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(54)

Ink-jet cartridge

(57) The present invention is about an ink-jet cartridge (1) for thermal bubble ink-jet printers, which comprises: a housing (11), for containing the necessary printing ink (13) for the printer; a printhead (14), having a plurality of opening orifices, through which ink may stream forth unto paper upon demand; and a pressure-adjustment means (12), having a hollow tube for receiving

ink therewithin, and one end of which having a ventilation opening for contact with the atmosphere and the other end thereof having at least one opening for contact with the ink, wherein said ventilation opening of the pressure-adjustment means being fixed onto the housing of the ink-jet cartridge and said opening being positioned at the bottom portion of the ink-jet cartridge on the same said as the printhead.

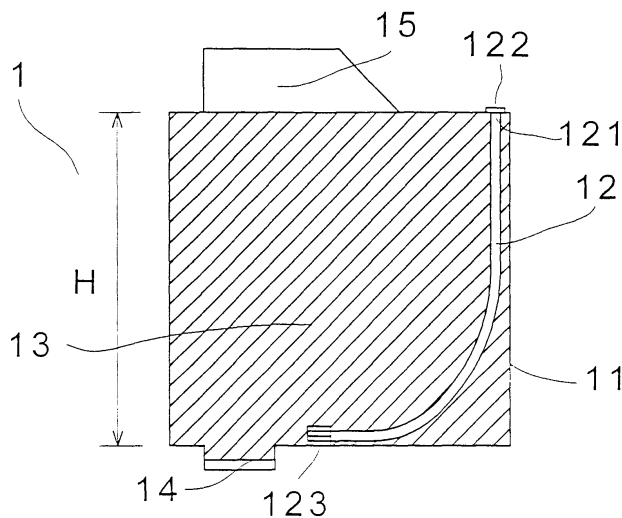


Figure2

Description

FIELD OF THE INVENTION

[0001] This present invention relates to an ink-jet cartridge for ink-jet printers; especially to a pressure-adjusting means internal to the ink-jet cartridge, so that the ink-jet cartridge does not leak ink as conditions change in the surrounding and is able to adjust its back pressure so that even when the ink level is low, ink can still be discharged smoothly.

DESCRIPTION OF THE PRIOR ART

[0002] Currently computer printers are generally available in three kinds: dot-matrix printers, ink-jet printers and laser printers. The dot-matrix printers are generally lower priced, but as their printing is slower and inferior in quality, they are unable to compete against ink-jet or laser printers in the general market and are confined to special niches for their usage. The great majority of printers available in the market are ink-jet and laser printers, each having its respective strengths and weaknesses. For instance, ink-jet printers are lower in price but cost more in printing. On the other hand, laser printers are more expensive, but cost less in printing. In addition, laser printers are generally confined to black-and-white printing only (because color laser printers are very expensive and generally high quality drafts are printed). On the other hand, ink-jet printers can print both black/white and color, and at greatly raised resolutions (from 300 dpi to 1200 dpi), so demand for them has soared recently. Therefore, given the limited storage space provided in the ink-jet cartridge, the problem of storing maximum amount of ink and insuring steady ink discharge under various changing conditions in the environment so as to lower the printing cost, thus becomes a pressing task.

[0003] To have maximum ink stored in the ink-jet cartridge, the simplest way is to fill the ink-jet cartridge with ink completely. However, there are many factors not susceptible to easy control that can affect the ink discharge. For instance, the hydraulic-pressure changes due to the lowering of ink level during usage; temperature and material composition of the ink, and the effect on the ink viscosity or surface tension by the impurities present in the ink; air-pressure within the ink-jet cartridge, atmospheric-pressure and temperature of the surrounding environment. When the balances of various forces can have a far greater impact than the fluid surface tension, any small change in any such force factor is liable to disrupt the equilibrium.

