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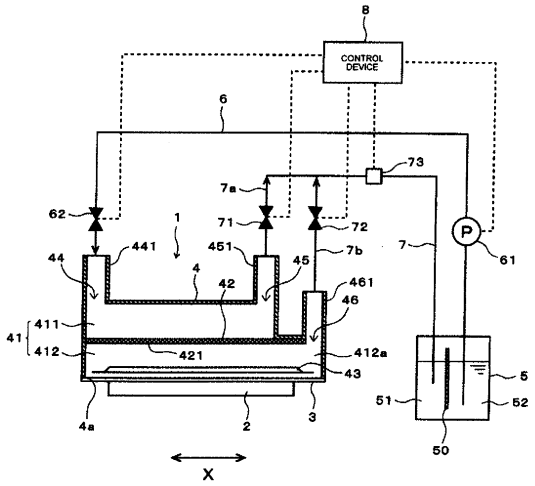
(54) **METHOD FOR REMOVING AIR BUBBLES FROM INKJET HEAD AND APPARATUS FOR REMOVING AIR BUBBLES FROM INKJET HEAD**

(57) The present invention addresses the problem of providing a method for removing air bubbles and an apparatus for removing air bubbles from an inkjet head, by which residual air bubbles in an ink storage chamber provided with a filter can be efficiently removed and the amount of wasted ink from a nozzle can be reduced. The problem is solved through a way in which: an ink storage chamber 41 is divided into an upstream-side ink chamber 411 and a downstream-side ink chamber 412 with a filter 42 disposed therebetween; a first ink port 44 and a second ink port 45 are disposed on upper portions of the upstream-side ink chamber 411; a third ink port 46 is disposed on an upper portion inside the downstream-side ink chamber 412 without the filter 42 therebetween; air bubbles in the upstream-side ink chamber 411 are removed by closing the passage of the third ink port 46 and discharging, from the second ink port 45, the ink that has been introduced into the upstream-side ink chamber 411 from the first ink port 44; and subsequently, air bubbles in the downstream-side ink chamber 412 are removed by closing the passage of the second ink port 45, allowing ink to flow down from the first ink port 44 to the downstream-side ink chamber 412 through the filter 42, and discharging the ink in the downstream-side ink chamber 412 from the third ink port 46.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a bubble removing method for an inkjet head and a bubble removing device for an inkjet head, and particularly to a bubble removing method for an inkjet head and a bubble removing device for an inkjet head that are capable of efficiently reducing residual bubbles in an ink storage chamber having a filter and also reducing the amount of waste ink from a nozzle.

BACKGROUND

[0002] An inkjet head is frequently used with the nozzle face thereof placed face down. Therefore, in the case where bubbles flow into the head or are caught from the nozzles at an initial ink introduction step, the bubbles remain on a ceiling surface in an ink storage chamber intercommunicating with a pressure chamber.

[0003] As a countermeasure, Patent Document 1 describes that bubbles in an ink storage chamber can be discharged from a liquid outlet located at a high position by circulating ink from a liquid inlet of the inkjet head to the liquid outlet. However, in connection with enhancement of the resolution, the nozzle diameter is also reduced to eject small ink droplets, which causes a risk that the nozzle is clogged with even minute dust or bubbles, and thus ejection failure occurs. Therefore, Patent Document 2 discloses that a filter for removing dust, etc. is provided in an ink storage chamber, and an ink discharge passage intercommunicating with the outside through a joint member is provided at the upper portion of the filter, whereby the ejection failure caused by clogging of dust or the like at the nozzle can be prevented. However, since the ink storage chamber is divided into an upstream side and a downstream side by the filter, bubbles remaining at the downstream side nearer to a pressure chamber than the filter cannot be sufficiently removed.

[0004] Therefore, there is a method of closing the port of a joint member to cause ink to flow from an ink inflow port under pressure, thereby purging ink together with bubbles from the nozzle to remove the bubbles. However, when it is intended to perfectly remove bubbles, a large amount of ink is discarded every time bubbles are removed, and also there is a problem in durability of the head because it is necessary to apply strong pressure.

[0005] In order to solve the above problem, according to the Patent Document 3, the ink storage chamber is provided with a bubble-releasing path intercommunicating with the downstream side of the filter through the filter in addition to an ink inflow passage and an ink discharge passage, and ink is made to flow from the ink inflow passage under pressure while the ink is passed through the filter and discharged from the bubble-releasing path, thereby removing bubbles remaining at the downstream side of the filter.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006]

Patent Document 1: JP-A-2006-175651
Patent Document 2: JP-A-2009-202490
Patent Document 3: JP-A-2012-218398

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0007] However, for example, when larger amounts of dust, etc. and bubbles are intended to be removed by a filter, the pressure loss of the filter increases, and thus in order to discharge residual bubbles from the bubble-releasing path to the downstream side, high pressure is required to be applied in consideration of the pressure loss of the filter. However, this causes a problem from the viewpoint of durability of the head and durability of the pump.

[0008] Therefore, the inventor of the present application has focused attention on an idea that bubbles can be removed by flow of ink in the downstream-side ink chamber of the filter, and has reached the present invention.

[0009] Therefore, the present invention has an object to provide a bubble removing method for an inkjet head and a bubble removing device for an inkjet head that can efficiently remove residual bubbles in the ink storage chamber provided with filter, and reduce the amount of waste ink from a nozzle.

[0010] Other object of the present invention will be made apparent from the description below.

MEANS FOR SOLVING PROBLEM

[0011] The above-described problems are solved by the following respective inventions.

[0012]

1. A bubble removing method for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

providing a first ink port for inflow of ink and a second ink port for discharge of ink at an upper portion of the upstream-side ink chamber, and providing a third ink port for discharge of ink at an upper portion inside the downstream-side ink

chamber without the filter existing therebetween;

opening each of flow passages intercommunicating with the first ink port and the second ink port, and closing a flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber; and subsequently closing the flow passage intercommunicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber.

2. The bubble removing method for an inkjet head according to 1, further comprising:

further providing a fourth ink port for inflow of ink intercommunicating, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;

opening of each of the flow passages intercommunicating with the first ink port and the second ink port respectively, and closing each of the flow passages intercommunicating with the third ink port and the fourth ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber;

subsequently closing the flow passage intercommunicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause to ink flow in from the first ink port and cause ink to flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber; and

subsequently closing each of the flow passages intercommunicating with the first ink port and the second ink port, and opening the flow passage intercommunicating with the fourth ink port so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles existing at a site where flow of ink directing to the third ink port is stagnant.

3. A bubble removing method for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

providing a first ink port for inflow of ink and a second ink port for discharge of ink at an upper portion of the upstream-side ink chamber, and providing a third ink port for discharge of ink at an upper portion inside the downstream-side ink chamber without the filter existing therebetween;

opening the flow passage intercommunicating with the first ink port, closing the flow passage intercommunicating with the second ink port and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and cause ink to flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge, from the third ink port, thereby removing bubbles in the downstream-side ink chamber; and

subsequently opening each of the flow passages intercommunicating with the first ink port and the second ink port, and closing the flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber.

4. The bubble removing method for an inkjet head according to 3, further comprising:

further providing a fourth ink port for inflow of ink intercommunicating, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;

opening the flow passage intercommunicating with the first ink port, closing the flow passage intercommunicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and cause ink to flow from the upstream-side ink chamber

through the filter to the downstream-side ink chamber and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber;
subsequently opening each of the flow passages intercommunicating with the first ink port and the second ink port, and closing the flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause the ink to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber; and
subsequently closing each of the flow passages intercommunicating with the first ink port and the second ink port, and opening the flow passage intercommunicating with the fourth ink port so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles existing at a site where flow of ink directing to the third ink port is stagnant.

5. The bubble removing method for an inkjet head according to any one of 1 to 4, wherein the pressure P [kPa] of ink flowing into the ink storage chamber satisfies the relationship of $P \leq P_{MN} + R_F$, wherein P_{MN} represents a nozzle meniscus break pressure, and R_F represents a pressure loss of the filter.

6. The bubble removing method for an inkjet head according to any one of 1 to 5, wherein the pressure P [kPa] of ink flowing into the ink storage chamber satisfies the relationship of $P > 7 - R_F$.

7. A bubble removing device for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

a first ink port for inflow of ink and a second ink port for discharge of ink that are provided at an upper portion of the upstream-side ink chamber;
a third ink port for discharge of ink that is provided at an upper portion inside the downstream-side ink chamber without the filter existing therebetween; and
an ink tank that stores ink to be supplied to the ink storage chamber through a liquid delivery pump,
wherein the ink tank is connected to the first ink port through a first ink supply pipe, and connected to the second ink port and the third ink port through a first ink discharge pipe and a second ink discharge pipe respectively, and the first ink supply pipe, the first ink discharge pipe and the second ink discharge pipe are provided with a first on-off valve, a second on-off valve and a third on-off valve respectively; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve and the third on-off valve,
wherein the control device controls to perform a first control operation of opening the first on-off valve and the second on-off valve, closing the third on-off valve, and driving the liquid delivery pump so as to cause ink flowing from the first ink port into the upstream-side ink chamber to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber, and after completion of the first control operation, perform a second control operation of closing the second on-off valve while the first on-off valve is left open, opening the third on-off valve and driving the liquid delivery pump so as to cause ink flowing from the first ink port to pass through the upstream-side ink chamber and the downstream-side ink chamber and discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber.

8. The bubble removing device for an inkjet head according to 7, further comprising:

a fourth ink port for inflow of ink that intercommunicates, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;
a second ink supply pipe that intercommunicates with the fourth ink port and causes to ink flow in from the ink tank, the second ink supply pipe being provided with a fourth on-off valve; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve,
wherein the control device controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve to close the first on-off valve and the second on-off valve, open the third on-off valve and the fourth on-off valve and drive the liquid delivery pump after completion of the second control operation so that ink flowing from the fourth ink port into the downstream-side ink chamber is discharged from the third ink port.

9. A bubble removing device for an inkjet head that includes a pressure chamber intercommunicating

with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

a first ink port for inflow of ink and a second ink port for discharge of ink that are provided at an upper portion of the upstream-side ink chamber;
a third ink port for discharge of ink that is provided at an upper portion inside the downstream-side ink chamber without the filter existing therebetween;
an ink tank that stores ink to be supplied to the ink storage chamber through a liquid delivery pump,
wherein the ink tank is connected to the first ink port through a first ink supply pipe, and connected to the second ink port and the third ink port through a first ink discharge pipe and a second ink discharge pipe respectively, and the first ink supply pipe, the first ink discharge pipe and the second ink discharge pipe are provided with a first on-off valve, a second on-off valve and a third on-off valve respectively; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve and the third on-off valve,
wherein the control device controls to perform a second control operation of opening the first on-off valve, closing the second on-off valve, opening the third on-off valve and driving the liquid delivery pump so as to cause ink to flow in from the first ink port and pass through the upstream-side ink chamber and the downstream-side ink chamber and discharge the ink from the third ink port, thereby removing bubbles in the downstream-side ink chamber, and after completion of the second control operation, perform a first control operation of opening the first on-off valve and the second on-off valve, closing the third on-off valve and driving the liquid delivery pump so as to cause ink flowing from the first ink port into the upstream-side ink chamber to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber.

