartridge and cartridges with separate printheads.

The expanded ink supply system according to the present invention comprises a used or new cartridge for the type of printers that are equipped with separate printheads, an expanded ink supply consisting of a bag containing ink and tubing that fluidically connects an outlet in the bag to said ink cartridge. The bag is advantageously, but not necessarily, equipped with two ports for the ink of which one is used for filling and the other one for supplying the cartridge.

Ink supplies for inkjet printers with separate printheads generally consist of a cartridge equipped with a pump and a septum to intermittently supply a separate printhead via fluid conduit to a printhead filling station typically located at one end of the printer carriage's maximum stroke. Separate printheads must be protected against damage by a continuous supply of ink and therefore, ink cartridges in printers of said kind are equipped with electronic means to estimate the ink consumption and to stop a printer from working when the quantity of ink in a cartridge is estimated to be depleted or close to being depleted. A depleted cartridge is still fully functional and such cartridges are often manually refilled for continued use. The refilling procedure is both time consuming and also creates objectionable stains on persons and materials. The present invention makes refilling unnecessary insomuch that the quantity of ink in the expanded ink supply system is several times the quantity in the original cartridges.

It is commonly held by persons skilled in the art that printheads should operate under negative pressure as described in U.S. Pat. No. 6,283, 586. Positive printhead pressure may cause the printhead to drool. This is only of particular concern for printheads that are affixed to a cartridge, but not to printers equipped with separate printheads of the kind here described. In printers with separate printheads, extreme overpressure conditions in the ink emanating from an external ink supply will be diminished or stopped by the cartridge's internal valve and a septum in the printhead fill station.

The present invention employs continuous overpressure to prevent air ingestion into the cartridge and the fluid connections. Air that reaches the printheads may damage them severly. A liquid such as an ink solution will be more disposed to dissolve air when the solution is under negative pressure. Thus, printing systems relying on capillary action and accompanying negative pressure will be more prone to air ingestion and the printheads in such systems will deteriorate more rapidly. Thus, a prominent feature of the invention is the overpressure condition and the ensuing prolonged life of printheads due to diminished air ingestion. Another reason, according to U.S. Pat. No. 6,283,586, is that each original cartridge contains a certain amount of air and frequent cartridge replacements due to the small ink capacity of the original cartridges, the printhead air budget limit will thus be exceeded in a shorter time span than when, advant-ageously, expanded ink supplies of the kind described in the present invention are used. Due to prevention of air ingestion and a positive ink flow to the printheads, according to this invention,

overpressure conditions corresponding to between 50 and 200 millimeters prolong the life of printheads considerably.

Positive pressure conditions according to the present invention are accomplished by several means. The preferred embodiment of the invention uses the force of gravity to directly feed ink from an inkbag at a higher level than the ink cartridge inside the printer. Indirect use of gravity or the use of bags to feed a cartridge is recited in U.S. Pat. No. 5,751, 319 describing an arrangement in which the cartridge is fed at a pressure substantially close to zero employing a float valve to regulate the flow to the cartridge, while U.S. Pat. No. 5,369,429 describes a system with an ink bag where the ink cartridge is kept at sub-atmospheric pressure and the printhead and cartridge are one unit.

In an alternative embodiment of the present invention, the inkbag is pressurized by placing a mass such as that of the printer itself over the inkbag. Typically, a printer relies on three ink colours (cyan, yellow and magenta) in addition to black ink and these inks are then stored in four separate bags. When the ink bags are pressurized by the mass of the printer itself, the inkbags according to the present invention are horizontally disposed between two surfaces of which at least one has a deformable surface covering to equalize the variances in pressure in the inkbags. In a second alternative pressurization embodiment, the use of a separate weight for each ink bag disposed similarly to the first alternative embodiment is used.

Pressurizing the system using gravity once the system is assembled is important. Equally important are methods described in the present invention to remove air from the expanded ink supply system during assembly. One such mechanical method according to the invention employs the forced movement of the ink through the fluid conduit to force any air to locations in the system where the air can be removed, which is described below.

The major quantity of air present in the expanded system after filling with ink is collected by allowing the ink to flow between the cartridge and the expanded ink bag in such a way that any air bubbles in the system are collected in the expanded ink bag. Most advantageously, but not necessarily, the ink bag is equipped with two openings of which one is in fluid connection with the cartridge and the other one is used for filling and also expelling visible air bubbles.

An alternative method to remove air from the system makes use of the cartridge pump and septum. By first forcing any air bubbles present in any part of the expanded ink supply system to the cartridge and then orienting the cartridge so the air is collected in close proximity to the pump channel, air can be admitted to the pump chamber by operating the pump. A hollow needle is forced into the cartridge septum to allow air or air and ink mixed together to be expelled from the pump chamber when the pump's flexible diaphragm is pressed. Preferably, the hollow needle is attached to tubing and a container to collect the air/ink effluent mixture.

A method to permanently seal said fill port of the ink bag after air has been released and only ink is present in the fill port is also included in the present invention. This is accomplished by inserting suitable fittings into the ports of the bag. One of said fittings is used in the bag's fill port and is also connected to a main ink fill supply via tubing. The fittings are thermoplastically deformable so that a suitable hot tool can melt and fuse the fitting end connected to the main ink fill supply making it possible to seal the bag after air has been expelled through the fitting and only ink is present in the fitting.

Although cartridges of the type here described have electronic means to estimate the quantity of ink remaining in a cartridge in an inkjet printer and such means are helpful when a cartridge is new, such means are of no use when used cartridges are continously supplied from an expanded ink supply according to the present invention. Typically, a new cartridge will report that the ink level is low or the cartridge is empty when it is removed after first use from the printer as is explained in U.S. Pat. No. 6,170,937. After refilling with new ink, the cartridge's integral memory chip will still report that the ink level is the same as it was when the cartridge was removed. An empty condition will however revert to being reported as low ink condition when used for the purposes of this invention. The present invention does not rely on electronic reporting of the ink condition. Instead, simple and dependable visual means are employed. Thus, a prominent and important feature of the invention is the transparent conduit used and, optionally, the transparent casing for the original ink cartridge that both are helpful for estimating how much ink is left in the system. Also, the inkbags are advantageously, but not necessarily, transparent.

We now turn to the specific methods for gaining access to the ink container inside a used or new cartridge. Ink cartridges for use together with separate printheads typically have three main parts comprising firstly the inner part with the internal ink volume and pump, secondly the cap containing the microchip for reporting ink condition and thirdly the casing. The inner part is enclosed in the casing and the cap. The casing and the cap are joined together by common mechanical means and a label tape. Severing of the casing and the cap is commonly done by removing the tape or cutting through it with a knife, both methods long known and described in early now expired patents. Therefore, such rudimentary methods to gain access to the inner part are not further described for the purposes of this invention. In a new cartridge, the cartridge's inner part's fill port is in the shape of a tube blocked by a resilient shape fitting the inside of the tube. Although basic and common tools are employed, such as using a threading tap or a pointed tool, methods to remove the resilient shape, most often in the form of a ball, are described more recently in U.S. Patents No's: 6,170,937 and 6,283,586. The present invention includes a novel method to remove the resilient shape from the tube by inserting a tool shaped like a fishhook's barbed end into the ball and then pulling it out making the cartridge port open for insertion of an elbow fitting.

