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### Liquid ejecting apparatus and liquid discharging method

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#### Abstract

A liquid ejecting apparatus includes: nozzles; individual flow paths communicating with each of the nozzles; a liquid storage portion storing liquid; a supply flow path for supplying the liquid from the liquid storage portion to the individual flow paths; a recovery flow path for recovering the liquid from the individual flow paths to the liquid storage portion; a bypass flow path that couples the supply flow path and the recovery flow path; and an on-off valve configured to close and open the recovery flow path, in which the on-off valve is disposed between the bypass flow path and the liquid storage portion in the recovery flow path, and a pressurization discharge operation of discharging the liquid from each of the nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve is executed.

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## References Cited

### U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
10906306	12/2020	Tamai	N/A	B41J 2/14233
11040534	12/2020	Miyagishi	N/A	B41J 2/14233
11135853	12/2020	Yu	N/A	B41J 2/18
11840085	12/2022	Watanabe	N/A	B41J 2/14233
2022/0024207	12/2021	Watanabe	N/A	N/A

### FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
2021-130258	12/2020	JP	N/A
2022-023542	12/2021	JP	N/A
2022-030641	12/2021	JP	N/A

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## Background/Summary

(1) The present application is based on, and claims priority from JP Application Serial Number 2022-085374, filed May 25, 2022, the disclosure of which is hereby incorporated by reference herein in its entirety.

### BACKGROUND

#### 1. Technical Field

(2) The present disclosure relates to a liquid ejecting apparatus and a liquid discharging method.

#### 2. Related Art

(3) In the related art, a liquid ejecting apparatus that ejects liquid such as ink is known, as represented by an ink jet type printer. For example, in JP-A-2021-130258, a liquid ejecting apparatus having a plurality of individual flow paths that communicate with each of a plurality of nozzles for ejecting ink, a supply flow path that supplies liquid to each of the plurality of individual flow paths, and a recovery flow path that recovers the liquid from each of the plurality of individual flow paths is disclosed.

(4) However, in the above-mentioned technique in the related art, even though the liquid flows in the order of the supply flow path, the individual flow path, and the recovery flow path, a bubble may stay in the recovery flow path.

## SUMMARY

(5) In order to solve the above problems, a liquid ejecting apparatus according to a preferred aspect of the present disclosure includes: a plurality of nozzles that eject liquid; a plurality of individual flow paths that communicate with each of the plurality of nozzles; a liquid storage portion that stores the liquid to be supplied to each of the plurality of nozzles; a supply flow path for supplying the liquid from the liquid storage portion to the plurality of individual flow paths; a recovery flow path for recovering the liquid from the plurality of individual flow paths to the liquid storage portion; a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the plurality of individual flow paths; and an on-off valve configured to close and open the recovery flow path, in which the on-off valve is disposed between the bypass flow path and the liquid storage portion in the recovery flow path, and a pressurization discharge operation of discharging the liquid from each of the plurality of nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve is executed.

(6) A liquid discharging method of a liquid ejecting apparatus according to another preferred aspect of the present disclosure, the liquid ejecting apparatus including a plurality of nozzles that eject liquid, a plurality of individual flow paths that communicate with each of the plurality of nozzles, a liquid storage portion that stores the liquid to be supplied to each of the plurality of nozzles, a supply flow path for supplying the liquid from the liquid storage portion to the plurality of individual flow paths, a recovery flow path for recovering the liquid from the plurality of individual flow paths to the liquid storage portion, a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the plurality of individual flow paths, and an on-off valve configured to close and open the recovery flow path, the method includes: disposing the on-off valve between the bypass flow path and the liquid storage portion in the recovery flow path; and executing a pressurization discharge operation of discharging the liquid from each of the plurality of nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve, by the liquid ejecting apparatus.

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## Description

### BRIEF DESCRIPTION OF THE DRAWINGS

- (1) FIG. 1 is a schematic view illustrating a configuration example of a liquid ejecting apparatus according to an embodiment.
- (2) FIG. 2 is a view illustrating a circulation mechanism and an on-off valve.
- (3) FIG. 3 is a perspective view of a liquid ejecting module.
- (4) FIG. 4 is an exploded perspective view of a liquid ejecting head illustrated in FIG. 3.
- (5) FIG. 5 is a schematic view illustrating a flow path in the liquid ejecting apparatus.
- (6) FIG. 6 is a plan view schematically illustrating a flow path of a head chip.
- (7) FIG. 7 is a cross-sectional view of a head chip.
- (8) FIG. 8 is a plan view of a holder.
- (9) FIG. 9 is a perspective view illustrating a flow path provided in the holder and the head chip.
- (10) FIG. 10 is a cross-sectional view taken along the line X-X in FIG. 8.
- (11) FIG. 11 is a plan view of a flow path structure.
- (12) FIG. 12 is a view illustrating a flowchart illustrating a series of processes at the time of filling ink.
- (13) FIG. 13 is a view illustrating a state of the head chip during a circulation operation.
- (14) FIG. 14 is a view illustrating a state of the head chip in a pressurization discharge operation.
- (15) FIG. 15 is a view illustrating a circulation mechanism in a first modification example.
- (16) FIG. 16 is a schematic view illustrating a flow path in a liquid ejecting apparatus in a second

modification example.

