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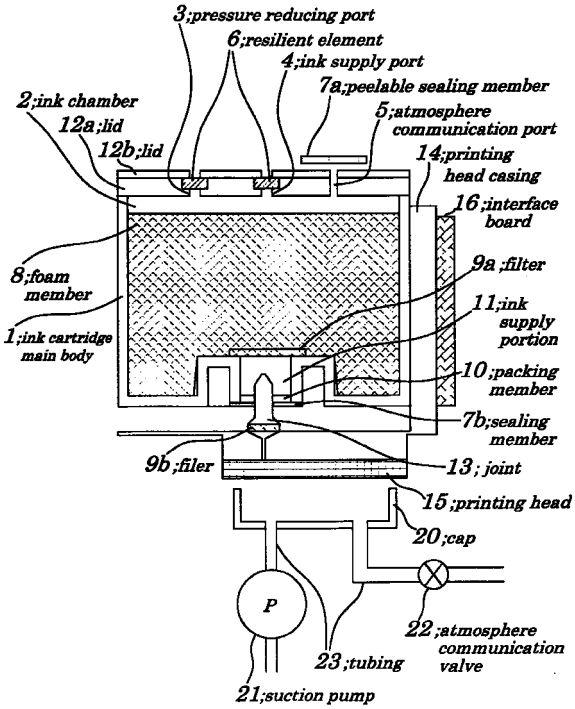
(54) Ink cartridge, manufacturing method thereof, and ink jet recording apparatus

(57) A manufacturing method of an ink cartridge is simplified, wherein the ink cartridge is capable of preventing ink from being damaged in its degassed properties. The ink cartridge is provided with: an ink chamber (2) filled with a foam member (8); an ink supply port (4); a pressure reducing port (3); a pair of lids (12a, 12b), wherein an atmosphere communication port (5) is formed so as to pass through the lids (12a, 12b); and, a sealing member (7a) for sealing the atmosphere communication port (5) shut.

A resilient element (6) is inserted into each of the ink supply port (4) and the pressure reducing port (3). The sealing member (7a) is made of material which is impermeable to both gases and water vapor.

FIG.1



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Description

[0001] The present invention relates to: an ink cartridge for containing ink for ink jet recording, wherein the ink cartridge is capable of preventing the ink from being damaged in its degassed properties; a manufacturing method for manufacturing the ink cartridge, wherein the manufacturing method is simplified; and, an ink jet recording apparatus using the ink cartridge.

[0002] In an ink jet recording apparatus, each of a plurality of ink compartments arranged in an ink head of the ink jet recording apparatus is subjected to a positive pressure in response to an electric signal received. As a result, a droplet of ink contained in each of the ink compartments is ejected from a nozzle onto a recording medium to form an information image thereon, wherein the nozzle communicates with each of the ink compartments.

[0003] As a method for applying the positive pressure to the ink compartment, there are: a method using a piezoelectric element, actuation of which causes the ink compartment itself to vary in volume; a method using a heating element to heat the ink of the ink compartment to produce a vapor bubble therein; and, a like.

[0004] In such ink jet recording method, air entering an ink passage such as the ink compartments of a printing head and a like decreases an ink ejection pressure to an insufficient level, which causes ink ejection failures and ink dot omissions to impair reliability of the ink jet recording apparatus.

[0005] Particularly, in the ink jet recording apparatus, when a used ink cartridge is replaced with a new one, a relatively large amount of air enters inside ink passages of the printing head. Due to this, a relatively extended period of time is often required before the ink jet recording apparatus stabilizes in printing quality at an expense of a relatively large amount of ink. In order to remove the air having entered inside the ink passages of the printing head, a conventional method uses a degassed ink. Using such a degassed ink, it is possible to reabsorb any existing air bubble remaining in the printing head, which improves the ink jet recording apparatus in reliability.

[0006] Now, referring to the ink cartridge, the ink cartridge is provided with: an ink supply port for supplying ink to the ink cartridge; and, an atmosphere communication port which prevents any negative pressure from being produced inside the ink cartridge when the ink is consumed in an ink jet recording operation. Further, in order to prevent the ink from being damaged in its degassed properties, the ink cartridge has its interior subjected to a pressure reducing treatment.

[0007] However, in this pressure reducing treatment of the ink cartridge, more pressure reduction is enhanced, more likely ink leakage occurs through the ink supply port and the atmosphere communication port of the ink cartridge. Particularly, this phenomenon is remarkable in a case that the ink cartridge is subjected to a mechanical impact and/or variations in ambient temperature.

[0008] In JP-A- 7-132611, there has been proposed a conventional method for packaging the ink cartridge in a hermetic container which is capable of holding the ink cartridge under negative pressure by using a sealing film, which is not permeable to water vapor but is permeable to gases, to seal both the ink supply port and the atmosphere communication port.

[0009] However, the above-mentioned conventional method for packaging the ink cartridge in the hermetic container suffers from the following problems.

[0010] First, the conventional method is complicated, because it includes: an ink supplying step which should be performed under negative pressure; a sealing step which should be performed at 1 atmospheric pressure; and, a re-degassing step which should be performed under negative pressure. As is clear from the above, the conventional method needs such the re-degassing step. This is because the sealing step is performed at 1 atmospheric pressure in spite of a fact that the ink supplying step is performed under negative pressure. Incidentally, in the conventional method, a purpose of the sealing film, which is not permeable to water vapor but is permeable to gases, is to enable a method to perform the re-degassing step.

[0011] Secondly, the conventional method is not capable of preventing the ink from being damaged in its degassed properties. This is because the degassed properties of the ink are damaged when the ink is brought into contact with atmosphere in the sealing step of the conventional method. In general, it is difficult to sufficiently degas the ink by using negative pressure only. Incidentally, it is possible to degas the ink to a predetermined degassed level by using a hollow fiber membrane and a like. Further, it is possible to prevent the ink from being damaged in degassed properties by packaging the ink cartridge under negative pressure. In this case, however, once the degassed properties of the ink are damaged, it is difficult for the degassed properties of the ink to recover from such damage.

[0012] In view of the above, it is an object of the present invention to provide an ink cartridge for containing ink for ink jet recording, wherein the ink cartridge is capable of preventing the ink from being damaged in its degassed properties; a manufacturing method for manufacturing the ink cartridge, wherein a method is simplified; and, an ink jet recording apparatus using the ink cartridge.