10. The bubble removing device for an inkjet head according to 9, further comprising:

a fourth ink port for inflow of ink that intercommunicates, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;
a second ink supply pipe that intercommunicates with the fourth ink port and causes to ink flow in from the ink tank, the second ink supply pipe being provided with a fourth on-off valve; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve,
wherein the control device controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve to close the first on-off valve and the second on-off valve, open the third on-off valve and the fourth on-off valve and drive the liquid delivery pump after completion of the first control operation so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port.

11. The bubble removing device for an inkjet head according to 8 or 10, wherein the fourth ink port is disposed at a site where flow of ink directing from the first ink port to the third ink port is stagnant in the downstream-side ink chamber.

12. The bubble removing device for an inkjet head according to any one of 7 to 11, wherein a control operation of discharging bubbles in the ink storage chamber controls the pressure P [kPa] of ink flowing into the ink storage chamber so that the pressure P satisfies the relationship of $P \leq P_{MN} + R_F$, wherein P_{MN} represents a nozzle meniscus break pressure, and R_F represents a pressure loss of the filter.

13. The bubble removing device for an inkjet head according to any one of 7 to 12, wherein the pressure P [kPa] of ink flowing into the ink storage chamber is controlled to satisfy the relationship of $P > 7 - R_F$ in the control operation.

14. The bubble removing device for an inkjet head according to any one of 7 to 13, wherein the first ink port and the second ink port are disposed at both the end portions in the longitudinal direction of the upstream-side ink chamber, and the third ink port is disposed at an end portion of the downstream-side ink chamber which is farther away from the first ink port than the second ink port.

15. The bubble removing device for an inkjet head according to any one of 7 to 14, wherein the third ink port is located at the same height as or higher than a lower surface of the filter by which the ink storage chamber is divided into the upstream-side ink chamber and the downstream-side ink chamber.

16. The bubble removing device for an inkjet head according to any one of 7 to 15, wherein the area of the filter by which the ink storage chamber is divided into the upstream-side ink chamber and the downstream-side ink chamber is sufficiently larger than the opening area of the first ink port.

17. The bubble removing device for an inkjet head according to any one of 7 to 16, wherein the ink tank is partitioned into an ink return chamber and an ink supply chamber by a partition plate that does not reach a bottom plate of the ink tank, an ink discharge pipe is connected to the ink return chamber and an ink supply pipe is connected to the ink supply chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a schematic diagram showing an example of a bubble removing device for an inkjet head according to a first embodiment to implement a bubble removing method for an inkjet head according to the present invention;

Fig. 2 is a partially enlarged cross-sectional view showing an example of the inkjet head used in Fig. 1;

Fig. 3 is a flowchart showing a bubble removing operation of the bubble removing device for an inkjet head according to the first embodiment;

Fig. 4 is a diagram showing the states of ink and bubbles in an ink storage chamber during the bubble removing operation according to the first embodiment;

Fig. 5 is a schematic diagram showing an example of a bubble removing device for an inkjet head according to a second embodiment to implement the bubble removing method for an inkjet head according to the present invention;

Fig. 6 is a flowchart showing the bubble removing operation of the bubble removing device for an inkjet head according to the second embodiment;

Fig. 7 is a diagram showing the states of ink and bubbles in an ink storage chamber during the bubble removing operation according to the second embodiment; and

Fig. 8 is a flowchart showing a nozzle purge operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Embodiments according to the present invention will be described hereunder in detail with reference to the drawings.

(First Embodiment)

[0015] Fig. 1 is a schematic diagram showing an example of a bubble removing device for an inkjet head according to a first embodiment to implement a bubble removing method for an inkjet head according to the present invention, and Fig. 2 is a partially enlarged cross-sectional view of an example of an inkjet head used in Fig. 1.

[0016] In Fig. 1, an inkjet head 1 includes a head chip 2, a substrate 3 adhering to the head chip 2, and a manifold 4 which adheres to a surface of the substrate 3 on the opposite side to the head chip 2 while the substrate 3 is sandwiched therebetween. A nozzle plate 21 having nozzles 22 adheres to a surface of the head chip 2 on the opposite side to the substrate 3.

[0017] The bubble removing device includes an ink tank 5 for ink to be supplied to the inkjet head 1. The inkjet head 1 and the ink tank 5 intercommunicate with each other so that ink can be supplied to the inkjet head 1 through an ink supply pipe 6, and ink can be returned from the inkjet head 1 through an ink discharge pipe 7.

[0018] Although the ink tank 5 is not specifically limited, the ink tank 5 is preferably partitioned into an ink return chamber 51 and an ink supply chamber 52 by a partition plate 50 which does not reach the bottom plate of the tank. The ink discharge pipe 7 is connected to the ink return chamber 51, and the ink supply pipe 6 is connected to the ink supply chamber 52.

[0019] The partition plate 50 is provided to sufficiently deaerate ink so that bubbles in the ink returned to the ink return chamber 51 are not supplied from the ink supply pipe 6 again. When the partition plate is configured not to reach the bottom plate of the tank, this is preferable because bubbles themselves have high buoyance and thus are restricted from passing through the lower side of the partition plate 50 and feeding into the ink supply chamber 52. Such an aspect is preferable to a case where ink is used under circulation.

[0020] The inkjet head 1 of this embodiment is illustrated to be used in such an arrangement that the nozzle faces thereof face the lower side in Figs. 1 and 2. In the specification, "up" or "down" is indicated with reference to the working conditions shown in Figs. 1 and 2. Accordingly, the upper side in Figs. 1 and 2 corresponds to "up", and the lower side in Figs. 1 and 2 corresponds to "down".

[0021] As shown in Fig. 2, the head chip 2 has pressure chambers 23. The number of pressure chambers 23 is not limited to a specific value, and at least one pressure chamber 23 may be provided. The head chip 2 according to this embodiment has plural pressure chambers 23 arranged along the X-direction in Figs. 1 and 2. The X-direction represents the longitudinal direction of the head chip 2. The pressure chambers 23 discharge liquid droplets from the nozzles 22 intercommunicating with one ends of the pressure chambers 23 by applying discharge pressure to ink in the pressure chambers 23. The other ends of the pressure chambers 23 are opened to an end face on the substrate 3 side of the head chip 2.

[0022] Any means may be used to apply the discharge pressure to the ink in the pressure chamber 23, and a well-known art is applicable. This embodiment exemplifies the head chip 2 in which the partition wall 24 for partitioning the adjacent pressure chambers 23, 23 therethrough comprises a piezoelectric element. The partition wall 24 undergoes shear deformation upon application of a voltage to driving electrodes (not shown) formed on

two opposed surfaces thereof. The shear deformation of the partition walls 24, 24 at both the sides of the pressure chamber 23 makes the pressure chamber 23 expand or contract, whereby the discharge pressure is applied to the ink and liquid droplets are discharged from the nozzles 22.

[0023] The substrate 3 is, for example, a glass substrate, and has a wiring (not shown) for applying a voltage to the driving electrodes of each partition wall 24 of the head chip 2. The substrate 3 adheres to the end face of the head chip 2 to which the other ends of the pressure chambers 23 are opened. The size of the substrate 3 is larger than that of the end face of the head chip 2. Therefore, the outer periphery of the substrate 3 protrudes to the outside of the head chip 2. In the substrate 3 are formed through-holes 31 which intercommunicate with the pressure chambers 23 of the head chip 2 to cause ink to flow into the pressure chambers 23.

[0024] The manifold 4 is formed of synthetic resin and configured in a horizontally-long box-shape having an opening portion 4a in one surface thereof, and adheres to the substrate 3 so as to block the opening portion 4a. The internal space of the manifold 4 constitutes an ink storage chamber 41 for storing ink supplied from an ink tank 5 described later. The ink storage chamber 41 intercommunicates with all the pressure chambers 23 of the head chip 2 through the through-holes 31 of the substrate 3. Accordingly, the ink in the ink storage chamber 41 is commonly supplied to the respective pressure chambers 23 through the through-holes 31.

[0025] A filter 42 formed of, for example, a mesh porous body of metal or resin is disposed in the ink storage chamber 41. The filter 42 prevents foreign substances contained in ink from flowing into the pressure chambers 23. The filter 42 is disposed substantially in parallel to the substrate 3 so that the ink storage chamber 41 is vertically bisected in Fig. 1, and fixed in the ink storage chamber 41, whereby the ink storage chamber 41 is divided into an upstream-side ink chamber 411 being distant from the pressure chambers 23 and a downstream-side ink chamber 412 being near to the pressure chambers 23 with the filter 42 being located therebetween.

[0026] In the present invention, the filter 42 functions as a pressure loss element during supply of ink.

[0027] In pump circulation of liquid, the length of an ink supply pipe, the number of bent portions of the supply pipe, the number of fittings of on-off valves and the like, etc. are considered as pressure loss elements. However, these pressure loss elements are negligible in level as compared with the pressure loss of the filter.

[0028] A damper member 43 in which gas is encapsulated is disposed in the downstream-side ink chamber 412. The damper member 43 is disposed at a predetermined distance from the substrate 3 so that a damper surface 431 formed of a flexible membrane (see Fig. 2) faces the substrate 3. The damper member 43 absorbs pressure waves propagating from the pressure chambers 23 to the ink storage chamber 41 under discharge of ink. Accordingly, an effect of pressure waves occurring in a pressure chamber 23 on the other pressure chambers 23 through the ink storage chamber 41 can be alleviated.

[0029] In the ink storage chamber 41, the upstream-side ink chamber 411 is provided with a first ink port 44 and a second ink port 45.

[0030] The first ink port 44 is a port through which ink is made to flow into the ink storage chamber 41. A connection portion 441 is provided at the first ink port 44 so as to be erected upwards. The connection portion 441 intercommunicates with the ink supply pipe 6. In this embodiment, the ink supply pipe 6 is a first ink supply pipe.

[0031] The second ink port 45 is a port through which ink flowing from the first ink port 44 into the upstream-side ink chamber 411 is discharged together with bubbles in the ink. A connection portion 451 is provided at the second ink port 45 so as to be erected upwards.

[0032] The connection portion 451 intercommunicates with the ink discharge pipe 7. Specifically, an end portion of the ink discharge pipe 7 on the inkjet head 1 side is split into two branch pipes 7a, 7b. The connection portion 451 of the second ink port 45 intercommunicates with the branch pipe 7a out of these branch pipes. In this embodiment, the branch pipe 7a of the ink discharge pipe 7 is a first ink discharge pipe.

[0033] The inner diameter of a flow passage extending from the second ink port 45 through the connection portion 451, the branch pipe 7a and the ink discharge pipe 7 and reaching the ink tank 5 is equal to or larger than the opening diameter of the second ink port 45. Therefore, the pressure loss of the flow passage intercommunicating with the second ink port 45 does not increase, so that ink and bubbles in the ink can be smoothly discharged.

[0034] Furthermore, it is preferable that the opening diameter of the second ink port 45 is equal to or larger than the opening diameter of the first ink port 44, whereby ink flowing in from the first ink port 44 can be smoothly discharged from the second ink port 45.