(17) FIG. 17 is a schematic view illustrating a flow path in a liquid ejecting apparatus in a third modification example.

## DESCRIPTION OF EXEMPLARY EMBODIMENTS

(18) Hereinafter, embodiments for carrying out the present disclosure will be described with reference to the accompanying drawings. However, in each drawing, the size and scale of each portion are appropriately different from the actual ones. In addition, since the embodiments described below are preferred specific examples of the present disclosure, various technically preferable limitations are attached, but the scope of the present disclosure is not limited to the embodiments unless otherwise stated to specifically limit the present disclosure in the following description.

(19) The following description will be given by appropriately using an X axis, a Y axis, and a Z axis which intersect with each other for convenience. In addition, one direction along the X axis is an X1 direction, and a direction opposite to the X1 direction is an X2 direction. Similarly, directions opposite to each other along the Y axis are a Y1 direction and a Y2 direction. In addition, directions opposite to each other along the Z axis are a Z1 direction and a Z2 direction.

(20) Here, typically, the Z axis is a vertical axis, and the Z2 direction corresponds to a downward direction in the vertical direction. In other words, the Z2 direction is a gravity direction. However, the Z axis may not be a vertical axis and may be inclined with respect to the vertical axis. In addition, although the X axis, the Y axis, and the Z axis are typically orthogonal to each other, the axes are not limited thereto and may intersect at an angle within the range of, for example, 80 degrees or more and 100 degrees or less.

### 1. FIRST EMBODIMENT

(21) 1-1. Outline of Liquid Ejecting Apparatus **100**

(22) FIG. 1 is a schematic view illustrating a configuration example of a liquid ejecting apparatus **100** according to an embodiment. The liquid ejecting apparatus **100** is an ink jet type printing apparatus that ejects ink which is an example of liquid onto a medium M as a droplet. The liquid ejecting apparatus **100** of the present embodiment is a so-called line type printing apparatus in which a plurality of nozzles N for ejecting the ink are distributed over the entire range in a width direction of the medium M. The medium M is typically printing paper. The medium M is not limited to the printing paper, and may be, for example, a printing target made of any material such as a resin film or cloth.

(23) As illustrated in FIG. 1, the liquid ejecting apparatus **100** includes a main tank **110**, a pump **112**, a control module **120**, a transport mechanism **130**, a liquid ejecting module **140** having a plurality of liquid ejecting heads **10**, a circulation mechanism **150**, and an on-off valve **160**.

(24) The main tank **110** is a container that stores the ink. Examples of a specific aspect of the main tank **110** include a cartridge attachable to and detachable from the liquid ejecting apparatus **100**, a bag-shaped ink pack formed of a flexible film, and an ink tank replenishable with the ink. The type of ink stored in the main tank **110** is optional.

(25) Although not illustrated in the drawing, the main tank **110** of the present embodiment includes a first liquid container and a second liquid container. The first liquid container stores a first ink. The second liquid container stores a second ink having a type different from that of the first ink. For example, the first ink and the second ink have different colors from each other. The first ink and the second ink may be the same type of ink. The pump **112** adjusts the amount of ink supplied from the main tank **110** to the circulation mechanism **150** under the control of the control module **120**. An apparatus other than the control module **120** may control the pump **112**. The pump **112** is provided for each container of the first liquid container and second liquid container described above.

(26) The control module **120** controls an operation of each element of the liquid ejecting apparatus **100**. Specifically, the control module **120** receives image data Img indicating an image from a host computer such as a personal computer or a digital camera. Based on the received image data Img,

the control module **120** supplies a drive signal Com for driving the liquid ejecting head **10** and a control signal SI for controlling the liquid ejecting head **10** to the liquid ejecting head **10**. Then, the liquid ejecting head **10** is driven by the drive signal Com under the control of the control signal SI, and ejects the ink in the Z2 direction from a part or all of the plurality of nozzles N provided in the liquid ejecting head **10**. That is, the liquid ejecting head **10** ejects the ink from a part or all of the plurality of nozzles N in conjunction with the transport of the medium M by the transport mechanism **130**, and causes the ejected ink to land on the surface of the medium M, thereby executing printing process for forming a desired image on the surface of the medium M. The nozzle N will be described later with reference to FIGS. 5, 6, and 7.

(27) The control module **120** includes, for example, one or a plurality of processing circuits such as a CPU or an FPGA, and one or a plurality of storage circuits such as a semiconductor memory. The CPU is an abbreviation of a central processing unit. The FPGA is an abbreviation of a field programmable gate array. Various programs and various data are stored in the storage circuit. The processing circuit realizes various controls by executing the programs and using the data as appropriate.