[0013] According to a first aspect of the present invention, there is provided an ink cartridge including:

an ink chamber filled with a foam member; a lid provided with an ink supply port, a pressure reducing port and an

atmosphere communication port;

a sealing member for sealing the atmosphere communication port shut, the sealing member being made of material which is impermeable to both gases and water vapor; and

a resilient element inserted into each of the ink supply port and the pressure reducing port.

[0014] In the foregoing, a preferable mode is one wherein a port is shared between the pressure reducing port and the ink supply port.

[0015] Also, a preferable mode is one wherein the sealing member is made up of a peelable material.

[0016] According to a second aspect of the present invention, there is provided a method of manufacturing an ink cartridge, including:

a first step of mounting a lid on a main body of the ink cartridge, wherein the lid is provided with an ink supply port, a pressure reducing port and an atmosphere communication port, wherein a resilient element is inserted into each of the ink supply port and the pressure reducing port;

a second step of inserting an ink supply needle into the ink supply port so as to penetrate the resilient element;

a third step of inserting a pressure reducing needle into the pressure reducing port so as to penetrate the resilient element;

a fourth step of mounting the main body of the ink cartridge in the pressure reducing chamber;

a fifth step of producing a vacuum in an ink chamber of the main body of the ink cartridge through the pressure reducing needle inserted into the pressure reducing port;

a sixth step of degassing ink in an ink tank through a degassing treatment portion, the ink having been not degassed;

a seventh step of supplying thus degassed ink through the ink supply port using the ink supply needle; and

an eighth step of pulling out the pressure reducing needle and the ink supply needle from the pressure reducing port and the ink supply port, respectively, after the degassed ink is supplied, whereby the resilient element blocks up each of the pressure reducing port and the ink supply port due to resiliency of the resilient element.

[0017] In the foregoing second aspect, a preferable mode is one wherein the first step and the second step include a ninth step of sealing the atmosphere communication port shut using a sealing member , the sealing member being made of material which is impermeable to both gases and water vapor.

[0018] Also, a preferable mode is one wherein the seventh step includes a tenth step of producing a vacuum of equal to or less than 160 torr in the pressure reducing chamber.

[0019] Furthermore, a preferable mode is one wherein the second step and the third step include an eleventh step in which the pressure reducing port is formed in a same port with the ink supply port to serve also as the ink supply port; and, the fifth step and the seventh step include a twelfth step in which the degassed ink is supplied after the ink chamber of the main body of the ink cartridge is reduced in pressure through the ink supply needle.

[0020] According to a third aspect of the present invention, there is provided an ink jet recording apparatus provided with an ink cartridge, the ink cartridge being produced by a method including:

a first step of mounting a lid on a main body of the ink cartridge, wherein the lid is provided with an ink supply port, a pressure reducing port and an atmosphere communication port, wherein a resilient element is inserted into each of the ink supply port and the pressure reducing port;

a second step of inserting an ink supply needle into the ink supply port so as to penetrate the resilient element;

a third step of inserting a pressure reducing needle into the pressure reducing port so as to penetrate the resilient element;

a fourth step of mounting the main body of the ink cartridge into the pressure reducing chamber;

a fifth step of producing a vacuum in an ink chamber of the main body of the ink cartridge through the pressure reducing needle inserted into the pressure reducing port;

a sixth step of degassing ink in an ink tank through a degassing treatment portion;

a seventh step of supplying thus degassed ink through the ink supply port using the ink supply needle; and

an eighth step of pulling out the pressure reducing needle and the ink supply needle from the pressure reducing port and the ink supply port, respectively, after the degassed ink is supplied, whereby the resilient element blocks up each of the pressure reducing port and the ink supply port due to resiliency of the resilient element.

[0021] The above and other objects, advantages and features of the present invention will be more apparent from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of an ink cartridge of a first embodiment of the present invention;

Fig. 2 is an exploded perspective view of the ink cartridge shown in Fig. 1;

Fig. 3 is a longitudinal sectional view of the ink cartridge shown in Fig. 1, illustrating its manufacturing method; and Fig. 4 is a longitudinal sectional view of an ink cartridge of a second embodiment of the present invention, illustrating its manufacturing method.

[0022] The best modes for carrying out the present invention will be described in detail using embodiments of the present invention with reference to the accompanying drawings.

FIRST EMBODIMENT

[0023] Fig. 1 shows a longitudinal sectional view of an ink cartridge of a first embodiment of the present invention. Fig. 2 shows an exploded perspective view of the ink cartridge shown in Fig. 1. Fig. 3 shows a longitudinal sectional view of the ink cartridge shown in Fig. 1, illustrating its manufacturing method.

[0024] As shown in Figs. 1 and 2, a foam member 8 is constructed of a porous material such as a polyurethane foam or a like, and mounted in an ink chamber 2. The ink chamber 2 is provided inside an ink cartridge main body 1 of the ink cartridge in an insertion manner. Further, the ink chamber 2 is closed with a pair of lids 12a, 12b. These lids 12a, 12b are provided with a pressure reducing port 3, an ink supply port 4 and an atmosphere communication port 5.

[0025] A resilient element 6 is made up of butyl rubber or a like, and press-fitted into each of the ink supply port 4 and the pressure reducing port 3. The resilient element 6 is fixed by means of the lids 12a, 12b. Physical properties required of the resilient element 6 are ink-resistant properties and sufficient resiliency. Namely, the resilient element 6 requires sufficient resiliency, to say nothing of a necessity of the ink-resistant properties. Necessity of sufficient resiliency will be described later in detail. Incidentally, it is possible to omit use of the pressure reducing port 3. A method of manufacturing the ink cartridge in which the pressure reducing port 3 is omitted will be described later.

[0026] On the other hand, the atmosphere communication port 5 is sealed with a peelable sealing member 7a. This sealing member 7a may be constructed of a material, for example such as an aluminum sheet or a like, which is impermeable to gases and water vapor. The ink cartridge main body 1 is provided with a printing head 15. The printing head 15 is provided with an ink supply portion 11 in its connection side. Provided in an upper portion of the ink supply portion 11 is a filter 9a for filtering the ink.

[0027] In mounting the ink cartridge main body 1 on the printing head 15, the ink cartridge main body 1 is fitted to a joint 13 in an insertion manner. The joint 13 is provided with a filer 9b. This filter 9b is provided in a printing head casing 14.

[0028] When the ink cartridge main body 1 is mounted on the printing head 15 in an insertion manner, in order to hermetically connect the ink cartridge main body 1 with the joint 13, a packing member 10 made up of a resilient material such as rubber or a like is interposed between the ink cartridge main body 1 and the joint 13. In order to seal a connection side of the printing head 15, a sealing member 7b is provided in a lower portion of the packing member 10. This sealing member 7b may be constructed of a material impermeable to gases and water vapor as is in a case of the sealing member 7a.