The elbow fitting to be inserted into the cartridge fill tube is most advantageously equipped with barbs for the tubing at one end while the fitting is threaded at the end to be screwed into the cartridge's fill tube. Therefore the inside of the fill tube must first be threaded by use of a common tap with the same thread as that of the fitting. A common sealing compound such as silicone may be applied to the fitting before it is screwed into the cartridge fill hole. Alternatively an angled fitting with barbs at both ends to which optionally a common sealing compound has been applied, can be pushed into the fill hole. During assembly of the expanded ink supply system, for both types of fittings, flexible tubing is forced over the barbed end, pushed through a hole in the cartridge casing and then connected to the barbed end of a connector inserted into the opening in said ink bag. The cartridge, the bag and the tubing now comprise the expanded ink system and is ready for filling. In a third alternative, a U-shaped fitting with barbed ends is used. One of the legs of the U is pushed into the cartridge's fill opening while the other leg is attached to tubing leading out of the cartridge through a hole and then connected to said expanded ink bag.

SUMMARY OF THE INVENTION

The invention applies to an expanded ink supply for inkjet printers that have detachably removable cartridges and printheads separately mounted in a carriage transversing a medium such as paper. An expanded ink supply for of the type here described comprises a collapsible bag containing ink, fluid conduit to continuously transfer the ink to an existing ink cartridge and means to attach the fluid conduit to an existing ink cartridge. In a first preferred embodiment, positive pressure is created by placing the bag at a higher level than the cartridge by suspending the bag from a stand. In a second alternative, positive pressure can be created by placing a weight such as the printer itself or as a third alternative a separate weight over the cartridge. The coupling of the conduit to the cartridge is done by removing an elastic body inserted into the cartridge's fill port channel by using a hook and then threading the channel with a tap. The fitting for the fluid conduit is then screwed into the threaded channel. Alternatively, the elastic body is removed with the hook and a barbed elbow or U-shaped fitting is then pushed into the channel opening.

The invention includes several modifications to a cartridge such as severing and permanently removing part of the cartridge's interior ink container to reveal the pump channel into which a barbed or threaded fitting is inserted and coupled to an inkbag via fluid conduit.

Also included in the invention are methods to remove air from the system by pumping using a cartridge's flexible diaphragm and by closing an ink bag after filling with ink using a heat sealing method to prevent air from re-entering through the bag's fill channel. The invention also includes a method to remove air dissolved in the ink by heating the main ink supply container either by heating the container itself or by using an immersion heater.

The stand for suspension of ink bags according to the invention advantageously consists of an upright such as a rod or tube of metal or polymeric material, a cap to top off the upright and a base plate of such a shape that the stand can either be free-standing or, alternatively and advantageously, part of the stand's base can be inserted underneath an inkjet printer to stabilize the stand with the suspended ink bags.

In the drawings, which form part of this specification,

Fig. 1 depicts a printer with an expanded ink supply system attached to it;

Fig. 2 is a partial view of a printer with the lid over the cartridges in the open state;

Fig. 3 is a perspective view showing the stand illustrating the base plate, the upright, the cap and a cross arm to suspend the ink bags from;

Fig. 4 is a perspective view with a cutout showing the base plate of the stand inserted under the bottom of a printer;

Fig. 5 depicts the expanded ink supply's fluidically coupled components in the assembled state;

Fig. 6 is an exploded view depicting the expanded ink supply's fluidically coupled components in the dis-assembled state;

Fig. 7 is an exploded perspective view of a typical arrangement showing a printer, an intermediate pressure plate and horizontally placed inkbags placed on a compressible base plate along with fluid conduits;

Fig. 8 is a partial sectional view of a cartridge with an attached effluent conduit taken generally on a line through the cartridge inner part;

Fig. 9 is a side view of a modified cartridge with a fitting and fluid conduit inserted into the cartridge's pump channel;

Fig. 10 is perspective view depicting the nose of a tool being used to seal the fitting of an inkbag;

Fig. 11 is a perspective view of a hook and an elastic body in the fill port of a cartridge.

DETAILED DESCRIPTION OF THE INVENTION

In the preferred embodiment of the invention illustrated in FIG. **1**, the expanded ink supply system comprises the inkbags **3** suspended from stand **4**, fluidically connected with tubing **5** to printer **1**. Tubing **5** enters printer **1** under the partially open lid **2**. As seen in FIG. **2**, tubing **5** enters cartridges **6** through holes **7**.

Stand 4 comprises as seen in FIG. **3** base plate **10**, upright **9** and cap **11**, all made of metal or polymeric material. Bags **5** are suspended from cross arm **12**. Base plate **10** is advantageously, but not necessarily, square and of adequate thickness to provide stable support for upright **9** and bags **3**. As seen in FIG. **4**, also advantageously, but not necessarily, the location of upright **9** on base plate **10** is offset toward corner **13** allowing opposite side **14** to be inserted under an edge **15** of printer **1** to gain additional support for upright **9** and bags **3**. Upright **9** is attached to base plate **10** by common means such as welding or screwing .

As illustrated in FIG. **5** a unitary inkbag assembly comprises inkbag **3**, tubing 5 and cartridge 6. Inkbag **3** is coupled to tubing **5** via supply port 16. Fill port **18** is sealed and further described in FIG. **6**. Tubing **5** enters cartridge **6** via hole **7**.

As seen in the exploded view in FIG. **6**, inkbag **3** is sealed at fill port **18** by fitting **19** most advantageously, but not necessarily, utilizing the sealing method described herein and depicted in FIG. **10**. Fitting **17** is inserted in supply port **16**. Tubing **5** is attached to fitting **17**, inserted through hole **7** and continuosly transfers ink via fitting **20**, **20a** or **20b** via fill opening **21** to cartridge **6**.

The parts of cartridge 6 are also depicted in the exploded view in FIG. **6**. Casing **22**, most advantageously, but not necessarily, made of transparent, polymeric material to reveal the quantity of ink left inside inner part **23**, encloses inner part **23** together with end cap **24**. Hole **21** in casing inner part **23** is advantageously, but not necessarily, threaded to accommodate threaded and barbed elbow fitting **20**. Alternatively, hole **20** is not threaded to accommodate barbed elbow fitting **20a** or barbed U-shaped fitting **20b**. Pump **25** and septum **26** are permanently affixed to inner part **23**.

As seen in FIGURES **1** and **4**, bags **3** are placed at a higher level than the cartridges **6** to create positive pressure. Another means to create positive pressure is seen in FIG. **7**, which is an exploded view of printer **1** over pressure plate **27**, which in turn is placed over ink bags **3** resting on compressible plate **28**. Pressure plate **27** advantageously consists of metal or polymeric material, while compressible plate **28** may consist of a polymeric material such as commercially available foam sheet.

Methods to remove air according to the invention consist of letting air escape during the fill process via fill port **18** in FIG. **6** or alternatively and advantageously, pump any air present in inner part **22** out via pump channel **29** and septum **26** using flexible diaphragm **30** as depicted in FIG. **8**. Air **31** collects in the vicinity of pump channel **29** when the cartridge is held so flexible diaphragm **30** points upwards. Pushing on diaphragm **30** pressurizes pump chamber **34** which is in fluid connection with septum **26**, hollow needle **32** and effluent tubing **33**. Effluent stream 35 out of end of tubing **33** typically consists of a mixture of air bubbles and ink which advantageously is collected in a suitable container **36** for re-use in the filling process.

Referring now to FIG. **9**, another means to transfer ink to a printer **1** consist of using a part of a cartridge 6. New configuration **22a** for inner part **22** only includes part of original inner part **22** (as seen in FIG. **6**) with the pump and septum assembly remaining intact and functional allowing fitting **37** to be inserted in pump channel **29**. Fitting **39** to be inserted in pump channel **29** is advantageously, but not necessarily barbed. Alternatively, channel **29** can be threaded to accommodate a threaded fitting.

Advantageously, but not necessarily, bags with two ports are used in the expanded ink supply system. Tubing **39** in FIG. **10** is in fluid connection with an ink bag fill container typically containing 10 or more times ink than bag **3**. After filling bag **3** to desired weight or volume, fill port **18** is sealed. Fill port **18** and fitting **39** together with tool **38** comprise the sealing means for bag **3**. During filling bag **3**, fitting **19** and tubing **39** are filled with ink. Tool **38**, which conveniently is equipped with two opposing and movable jaws **40**, is hot and able to melt thermoplastic tubing **39** and thermoplastic fitting **19** to form a durable seal when the jaws **40** close.