(28) The transport mechanism **130** transports the medium M in a direction DM under control of the control module **120**. The direction DM of the present embodiment is the Y2 direction. In an example illustrated in FIG. 1, the transport mechanism **130** includes a long transport roller along the X axis and a motor that rotates the transport roller. The transport mechanism **130** is not limited to the configuration using the transport roller, and may be configured to use, for example, a drum or an endless belt that transports the medium M in a state in which the medium M is attracted to an outer peripheral surface by electrostatic force or the like.

(29) Under the control of the control module **120**, the liquid ejecting module **140** ejects the ink supplied from the main tank **110** via the pump **112** and the circulation mechanism **150** onto the medium M in the Z2 direction from each of the plurality of nozzles N. The liquid ejecting module **140** is a line head having a plurality of the liquid ejecting heads **10** disposed such that the plurality of nozzles N are distributed throughout the entire range of the medium M in a direction of the X axis. That is, the group of the plurality of liquid ejecting heads **10** constitutes a long line head extending in a direction along the X axis. By ejecting the ink from the plurality of liquid ejecting heads **10** in parallel with the transport of the medium M by the transport mechanism **130**, an image is formed on a surface of the medium M by the ink. The plurality of nozzles N included in one liquid ejecting head **10** may be disposed so as to be distributed throughout the entire range of the medium M in the direction along the X axis. In such a case, for example, the liquid ejecting module **140** is constituted of the one liquid ejecting head **10**.

(30) The main tank **110** is coupled to the liquid ejecting module **140** via the circulation mechanism **150**. The circulation mechanism **150** is a mechanism that supplies the ink to each of the plurality of liquid ejecting heads **10** in the liquid ejecting module **140** under the control of the control module **120**, and that recovers the ink discharged from each of the plurality of liquid ejecting heads **10** in order to resupply the ink to the liquid ejecting head **10**. The circulation mechanism **150** and the on-off valve **160** are provided for each container of the first liquid container and second liquid container described above. By the operation of the circulation mechanism **150**, it is possible to suppress an increase in the viscosity of the ink and reduce the retention of the bubble in the ink. The circulation mechanism **150** and the on-off valve **160** will be described with reference to FIG. 2.

(31) 1-2. Circulation Mechanism **150** and On-Off Valve **160**

(32) FIG. 2 is a view illustrating the circulation mechanism **150** and the on-off valve **160**. Elements related to the first ink are displayed in FIG. 2. Since the elements related to the second ink are the same as the elements related to the first ink, illustration and description thereof will be omitted.

(33) As illustrated in FIG. 2, the circulation mechanism **150** includes a liquid storage portion **151**, a compressor **152**, a regulator **153**, a vacuum pump **154**, a regulator **155**, a pressure sensor **156**, a pressure sensor **157**, and a pump **1514**.

(34) The liquid storage portion **151** is coupled to a supply flow path **SF1** and a recovery flow path **CF1**, which will be described in detail later, and stores the first ink to be supplied to each of the plurality of liquid ejecting heads **10**. The liquid storage portion **151** of the present embodiment has a first sub tank **1512** coupled to the supply flow path **SF1** and a second sub tank **1516** coupled to the recovery flow path **CF1**. In the first sub tank **1512**, the first ink to be supplied to each of the plurality of liquid ejecting heads **10** is stored. In the second sub tank **1516**, the first ink recovered from each of the plurality of liquid ejecting heads **10** and the first ink replenished from the main tank **110** are stored.

(35) The supply flow path **SF1** has an in-apparatus supply flow path **SJ1** that is coupled to the first sub tank **1512** and distributes and supplies the first ink to the plurality of liquid ejecting heads **10**, and a plurality of in-head supply flow paths which will be described in detail later. The in-apparatus supply flow path **SJ1** is a flow path provided outside the liquid ejecting head **10**, and includes a main flow portion coupled to the first sub tank **1512** and a plurality of tributary portions branched from the main flow portion for each of the plurality of in-head supply flow paths.

(36) The recovery flow path **CF1** has an in-apparatus recovery flow path **CJ1** that is coupled to the second sub tank **1516** and recovering the first ink by merging the first ink from the plurality of liquid ejecting heads **10**, and a plurality of in-head recovery flow paths which will be described in detail later. The in-apparatus recovery flow path **CJ1** is a flow path provided outside the liquid ejecting head **10**, and includes a main flow portion coupled to the second sub tank **1516** and a plurality of tributary portions for coupling the main flow portion and each of the plurality of in-head recovery flow paths.

(37) The on-off valve **160** is provided in the middle of the in-apparatus recovery flow path **CJ1**. The on-off valve **160** can close and open the in-apparatus recovery flow path **CJ1** under the control of the control module **120**. In the following description, closing the in-apparatus recovery flow path **CJ1** by the on-off valve **160** may be described as “closing the on-off valve **160**”, and opening the in-apparatus recovery flow path **CJ1** by the on-off valve **160** may be described as “opening the on-off valve **160**”. An apparatus other than the control module **120** may control the on-off valve **160**. The on-off valve **160** may be any valve as long as it can be controlled by an apparatus such as the control module **120**, and is, for example, a diaphragm valve, an electromagnetic valve, an electric valve, or the like.