[0029] At this time, since the ink chamber 2 is under negative pressure as a whole, it is necessary to open the sealing member 7a to have an interior of the ink cartridge main body 1 communicated with the atmosphere communication port 5 before the ink cartridge main body 1 is mounted on the printing head 15. The reason why the sealing member 7a is previously opened will be described later.

[0030] Further, at this time, the ink is supplied from the ink cartridge main body 1 to the printing head 15 under influence of negative pressure. This negative pressure is created by a suction pump 21, and applied to an interior of a cap 20 through tubings 23 in a condition in which the cap 20 is hermetically connected with a nozzle plate (not shown) of the printing head 15. On the other hand, the ink received in the cap 20 is discharged out of the cap 20 through use of suction force applied to interior of the cap 20 through the tubing 23 and an atmosphere communication valve 22.

[0031] Ink (not shown) is filled in the printing head 15 under influence of the above suction force. After that, in operation, in response to an electric signal which is issued from a flexible printed circuit (FPC, not shown) and transmitted through an interface board 16, a positive pressure is applied to each of a plurality of ink compartments (not shown) which are arranged in the printing head 15, so that an ink droplet is ejected from a nozzle (not shown) which is communicated with each of the ink compartments (not shown), whereby an information image is formed on a recording medium (not shown).

[0032] In this connection, when the printing head 15 is actuated to consume the ink in its printing operation, make-up for ink loses cannot be added in a form of air when the atmosphere communication port 5 is still not opened. Due to this, the ink chamber 2 including the ink supply portion 11 is subjected to large negative pressure. On the other hand, the ink supplied into the ink chamber 2 is, due to capillarity, further supplied into the nozzle (not shown) of the printing head 15, and stably held therein because the ink forms a meniscus on a surface of a discharge port (not shown) at a leading end portion of the nozzle (not shown).

[0033] However, due to presence of the above-mentioned large negative pressure, the meniscus of the ink is deeply pulled into the nozzle (not shown) of the printing head 15. When a magnitude of the large negative pressure exceeds a certain limit (that is, surface tension of the ink in the meniscus), the meniscus of the ink is broken to make it impossible to eject any ink droplet from the leading end portion of the nozzle (not shown).

[0034] Further, when the ink cartridge is used and replaced with a new one or subjected to a cleaning operation, the cap 20 is hermetically connected with the nozzle plate (not shown) of the printing head 15 to have the interior of the cap 20 subjected to negative pressure, which is created by the suction pump 21 and applied to the interior of the cap 20 through the tubing 23 extending from the pump 21 to the cap 20. However, in a condition in which the atmosphere communication port 5 of the ink cartridge main body 1 is still not opened, the negative pressure remains inside the ink chamber 2 after sufficient amount of ink is pulled into the printing head 15. As a result, the ink (not shown) received in the printing head 15 is pulled back into the ink chamber 2 under the influence of such negative pressure of the interior of the ink chamber 2, which makes it difficult to supply the ink to the ink printing head 15 in the ink jet recording operation. Consequently, it is necessary to open the atmosphere communication port 5 before the ink jet recording operation is performed using the ink cartridge of the first embodiment of the present invention.

[0035] Now, a method of manufacturing the ink cartridge having the above construction will be described with reference to Fig. 3.

[0036] First, the lids 12a and 12b are provided with the pressure reducing port 3, the ink supply port 4 and the atmosphere communication port 5 and so forth, and mounted on the ink cartridge main body 1 which has been already provided with the packing member 10, the filter 9a, the foam member 8 and so forth. After that, under such circumstances, the ink is supplied to the ink cartridge main body 1.

[0037] At this time, the atmosphere communication port 5 remains sealed with the sealing member 7a. Further, when the ink is supplied to the ink cartridge, the ink cartridge main body 1 is mounted in a pressure reducing chamber 30 in which: as shown in Fig. 3, an ink supply needle 32 and a pressure reducing needle 31 are inserted into the ink supply port 4 and the pressure reducing port 3 of the ink cartridge main body 1, respectively, in a manner such that each of the ink supply needle 32 and the pressure reducing needle 31 penetrates the resilient element 6 which is press-fitted into each of the ink supply port 4 and the pressure reducing port 3.

[0038] Then, the ink chamber 2 is evacuated to pull air out of the ink chamber 2 through the pressure reducing port 3. After that, ink 35, which is received in an ink tank 36 and is still not degassed, is degassed through a degassing treatment portion 33 in which a hollow fiber membrane or a like is used to degas the ink 35. The thus degassed ink is then supplied to the ink chamber 2 through the ink supply port 4.

[0039] At this time, preferably, the pressure reducing chamber 30 is evacuated to a negative pressure of less than or equal to 160 torr. After the ink is supplied, both the pressure reducing needle 31 and the ink supply needle 32 are retracted. As a result, both the pressure reducing port 3 and the ink supply port 4 are automatically closed with the resilient element 6 due to its resiliency.

[0040] Consequently, even after the pressure reducing chamber 30 is communicated with the atmosphere, it is possible for the ink chamber 2 to remain under negative pressure. This ensures that the degassed properties of the ink are not damaged in the ink chamber 2. Consequently, any further degassing step of the ink is not required in this embodiment. Further, in this method for supplying the ink, since a connection area between the ink supply needle 32 and the ink supply port 4 is hermetically sealed, it is possible to prevent any ink leakage from occurring in this connection area, which makes it possible to supply a large amount of ink to the ink chamber 2.

[0041] Although degree of negative pressure or vacuum in the ink chamber 2 is considerably large after the ink supplied to the ink chamber 2, it is possible to prevent any ink leakage from occurring even when the ink chamber 2 is subjected to a mechanical impact and/or variations in its ambient temperature, because the resilient element 6 is inserted in each of the ink supply port 4 and the pressure reducing port 3, and because the sealing member 7a is made of material impermeable to both gases and water vapor.

[0042] Here, the degassed properties of the ink used in the first embodiment will be described with reference to measurement results of the degassed properties, wherein the degassed properties of the ink represents an amount of air dissolved in the ink. The following Table 1 shows the measurement results of a level of the ink dissolved oxygen (hereinafter referred to as DO values).