Cartridge **6** fill port **21** as shown in FIG. **6** is originally closed with an elastic body, usually in the form of a sphere **41** as shown in FIG. **11**. A method and a tool to remove elastic, sphereoidal body **41** utilizes a barbed hook **42**, which is pushed into body **41** preferentially at an angle to the fill port channel. When barb **43** is pushed below the surface of spheroidal body **41**, body **41** can be pulled out.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1.An expanded ink supply system for an inkjet printer having a body and a print carriage and print head that moves in relation to a print medium and at least one ink cartridge inside said printer, said ink cartridge having an inner part holding a first quantity of ink and having an ink fill port , comprising:

an ink container locateable outside said printer body for containing a second quantity of ink ;

tubing means for transferring ink from said ink container to said ink cartridge via said ink fill port;

said tubing extending out through said ink fill port of said ink cartridge thereby fluidically connecting between said ink cartridge and said ink container at its location outside the body of said inkjet printer;

whereby said ink in said ink cartridge is supplemented by ink transferred from said ink container.

2.An expanded ink supply system for an inkjet printer as claimed in claim 1 wherein the ink in the ink cartridge is in fluid connection with the ink contained in said ink container external to the inkjet printer.

3. An expanded ink supply system for an inkjet printer as claimed in claim 1 wherein the ink container is in the form of an ink bag containing said ink with an outlet at a height above the ink fill port of the ink cartridge and means to support said ink bag at said height.

4. An expanded ink supply system for an inkjet printer as claimed in claim 1 wherein a stand is provided to support at least one suspended ink bag fluidically connected to the ink container.

5. An expanded ink supply system for an inkjet printer as claimed in claim 1 wherein said ink container is in the form of a bag and wherein said bag is adapted to be inserted underneath said inkjet printer whereby to apply the mass of said inkjet printer to said bag for delivery of ink therefrom to said ink cartridge .

6. An expanded ink supply system for an inkjet printer as claimed in claim 4 and including means to structurally support and attach at least one said ink container to a separate stand not attached to said inkjet printer.

7. An expanded ink supply system for an inkjet printer as claimed in claim 1 wherein said ink container has an outlet at a height below the ink cartridge; and a mass adapted to be applied to said ink container whereby to force the ink to the ink fill port.

8. An expanded ink supply system for an inkjet printer as claimed in claim 7 wherein, the ink container is horizontally disposed on a compressible medium, and including a pressure plate inserted between said inkjet printer and said ink container .

9.An expanded ink supply system for an inkjet printer as claimed in claim 1 including a fitting inserted into the ink fill port in the ink cartridge to allow said tubing

means free passage therein.

10.An expanded ink supply system for an inkjet printer as claimed in claim 5 wherein the ink cartridge comprises a casing, and a transparent cap for said casing to allow the inkjet printer user to check the amount of ink remaining in the said ink cartridge.

11.A method supplying make up ink to an ink cartridge in an ink jet printer, said ink cartridge having an ink fill port , and comprising the steps of;

connecting an ink container to said ink fill port of said ink cartridge of an ink jet printer;

applying pressure to said ink in said ink container whereby to cause said ink to flow from said ink container to said ink cartridge .

12. A method supplying make up ink to an ink cartridge in an ink jet printer, as claimed in claim 11 and further including the steps of venting air from said ink cartridge prior to admitting said make up ink thereto.

13. A method suppling make up ink to an ink cartridge in an ink jet printer, as claimed in claim 11 wherein said ink cartridge has a flexible diaphragm and including the steps of holding the ink cartridge in a first position so that any air inside the said ink cartridge will be stored in the immediate vicinity of the ink fill port, and activating said flexible diaphragm to pressurize the air, and turning the ink cartridge into a second position to allow any air ingested into the said ink cartridge to rise.

14.A method suppling make up ink to an ink cartridge in an ink jet printer, as claimed in claim 11 and further including the steps of heating the ink .

15.A method suppling make up ink to an ink cartridge in an ink jet printer, as claimed in claim 13 and including the step of immersing the said ink container in a medium at a higher temperature than room temperature.

16.A method suppling make up ink to an ink cartridge in an ink jet printer, as claimed in claim 11 and including the steps of threading said ink fill port and screwing a connection fitting into said ink fill port.