(38) In the present embodiment, the on-off valve **160** is provided in the middle of the main flow portion of the in-apparatus recovery flow path **CJ1**, but a plurality of the on-off valves **160** may be provided in the middle of each of the plurality of tributary portions of the in-apparatus recovery flow path **CJ1**.

(39) The compressor **152** and the vacuum pump **154** generate differential pressure between the pressure in the first sub tank **1512** and the pressure in the second sub tank **1516**. In the present embodiment, the compressor **152** generates only pressure higher than pressure generated by the vacuum pump **154**. Specifically, the compressor **152** generates positive pressure higher than atmospheric pressure. The vacuum pump **154** generates negative pressure lower than the atmospheric pressure. The compressor **152** is an example of a “pressurizing mechanism”. However, the pressurizing mechanism is not limited to the compressor, and may be a pump such as a tube pump, a syringe pump, or a diaphragm pump.

(40) The regulator **153** is provided between the compressor **152** and the first sub tank **1512**. The regulator **153** adjusts the pressure generated in the compressor **152** to predetermined positive pressure under the control of the control module **120**, and supplies the predetermined positive pressure to the first sub tank **1512**. A value of the predetermined positive pressure is a value determined by a manufacturer of the liquid ejecting apparatus **100** or the like.

(41) The regulator **155** is provided between the vacuum pump **154** and the second sub tank **1516**. The regulator **155** adjusts the pressure generated in the vacuum pump **154** to predetermined negative pressure under the control of the control module **120**, and supplies the predetermined

negative pressure to the second sub tank **1516**. A value of the predetermined negative pressure is a value determined by the manufacturer of the liquid ejecting apparatus **100** or the like.

(42) The pump **1514** is provided between the first sub tank **1512** and the second sub tank **1516**. The pump **1514** causes the first ink of the second sub tank **1516** to flow to the first sub tank **1512** under the control of the control module **120**.

(43) The pressure sensor **156** is provided in the middle of the in-apparatus supply flow path **SJ1** between the first sub tank **1512** and the liquid supply port **Pin** of the liquid ejecting head **10**. The pressure sensor **156** measures the pressure of the in-apparatus supply flow path **SJ1**, and transmits the measurement information indicating the measured value which is the measurement result to the control module **120**.

(44) The pressure sensor **157** is provided in the middle of the in-apparatus recovery flow path **CJ1** between the second sub tank **1516** and the liquid discharge port **Pout** of the liquid ejecting head **10**. More specifically, the pressure sensor **157** is provided between the on-off valve **160** and the second sub tank **1516**. The pressure sensor **157** measures the pressure of the in-apparatus recovery flow path **CJ1**, and transmits the measurement information indicating the measured value which is the measurement result to the control module **120**.

(45) As described above, the first ink flows into the liquid ejecting head **10** from the first sub tank **1512** via the liquid supply port **Pin**, the first ink is recovered from the liquid discharge port **Pout** to the second sub tank **1516**, and the first ink flows into the first sub tank **1512** from the second sub tank **1516** by the pump **1514** to circulate the first ink.

(46) The control module **120** controls the regulator **153** so that the measured value indicated by the measurement information received from the pressure sensor **156** approaches the predetermined positive pressure. Similarly, the control module **120** controls the regulator **155** so that the measured value indicated by the measurement information received from the pressure sensor **157** approaches the predetermined negative pressure.

(47) By the control of the control module **120** described above, the control module **120** can keep the pressure of the meniscus, which is a liquid level of the nozzle **N**, constant while circulating the first ink via the inside of the liquid ejecting head **10**. An apparatus other than the control module **120** may control the circulation mechanism **150**.

(48) When the first ink is ejected from the nozzle **N**, the sum of the first ink amount in the first sub tank **1512** and the second sub tank **1516** is reduced. Therefore, the pump **112** appropriately replenishes the first ink in the second sub tank **1516** by supplying the ink from the main tank **110** to the second sub tank **1516** under the control of the control module **120**. For example, the first ink in the second sub tank **1516** is replenished at the timing when the height of the first ink in the second sub tank **1516** is lower than a predetermined height.

(49) 1-3. Liquid Ejecting Module **140**

(50) FIG. **3** is a perspective view of the liquid ejecting module **140**. As illustrated in FIG. **3**, the liquid ejecting module **140** has a support body **41** and the plurality of liquid ejecting heads **10**. The support body **41** is a member that supports the plurality of liquid ejecting heads **10**. In an example illustrated in FIG. **3**, the support body **41** is a plate-shaped member made of metal or the like, and is provided with mount holes **41a** for mounting the plurality of liquid ejecting heads **10**. The plurality of liquid ejecting heads **10** are inserted into the mount holes **41a** in a state of being lined up in a direction along the **X** axis. Each liquid ejecting head **10** is fixed to the support body **41** by screwing or the like. FIG. **3** illustrates two liquid ejecting heads as a representative. The number of liquid ejecting heads in the liquid ejecting module **140** is optional. In addition, the shape of the support body **41** and the like are not limited to the example illustrated in FIG. **3**, and are optional.