[0035] It is preferable that the first ink port 44 and the second ink port 45 are located at both the ends in the longitudinal direction of the upstream-side ink chamber 411 as shown in Fig. 1. Specifically, in this embodiment, the first ink port 44 is opened to the upper surface of the end portion at the left side of the upstream-side ink chamber 411 in Fig. 1, and the second ink port 45 is opened to the upper surface of the end portion at the right side of the upstream-side ink chamber 411 in Fig. 1, whereby ink flowing from the first ink port 44 into the upstream-side ink chamber 411 can be made to efficiently flow to the second ink port 45 over the whole inside of the upstream-side ink chamber 411. Accordingly, a site at which ink is stagnant is hardly formed in the upstream-side ink chamber 411, and thus bubbles in the ink can be more efficiently removed.

[0036] In the ink storage chamber 41, the downstream-side ink chamber 412 is provided with a third ink port 46.

The third ink port 46 is a port through which ink flowing from the first ink port 44 through the upstream-side ink chamber 411 into the downstream-side ink chamber 412 is discharged together with bubbles in the ink. The filter 42 is disposed between the upstream-side ink chamber 411 and the downstream-side ink chamber 412. Therefore, when ink is discharged from the third ink port 46, the ink necessarily passes through the filter 42 and flows into the downstream-side ink chamber 412. Accordingly, bubbles remaining in the filter 42 can be also discharged to the downstream-side ink chamber 412, and removed from the third ink port 46.

[0037] A connection portion 461 is provided at the third ink port 46 so as to be erected upwards. The connection portion 461 intercommunicates with the ink discharge pipe 7. Specifically, the connection portion 461 of the third ink port 46 intercommunicates with the branch pipe 7b of the ink discharge pipe 7. In this embodiment, the branch pipe 7b of the ink discharge pipe 7 is a second ink discharge pipe.

[0038] The inner diameter of a flow passage extending from the third ink port 46 through the connection portion 461, the branch pipe 7b and the ink discharge pipe 7, and reaching the ink tank 5 is equal to or larger than the opening diameter of the third ink port 46. Therefore, the pressure loss of the flow passage intercommunicating with the third ink port 46 does not increase, and ink and bubbles in the ink can be smoothly discharged.

[0039] The third ink port 46 is not covered by the filter 42. Accordingly, the third ink port 46 intercommunicates with the downstream-side ink chamber 412 through no filter. Accordingly, when ink and bubbles in the ink in the downstream-side ink chamber 412 are discharged from the third ink port 46, they undergo no pressure loss from a filter. Therefore, the ink and the bubbles in the ink can be efficiently discharged without increasing the inflow pressure when the ink is made to flow into the manifold 4.

[0040] Further describing, according to the present invention, the pressure P of ink which is fed to the first ink port 44 by a liquid delivery pump 61 is preferably determined in consideration of the pressure loss of the filter, the nozzle meniscus break pressure of the nozzle 22 and other non-negligible pressure losses. In the present invention, the nozzle meniscus break pressure of the nozzle 22 must be sufficiently considered from the viewpoint of preventing waste of ink.

[0041] In the present invention, the pressure P of ink means the inflow pressure of ink which is made to flow into the manifold 4 by driving the liquid delivery pump 61, and it is measured at a flow passage at the upstream of the first ink port 44 (total pressure is measured when there is a fourth ink port 47 described later).

[0042] For example, when an on-off valve represented by reference numeral 72 of Fig. 1 is provided at the downstream of the third ink port 46, the pressure loss of the on-off valve occurs in addition to the pressure loss of the filter 42. Accordingly, when the on-off valve is provided, it is more preferable to set the pressure in consideration of addition of the pressure loss of the on-off valve.

[0043] Furthermore, the pressure P of ink also varies according to the water head difference between the ink tank 5 and the inkjet head 1. The pressure P of ink in the present invention is defined as the pressure when the water head difference between the ink tank 5 and the inkjet head 1 is set to zero.

[0044] Furthermore, the opening diameter of the third ink port 46 is preferably larger than the opening diameter of one nozzle 22. Such a configuration makes it easier for ink flowing into the downstream-side ink chamber 412 to be discharged smoothly from the third ink port 46 than that from the nozzles 22. Accordingly, the amount of waste ink to be discharged from the nozzles 22 under removal of bubbles can be reduced.

[0045] The opening diameter of the nozzle 22 means the opening diameter of the tip in the discharge direction of the nozzle 22. When the opening shape of the tip in the discharge direction of the nozzle 22 is circular, the opening diameter indicates the diameter of the circle. On the other hand, when the opening shape is not circular, the opening shape is replaced by a circle having the same area as the opening area of the tip in the discharge direction of the nozzle 22, and the opening diameter is set to the diameter of the circle.

[0046] When ink is made to flow in from the first ink port 44 and then discharged from the third ink port 46 for removal of bubbles, it is preferable that the pressure P of ink to flow from the first ink port 44 into the ink storage chamber 41 satisfies the relationship of $P \leq P_{MN} + R_F$ [kPa] wherein the P_{MN} represents the nozzle meniscus break pressure and R_F represents the pressure loss of the filter 42. With this configuration, when the ink flowing into the downstream-side ink chamber 412 is discharged from the third ink port 46, the ink is not discharged from the nozzle 22, and the amount of waste ink can be reduced to substantially zero.

[0047] The lower limit of the pressure P of ink is required to be larger than the filter meniscus break pressure P_{MF} as the pressure under which ink can pass through the filter 42. Specifically, it is preferable to satisfy the relationship of $P > 7 - R_F$ [kPa]. With this configuration, the ink flowing from the first ink port 44 into the upstream-side ink chamber 411 can be made to rapidly flow through the filter 42 into the downstream-side ink chamber 412. Accordingly, the bubble removing operation can be early completed.

[0048] The opening diameter of the third ink port 46 is preferably set to be equal to or larger than the opening diameter of the first ink port 44, whereby the ink flowing in from the first ink port 44 can be smoothly discharged from the third ink port 46.

[0049] It is preferable that the third ink port 46 is located at an end portion of the downstream-side ink chamber 412 which is more distant from the first ink port 44 than the second ink port 45. Specifically, in this embodiment, the downstream-side ink chamber 412 has an extension portion 412a which protrudes outwards from the end por-

tion on the second ink port 45 side of the upstream-side ink chamber 411. The third ink port 46 is opened to the upper surface of the extension portion 412a.

[0050] With the above configuration, the ink passing through the filter 42 and flowing into the downstream-side ink chamber 412 can be made to efficiently flow to the third ink port 46 over the whole inside of the downstream-side ink chamber 412. Accordingly, a site at which ink is stagnant is hardly formed in the downstream-side ink chamber 412, and bubbles in ink can be more efficiently removed.

[0051] Furthermore, the third ink port 46 is preferably located at the same height position as the lower surface 421 of the filter 42 or a position higher than the lower surface 421. With this arrangement, a step portion serving as a weir for disturbing discharge of bubbles adhering to the lower surface 421 of the filter 42 is not formed between the filter 42 and the third ink port 46, so that the discharge performance of bubbles can be more enhanced. The height means the distance by which the manifold 4 is spaced from the opening portion 4a.

[0052] It is preferable that the area of the filter 42 is sufficiently larger than the opening area of the first ink port 44. Accordingly, even when dust contained in ink flowing from the first ink port 44 adheres to the filter 42 during discharge of the ink from the third ink port 46, flow of the ink passing through the filter 42 to the downstream-side ink chamber 412 is not immediately disturbed.

[0053] The liquid delivery pump 61 for supplying ink in the ink tank 5 to the inkjet head 1 and a first on-off valve 62 for electrically opening/closing a flow passage intercommunicating with the first ink port 44 are connected to some points of the ink supply pipe 6. A second on-off valve 71 for electrically opening/closing a flow passage intercommunicating with the second ink port 45 is connected to some point of the branch pipe 7a of the ink discharge pipe 7. Furthermore, the third on-off valve 72 for electrically opening/closing a flow passage intercommunicating with the third ink port 46 is connected to some point of the branch pipe 7b of the ink discharge pipe 7.

[0054] A bubble detection sensor 73 for detecting bubbles in the ink discharged from the second ink port 45 and the third ink port 46 is connected to some point of the ink discharge pipe 7.

[0055] For example, an electrode type sensor, an optical sensor or the like may be used as the bubble detection sensor 73. The electrode type bubble sensor, for example, measures minute current flowing between two electrodes, and monitors the difference between current values of flowing current when liquid is fully filled in a detector and when bubbles are mixed in the detector. It is also preferable that the detector to be fully filled with liquid containing no bubbles detects ink in the ink supply pipe 6 because ink containing no bubble is preferable as the liquid.

[0056] As shown in Fig. 1, the bubble detection sensor 73 is preferably connected to some point at the downstream of the ink discharge pipe 7 with respect to the branch pipes 7a, 7b. With this arrangement, bubbles in ink discharged from any port of the second ink port 45 and the third ink port 46 can be detected by one bubble detection sensor 73, and thus the configuration can be simplified. However, each of the branch pipes 7a, 7b may be provided with the bubble detection sensor as not shown.

[0057] The liquid delivery pump 61 and the first on-off valve 62, the second on-off valve 71 and the third on-off valve 72 are electrically connected to a control device 8. The control device 8 controls the driving of the liquid delivery pump 61 (ON/OFF) and the opening/closing of the first on-off valve 62, the second on-off valve 71 and the third on-off valve 72 according to a pre-stored predetermined program when bubbles in the ink storage chamber 41 are removed.

[0058] A detection signal of the bubble detection sensor 73 is input to the control device 8. After the driving of the liquid delivery pump 61 is started for bubble removal, the control device 8 monitors the detection signal input from the bubble detection sensor 73 at a predetermined time interval, and determines the presence or absence of bubbles in ink discharged from the ink storage chamber 41.

[0059] Next, an example of the bubble removing operation of the bubble removing device described with respect to the first embodiment will be further described with reference to Figs. 3 and 4. Fig. 3 is a flowchart showing the bubble removing operation, and Fig. 4 is a diagram showing the states of ink and bubbles in the ink storage chamber 41 during the bubble removing operation.

[0060] The bubble removing operation is performed in an initial ink introduction step in which the ink storage chamber 41 is filled with ink from its empty state or a maintenance step for the inkjet head 1. In the following description, a case where the bubble removing operation is executed in the initial ink introduction step will be described. However, the bubble removing operation executed in the maintenance step may be likewise performed.

[0061] In the initial state, the ink storage chamber 41 is under an empty state. The control device 8 opens all the on-off valves 62, 71 and 72 to open the respective flow passages intercommunicating with all the ink ports 44, 45 and 46 when performing the bubble removing operation. Furthermore, a flag a is set to 0.

[0062] First, the control device 8 checks the flag a (S101). At this time, since flag a = 0 is set, the control device 8 closes the third on-off valve 72 so as to close the flow passage intercommunicating with the third ink port 46 (S102).

[0063] Subsequently, the control device 8 controls the liquid delivery pump 61 to start its driving and supply ink into the ink storage chamber 41 (S103), whereby ink in the ink tank 5 flows from the first ink port 44 into the upstream-side ink chamber 411 under predetermined pressure (Fig. 4(a)).