[0004] In the U.S. Patent No. 5,409,134, an air-bag connected to atmospheric-pressure and an elastic device are placed inside the ink-jet cartridge for adjusting the balance of the back pressure. In U.S. Patent No. 5,600,358, a valve, which does not leak ink, is installed at the bottom of the ink-jet cartridge, so that when the

temperature inside rises and there arises a pressure difference, the valve can release in more air to prevent unnecessary ink leakage. However, in either case, the necessary structure is very complex and requiring very many components that the manufacturing cost thereby proportionally increases greatly.

[0005] In addition, liquid-absorbent material (such as sponge) has been filled into the ink-jet cartridge, as shown in Figure 1. Although it improves on the problem of ink leakage, it brings the drawback of small ink discharge and the inability to completely consume all of the stored ink.

[0006] As shown in Figure 1, when the ink-jet cartridge 2 is filled with sponge 21, which is very absorbent, as the ink 22 is thus absorbed by the sponge 21, it does not leak. Therefore, during the equilibrium, as the absorption of the sponge 21 is greater than the surface tension of the ink 22, the state of equilibrium is not easily disturbed. In this circumstance, by virtue of the absorption of the sponge 21, the ink 22 in the ink-jet cartridge 2 will not easily leak, and thus avoiding the problem of leakage and maintaining a steady ink pressure. However, as the space in the ink-jet cartridge 2 is quite limited, thus the amount of ink it may contain is reduced. Furthermore, due to the absorbency of the sponge 21, part of the ink 22 will be absorbed in the sponge and be retained inside the ink-jet cartridge. For instance, in the ink-jet cartridge space which normally contains 40g of ink, with the sponge inside, only about 30g of ink can be contained; moreover, 6-7g of this 30g of ink will be absorbed by the sponge and thus not usable. Therefore what theoretically can contain 40g of ink is in practice only able to contain 23-24g of ink, quite a waste in the ink storage capacity.

[0007] In addition, beside absorbing liquids, due to its loose structure, non-ink items such as air can also be trapped inside the sponge. Thus, as the sponge discharges ink, it will also discharge air bubbles of various sizes, which, if not flushed out, can disrupt the ink discharge during printing, such as causing the printing to stop or the printing color to vary, thus reducing the printing quality.

[0008] Therefore, the primary object of this invention is to provide an internal pressure-adjustment means for ink-jet cartridges, which can prevent ink leaking from the ink-jet cartridge due to changes in the conditions of the environment (under abnormal temperature or pressure) and provide ease of preservation.

[0009] An additional object of this invention is to provide an internal pressure-adjustment means for ink-jet cartridges, so that as the ink level lowers, the back pressure inside may remain in equilibrium state so that there is smooth ink discharge during printing.

[0010] A further object of this invention is to provide a simplified pressure-adjustment means, so that the amount of ink stored in the ink-jet cartridge may be increased by employing less material and lower manufacturing cost.

SUMMARY OF THE INVENTION

[0011] This invention is an internal pressure-adjustment means for ink-jet cartridges, said means is a hollow structure, one end of which is a ventilation opening to atmosphere and on the other end thereof are small openings in contact with the ink at the bottom portion of the ink-jet cartridge, so that the back pressure of the ink-jet cartridge is thereby adjusted for maintaining the state of equilibrium.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The following drawings can further illustrate the characteristics of the present invention:

- Figure 1. The conventional ink-jet cartridge, where sponge is used to absorb ink.
- Figure 2. One embodiment of the present invention, wherein the pressure-adjustment means employs a hollow tube.
- Figure 3. A partial magnifying drawing of the end of the hollow tube in Figure 2.
- Figure 4. An illustration showing the ink level as the ink-jet cartridge prints.
- Figure 5. Another embodiment of the present invention, wherein the pressure-adjustment means is integrally formed with the structure of the ink-jet cartridge.