[0043] In the following Table 1, an example of comparative measurement results were obtained in a condition in which: each of the pressure reducing port 3 and the ink supply port 4 of the comparative example of the ink cartridge was not provided with the resilient element 6, and was sealed with a sealing member which is permeable to gases but not to water vapor; and, the comparative example of the ink cartridge thus prepared was then packaged under negative pressure to degas its ink, the DO values of which were measured and listed in the following Table 1.

TABLE 1

	DO values [mg/L] in Embodiment	DO values [mg/L] in Comparative Example
Measurement conducted immediately after ink supply operation	From 0.9 to 1.3	From 2.3 to 2.9
Measurement conducted after two-day lapse from ink supply operation	From 1.0 to 1.3	From 2.2 to 3.0
Measurement conducted after 30-day lapse from ink supply operation	From 1.0 to 1.2	From 2.3 to 3.1

[0044] Where:

a degree of vacuum of the pressure reducing chamber in the embodiment was 160 torr;
a degree of vacuum of the pressure reducing chamber in the comparative example was 160 torr;
a degree of vaccum of the ambient pressure, under which the ink cartridge was packaged in each of the embodiment and the comparative example, was 100 torr;
a period of time between: communication of the ink cartridge with the atmosphere immediately after completion of the ink supply operation; and, packaging of the ink cartridge under negative pressure, was 5 minutes;

[0045] Number of test pieces of each of the embodiment and the comparative example was 5 pieces;

ambient temperature in measurement was 25 °C; and
ambient pressure in measurement was 1 atmospheric pressure.

[0046] Incidentally, the DO value of the ink still not degassed was within a range of from 7.5 to 8.5 mg/L at the ambient temperature of 25 °C under the ambient pressure of 1 atmospheric pressure.

[0047] The Table 1 shows that: the degassed state of the ink was kept for a considerable period of time in both the embodiment and the comparative example; and, an initial level of degassed properties of the ink in the embodiment was more than twice as large as that of degassed properties of the ink in the comparative example. This difference in initial level of the degassed properties between the embodiment and the comparative example is resulted from a difference in ambient conditions of the ink after completion of the ink supply operation between the embodiment and the comparative example, wherein the ink in the embodiment after completion of the ink supply operation was prevented from communicating with the atmosphere, while the ink in the comparative example after completion of the ink supply operation was permitted to communicate with the atmosphere. Consequently, judging from measurement results of the above Table 1, it is recognized that the degassed properties of the ink are damaged when the degassed ink is brought into contact with the atmosphere, because air in the atmosphere tends to dissolve in the degassed ink.

[0048] Incidentally, though the comparative example of the ink cartridge is packaged under negative pressure to keep the degassed properties of the ink, such packaging performed under negative pressure has substantially no effect on improvements in the degassed properties of the ink. In other words, it is difficult to degas the ink using only negative pressure. In general, a degassing operation of the ink is performed by using a hollow fiber membrane. Once the degassed properties of the ink are damaged, it is difficult to improve thus damage degassed properties of the ink by using the negative pressure only.

[0049] Each of the embodiment and the comparative example of the ink cartridge was mounted on the printing head 15, and used in the ink jet recording operation after performance of an ink suction operation of a replaced new ink cartridge, so that information images were formed on the recording medium and evaluated in dot omission in these images, the measurement results of which are listed in the following Table 2:

TABLE 2

	Dot omission rate [%] in Embodiment	Dot omission rate [%] in Comparative Example
Measurement conducted immediately after ink supply operation	0.1	1.2

TABLE 2 (continued)

	Dot omission rate [%] in Embodiment	Dot omission rate [%] in Comparative Example
Measurement conducted after two-day lapse from ink supply operation	0.1	1.3
Measurement conducted after 30-day lapse from ink supply operation	0.1	1.2

[0050] Where: number of test pieces of each of the embodiment and the comparative example was 8 pieces; and, the measurement results or values listed in the above Table 2 are shown in total.

[0051] Judging from the above Table 2, it is recognized that the dot omission rate is very rate in the images formed using the embodiment, which rate is substantially equal to one hundredth of the dot omission rate of the image formed using the comparative example. A reason why the dot omission rate in the image formed using the embodiment is very rare is that: a more the degree of degassing level of the ink increases, a more likely the air dissolves in the thus degassed ink and thereby reabsorbing any air bubbles existing in the printing head 15. In other words, the measurement results or values listed in the Table 2 reflects a difference in the degassed properties of the ink between the embodiment and the comparative example both listed in the Table 1.

[0052] As described above, in the first embodiment of the ink cartridge: the ink chamber 2 is filled with the foam member 8; the lids 12a, 12b are provided with the ink supply port 4, the pressure reducing port 3 and the atmosphere communication port 5; the sealing member 7a for hermetically sealing the atmosphere communication port 5 is provided; the resilient element 6 is inserted into each of the ink supply port 4 and the pressure reducing port 3; and, the sealing member 7a is made of material impermeable to both gases and water vapor.

[0053] Further, in the ink supply operation, the ink supply needle 32 and the pressure reducing needle 31 are inserted into the ink supply port 4 and the pressure reducing port 3, respectively, so that the ink chamber 2 is evacuated to pull the air out of the ink chamber 2 through the pressure reducing port 3. Under such circumstances, the degassed ink is supplied to the ink chamber 2 through the ink supply port 4.

[0054] After completion of this ink supply operation, both the pressure reducing needle 31 and the ink supply needle 32 are retracted to permit each of the pressure reducing port 3 and the ink supply port 4 to be automatically closed with the resilient element 6 under the influence of its resiliency.

[0055] Consequently, even after the pressure reducing chamber 30 communicates with the atmosphere, it is possible to keep the ink chamber in its negative pressure state, which prevents the degassed properties of the ink from being damaged. Due to this, there is no need to perform a re-degassing operation of the ink after completion of the ink supply operation. This renders it unnecessary to perform the packing operation of the ink cartridge under negative pressure, which may simplify the ink cartridge in its manufacturing steps.

[0056] Further, since the ink supply needle 32 is completely sealed, it is possible to prevent any ink leakage from occurring in the ink supply operation, which permits a large amount of the ink to be supplied to the ink chamber 2.

[0057] Further, since the resilient element 6 is inserted in each of the ink supply port 4 and the pressure reducing port 3, and since the sealing member 7a is made of material impermeable to both gases and water vapor, it is possible to prevent any ink leakage from occurring in the ink cartridge of the embodiment even when the ink cartridge of the embodiment is subjected to a mechanical impact and variations in ambient temperature.