[0064] The ink flowing from the first ink port 44 into the upstream-side ink chamber 411 is made to flow over the entire inside of the upstream-side ink chamber 411, pass from the second ink port 45 through the branch pipe 7a and the ink discharge pipe 7 and then return to the ink tank 5. During the driving of the liquid delivery pump 61, ink circulation is performed such that the ink is made to flow from the ink tank 5 through the upstream-side ink chamber 411 and return to the ink tank 5 again. In this process, bubbles B1 in the upstream-side ink chamber 411 are efficiently discharged from the second ink port 45 by the circulation flow of ink (Fig. 4(b)).

[0065] The bubbles B1 in the ink passed from the second ink port 45 through the ink discharge pipe 7 and returned to the ink tank 5 are detected by the bubble detection sensor 73. The control device 8 monitors the detection signal from the bubble detection sensor 73 at a predetermined time interval after the driving of the liquid delivery pump 61 is started in the bubble removing operation. This time interval is set to a predetermined time period for which it is estimated that bubbles in the upstream-side ink chamber 411 or the downstream-side ink chamber 412 have been removed from the start of the driving of the liquid delivery pump 16. The control device 8 continues to drive the liquid delivery pump 61 and circulates the ink in the upstream-side ink chamber 411 until the bubble detection sensor 73 detects no longer the bubbles B1 in the ink inside the ink discharge pipe 7 (S104).

[0066] When the bubble detection sensor 73 detects no longer the bubbles B1 in the ink flowing inside the ink discharge pipe 7, the control device 8 stops the driving of the liquid delivery pump 61 to stop supply of ink to the ink storage chamber 41 (S105).

[0067] Thereafter, the control device 8 sets flag a = 1 (S106), opens all the on-off valves 62, 71 and 72 (S107) and then returns to the processing starting from step S101.

[0068] Since flag a = 1 is set in second step S101, the control device 8 closes only the second on-off valve 71 to close only the flow passage intercommunicating with the second ink port 45 (S108).

[0069] Thereafter, the control device 8 starts the driving of the liquid delivery pump 61 again so that ink is supplied into the ink storage chamber 41 (S109). At this time, since the flow passage intercommunicating with the second ink port 45 is closed, ink flowing from the first ink port 44 into the upstream-side ink chamber 411 passes through the filter 42, and flows into the downstream-side ink chamber 412. The ink flowing into the downstream-side ink chamber 412 is made to pass from the third ink port 46 through the branch pipe 7b and the ink discharge pipe 7, and return to the ink tank 5, whereby the ink is circulated between the ink storage chamber 41 and the ink tank 5.

[0070] The control device 8 continues the driving of the liquid delivery pump 61 and continues to supply ink to the first ink port 44, thereby continuing discharge of ink from the third ink port 46. During the driving of the liquid delivery pump 61, ink is circulated such that the ink is made to pass from the ink tank 5 through the upstream-side ink chamber 411 and the downstream-side ink chamber 412 and return to the ink tank 5 again, whereby the ink is circulated between the ink storage chamber 41 and the ink tank 5. In this process, bubbles B2 in the downstream-side ink chamber 412 are efficiently discharged from the third ink port 46 by circulation flow of ink (Fig. 4(c)).

[0071] In a preferable aspect of the present invention, the opening diameter of the third ink port 46 is set to be larger than the opening diameter of one nozzle 22, so that ink flowing into the downstream-side ink chamber 412 is more easily and smoothly discharged from the third ink port 46 than that from the nozzle 22. Therefore, when the bubbles B2 in the downstream-side ink chamber 412 are removed, a large amount of ink is prevented from being needlessly discharged from the nozzles 22, and thus the amount of waste ink is reduced.

[0072] Furthermore, by setting the pressure P of ink flowing from the first ink port 44 into the ink storage chamber 41 so as to satisfy the relationship of $P \leq P_{MN} + R_F$ [kPa], ink flowing into the downstream-side ink chamber 412 is not discharged from the nozzles 22 during discharge of the ink from the third ink port 46, so that the amount of waste ink can be reduced to substantially zero.

[0073] By setting the pressure P of the ink so as to satisfy the relationship of $P > 7 - R_F$ [kPa], ink flowing into the upstream-side ink chamber 411 can be made to rapidly pass through the filter 42 and flow to the downstream-side ink chamber 412. Accordingly, the bubble removing operation can be early completed.

[0074] The control device 8 also monitors the detection signal from the bubble detection sensor 73 at a predetermined time interval when bubbles in the downstream-side ink chamber 412 are removed as in the case of the removal of bubbles in the upstream-side ink chamber 411. The driving of the liquid delivery pump 61 is continued until the bubbles B2 in the ink flowing in the ink discharge pipe 7 are not detected any longer (S110).

[0075] When the bubbles B1 in the ink flowing in the ink discharge pipe 7 are not detected any longer by the bubble detection sensor 73, the control device 8 stops the driving of the liquid delivery pump 61 to stop the ink supply to the ink storage chamber 41 (S111).

[0076] Thereafter, the control device 8 closes all the on-off valves 62, 71 and 72 to close the respective flow passages intercommunicating with all the ink ports 44, 45 and 46 (S112).

[0077] Through the above operation, ink is filled in the upstream-side ink chamber 411 and the downstream-side ink chamber 412 of the ink storage chamber 41. The amount of waste ink which is needlessly discharged from the nozzles 22 is reduced, and residual bubbles in the ink storage chamber 41 are efficiently removed.

[0078] When the bubbles in the downstream-side ink chamber 412 are removed, ink flowing from the first ink

port 44 into the upstream-side ink chamber 411 necessarily passes through the filter 42, and then flows into the downstream-side ink chamber 412, so that bubbles remaining in the filter 42 can be also removed.

[0079] As described with respect to the embodiment, the bubble removing operation is preferably performed such that the bubbles B2 in the downstream-side ink chamber 412 are removed after the bubbles B1 in the upstream-side ink chamber 411 of the ink storage chamber 41 are removed, whereby the residual bubbles can be more efficiently removed with a small ink circulation amount.

(Second Embodiment)

[0080] Fig. 5 is a schematic configuration diagram showing an exemplary bubble removing device for an inkjet head according to a second embodiment to implement the bubble removing method for an inkjet head according to the present invention. The components represented by the same reference numerals as shown in Fig. 1 have the same configurations, and the detailed description thereof are omitted because the description of Fig. 1 can be referred to.

[0081] The second embodiment is particularly preferably applicable to a case where bubbles in the ink storage chamber 41 cannot be sufficiently removed by the bubble removing operation using the aforementioned third ink port 46 or cannot be rapidly removed.

[0082] In the second embodiment, the manifold 4 of the inkjet head 1 is added with a fourth ink port 47 for causing ink to flow into the ink storage chamber 41. The fourth ink port 47 is a port for causing ink to flow into the downstream-side ink chamber 412. A connection portion 471 is provided at the fourth ink port 47 so as to be erected upwards.

[0083] The connection portion 471 intercommunicates with the ink supply pipe 6. Specifically, the ink supply pipe 6 is configured so that an end portion on the inkjet head 1 side thereof is split into two branch pipes 6a and 6b. In this embodiment, the connection portion 471 of the fourth ink port 47 intercommunicates with the branch pipe 6b of these pipes. The connection portion 441 of the first ink port 44 intercommunicates with the branch pipe 6a. The first on-off valve 62 is connected to some point of the branch pipe 6a. In this embodiment, the branch pipe 6a of the ink supply pipe 6 is a first ink supply pipe, and the branch pipe 6b is a second ink supply pipe.

[0084] A fourth on-off valve 63 for electrically opening/closing a flow passage intercommunicating with the fourth ink port 47 is connected to some point of the branch pipe 6b. The fourth on-off valve 63 is electrically connected to and controlled by the control device 8.

[0085] The fourth ink port 47 intercommunicates with the downstream-side ink chamber 412 not through the upstream-side ink chamber 411. Accordingly, the flow rate of ink directing from the fourth ink port 47 to the third ink port 46 can be set to be higher than the flow rate of ink directing from the first ink port 44 to the third ink port 46. This is because the flow passage through which ink flows from the fourth ink port 47 to the downstream-side ink chamber 412 is remarkably narrower than the flow passage through which ink flows from the upstream-side ink chamber 411 to the downstream-side ink chamber 412. Therefore, bubbles in the downstream-side ink chamber 412 can be more surely and efficiently removed as compared with a case where ink is made to flow in from the first ink port 44.

[0086] Unlike the third ink port 46, the fourth ink port 47 is covered by the filter 48. Accordingly, the fourth ink port 47 intercommunicates with the downstream-side ink chamber 412 through the filter 48. Therefore, ink supplied to the fourth ink port 47 necessarily passes through the filter 48 and then flows into the downstream-side ink chamber 412.

[0087] A different filter from the filter 42 may be used as the filter 48 or the same filter as the filter 42 may be used.

[0088] When the filter 48 is a filter different from the filter 42, the filter 48 having a smaller pressure loss than the filter 42 may be used and is preferable. The flow rate of ink flowing from the fourth ink port 47 into the downstream-side ink chamber 412 can be more increased without increasing the inflow pressure of the ink, so that bubbles in the downstream-side ink chamber 412 can be still more surely and efficiently removed.

[0089] When the filter 48 is the same filter as the filter 42, the filter 48 can be configured by merely extending an end portion of the filter 42 toward the fourth ink port 47 so that the filter 42 covers the fourth ink port 47. Therefore, the configuration can be simplified, and the assembling can be also easily performed.

[0090] It is preferable that the fourth ink port 47 is disposed at a site where flow of ink directing from the first ink port 44 to the third ink port 46 is stagnant in the downstream-side ink chamber 412. According to this arrangement, bubbles remaining at the stagnant site when the ink flowing in from the first ink port 44 is discharged from the third ink port 46 can be also surely removed.

[0091] Specifically, in this embodiment, the fourth ink port 47 is disposed at an end portion of the downstream-side ink chamber 412 which is farther away from the third ink port 46 than the first ink port 44. More specifically, the downstream-side ink chamber 412 has an extension portion 412b protruding outwards from the end portion on the first ink port 44 side of the upstream-side ink chamber 411. The fourth ink port 47 is opened to the upper surface of the extension portion 412b. Accordingly, the fourth ink port 47 is disposed at the end portion opposed to the third ink port 46 in the longitudinal direction along an X-direction of the ink storage chamber 41 in Fig. 5.

[0092] Accordingly, the ink flowing from the fourth ink port 47 into the downstream-side ink chamber 412 efficiently flows over the entire inside of the downstream-side ink chamber 412, and is discharged from the third ink port 46. Therefore, stagnation can be made hard to

be formed in the downstream-side ink chamber 412, so that bubbles can be more surely removed.

[0093] In this embodiment, the opening diameter of the third ink port 46 is preferably equal to or larger than the opening diameter of the fourth ink port 47, whereby the ink flowing from the fourth ink port 47 into the downstream-side ink chamber 412 can be smoothly discharged from the third ink port 46.

[0094] Next, an example of the bubble removing operation of the bubble removing device according to the second embodiment will be further described with reference to Figs. 6 and 7. Fig. 6 is a flowchart showing the bubble removing operation, and Fig. 7 is a diagram showing the states of ink and bubbles in the ink storage chamber 41 during the bubble removing operation according to the second embodiment.