DETAILED DESCRIPTION OF THE INVENTION

[0013] First, referring to Figure 2, which shows a cross-sectional view of the ink-jet cartridge 1. The ink-jet cartridge 1 provides the ink needed in printing for thermal ink-jet printers, and comprises of a housing 11, a pressure-adjustment means 12, ink 13 and a printhead 14. Please note that the ink-jet cartridge 1 of the present invention does not employ any absorbent material (such as a sponge), so as to have maximum ink storage space and a reserved chamber 15 is inside the ink-jet cartridge 1 for providing the back pressure to the ink-jet cartridge during printing (with initial pressure P_0 and volume V_0 inside said chamber.) In the printing method of the ink-jet printer as commonly known in the industry, when demanded the printhead 14 heats up partially the ink 13 stored in the ink-jet cartridge 1 till boiling and shoots the same through its open orifices to print. Referring to Figure 2, in the present invention, where a pressure-adjustment means 12 is installed in the ink-jet cartridge 1. In this embodiment, the pressure-adjustment means 12 is a hollow tube structure, the length of the narrow tube exceeds the height H of the ink-jet cartridge 1, so that one end of the means 12 forms a vent 121 for contacting with the atmospheric pressure and fastened to the top of said ink-jet cartridge 1, and the tube can hang over the bottom part of the ink-jet cartridge 1. The tube of the pressure-adjustment means 12

has a diameter between 0.5mm and 2mm; as the diameter area is much smaller than the cross area of the ink-jet cartridge 1, so that the effect of capillary can form inside the narrow tube with respect to the ink. As in prior art, a shut-off valve 122 may be installed at the ventilation opening 121 of the pressure-adjustment means 12 for preventing both ink leakage through the ventilation opening 121 and ink clogging inside the tube due to over-dryness. As shown in Figure 3, the pressure-adjustment means 12 is a hollow tube, hanging over the bottom of the ink-jet cartridge 1 on the same side as the printhead 14, and having at least one open hole 123. In the preferred embodiment, the hole 123 may have a diameter of 0.1mm, 0.5mm or 0.2mm, wherein said hole 123 can be formed on one end of the tube by various conventional methods of pressing the opening of the hollow tube, stamping or injection. So the manufacturing process is very simple and should not increase cost. Additionally, the hollow tube may also be made with metal or plastic, and having ventilation opening 121 fixed on top portion of the ink-jet cartridge 1.

[0014] In the prior art, after production, the ink-jet cartridges are generally sealed and transport to various vending outlets for sale. However, during transportation or storage, the changes in the environment (such as temperature or pressure) are difficult to control. From the formula for ideal-gas:

$$PV = nRT,$$

where P : pressure, V : Volume, n : number mole of molecules for gas, R : a gas constant, T : Temperature.

[0015] Therefore, when temperature rises, the initial pressure P_0 inside the reserved chamber 15 of the conventional ink-jet cartridges also increases and so causes ink leakage. Or, when the atmospheric pressure P_{atm} decreases, and the pressure P_0 inside the sealed chamber 15 remains unchanged, the ink would leak because of the pressure difference. As shown in Figure 2, as the ink-jet cartridge 1 of the present invention is first produced, due to the pressure difference between the initial pressure P_0 and the atmospheric pressure p_{atm} , and the effect of capillary inside the pressure-adjustment means 12, the ink 13 will flow into the narrow tube and achieves force equilibrium. If the temperature increases and so causes the initial pressure P_0 inside the chamber 15 to increase, as the diameter of open hole 123 (about between 0.1mm~0.2mm) is much larger than the areas of the orifices on the printhead 14, the increased pressure-difference will cause the ink 13 to flow into the tube of the pressure-adjustment means 12, causing the level of ink inside the tube to rise and so reaching a new state of equilibrium. Similarly, if the atmospheric pressure P_{atm} lowers, the change in pressure difference will cause the ink 13 to flow into the pressure-adjustment means 12, causing the level of ink inside to rise and a new equilibrium state is reached. Thus

the ink-jet cartridge under the present patent will not have ink-leakage problem as the conditions in the environment change.