DRAWINGS

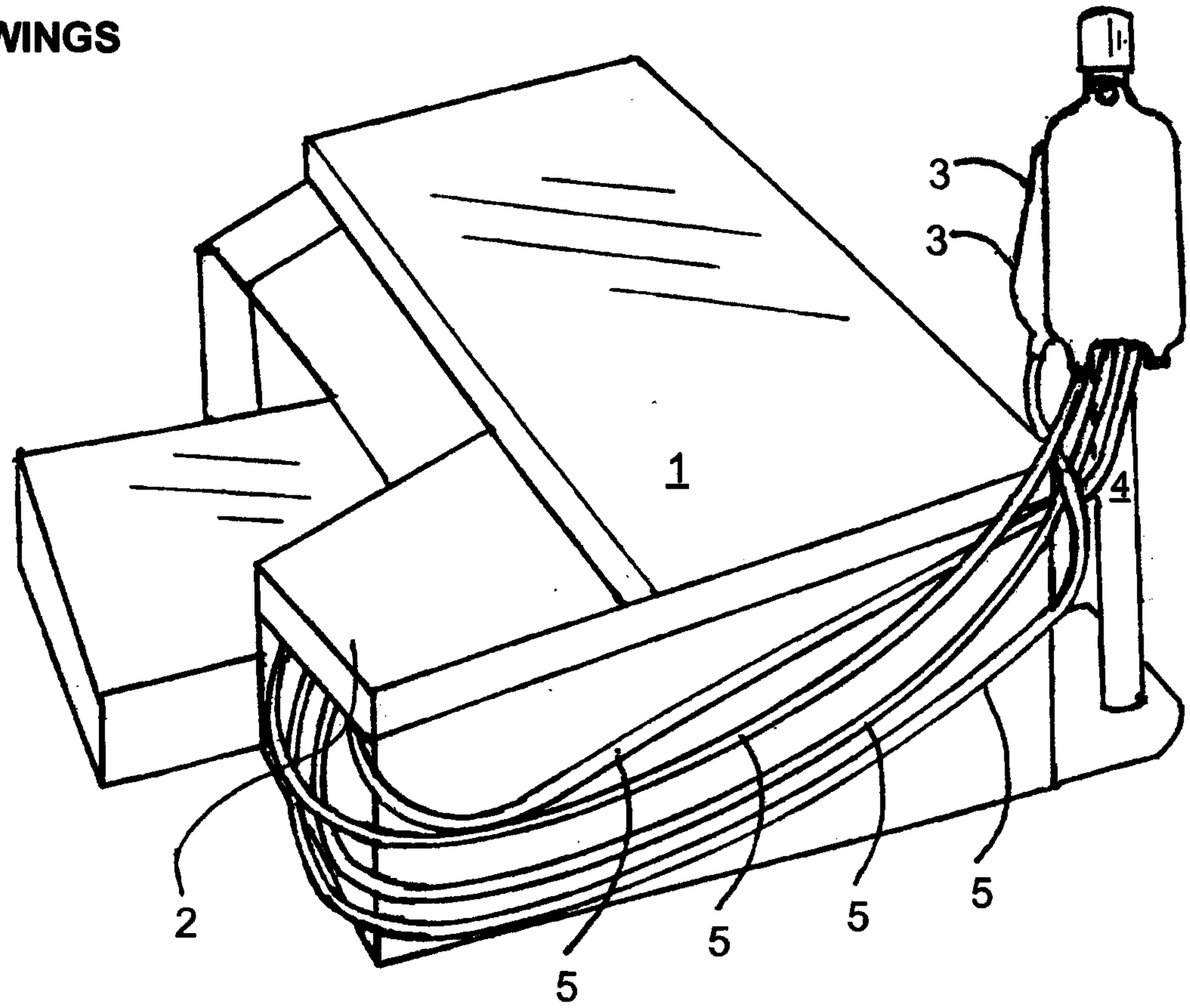


Figure 1

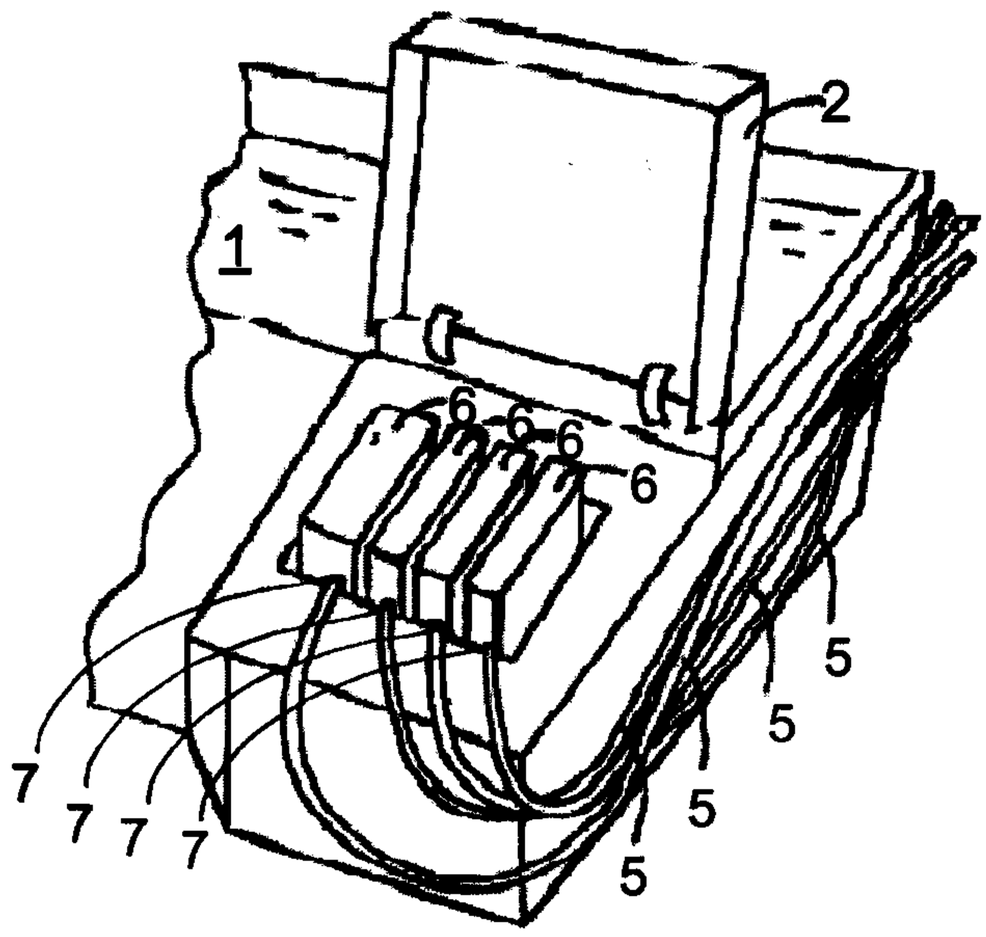


Figure 2

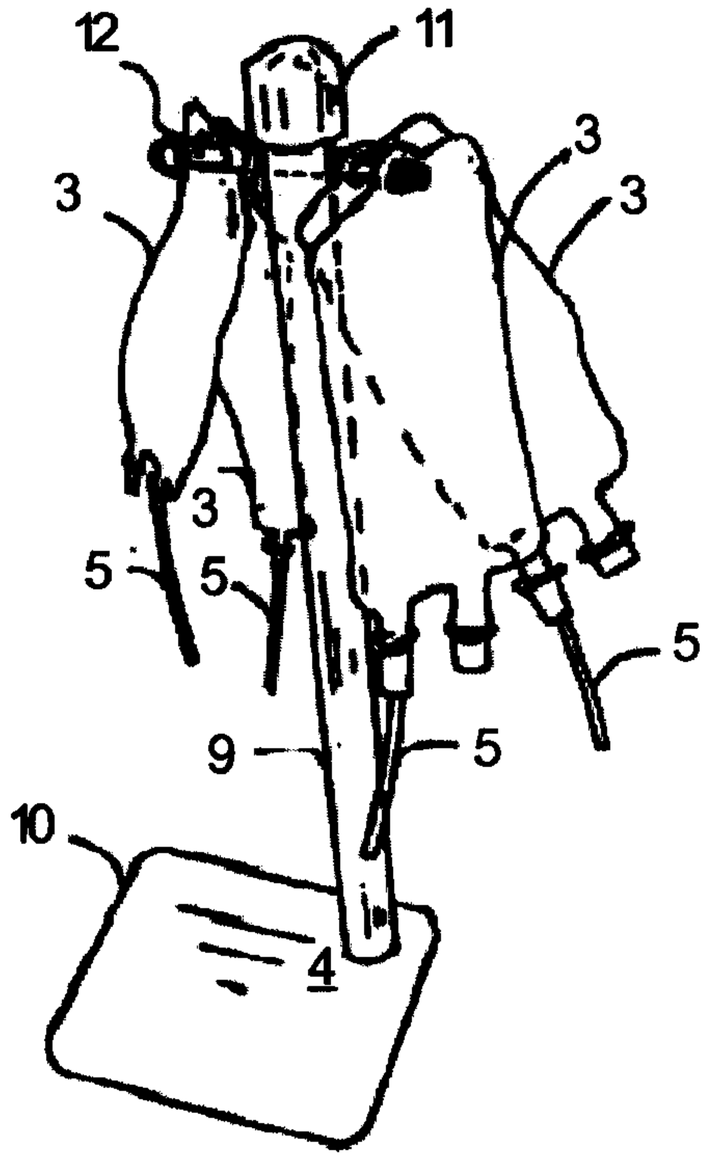