[0095] In the following description, a case where the bubble removing operation is performed in the initial ink introduction step will be described, and the same is also applied in the maintenance step.

[0096] In the initial state, the ink storage chamber 41 is under an empty state. When the bubble removing operation is started, the control device 8 opens all the on-off valves 62, 63, 71 and 72 to open the respective flow passages intercommunicating with all the ink ports 44, 45, 46 and 47. Furthermore, the flag a is set to 0.

[0097] First, the control device 8 checks the flag a (S201). At this time, flag a = 0 is set, so that the control device 8 closes the third on-off valve 72 and the fourth on-off valve 63 to close the respective flow passages intercommunicating with the third ink port 46 and the fourth ink port 47 (S202).

[0098] Next, the control device 8 controls the liquid delivery pump 61 to start its driving and supply ink into the ink storage chamber 41 (S203). Accordingly, the ink in the ink tank 5 flows from the first ink port 44 into the upstream-side ink chamber 411 under predetermined pressure, and is discharged from the second ink port 45 as in the case of the first embodiment. In this process, bubbles in the upstream-side ink chamber 411 are removed.

[0099] Thereafter, the control device 8 continues ink supply to the first ink port 44 until bubbles in the ink flowing from the second ink port 45 through the ink discharge pipe 7 and returning to the ink tank 5 are not detected any longer by the bubble detection sensor 73 as in the case of the steps S103 to S106 of the bubble removing operation in the first embodiment shown in Fig. 3, thereby circulating ink between the ink storage chamber 41 and the ink tank 5 (S204).

[0100] When no bubble is detected, the control device 8 stops the driving of the liquid delivery pump 61 to stop ink supply (S205). Thereafter, the control device 8 sets flag a = 1 (S206), and opens all the on-off valves 62, 63, 71 and 72 (S207), and then returns to the processing starting from step S201.

[0101] Then, since flag a = 1 is set in the second step S201, the control device 8 closes the second on-off valve 71 and the fourth on-off valve 63 to close the flow passage intercommunicating with the second ink port 45 and the fourth ink port 47 (S208, S209).

[0102] Thereafter, the control device 8 controls the liquid delivery pump 61 again to starts its driving and supply ink into the ink storage chamber 41 (S210). At this time, the control device 8 continues the ink supply to the first ink port 44 for a preset predetermined time without referring to any detection signal of the bubble detection sensor 73, whereby the ink flowing from the first ink port 44 into the upstream-side ink chamber 411 passes through the filter 42 and flows into the downstream-side ink chamber 412 as in the case of the first embodiment. The ink flowing into the downstream-side ink chamber 412 is made to pass from the third ink port 46 through the branch pipe 7b and the ink discharge pipe 7 and return to the ink tank 5, whereby ink is circulated between the ink storage chamber 41 and the ink tank 5.

[0103] When a predetermined time elapses, the control device 8 stops the driving of the liquid delivery pump 61 to stop ink supply (S211).

[0104] Subsequently, the control device 8 opens the fourth on-off valve 63 to open the fourth ink port 47, and further closes the first on-off valve 62 to close the flow passage intercommunicating with the first ink port 44 (S212).

[0105] Thereafter, the control device 8 controls the liquid delivery pump 61 to start its driving again and supply ink into the ink storage chamber 41 (S213).

[0106] At this time, ink flows from the fourth ink port 47 into the downstream-side ink chamber 412, and is discharged from the third ink port 46. Since the ink does not pass through the upstream-side ink chamber 411, the ink is circulated at a high flow rate in the downstream-side ink chamber 412, and bubbles B2 remaining in the downstream-side ink chamber 412 are removed (Fig. 7). Particularly, ink adhering to the lower surface 421 of the filter 42 can be also surely discharged from the third ink port 46 by the ink flowing at the high flow rate.

[0107] Furthermore, in this embodiment, the fourth ink port 47 is disposed at a site where flow of ink directing from the first ink port 44 to the third ink port 46 is stagnant in the downstream-side ink chamber 412, so that bubbles remaining in the neighborhood of and just below the first ink port 44 can be surely removed.

[0108] The control device 8 monitors the detection signal from the bubble detection sensor 73 at a predetermined time interval during ink supply to the fourth ink port 47. The driving of the liquid delivery pump 61 is continued until bubbles B2 in ink flowing in the ink discharge pipe 7 are not detected any longer (S214).

[0109] When the bubbles B2 in the ink flowing in the ink discharge pipe 7 are not detected any longer by the bubble detection sensor 73, the control device 8 controls the liquid delivery pump 61 to stop its driving and stop ink supply to the ink storage chamber 41 (S215).

[0110] Thereafter, the control device 8 closes all the on-off valves 62, 63, 71 and 72 to close the respective

flow passages intercommunicating with all the ink ports 44, 45, 46 and 47 (S216).

[0111] Through the above operation, ink is filled in the upstream-side ink chamber 411 and the downstream-side ink chamber 412 of the ink storage chamber 41. As in the case of the first embodiment, the amount of waste ink which is needlessly discharged from the nozzles 22 is reduced, and bubbles remaining in the ink storage chamber 41 are efficiently removed.

[0112] When bubbles are detected in step S214 of the flowchart of the bubble removing operation shown in Fig. 6, the control device 8 may control the liquid delivery pump 61 to temporarily stop its driving, and open the first on-off valve 62 to open the flow passage intercommunicating with the first ink port 44. Thereafter, the control device 8 may return to step S209 to circulate ink from the first ink port 44 to the third ink port 46. In this case, a time required to complete the bubble removing operation is longer, but bubbles can be more surely removed.

[0113] In step S210 of the flowchart of the bubble removing operation shown in Fig. 6, the control device 8 does not continue ink supply for a preset predetermined time, but may refer to the detection signal of the bubble detection sensor 73 and circulate ink from the first ink port 44 to the third ink port 46 until bubbles are not detected any longer. In this case, bubbles can be more surely removed.

[0114] Furthermore, in step S207 of the flowchart of the bubble removing operation shown in Fig. 6, the processing is executed before returning to step S201. However, the processing may be executed after the determination of step S201. Furthermore, all the on-off valves 62, 63, 71 and 72 are opened. However, only the second on-off valve 71 may be opened so that ink is circulated to the third ink port 46.

[0115] In step S107 of the flowchart of the bubble removing operation shown in Fig. 3, the processing is executed before returning to step S101. However, the processing may be executed after the determination of step S101. Furthermore, all the on-off valves 62, 63 and 71 are opened. However, only the second on-off valve 71 may be opened so that ink is circulated to the third ink port 46.

[0116] Furthermore, in the first embodiment, the steps S102 to S104 and the steps S108 to S110 of the bubble removing flowchart shown in Fig. 3 may be interchanged with each other, or in the second embodiment, the steps S202 to S204 and the steps S208 to S214 of the bubble removing flowchart shown in Fig. 6 may be interchanged with each other.

[0117] Furthermore, the steps S202 to S204 and the steps S208 to S210 may be interchanged with each other. At this time, in step S210, ink supply is not continuously performed for a predetermined time, but the detection signal of the bubble detection sensor 73 may be referred to.

[0118] In the first and second embodiments, after ink discharged from the second ink port 45 and/or the third ink port 46 may be returned to an ink tank different from the ink tank 5 and deaerated, the ink may be circulated and reused.

[0119] After the bubbles B1 and B2 in the ink storage chamber 41 are removed, nozzle purge for discharging ink from the nozzles 22 may be performed, whereby bubbles remaining in the pressure chambers 23 and the nozzles 22 can be also removed. It has been experimentally verified that the time required for the purge is shorter and the amount of waste ink caused by the purge is reduced as compared with a case where the bubbles in the ink storage chamber 41 are removed by only purge because the purge is performed after the bubbles in the ink storage chamber 41 are removed.

[0120] An example of a nozzle purge operation in the first embodiment will be described with reference to Fig. 8.

[0121] In the initial state, all the on-off valves 62, 71 and 72 are closed. Therefore, the control device 8 opens only the first on-off valve 62 to open only the flow passage intercommunicating with the first ink port 44 (S301).

[0122] Subsequently, the control device 8 controls the liquid delivery pump 61 to drive and supply ink in the ink tank 5 from the first ink port 44 into the ink storage chamber 41 under predetermined pressure, whereby the ink flowing from the first ink port 44 into the ink storage chamber 41 passes through the through-holes 31 of the substrate 3, flows into the respective pressure chambers 23, and is purged from the nozzles 22 together with residual bubbles (S302).

[0123] The ink pressure P at this time is larger than the nozzle meniscus break pressure P_{MN} and the filter meniscus break pressure P_{MF}. When the ink pressure P is small, much time is taken to complete nozzle purge, and thus specifically the pressure P is preferably set to 10 kPa or more. The upper limit of the ink pressure P is set to the pressure durability of the inkjet head 1 or less. Specifically, it is preferably set to 50 kPa or less.

[0124] The ink supply to the first ink port 44 is continued for a predetermined time. During this time period, ink is continued to be purged from the nozzles 22 (S303). When a preset time elapses, the control device 8 controls the liquid delivery pump 61 to stop its driving and stop ink supply, and finishes the purge (S304).

[0125] An example of the nozzle purge operation in the first embodiment has been described. The same nozzle purge may be performed after the bubble removing operation in the second embodiment as in the case of the first embodiment.

[0126] It has been recently known that the speed can be increased by using a line head including plural inkjet heads which are disposed in the width direction of a recording medium. When plural inkjet heads are provided, the liquid delivery pump and the plural inkjet heads are arranged to intercommunicate with one another and apply pressure. Therefore, the device configuration is simplified. However, when bubbles are removed by applying pressure in consideration of the pressure losses of filters

provided to the plural inkjet heads, the load imposed on the liquid delivery pump is more remarkable. However, the present invention is also appropriately applicable to such a case.

[0127] The line head is exemplified as an example using plural inkjet heads. However, it is needless to say that the present invention is not limited to the above style. For example, a scan type head in which plural inkjet heads are disposed may be used.

EXPLANATIONS OF LETTERS OR NUMERALS

[0128]

1:	inkjet head
21:	nozzle plate
2:	head chip
22:	nozzle
23:	pressure chamber
24:	partition wall
3:	substrate
31:	through-hole
4:	manifold
4a:	opening portion
41:	ink storage chamber
411:	upstream-side ink chamber
412:	downstream-side ink chamber
412a:	extension portion
42:	filter
421:	lower surface
43:	damper member
431:	damper surface
44:	first ink port
441:	connection portion
45:	second ink port
451:	connection portion
46:	third ink port
461:	connection portion
47:	fourth ink port
471:	connection portion
48:	filter
5:	ink tank
50:	partition plate
6:	ink supply pipe
6a, 6b:	branch pipe
61:	liquid delivery pump
62:	first on-off valve
63:	fourth on-off valve
7:	ink discharge pipe
7a, 7b:	branch pipe
71:	second on-off valve
72:	third on-off valve
73:	bubble detection sensor
8:	control device
B1, B2:	bubble

Claims

1. A bubble removing method for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

providing a first ink port for inflow of ink and a second ink port for discharge of ink at an upper portion of the upstream-side ink chamber, and providing a third ink port for discharge of ink at an upper portion inside the downstream-side ink chamber without the filter existing therebetween;

opening each of flow passages intercommunicating with the first ink port and the second ink port, and closing a flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber; and subsequently closing the flow passage intercommunicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber.