(51) 1-4. Liquid Ejecting Head **10**

(52) FIG. **4** is an exploded perspective view of the liquid ejecting head **10** illustrated in FIG. **3**. As illustrated in FIG. **4**, the liquid ejecting head **10** has a flow path structure **11**, a wiring substrate **12**, a holder **13**, a plurality of head chips **14\_1**, **14\_2**, **14\_3**, **14\_4**, **14\_5**, and **14\_6**, a fixing plate **15**,

and a base **16**. These are disposed in the order of the base **16**, the flow path structure **11**, the wiring substrate **12**, the holder **13**, the plurality of head chips **14\_1**, **14\_2**, **14\_3**, **14\_4**, **14\_5**, and **14\_6**, and the fixing plate **15** in the Z2 direction. Hereinafter, each portion of the liquid ejecting head **10** will be described in sequence. In the following, each of the head chips **14\_1**, **14\_2**, **14\_3**, **14\_4**, **14\_5**, and **14\_6** may be described as a head chip **14**.

(53) The flow path structure **11** is a structure in which a flow path for flowing the ink between the circulation mechanism **150** and the plurality of head chips **14** are provided inside. As illustrated in FIG. **4**, the flow path structure **11** is provided with a coupling tube **11a**, a coupling tube lib, a coupling tube **11c**, a coupling tube **11d**, and a hole **11e**.

(54) Here, although not illustrated in FIG. **4**, two in-structure supply flow paths CC1 and CC2 and two in-structure discharge flow paths CM1 and CM2 are provided inside the flow path structure **11**. Each of the in-structure supply flow paths CC1 and CC2 is a flow path for supplying the ink to the plurality of head chips **14**. A filter **25** for capturing foreign matter and the like is installed in the middle of each of the two in-structure supply flow paths CC1 and CC2. The in-structure discharge flow paths CM1 and CM2 are flow paths through which the ink is discharged from the plurality of head chips **14**. The flow path of the flow path structure **11** will be described with reference to FIGS. **5** and **11** which will be described later.

(55) The coupling tubes **11a**, **11b**, **11c**, and **11d** are tube bodies protruding in the Z1 direction. More specifically, the coupling tube **11a** is a tube body that constitutes a flow path through which the first ink is supplied to the in-structure supply flow path CC1. In addition, the coupling tube **11b** is a tube body that constitutes a flow path through which the second ink is supplied to the in-structure supply flow path CC2. Meanwhile, the coupling tube **11c** is a tube body that constitutes a flow path through which the first ink is discharged from the in-structure discharge flow path CM1. In addition, the coupling tube **11d** is a tube body that constitutes a flow path through which the second ink is discharged from the in-structure discharge flow path CM2. The hole **11e** is a hole for inserting a connector **12c** which will be described later. An opening of the coupling tube **11a** is the liquid supply port Pin. An opening of the coupling tube **11c** is the liquid discharge port Pout.

(56) The wiring substrate **12** is a mount component that electrically couples the plurality of head chips **14** and an assembly substrate **16b** which will be described later. The wiring substrate **12** is, for example, a rigid wiring substrate. The wiring substrate **12** is disposed between the flow path structure **11** and the holder **13**, and the connector **12c** is installed on a surface of the wiring substrate **12** facing the flow path structure **11**. The connector **12c** is a coupling component coupled to the assembly substrate **16b** which will be described later. In addition, the wiring substrate **12** is provided with a plurality of holes **12a** and a plurality of opening portions **12b**. Each hole **12a** is a hole for allowing coupling between the flow path structure **11** and the holder **13**. Each opening portion **12b** is a hole through which the wiring substrate **14h** coupling the head chip **14** and the wiring substrate **12** is passed. The wiring substrate **14h** is coupled to a surface of the wiring substrate **12** facing the Z1 direction. The wiring substrate **14h** is a member including wiring electrically coupled to a piezoelectric element **14e** which will be described later, and is, for example, an FPC, a COF, or the like. The FPC is an abbreviation of flexible printed circuits. The COF is an abbreviation of a chip on film.

(57) The holder **13** is a structure that accommodates and supports the plurality of head chips **14**. For example, the holder **13** is made of a resin material or a metal material. The holder **13** has a plate shape that extends in a direction perpendicular to the Z axis. In addition, the holder **13** is provided with a coupling tube **13a**, a coupling tube **13b**, a plurality of coupling tubes **13c**, a plurality of coupling tubes **13d**, and a plurality of wiring holes **13e**. Although not illustrated in the drawing, a plurality of recessed portions that accommodate the plurality of head chips **14** are provided on the surface of the holder **13** facing the Z2 direction.