Figure 3

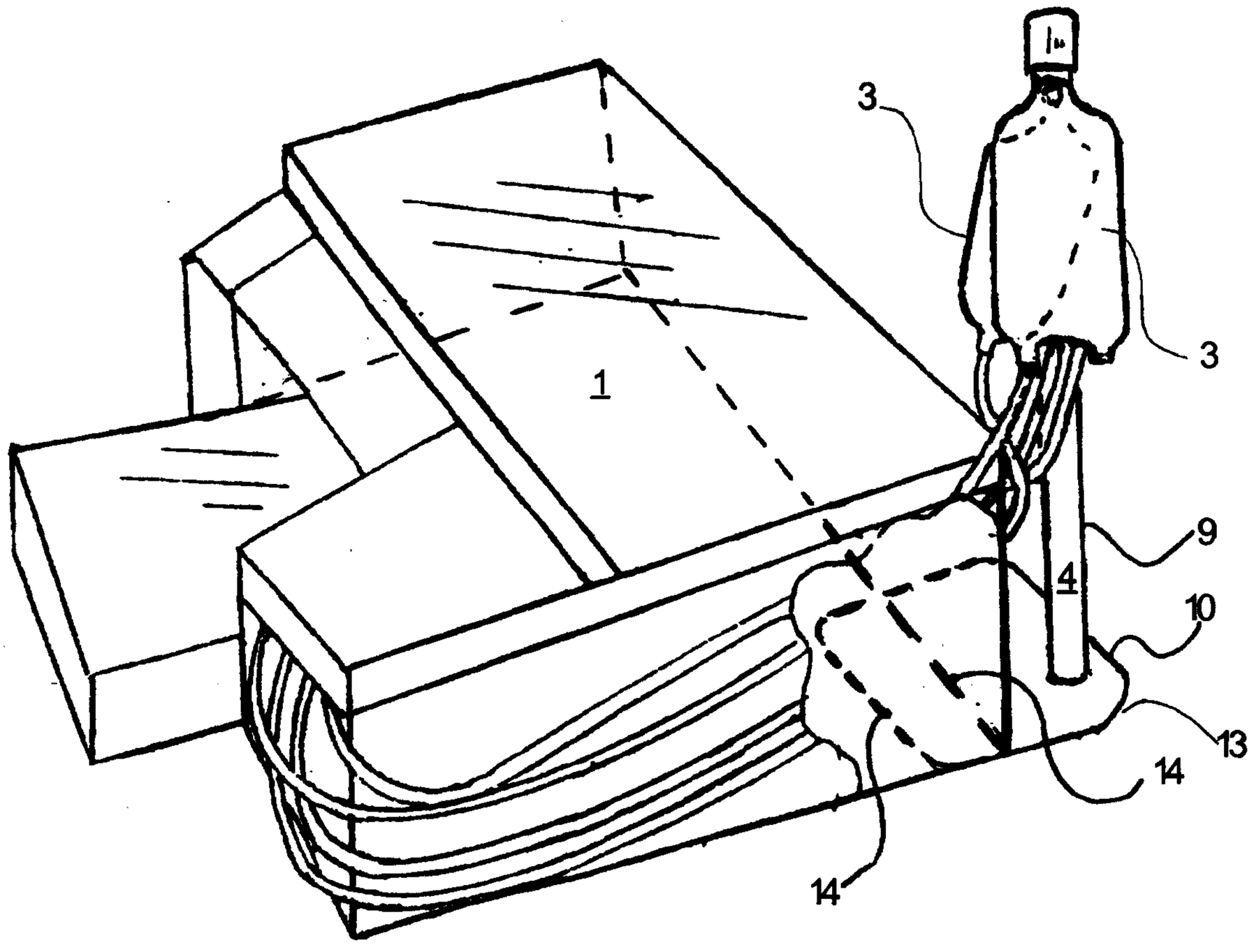


Figure 4

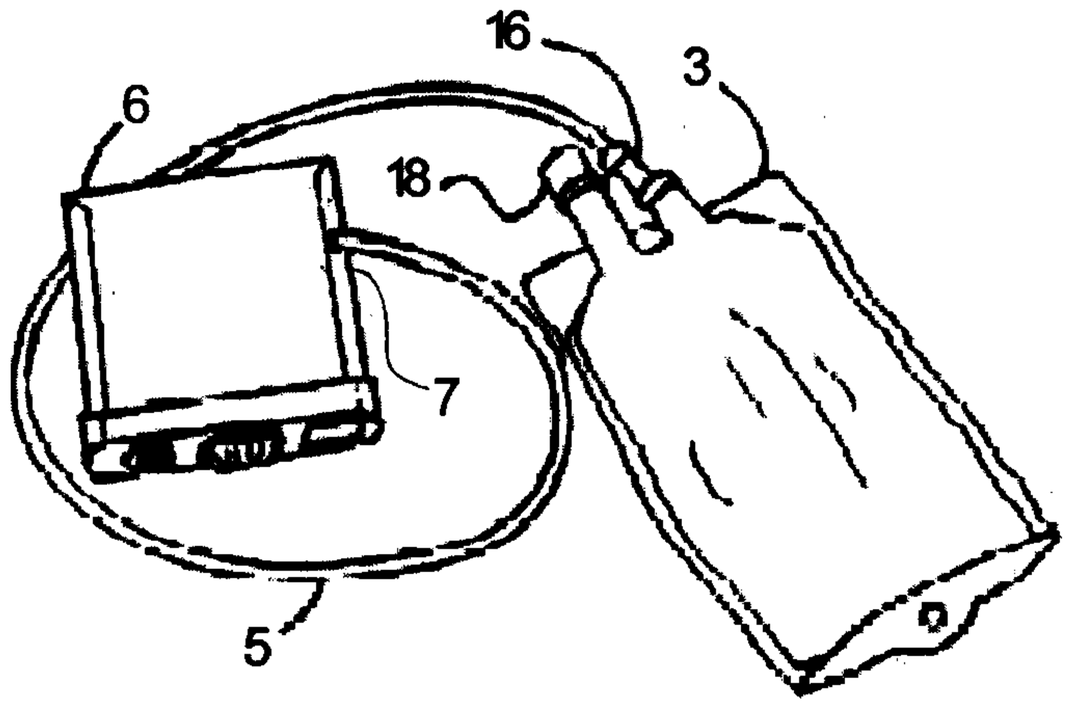


Figure 5