2. The bubble removing method for an inkjet head according to claim 1, further comprising:

further providing a fourth ink port for inflow of ink intercommunicating, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;

opening of each of the flow passages intercommunicating with the first ink port and the second ink port respectively, and closing each of the flow passages intercommunicating with the third ink port and the fourth ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber;

subsequently closing the flow passage inter-

communicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause to ink flow in from the first ink port and cause ink to flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber; and
subsequently closing each of the flow passages intercommunicating with the first ink port and the second ink port, and opening the flow passage intercommunicating with the fourth ink port so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles existing at a site where flow of ink directing to the third ink port is stagnant.

3. A bubble removing method for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

providing a first ink port for inflow of ink and a second ink port for discharge of ink at an upper portion of the upstream-side ink chamber, and providing a third ink port for discharge of ink at an upper portion inside the downstream-side ink chamber without the filter existing therebetween;
opening the flow passage intercommunicating with the first ink port, closing the flow passage intercommunicating with the second ink port and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and cause ink to flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber, and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge, from the third ink port, thereby removing bubbles in the downstream-side ink chamber; and
subsequently opening each of the flow passages intercommunicating with the first ink port and the second ink port, and closing the flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause ink to discharge the ink from the second ink port, thereby removing bubbles in the upstream-side ink chamber.

4. The bubble removing method for an inkjet head according to claim 3, further comprising:

further providing a fourth ink port for inflow of ink intercommunicating, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;
opening the flow passage intercommunicating with the first ink port, closing the flow passage intercommunicating with the second ink port, and opening the flow passage intercommunicating with the third ink port so as to cause ink to flow in from the first ink port and cause ink to flow from the upstream-side ink chamber through the filter to the downstream-side ink chamber and cause ink flowing to the third ink port in the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber;
subsequently opening each of the flow passages intercommunicating with the first ink port and the second ink port, and closing the flow passage intercommunicating with the third ink port so as to cause ink to flow from the first ink port into the upstream-side ink chamber and cause the ink to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber; and
subsequently closing each of the flow passages intercommunicating with the first ink port and the second ink port, and opening the flow passage intercommunicating with the fourth ink port so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port, thereby removing bubbles existing at a site where flow of ink directing to the third ink port is stagnant.

5. The bubble removing method for an inkjet head according to any one of claims 1 to 4, wherein the pressure P [kPa] of ink flowing into the ink storage chamber satisfies the relationship of $P \leq P_{MN} + R_F$, wherein P_{MN} represents a nozzle meniscus break pressure, and R_F represents a pressure loss of the filter.

6. The bubble removing method for an inkjet head according to any one of claims 1 to 5, wherein the pressure P [kPa] of ink flowing into the ink storage chamber satisfies the relationship of $P > 7 - R_F$.

7. A bubble removing device for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink

chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

a first ink port for inflow of ink and a second ink port for discharge of ink that are provided at an upper portion of the upstream-side ink chamber;
a third ink port for discharge of ink that is provided at an upper portion inside the downstream-side ink chamber without the filter existing therebetween; and
an ink tank that stores ink to be supplied to the ink storage chamber through a liquid delivery pump,
wherein the ink tank is connected to the first ink port through a first ink supply pipe, and connected to the second ink port and the third ink port through a first ink discharge pipe and a second ink discharge pipe respectively, and the first ink supply pipe, the first ink discharge pipe and the second ink discharge pipe are provided with a first on-off valve, a second on-off valve and a third on-off valve respectively; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve and the third on-off valve,
wherein the control device controls to perform a first control operation of opening the first on-off valve and the second on-off valve, closing the third on-off valve, and driving the liquid delivery pump so as to cause ink flowing from the first ink port into the upstream-side ink chamber to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber, and after completion of the first control operation, perform a second control operation of closing the second on-off valve while the first on-off valve is left open, opening the third on-off valve and driving the liquid delivery pump so as to cause ink flowing from the first ink port to pass through the upstream-side ink chamber and the downstream-side ink chamber and discharge from the third ink port, thereby removing bubbles in the downstream-side ink chamber.

8. The bubble removing device for an inkjet head according to claim 7, further comprising:

a fourth ink port for inflow of ink that intercommunicates, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;
a second ink supply pipe that intercommunicates with the fourth ink port and causes to ink flow in from the ink tank, the second ink supply pipe being provided with a fourth on-off valve; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve,
wherein the control device controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve to close the first on-off valve and the second on-off valve, open the third on-off valve and the fourth on-off valve and drive the liquid delivery pump after completion of the second control operation so that ink flowing from the fourth ink port into the downstream-side ink chamber is discharged from the third ink port.

9. A bubble removing device for an inkjet head that includes a pressure chamber intercommunicating with a nozzle, an ink storage chamber intercommunicating with the pressure chamber, and a filter disposed in the ink storage chamber, the ink storage chamber being divided by the filter into an upstream-side ink chamber distal to the pressure chamber and a downstream-side ink chamber proximal to the pressure chamber, comprising:

a first ink port for inflow of ink and a second ink port for discharge of ink that are provided at an upper portion of the upstream-side ink chamber;
a third ink port for discharge of ink that is provided at an upper portion inside the downstream-side ink chamber without the filter existing therebetween;
an ink tank that stores ink to be supplied to the ink storage chamber through a liquid delivery pump,
wherein the ink tank is connected to the first ink port through a first ink supply pipe, and connected to the second ink port and the third ink port through a first ink discharge pipe and a second ink discharge pipe respectively, and the first ink supply pipe, the first ink discharge pipe and the second ink discharge pipe are provided with a first on-off valve, a second on-off valve and a third on-off valve respectively; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve and the third on-off valve,
wherein the control device controls to perform a second control operation of opening the first on-off valve, closing the second on-off valve, opening the third on-off valve and driving the liquid delivery pump so as to cause ink to flow in from the first ink port and pass through the upstream-side ink chamber and the downstream-side ink chamber and discharge the ink from the third ink port, thereby removing bubbles in the downstream-side ink chamber, and after completion

of the second control operation, perform a first control operation of opening the first on-off valve and the second on-off valve, closing the third on-off valve and driving the liquid delivery pump so as to cause ink flowing from the first ink port into the upstream-side ink chamber to discharge from the second ink port, thereby removing bubbles in the upstream-side ink chamber.

10. The bubble removing device for an inkjet head according to claim 9, further comprising:

a fourth ink port for inflow of ink that intercommunicates, through the filter, with a site which is located away from the third ink port of the downstream-side ink chamber and at which flow of ink directing from the first ink port to the third ink port is stagnant;
a second ink supply pipe that intercommunicates with the fourth ink port and causes to ink flow in from the ink tank, the second ink supply pipe being provided with a fourth on-off valve; and
a control device that controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve,
wherein the control device controls the liquid delivery pump, the first on-off valve, the second on-off valve, the third on-off valve and the fourth on-off valve to close the first on-off valve and the second on-off valve, open the third on-off valve and the fourth on-off valve and drive the liquid delivery pump after completion of the first control operation so as to cause ink flowing from the fourth ink port into the downstream-side ink chamber to discharge from the third ink port.

11. The bubble removing device for an inkjet head according to claim 8 or 10, wherein the fourth ink port is disposed at a site where flow of ink directing from the first ink port to the third ink port is stagnant in the downstream-side ink chamber.

12. The bubble removing device for an inkjet head according to any one of claims 7 to 11, wherein a control operation of discharging bubbles in the ink storage chamber controls the pressure P [kPa] of ink flowing into the ink storage chamber so that the pressure P satisfies the relationship of $P \leq P_{MN} + R_F$, wherein P_{MN} represents a nozzle meniscus break pressure, and R_F represents a pressure loss of the filter.

13. The bubble removing device for an inkjet head according to any one of claims 7 to 12, wherein the pressure P [kPa] of ink flowing into the ink storage chamber is controlled to satisfy the relationship of $P > 7 - R_F$ in the control operation.

14. The bubble removing device for an inkjet head according to any one of claims 7 to 13, wherein the first ink port and the second ink port are disposed at both the end portions in the longitudinal direction of the upstream-side ink chamber, and the third ink port is disposed at an end portion of the downstream-side ink chamber which is farther away from the first ink port than the second ink port.

15. The bubble removing device for an inkjet head according to any one of claims 7 to 14, wherein the third ink port is located at the same height as or higher than a lower surface of the filter by which the ink storage chamber is divided into the upstream-side ink chamber and the downstream-side ink chamber.

16. The bubble removing device for an inkjet head according to any one of claims 7 to 15, wherein the area of the filter by which the ink storage chamber is divided into the upstream-side ink chamber and the downstream-side ink chamber is sufficiently larger than the opening area of the first ink port.

17. The bubble removing device for an inkjet head according to any one of claims 7 to 16, wherein the ink tank is partitioned into an ink return chamber and an ink supply chamber by a partition plate that does not reach a bottom plate of the ink tank, an ink discharge pipe is connected to the ink return chamber and an ink supply pipe is connected to the ink supply chamber.