[0058] Still further, in the ink cartridge of the embodiment, since the degassed ink is prevented from communicating with the atmosphere after completion of the ink supply operation, there is no danger that degassed properties of the ink are damaged during manufacturing steps of the ink cartridge. Further, since the sealing member 7a is made of material impermeable to both gases and water vapor, there is no danger that the degassed properties of the ink are damaged even when the ink is stored for an extended period of time.

[0059] As described above, it is possible for the ink cartridge of the embodiment to prevent any air from entering the ink cartridge when the ink cartridge of the embodiment is mounted in the printing head 15, which may prevent any ink ejection failures from occurring in ink jet recording operation.

[0060] By using the ink cartridge of the embodiment produced in the above-mentioned manufacturing method, it is possible to realize a small-sized ink jet recording apparatus at low cost, wherein the ink jet recording apparatus is stabilized in ink ejection pressure created in the printing head 15, and may be free from any dot omission and ink ejection failure. Due to this, the ink jet recording apparatus using the ink cartridge of the embodiment is improved in reliability.

SECOND EMBODIMENT

[0061] Fig. 4 shows a longitudinal sectional view of an ink cartridge of a second embodiment of the present inven-

tion, illustrating its manufacturing method.

[0062] In this second embodiment, a pressure reducing port 3 shown in Figs. 1 to 3 is eliminated. Consequently, an ink chamber 2 is evacuated through an ink supply port 4 not through the pressure reducing port 3.

[0063] In other words, as shown in Fig. 4, provided in an ink cartridge main body 1 are: a packing member 10; a filter 9a; a foam member 8; and, other components. Lids 12a, 12b are provided with a resilient element 6 which is inserted in each of the ink supply port 4 and an atmosphere communication port 5. These lids 12a, 12b are mounted on the ink cartridge main body 1. Under such circumstances, ink is supplied to the ink cartridge main body 1.

[0064] At this time, the atmosphere communication port 5 remains still sealed with a sealing member 7a. When the ink is supplied, the ink cartridge main body 1 is mounted in a pressure reducing chamber 30 in which: an ink supply needle 32 penetrates the resilient element 6 which is inserted into the ink supply port 4.
Then, as shown in Fig. 4, a pressure reducing valve 37 is opened in a condition in which a ink supply valve 38 is closed, so that the ink chamber 2 is evacuated to pull air out of the ink chamber 2 through the ink supply port 4. After that, ink 35, which is received in an ink tank 36 and is still not degassed, is degassed through a degassing treatment portion 33 in which a hollow fiber membrane or a like is used to degas the ink 35. The thus degassed ink is then supplied to the ink chamber 2 through the ink supply port 4.

[0065] A degree of vacuum in the pressure reducing chamber 30 is preferably less than or equal to 160 torr. After completion of an ink supply operation, when the ink supply needle 32 is retracted, the ink supply port 4 is automatically closed with the resilient element 6 due to its resiliency.

[0066] Consequently, even after the pressure reducing chamber 30 communicates with atmosphere, it is possible to keep a negative pressure state of the ink chamber 2, which prevents degassed properties of the ink from being damaged. Due to this, any re-degassing operation of the ink is not required in the second embodiment. In this ink supply operation, since the ink supply needle 32 is completely sealed, there is no danger of ink leakage in the ink supply operation, which permits a large amount of the ink to be supplied to the ink chamber 2 of the ink cartridge.

[0067] Although the degree of vacuum of the ink chamber 2 after completion of the ink supply operation is considerably large, there is no danger that ink leakage occurs even when the ink cartridge is subjected to a mechanical impact and/or variations in ambient temperature, because the resilient element 6 is inserted into the ink supply port 4, and because the sealing member 7a is made of material impermeable to both gases and water vapor.

[0068] As described above, in the second embodiment of the ink cartridge, in addition to effects obtained in the first embodiment of the ink cartridge, the following effects are obtained: namely, first, since the pressure reducing port 3 shown in Figs. 1 to 3 is eliminated in the second embodiment to make it possible for the ink supply port 4 to serve as the pressure reducing port 3 in place of this pressure reducing port 3, which permits the second embodiment to eliminate necessity of formation of the pressure reducing port 3 and further permits the second embodiment to eliminate the resilient element 6 inserted into such pressure reducing port 3; and, due to elimination of the pressure reducing port 3, insertion of the pressure reducing needle 31 into the pressure reducing port 3 is not required in the ink supply operation, which may further simplify manufacturing steps of the second embodiment of the ink cartridge.

[0069] In other words, the ink cartridge of each of the embodiments, its manufacturing method and the ink jet recording apparatus carrying the ink cartridge having the above constructions have the following individual effects. Namely, in the ink cartridge of the present invention provided with the ink chamber filled with the foam member, the ink supply port, the lids through which the atmosphere communication port is formed, and the sealing member for sealing the atmosphere communication port shut: the resilient element is inserted into each of the ink supply port and the pressure reducing port; and, the sealing member is made of material which is impermeable to both gases and water vapor. Consequently, it is possible for the present invention to simplify a manufacturing method of the ink cartridge , and also possible to prevent the degassed ink from being damaged in its degassed properties.

[0070] It is apparent that the present invention is not limited to the above embodiments but may be changed and modified without departing from the scope and spirit of the invention.

[0071] Finally, the present application claims the Convention Priority based on Japanese Patent application No. Hei11-283762 filed on October 5, 1999, the disclosures of which are totally incorporated herein by reference.

Claims

1. An ink cartridge characterized by comprising:

an ink chamber (2) filled with a foam member (8); a lid (12a, 12b) provided with an ink supply port (4), a pressure reducing port (3) and an atmosphere communication port (5);
a sealing member (7a) for sealing said atmosphere communication port (5) shut, said sealing member (7a) being made of material which is impermeable to both gases and water vapor; and
a resilient element (6) inserted into each of said ink supply port (4) and said pressure reducing port (3).

2. The ink cartridge according to claim 1, characterized in that a port is shared between said pressure reducing port (3) and said ink supply port (4).