(58) In the present embodiment, the holder **13** holds six head chips **14\_1** to **14\_6**. These head chips **14** are arranged in the X2 direction in the order of head chips **14\_1**, **14\_4**, **14\_2**, **14\_5**, **14\_3**, and



**14\_6.** Here, the head chips **14\_1** to **14\_3** are disposed at positions shifted in the Y1 direction with respect to the head chips **14\_4** to **14\_6**. However, the head chips **14\_1** to **14\_6** have portions that overlap each other as viewed in the X1 direction or the X2 direction. The arrangement directions DN of the plurality of nozzles N which will be described later in the head chips **14\_1** to **14\_6** are parallel to each other. Furthermore, each of the head chips **14\_1** to **14\_6** is disposed such that the arrangement direction DN is inclined with respect to the direction DM which is the transport direction of the medium M.

(59) Here, although not illustrated in FIG. 4, inside the holder **13**, two in-holder supply flow paths SP1 and SP2, in-holder discharge flow paths DS1 and DS2 for each head chip **14**, and a plurality of bypass flow paths BP1 and BP2 are provided. Each of the in-holder supply flow paths SP1 and SP2 is a flow path having a branch for supplying ink to the plurality of head chips **14**. The in-holder discharge flow paths DS1 and DS2 are flow paths for introducing the ink discharged from the head chip **14** into the in-structure discharge flow path CM1 of the flow path structure **11**. The bypass flow paths BP1 and BP2 are provided for each head chip **14**, and are bypass flow paths through which a first common liquid chamber R1 communicates with a second common liquid chamber R2 which will be described later. The flow path of the holder **13** will be described with reference to FIGS. 6 to 8 which will be described later.

(60) In the present embodiment, among the head chips **14\_1** to **14\_6**, the first ink is supplied to the head chips **14\_1** to **14\_3**, and the second ink is supplied to the head chips **14\_4** to **14\_6**.

(61) The coupling tubes **13a**, **13b**, **13c**, and **13d** are tubular protrusions protruding in the Z1 direction. More specifically, the coupling tube **13a** is a tube body that constitutes a flow path for supplying the first ink to the in-holder supply flow path SP1, and communicates with the in-structure supply flow path CC1 of the flow path structure **11**. In addition, the coupling tube **13b** is a tube body that constitutes a flow path for supplying the second ink to the in-holder supply flow path SP2, and communicates with the in-structure supply flow path CC2 of the flow path structure **11**. Meanwhile, the coupling tube **13c** is a tube body that constitutes a flow path for discharging the first ink to the in-holder discharge flow path DS1, and communicates with the in-structure discharge flow path CM1 of the flow path structure **11**. In addition, the coupling tube **13d** is a tube body that constitutes a flow path for discharging the second ink to the in-holder discharge flow path DS2, and communicates with the in-structure discharge flow path CM2 of the flow path structure **11**. The wiring hole **13e** is a hole through which the wiring substrate **14h** coupling the head chip **14** and the wiring substrate **12** is passed.

(62) Each head chip **14** ejects the ink. Specifically, although not illustrated in FIG. 4, each head chip **14** has a plurality of nozzles N for ejecting the first ink and a plurality of nozzles N for ejecting the second ink. The nozzles N are provided on a nozzle surface FN, which is a surface of each head chip **14** facing the Z2 direction. Details of the head chip **14** will be described with reference to FIG. 7, which will be described later.

(63) The fixing plate **15** is a plate member which fixes the plurality of head chips **14** to the holder **13**. Specifically, the fixing plate **15** is disposed in a state in which the plurality of head chips **14** are sandwiched between the fixing plate **15** and the holder **13**, and is fixed to the holder **13** with an adhesive. The fixing plate **15** is made of, for example, a metal material. The fixing plate **15** is provided with a plurality of opening portions **15a** for exposing the nozzles N of the plurality of head chips **14**. In an example illustrated in FIG. 4, the plurality of opening portions **15a** are individually provided for each head chip **14**.

(64) The base **16** is a member which fixes the flow path structure **11**, the wiring substrate **12**, the holder **13**, the plurality of head chips **14**, and the fixing plate **15** to the above-mentioned support body **41**. The base **16** has a main body **16a**, the assembly substrate **16b**, and a cover **16c**.

(65) The main body **16a** holds the flow path structure **11** and the wiring substrate **12** disposed between the base **16** and the holder **13** by being fixed to the holder **13** by screwing or the like. The main body **16a** is made of, for example, a resin material or the like. The main body **16a** has a plate-

shaped portion facing the plate-shaped portion of the flow path structure **11** described above, and the plate-shaped portion is provided with a plurality of holes **16d** into which the coupling tubes **11a**, **11b**, **11c**, and **11d** described above are inserted. The main body **16a** has a portion extending in the Z2 direction from the plate-shaped portion, and a tip of the portion is provided with a flange **16e** to be fixed to the support body **41** described above.

(66) The assembly substrate **16b** is a mount component for electrically coupling the control module **120** and the wiring substrate **12** described above. The assembly substrate **16b** is, for example, a rigid wiring substrate. The cover **16c** is a plate-shaped member which protects the assembly substrate **16b** and fixes the assembly substrate **16b** to the main body **16a**. The cover **16c** is made of, for example, a resin material or the like, and is fixed to the main body **16a** by screwing or the like.