FIG. 1

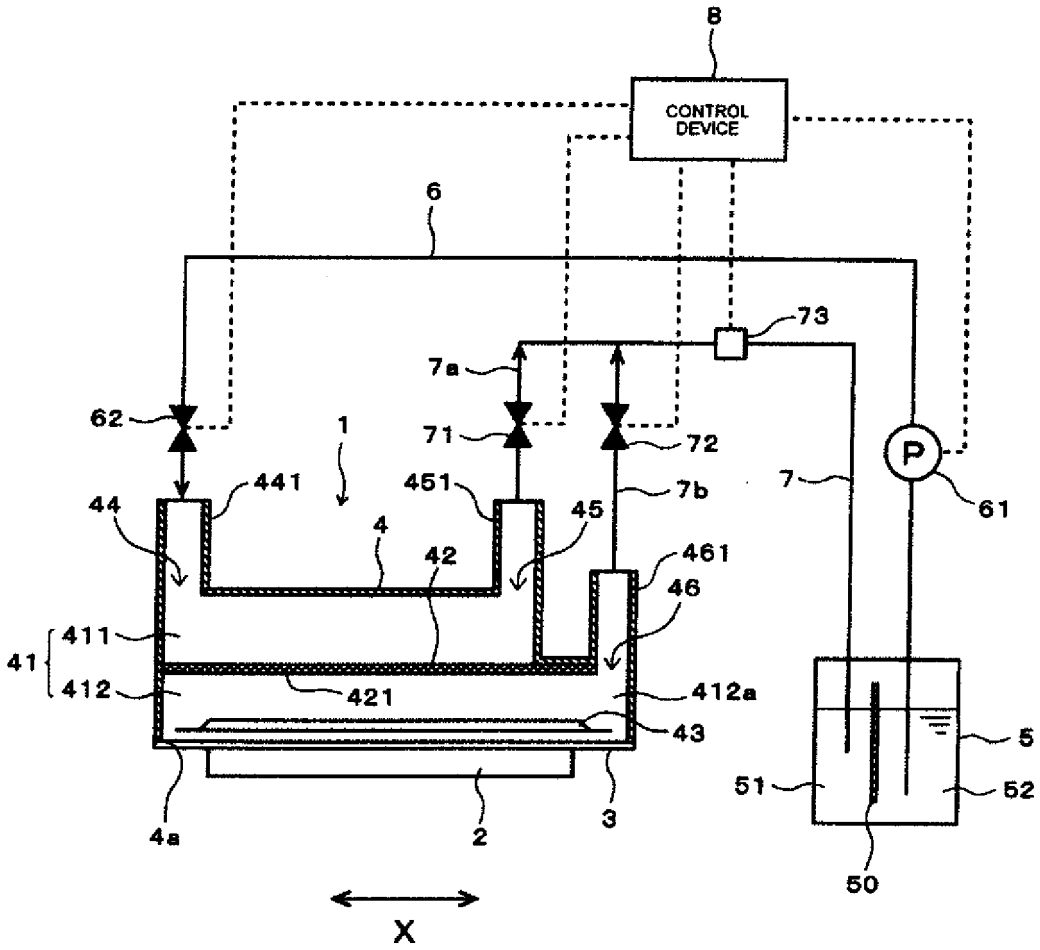

8
CONTROL DEVICE
6
73
7a
62
1
71
72
441
451
7b
7
P
61
44
4
45
42
461
46
411
41
412
421
412a
43
5
51
52
50
4a
2
3
X

FIG. 2

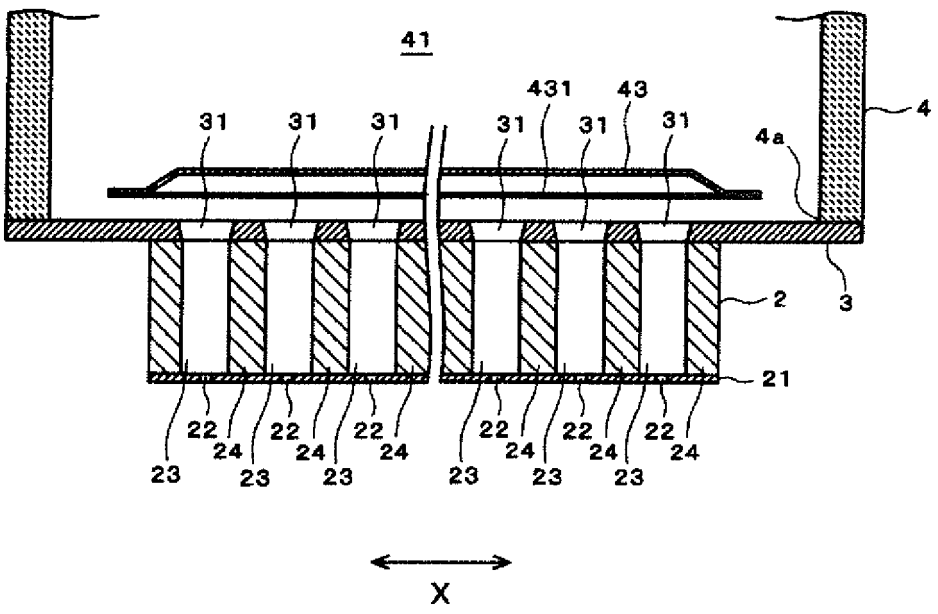


FIG. 3

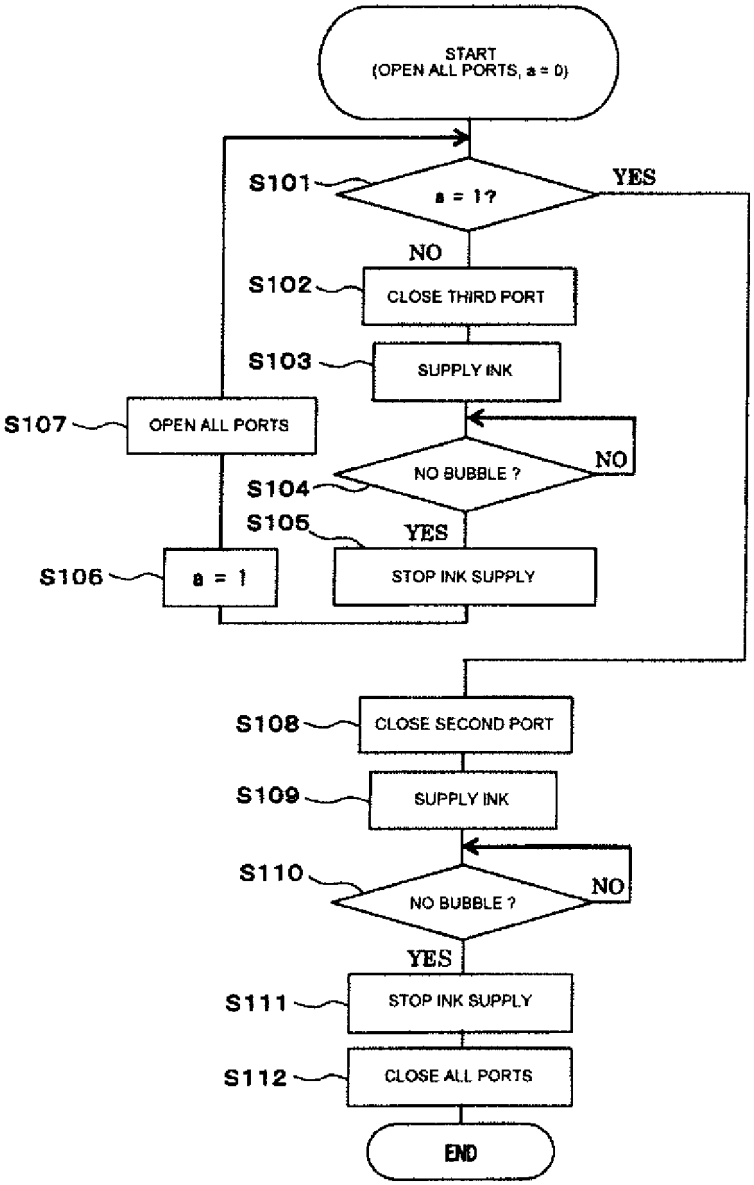

START
(OPEN ALL PORTS, a = 0)
S101
a = 1?
YES
NO
S102
CLOSE THIRD PORT
S103
SUPPLY INK
S107
OPEN ALL PORTS
NO BUBBLE ?
NO
S104
S105
YES
S106
a = 1
STOP INK SUPPLY
S108
CLOSE SECOND PORT
S109
SUPPLY INK
S110
NO BUBBLE ?
NO
YES
S111
STOP INK SUPPLY
S112
CLOSE ALL PORTS
END

FIG. 4

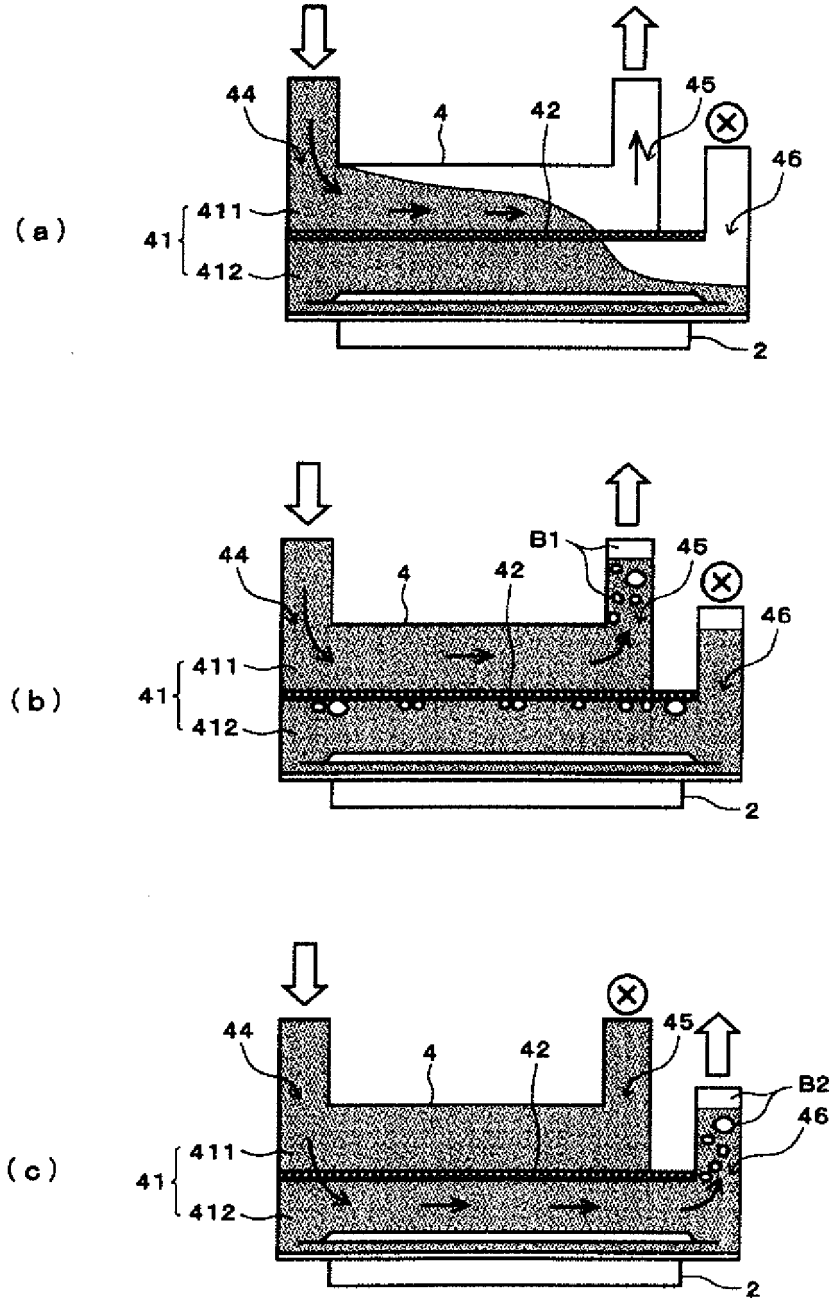

(a)
44
4
42
45
46
411
41
412
2
(b)
44
B1
45
4
42
46
411
41
412
2
(c)
44
45
4
42
B2
46
411
41
412
2