3. The ink cartridge according to claim 1 or 2, wherein said sealing member (7a) is made up of a peelable material.

4. A method of manufacturing an ink cartridge characterized by comprising:

a first step of mounting a lid (12a, 12b) on a main body (1) of said ink cartridge, wherein said lid (12a, 12b)is provided with an ink supply port (4), a pressure reducing port (3) and an atmosphere communication port (5), wherein a resilient element (6) is inserted into each of said ink supply port (4) and said pressure reducing port (3);
a second step of inserting an ink supply needle (32) into said ink supply port (4) so as to penetrate said resilient element (6);
a third step of inserting a pressure reducing needle (31) into said pressure reducing port (3) so as to penetrate said resilient element (6);
a fourth step of mounting said main body of said ink cartridge in said pressure reducing chamber;
a fifth step of producing a vacuum in an ink chamber (2) of said main body (1) of said ink cartridge through said pressure reducing needle (31) inserted into said pressure reducing port (3);
a sixth step of degassing ink in an ink tank (36) through a degassing treatment portion (33), said ink having been not degassed;
a seventh step of supplying the degassed ink through said ink supply port (4) using said ink supply needle (32); and
an eighth step of pulling out said pressure reducing needle (31) and said ink supply needle (32) from said pressure reducing port (3) and said ink supply port (4), respectively, after said degassed ink is supplied, whereby said resilient element (6) blocks up each of said pressure reducing port (3) and said ink supply port (4) due to resiliency of said resilient element (6).

5. The method of manufacturing the ink cartridge according to claim 4, characterized in that said first step and said second step include a ninth step of sealing said atmosphere communication port (5) shut using a sealing member (7a), said sealing member (7a) being made of material which is impermeable to both gases and water vapor.

6. The method of manufacturing the ink cartridge according to claim 4 or 5, wherein said seventh step includes a tenth step of producing a vacuum of equal to or less than 160 torr in said pressure reducing chamber (30).

7. The method according to claim 4,5 or 6 wherein said second step and said third step include an eleventh step in which said pressure reducing port (3) is formed in a same port with said ink supply port (4) to serve also as said ink supply port (4); and, said fifth step and said seventh step include a twelfth step in which said degassed ink is supplied after said ink chamber (2) of said main body (1) of said ink cartridge is reduced in pressure through said ink supply needle (32).

8. An ink jet recording apparatus provided with an ink cartridge, said ink cartridge comprising:

an ink chamber (2) filled with a foam member (8); a lid (12a, 12b) provided with an ink supply port (4), a pressure reducing port (3) and an atmosphere communication port (5);
a sealing member (7a) for sealing said atmosphere communication port (5) shut, said sealing member (7a) being made of material which is impermeable to both gases and water vapor; and
a resilient element (6) inserted into each of said ink supply port (4) and said pressure reducing port (3).

9. An ink jet recording apparatus provided with an ink cartridge, said ink cartridge being produced by a method comprising:

a first step of mounting a lid (12a, 12b) on a main body (1) of said ink cartridge, wherein said lid (12a, 12b)is provided with an ink supply port (4), a pressure reducing port (3) and an atmosphere communication port (5), wherein a resilient element (6) is inserted into each of said ink supply port (4) and said pressure reducing port (3);
a second step of inserting an ink supply needle (32) into said ink supply port (4) so as to penetrate said resilient element (6);
a third step of inserting a pressure reducing needle (31) into said pressure reducing port (3) so as to penetrate

said resilient element (6);

a fourth step of mounting said main body of said ink cartridge in said pressure reducing chamber;

a fifth step of producing a vacuum in an ink chamber (2) of said main body (1) of said ink cartridge through said pressure reducing needle (31) inserted into said pressure reducing port (3);

a sixth step of degassing ink in an ink tank (36) through a degassing treatment portion (33), said ink having been not degassed;

a seventh step of supplying the degassed ink through said ink supply port (4) using said ink supply needle (32); and

an eighth step of pulling out said pressure reducing needle (31) and said ink supply needle (32) from said pressure reducing port (3) and said ink supply port (4), respectively, after said degassed ink is supplied, whereby said resilient element (6) blocks up each of said pressure reducing port (3) and said ink supply port (4) due to resiliency of said resilient element (6).