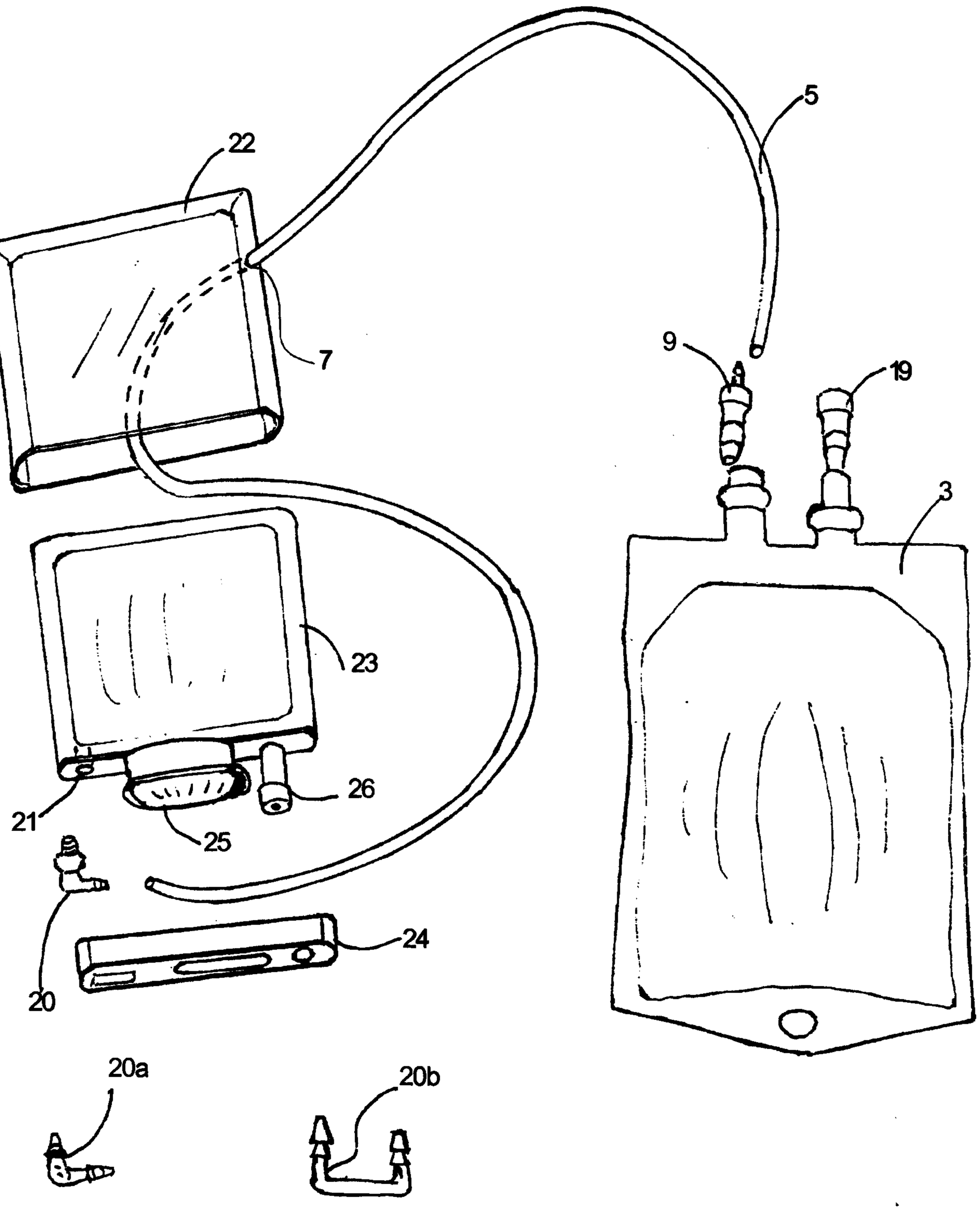


Figure 6

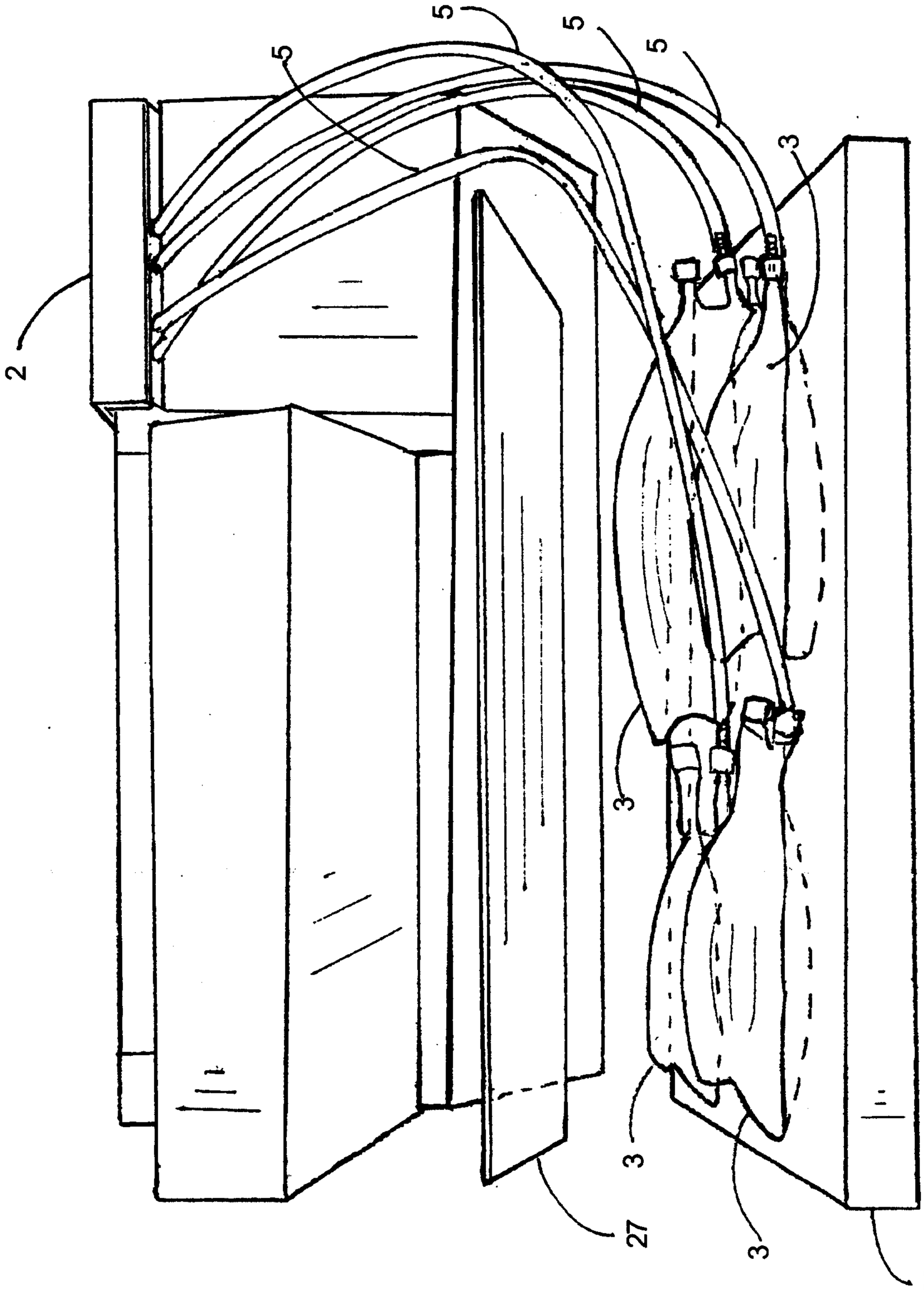


Figure 7

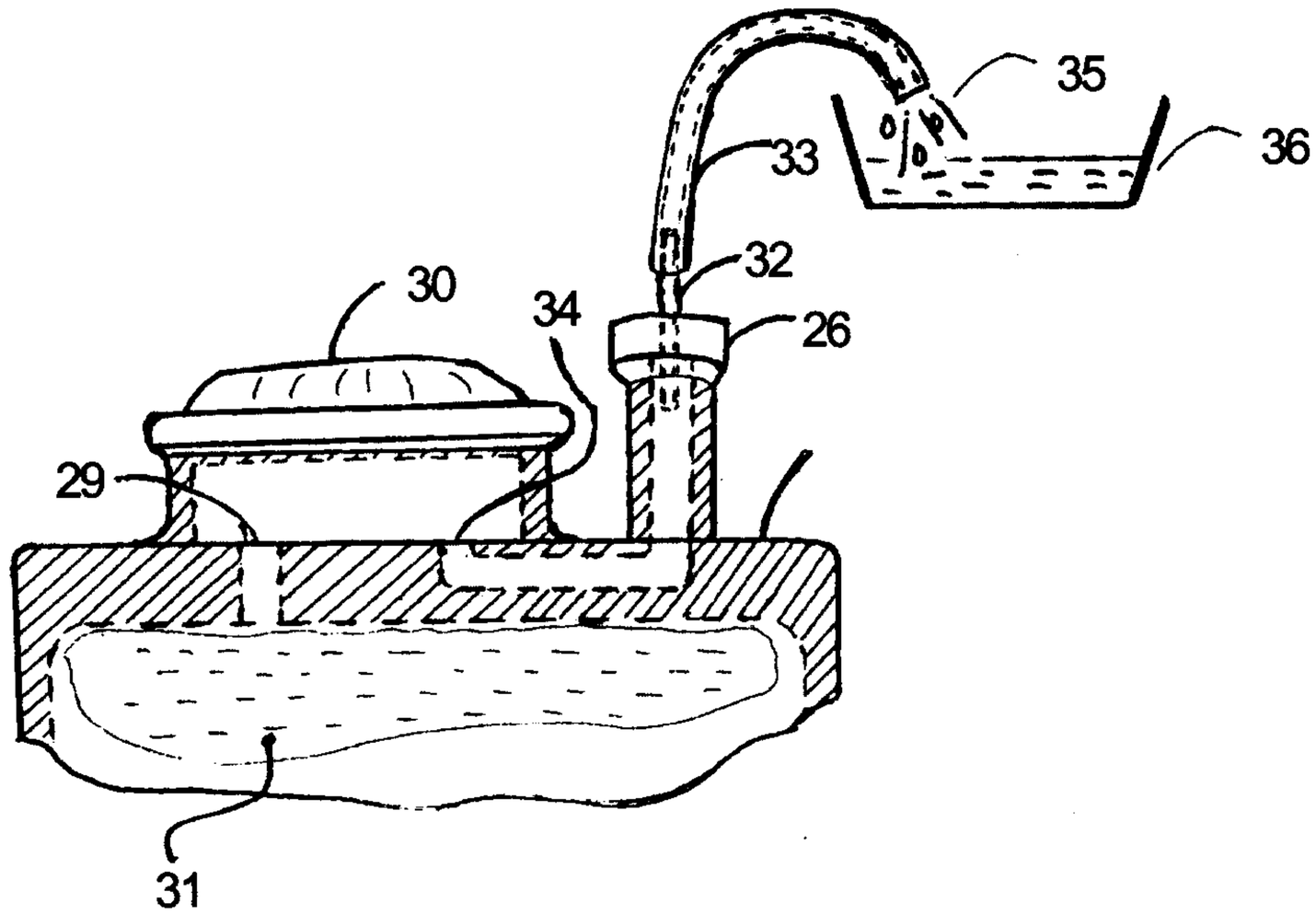