(67) 1-5. Flow Path in Liquid Ejecting Apparatus **100**

(68) FIG. 5 is a schematic view illustrating the flow path in the liquid ejecting apparatus **100**. FIG. 5 illustrates the flow path through which the first ink flows. As described above, among the head chips **14\_1** to **14\_6**, the head chips **14** to which the first ink is supplied are the head chips **14\_1** to **14\_3**. Therefore, in FIG. 5, the head chips **14\_1** to **14\_3** are displayed inside the liquid ejecting head **10**. Since the flow path through which the second ink flows is the same as the flow path through which the first ink flows, the illustration and description thereof will be omitted.

(69) As illustrated in FIG. 5, the liquid ejecting apparatus **100** has a plurality of individual flow paths PJ communicating with each of the plurality of nozzles N, a liquid storage portion **151**, a supply flow path SF1 for supplying the first ink from the liquid storage portion **151** to the plurality of individual flow paths PJ, a recovery flow path CF1 for recovering the first ink from the plurality of individual flow paths PJ to the liquid storage portion **151**, the bypass flow paths BP1 and BP2 that couple the supply flow path SF1 and the recovery flow path CF1 without passing through any of the plurality of individual flow paths PJ, and the on-off valve **160** that can close and open the recovery flow path CF1. In the following description, the bypass flow paths BP1 and BP2 may be collectively referred to as the bypass flow path BP. As illustrated in FIG. 5, the on-off valve **160** is disposed between the bypass flow path BP and the liquid storage portion **151** in the recovery flow path CF1. The plurality of individual flow paths PJ and the plurality of nozzles N have a one-to-one correspondence with each other. The individual flow path PJ will be described with reference to FIG. 6.

(70) As described above, since the compressor **152** generates only pressure higher than the pressure generated by the vacuum pump **154**, the ink in the supply flow path SF1 flows only in a direction in which the first ink flows from the liquid storage portion **151** to the plurality of individual flow paths PJ via the supply flow path SF1.

(71) As illustrated in FIG. 5, the supply flow path SF1 for supplying the first ink includes the in-apparatus supply flow path SJ1 illustrated in FIG. 2 and the in-head supply flow path described above. The in-head supply flow path includes the in-structure supply flow path CC1, the in-holder supply flow path SP1, and the first common liquid chamber R1 of each of the head chips **14\_1** to **14\_3**. In addition, the recovery flow path CF1 has the in-apparatus recovery flow path CJ1 illustrated in FIG. 2 and the in-head discharge flow path described above. The in-head discharge flow path includes the second common liquid chamber R2 of each of the head chips **14\_1** to **14\_3**, the in-holder discharge flow path DS1, and the in-structure discharge flow path CM1.

(72) The in-structure supply flow path CC1 is a flow path for supplying the first ink introduced from the liquid supply port Pin of the coupling tube **11a** to the in-holder supply flow path SP1. As illustrated in FIG. 5, a filter **25** is provided in the in-structure supply flow path CC1. As illustrated in FIG. 5, the bypass flow path BP is provided downstream of the filter **25**.

(73) The in-holder supply flow path SP1 is a flow path for supplying the first ink introduced from the in-structure supply flow path CC1 via a liquid supply port Qin of the coupling tube **13a** to the head chips **14\_1** to **14\_3**. The liquid supply port Qin is an opening of the coupling tube **13a** illustrated in FIG. 4. The in-holder supply flow path SP1 has three branched portions for supplying

the first ink to the head chips **14\_1** to **14\_3**.

(74) The first common liquid chamber **R1** stores the first ink to be supplied to each individual flow path **PJ**. The first common liquid chamber **R1** stores the first ink supplied from the in-holder supply flow path **SP1**. The second common liquid chamber **R2** stores the first ink discharged from each individual flow path **PJ** without being ejected. The first common liquid chamber **R1** and the second common liquid chamber **R2** communicate with each other via the plurality of individual flow paths **PJ**. In addition, the bypass flow paths **BP1** and **BP2** are coupled to the first common liquid chamber **R1** and the second common liquid chamber **R2**. The bypass flow paths **BP1** and **BP2** are flow paths that bypass the plurality of individual flow paths **PJ** and through which the first common liquid chamber **R1** communicates with the second common liquid chamber **R2**, and are provided in the holder **13**. The bypass flow path **BP** is not provided with the nozzle **N**. Details of the bypass flow paths **BP1** and **BP2** will be described with reference to FIGS. **6**, **8**, **9**, and **10** which will be described later.

(75) The in-holder discharge flow path **DS1** is provided for each head chip **14** that uses the first ink, and is a flow path for discharging the first ink introduced from the head chip **14** from a liquid discharge port **Qout** of the coupling tube **13c**. The liquid discharge port **Qout** is an opening of the coupling tube **13c** illustrated in FIG. **4**.