FIG.1

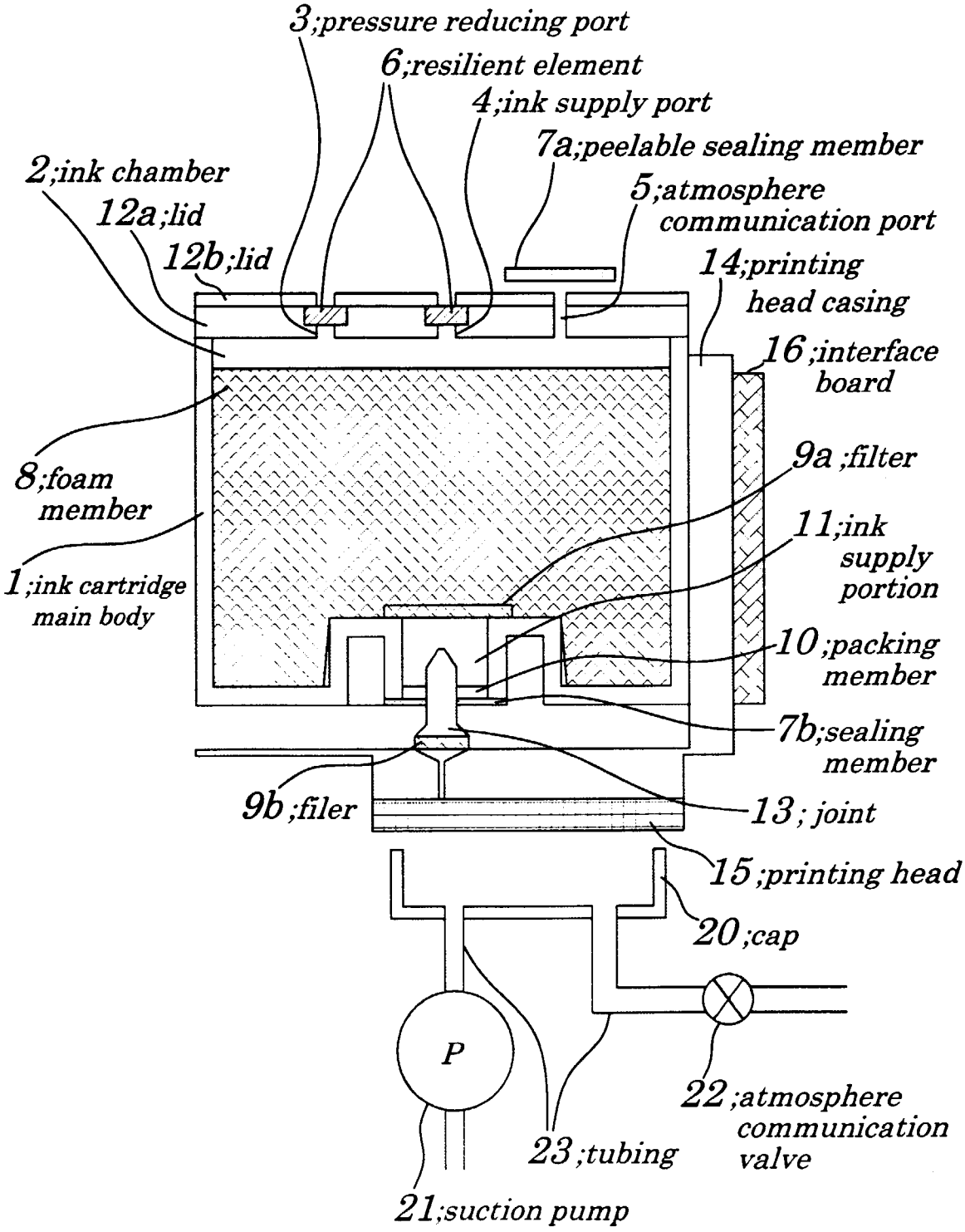

3;pressure reducing port
6;resilient element
4;ink supply port
7a;peelable sealing member
5;atmosphere communication port
2;ink chamber
12a;lid
12b;lid
14;printing head casing
16;interface board
8;foam member
9a;filter
11;ink supply portion
1;ink cartridge main body
10;packing member
7b;sealing member
9b;filer
13;joint
15;printing head
20;cap
P
22;atmosphere communication valve
23;tubing
21;suction pump