[0016] When the conventional ink-jet cartridges are used in the ink-jet printers, as the ink is used, the level of ink lowers to a height H1 and the volume in the chamber 15 increases to V1. Based on the ideal gas formula, the pressure inside the chamber 15 will lower from the initial pressure P0 to P1. In the case where the atmospheric pressure Patm remains constant, the pressure difference between P1 and Patm will increase until the ink inside the ink-jet cartridge fails to discharge smoothly. Referring to Figure 5, as the level of the ink 15 lowers, the ink-jet cartridge 1 of the present invention, because the diameter of the open hole 121 is much larger than those of the orifices on the printhead 14, that portion of the ink previously flowed into the pressure-adjustment means 12 will flow back to the ink-jet cartridge 1 for achieving a new equilibrium. If the surface of the ink 13 lowers even further, the atmospheric pressure Patm will be much greater than the pressure P1 inside the internal chamber 15, and will compress air into the chamber 15, and so the pressure P1 inside the chamber 15 then rises, causing the pressure difference between the pressure P1 inside the chamber 15 and the atmospheric pressure to decrease, and thus the ink 13 may be smoothly discharge through the orifices of the printhead 14.

[0017] Figure 5 shows another embodiment of the present invention, wherein the pressure-adjustment means 12 is formed integrally with the housing 11. In this embodiment, the pressure-adjustment means 12 may be made by modifying the tool mode so that when producing the housing 11 of the ink-jet cartridge 1, the structure of narrow tube with open holes 121 are simultaneously created, so that there is no added cost due to additional processes, but achieving the same desired result.

Numbering Scheme

[0018]

- 1 Ink-jet cartridge
- 11 Housing
- 12 Pressure-adjustment means
- 121 Open holes
- 13 Ink
- 14 Printhead
- 15 Chamber

EFFECTIVENESS OF THE INVENTION

[0019] Following the detailed illustration of the preferred embodiment of the present invention, those skilled in the art should be enabled to grasp the meaning and make modification without departing from the scope of the claims.

[0020] This ink-jet cartridge invention should simplify the manufacturing process and increase the production efficiency, and as the amount of ink which can be stored greatly increases, the cost of printing of ink-jet printers can therefore be reduced.

[0021] In summary, this invention combines many useful features, improves upon the drawbacks associated with prior art, and is a practical and reliable device which is novel and useful, and meets the statutory requirements for an invention patent.

Claims

1. An ink-jet cartridge for thermal ink-jet printers, comprising:
 - a housing for containing ink therewithin for printing;
 - a printhead, having a plurality of open orifices through which heated ink may stream forth unto papers upon demand; and,
 - a pressure-adjustment means, having the shape of hollow tube for receiving ink therewithin, and one end of which having a ventilation opening for contact with air and the other end thereof having at least one opening in contact with the ink, wherein the ventilation opening of said pressure-adjustment means being fixed on the housing of the ink-jet cartridge and said opening of said pressure-adjustment means being fastened at the bottom portion of the ink-jet cartridge on the same side as the printhead.
2. An ink-jet cartridge as recited in Claim 1, wherein said ventilation opening of the pressure-adjustment means is fixed on top portion of the ink-jet cartridge.
3. An ink-jet cartridge as recited in Claim 1, wherein said hollow tube of the pressure-adjustment means having fairly small cross-sectional area such that capillary effect results with respect to the ink.
4. An ink-jet cartridge as recited in Claim 1, wherein said opening of the pressure-adjustment means having cross-sectional area much greater than each cross-sectional area of the opening orifices of the printhead.
5. An ink-jet cartridge as recited in Claim 1, wherein a anti-flow prevention valve is installed at the fixed end of said ventilation opening for prevention of ink flowing in the reversed direction.
6. An ink-jet cartridge as recited in Claim 1, wherein said pressure-adjustment means forms as part of an integral structure with the housing of the ink-jet cartridge.