Figure 8

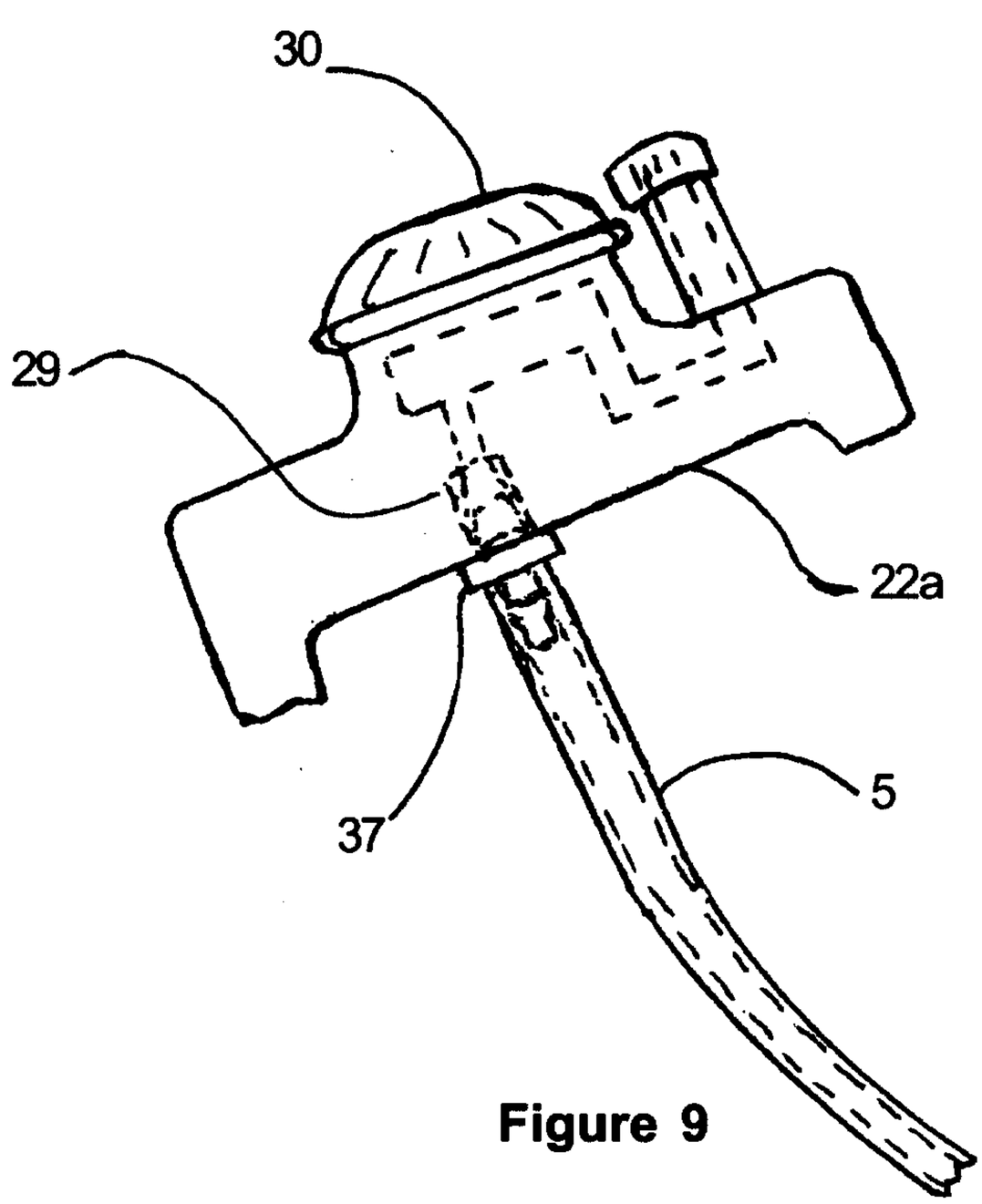


Figure 9

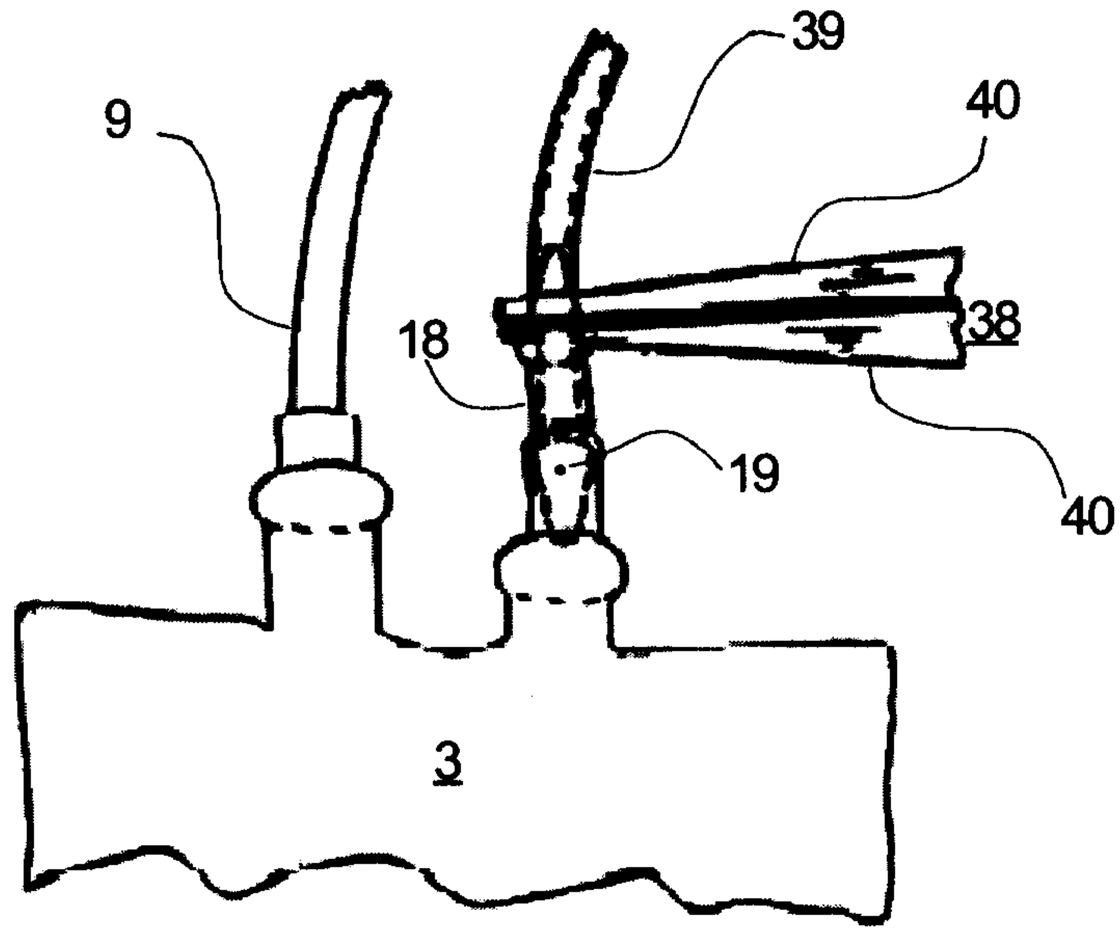


Figure 10