FIG.2

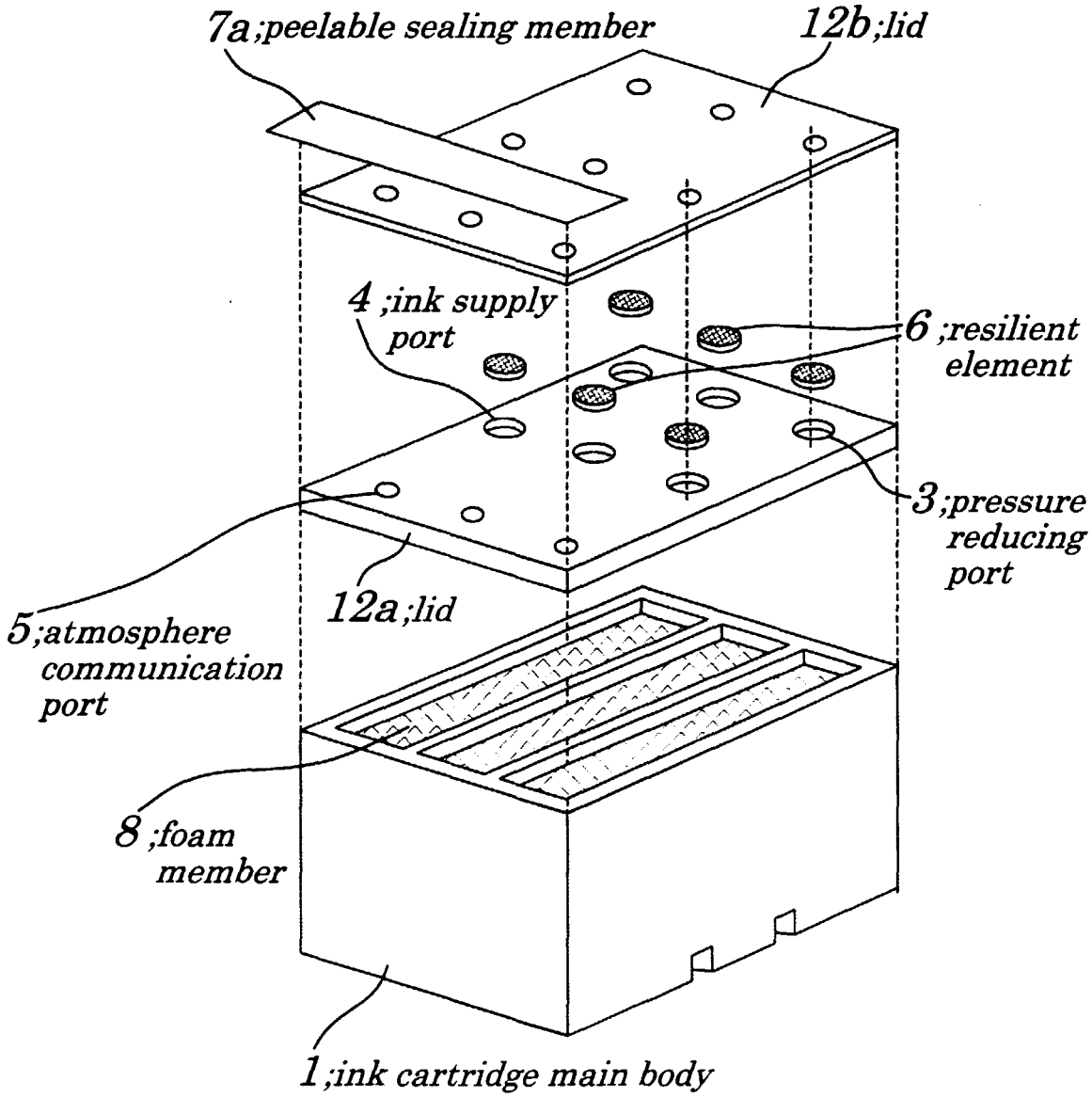
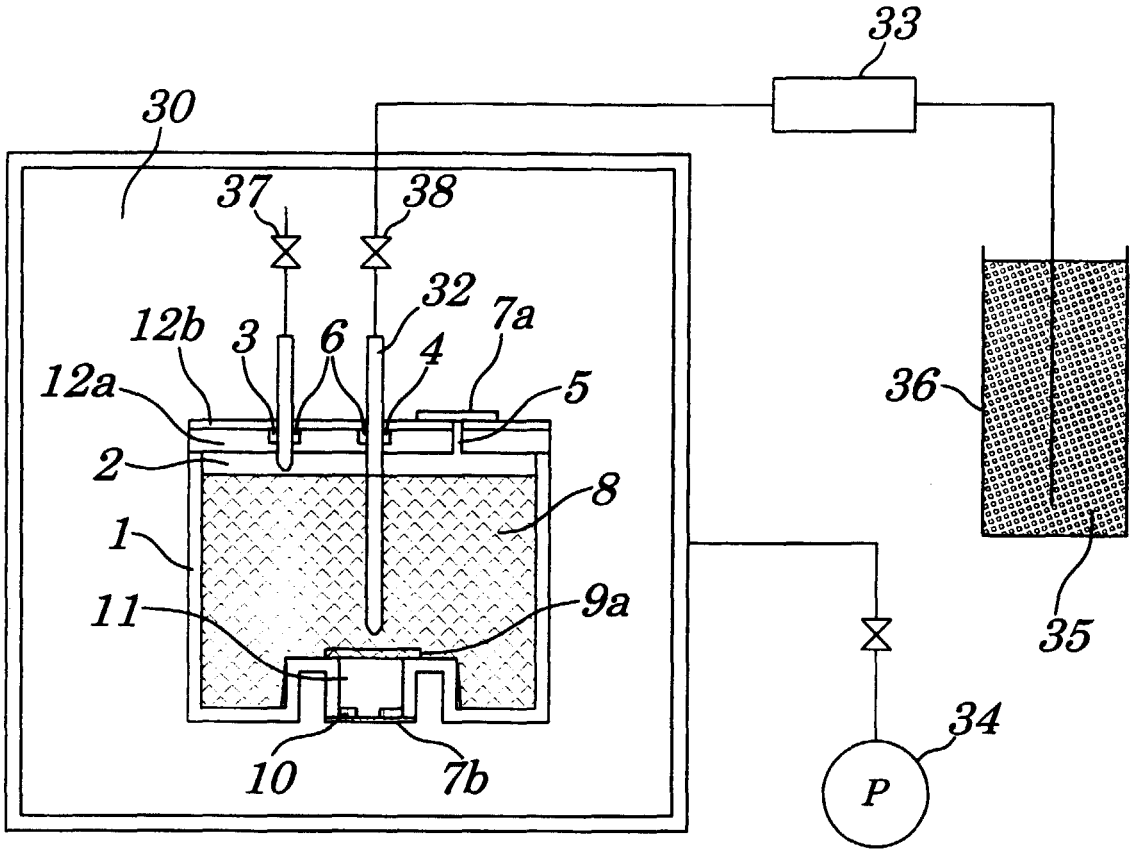
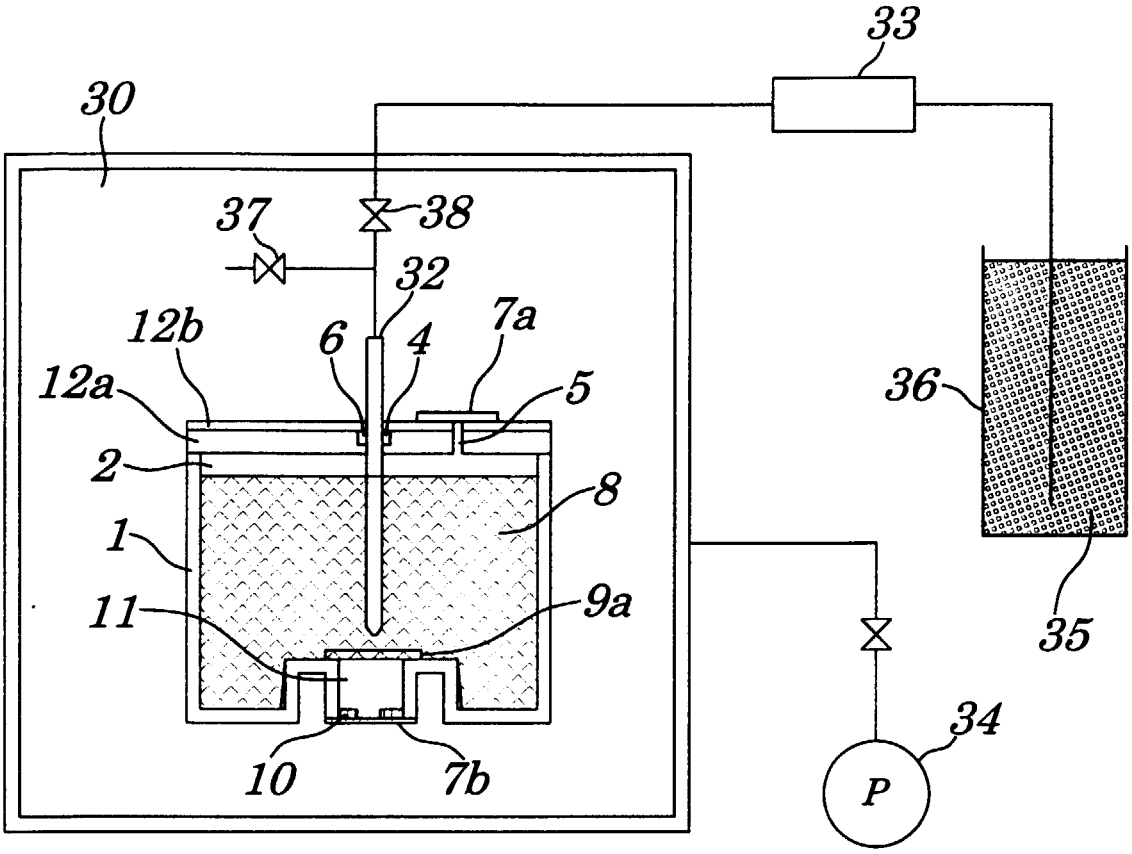

7a;peelable sealing member
12b;lid
4;ink supply port
6;resilient element
3;pressure reducing port
5;atmosphere communication port
12a;lid
8;foam member
1;ink cartridge main body

FIG.3



1;ink cartridge main body
2;ink chamber
3;pressure reducing port
4;ink supply port
5;atmosphere communication port
6;resilient element
7a;peelable sealing member
7b;sealing member
8;foam member
9a;filter
10;packing member
11;ink supply portion
12a,12b;lid
30;pressure reducing chamber
31;pressure reducing needle
32;ink supply needle
33;degassing treatment portion
34;pressure reducing pump
35;ink (not degassed)
36;ink tank
37;pressure reducing valve
38;ink supply valve

FIG.4



1;ink cartridge main body
2;ink chamber
4;ink supply port
5;atmosphere communication port
6;resilient element
7a;peelable sealing member
7b;sealing member
8;foam member
9a;filter
10;packing member
11;ink supply portion
12a, 12b;lid
30;pressure reducing chamber
32;ink supply needle
33;degassing treatment portion
34;pressure reducing pump
35;ink (not degassed)
36;ink tank
37;pressure reducing valve
38;ink supply valve

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 12 1274

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 December 2000	Bridge, S

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