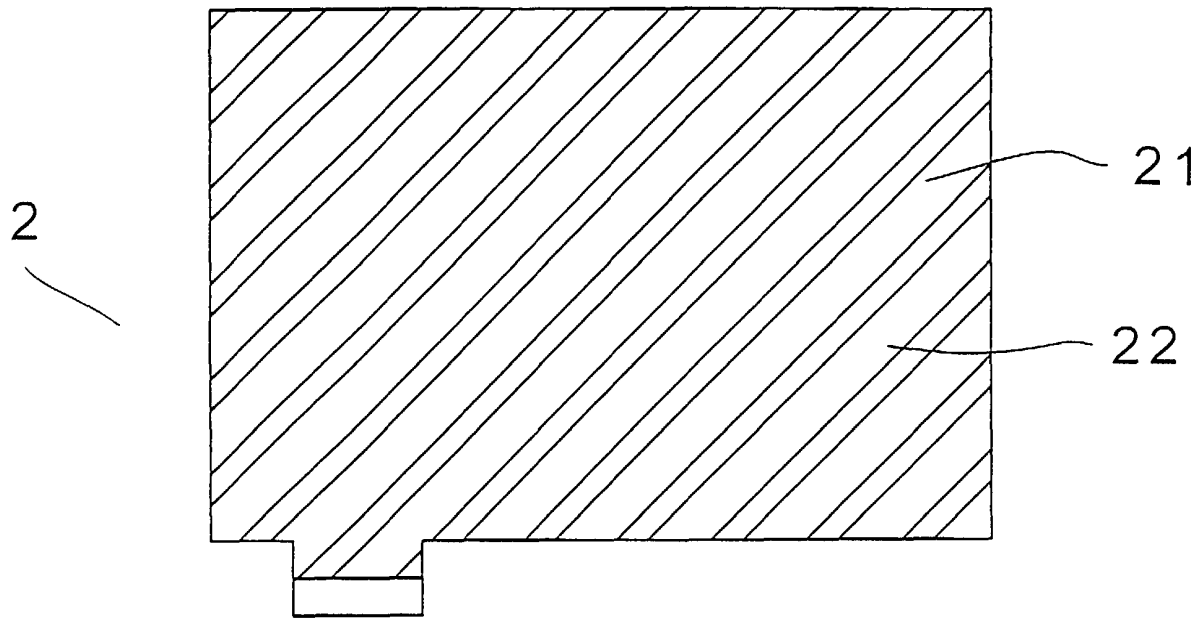


Figure 1

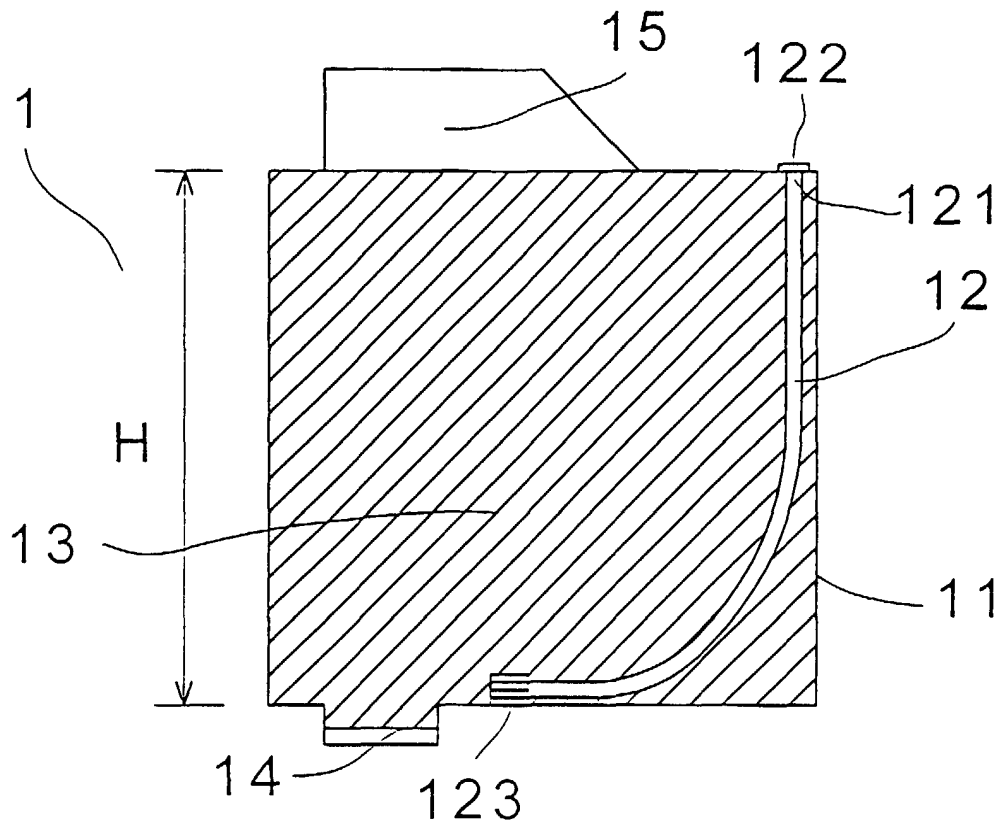


Figure2

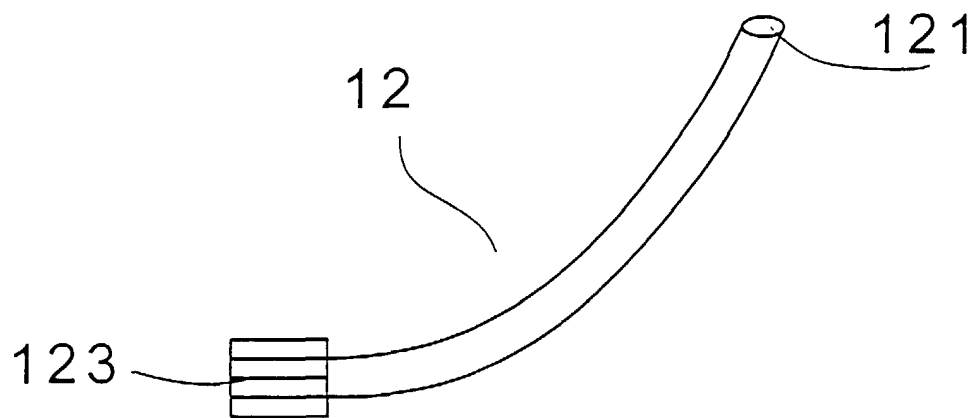