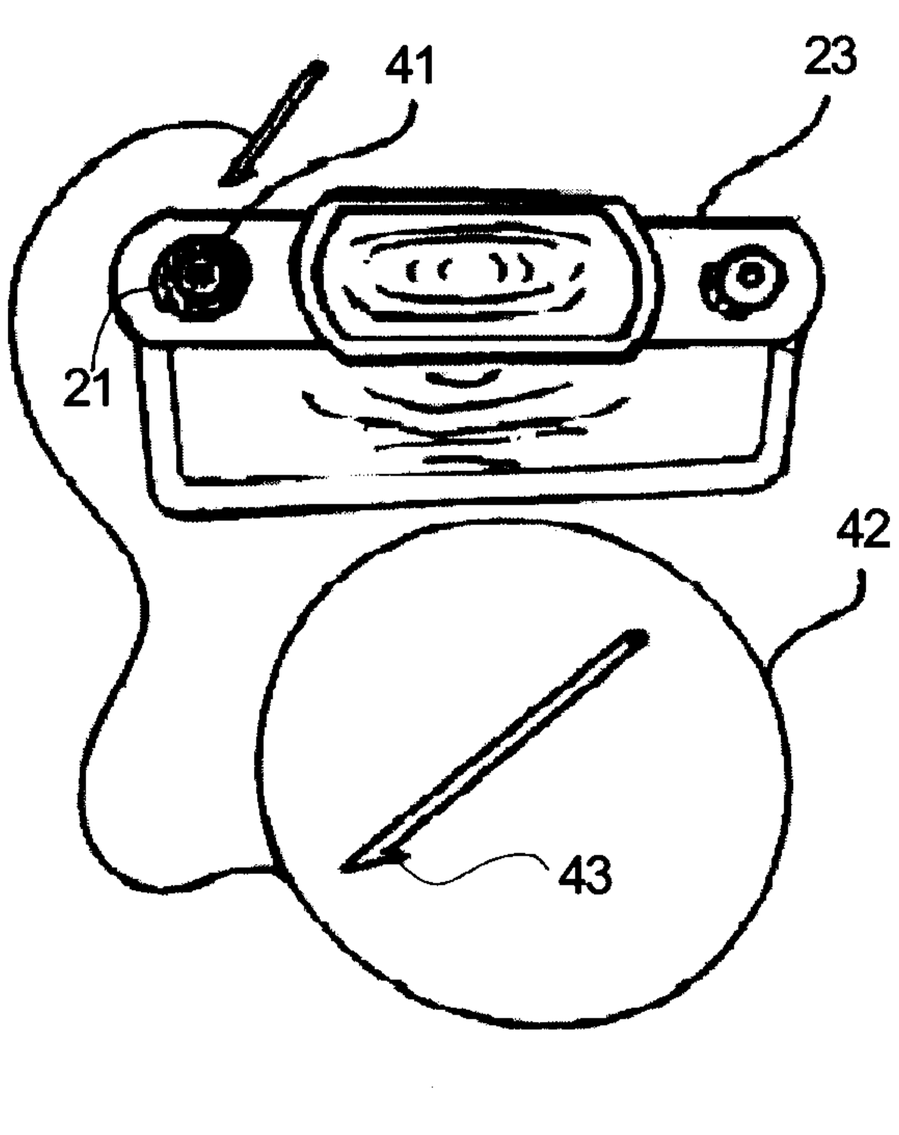
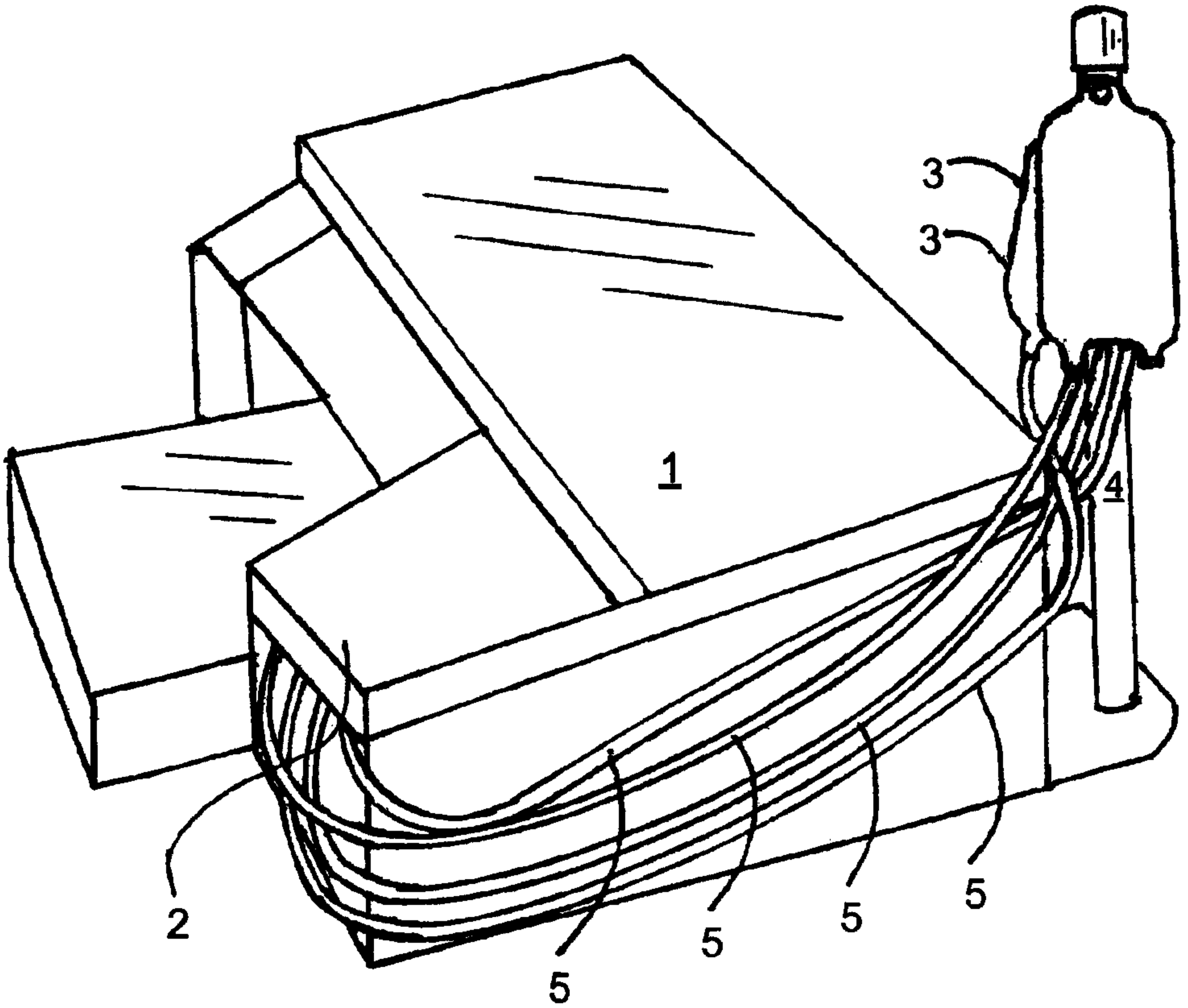


Figure 11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