FIG. 5

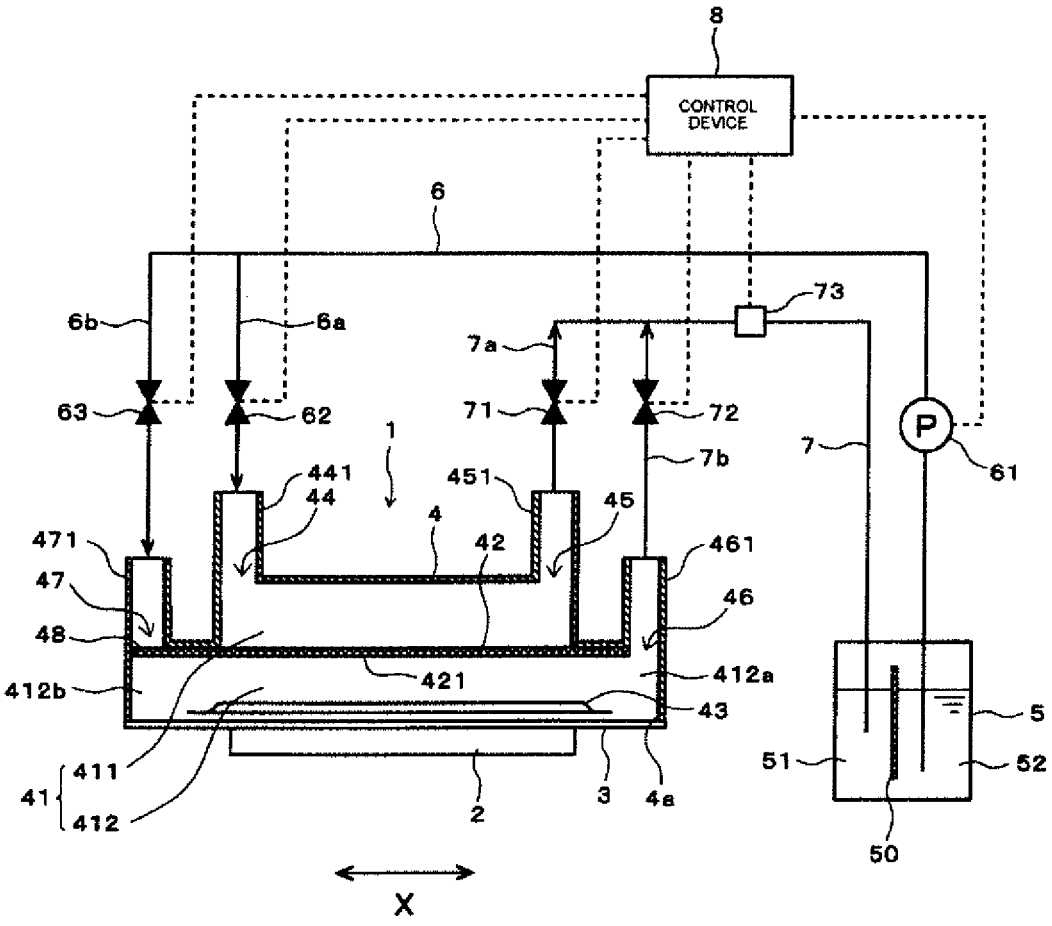

8
CONTROL DEVICE
6
6b
6a
73
7a
63
62
71
72
1
7
7b
61
441
44
451
45
471
4
42
461
47
46
48
421
412a
412b
43
5
411
41
412
2
3
4a
51
52
50
X

FIG. 6

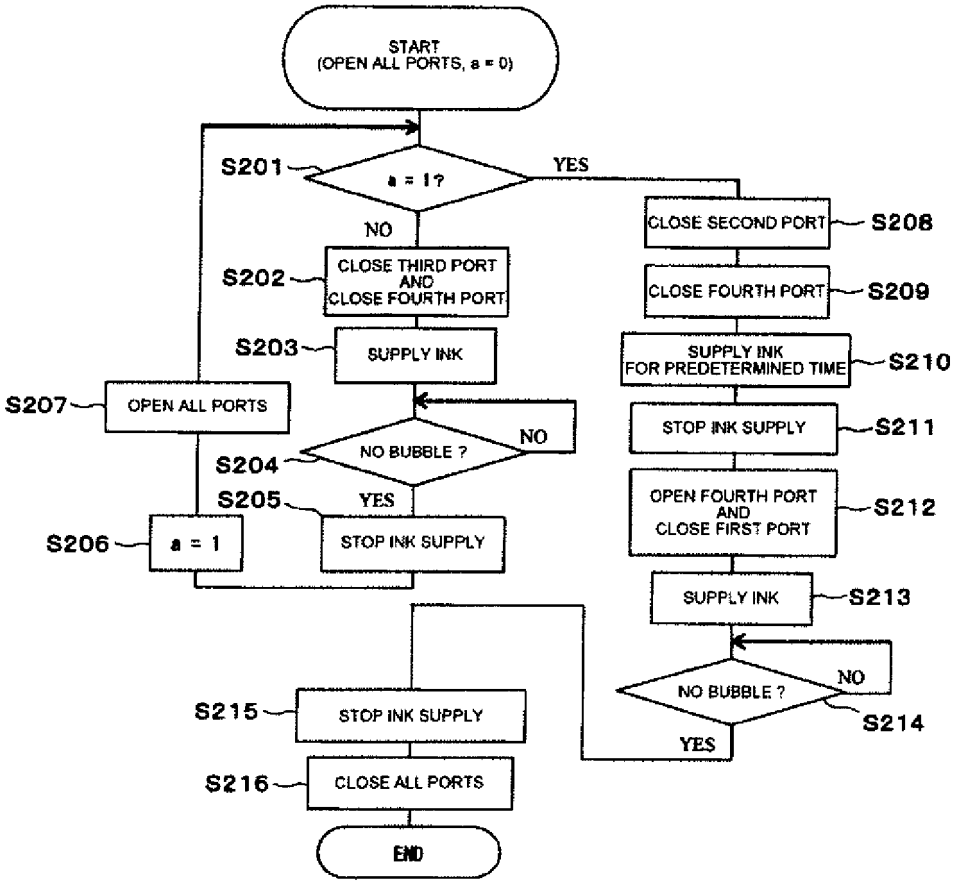

START
(OPEN ALL PORTS, a = 0)
S201
a = 1?
YES
NO
S202
CLOSE THIRD PORT AND CLOSE FOURTH PORT
S203
SUPPLY INK
S204
NO BUBBLE ?
NO
YES
S205
STOP INK SUPPLY
S206
a = 1
S207
OPEN ALL PORTS
S208
CLOSE SECOND PORT
S209
CLOSE FOURTH PORT
S210
SUPPLY INK FOR PREDETERMINED TIME
S211
STOP INK SUPPLY
S212
OPEN FOURTH PORT AND CLOSE FIRST PORT
S213
SUPPLY INK
S214
NO BUBBLE ?
NO
YES
S215
STOP INK SUPPLY
S216
CLOSE ALL PORTS
END

FIG. 7

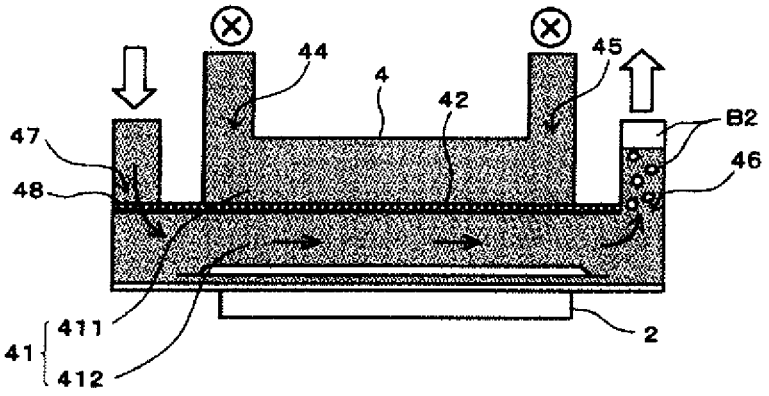
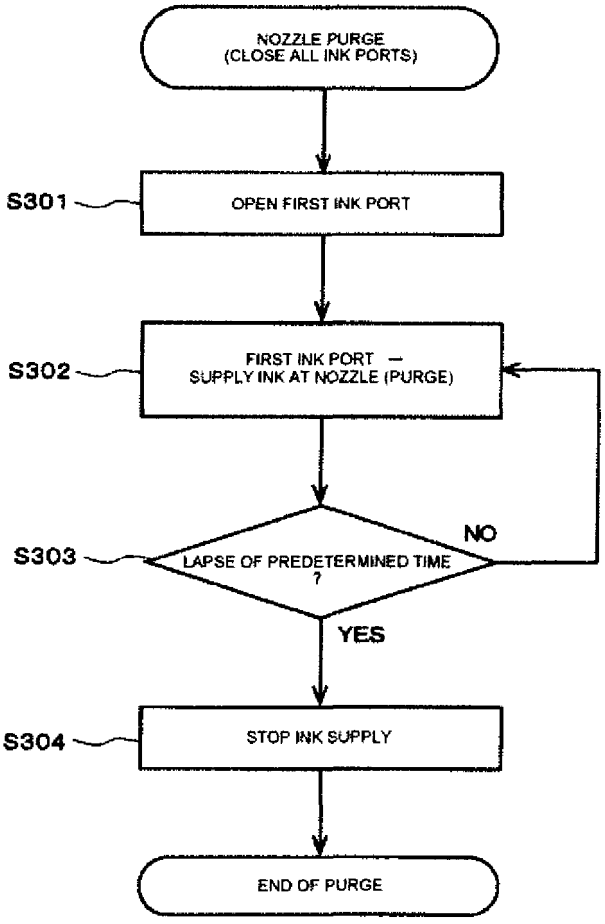


FIG. 8


NOZZLE PURGE
(CLOSE ALL INK PORTS)
S301
OPEN FIRST INK PORT
S302
FIRST INK PORT —
SUPPLY INK AT NOZZLE (PURGE)
S303
LAPSE OF PREDETERMINED TIME
?
NO
YES
S304
STOP INK SUPPLY
END OF PURGE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/076471

A. CLASSIFICATION OF SUBJECT MATTER
B41J2/19(2006.01)i, *B41J2/175*(2006.01)i, *B41J2/18*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J2/19, B41J2/175, B41J2/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2011-88400 A (Seiko Epson Corp.), 06 May 2011 (06.05.2011), paragraphs [0019] to [0026]; fig. 2 to 3 (Family: none)	1,5-7,12-17 2-4,8-11
Y A	JP 2012-96510 A (Ricoh Co., Ltd.), 24 May 2012 (24.05.2012), paragraphs [0024] to [0039]; fig. 1 to 13 (Family: none)	1,5-7,12-17 2-4,8-11
Y A	JP 2009-126044 A (Canon Inc.), 11 June 2009 (11.06.2009), paragraphs [0035] to [0038]; fig. 1 & WO 2009/066612 A1 paragraphs [0054] to [0056]; fig. 1 & US 2010/0289856 A1 & CN 101861246 A	1,5-7,12-17 2-4,8-11

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 November 2015 (27.11.15)	08 December 2015 (08.12.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/076471

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2009-148976 A (Olympus Corp.), 09 July 2009 (09.07.2009), paragraphs [0098] to [0099]; fig. 10 (Family: none)	17
A	JP 2006-122814 A (Ulvac, Inc.), 18 May 2006 (18.05.2006), entire text; all drawings & US 2007/0216739 A1 & WO 2006/046447 A1 & EP 1806615 A1 & KR 10-2007-0073818 A	1-17
A	JP 2009-285900 A (Konica Minolta Holdings, Inc.), 10 December 2009 (10.12.2009), entire text; all drawings (Family: none)	1-17

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006175651 A **[0006]**
- JP 2009202490 A **[0006]**
- JP 2012218398 A **[0006]**