Figure3

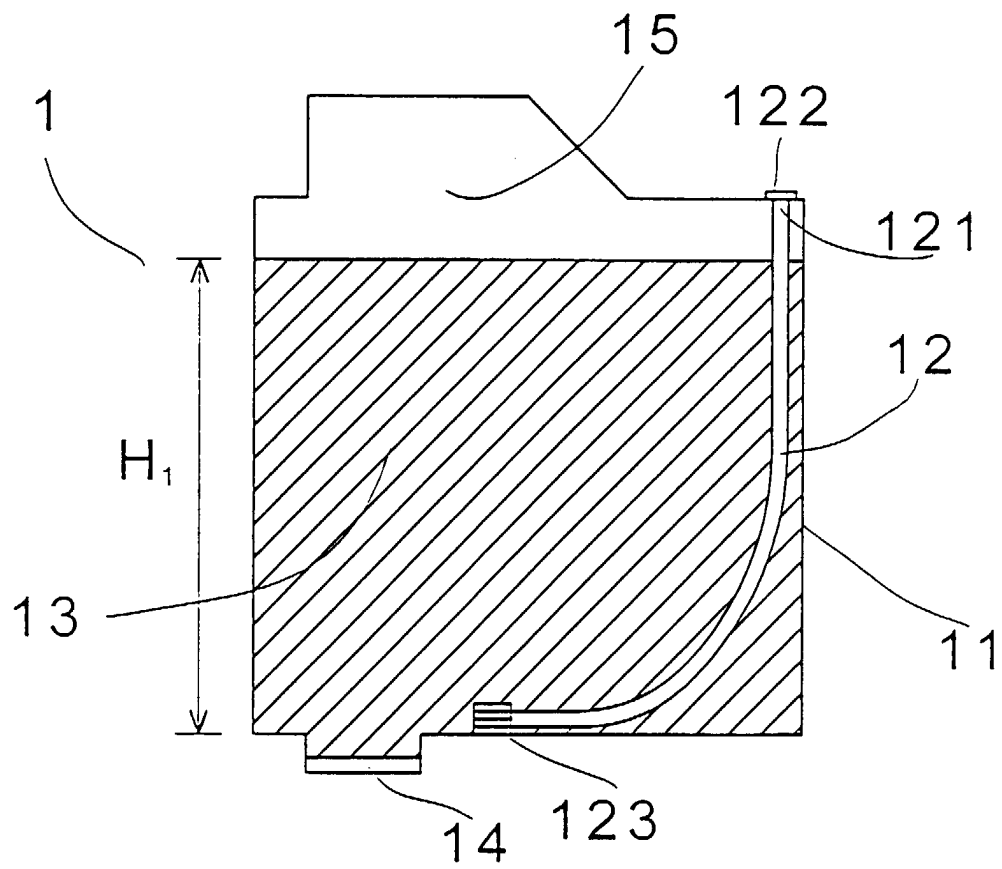


Figure4

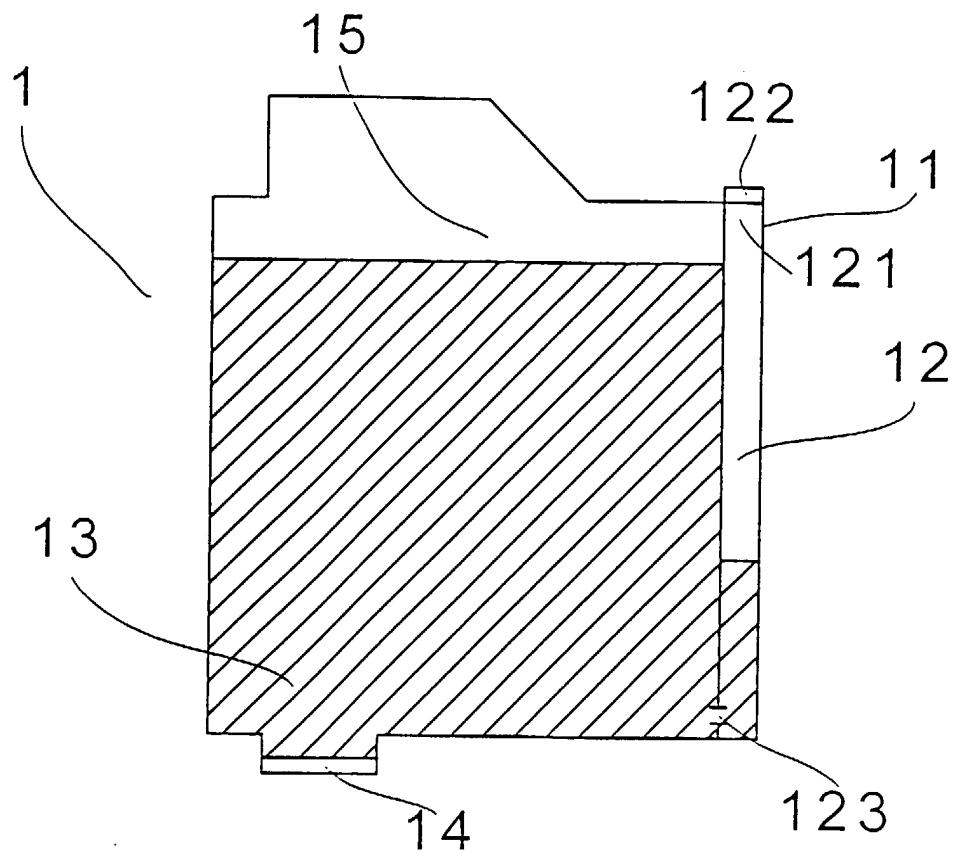


Figure 5



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EUROPEAN SEARCH REPORT

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