(76) The in-structure discharge flow path **CM1** is a flow path for supplying the first ink introduced from the in-holder discharge flow path **DS1** via the liquid discharge port **Qout** to the in-apparatus recovery flow path **CJ1**.

(77) The circulation mechanism **150** executes a circulation operation of circulating the first ink in the order of the liquid storage portion **151**, the supply flow path **SF1**, the individual flow path **PJ**, the recovery flow path **CF1**, and the liquid storage portion **151**. That is, the liquid storage portion **151**, the supply flow path **SF1**, the individual flow path **PJ**, and the recovery flow path **CF1** constitute a circulation path through which the first ink circulates. The upstream in the present specification means an upstream portion of the circulation path in the circulation operation unless otherwise specified. The downstream in the present specification means a downstream of the circulation path in the circulation operation unless otherwise specified. That is, a coupling position between the liquid storage portion **151** (first sub tank **1512**) and the supply flow path **SF1** is the most upstream position in the circulation path, and a coupling position between the liquid storage portion **151** (second sub tank **1516**) and the recovery flow path **CF1** is the most downstream position. Therefore, in the first embodiment, when one element of the two elements is close to the first sub tank **1512** with respect to the other element, it means that one element is located upstream with respect to the other element. Similarly, when one element of the two elements is close to the second sub tank **1516** with respect to the other element, it means that one element is located downstream with respect to the other element.

(78) 1-6. Head Chip **14**

(79) FIG. **6** is a plan view schematically illustrating the flow path of the head chip **14\_1**. The following description will be given by appropriately using a **V** axis and a **W** axis in addition to the **X** axis, the **Y** axis, and the **Z** axis for convenience. In addition, one direction along the **V** axis is a **V1** direction, and a direction opposite to the **V1** direction is a **V2** direction. Similarly, the directions opposite to each other along the **W** axis are a **W1** direction and a **W2** direction.

(80) Here, the **V** axis is an axis along an arrangement direction of the plurality of nozzles **N** which will be described later, and is an axis that is obtained by rotating the **Y** axis around the **Z** axis at a predetermined angle. The **W** axis is an axis that is obtained by rotating the **X** axis around the **Z** axis at the predetermined angle. Therefore, the **V** axis and the **W** axis are typically orthogonal to each other, but are not limited to this, and may intersect at an angle within a range of, for example, 80 degrees or more and 100 degrees or less. In addition, the predetermined angle, that is, the angle which is formed by the **V** axis and the **Y** axis, or the angle which is formed by the **W** axis and the **X** axis is, for example, within a range of 40 degrees or more and 60 degrees or less.

(81) In FIG. 6, among the head chips **14\_1** to **14\_6**, the flow path of the head chip **14\_1** is illustrated as a representative.

(82) As illustrated in FIG. 6, the head chip **14** is provided with the plurality of nozzles **N**, a plurality of individual flow paths **PJ**, the first common liquid chamber **R1**, and the second common liquid chamber **R2**. As illustrated by a chain double-dashed line in FIG. 6, the bypass flow paths **BP1** and **BP2** are coupled to the first common liquid chamber **R1** and the second common liquid chamber **R2**.

(83) The head chip **14** has a surface facing the medium **M**, and as illustrated in FIG. 6, the plurality of nozzles **N** are provided on the surface. The plurality of nozzles **N** are arranged along the **V** axis. Each of the plurality of nozzles **N** ejects the ink in the **Z2** direction.

(84) Here, a set of the plurality of nozzles **N** constitutes a nozzle row **Ln**. In addition, the plurality of nozzles **N** are arranged at equal intervals at a predetermined pitch. The predetermined pitch is a distance between the centers of the plurality of nozzles **N** in the direction along the **V** axis.

(85) The individual flow path **PJ** communicates with each of the plurality of nozzles **N**. Each of the plurality of individual flow paths **PJ** extends along the **W** axis and communicates with the nozzles **N** that are different from each other. The plurality of individual flow paths **PJ** are arranged along the **V** axis.

(86) As illustrated in FIG. 6, each individual flow path **PJ** has a pressure chamber **Ca**, a pressure chamber **Cb**, a nozzle flow path **Nf**, an individual supply flow path **Ra1**, an individual discharge flow path **Ra2**, a first communication flow path **Na1**, and a second communication flow path **Na2**.

(87) Each of the pressure chamber **Ca** and the pressure chamber **Cb** in each individual flow path **PJ** extends along the **W** axis and is a space in which the ink ejected from the nozzle **N** communicating with the individual flow path **PJ** is stored. In an example illustrated in FIG. 6, the plurality of pressure chambers **Ca** are arranged along the **V** axis. Similarly, a plurality of the pressure chambers **Cb** are arranged along the **V** axis. In each individual flow path **PJ**, positions of the pressure chamber **Ca** and the pressure chamber **Cb** in the direction along the **V** axis are the same in the example illustrated in FIG. 6, but may be different from each other. In the following, when the pressure chamber **Ca** and the pressure chamber **Cb** are not particularly distinguished, each pressure chamber may be referred to as “pressure chamber **C**”.

(88) The nozzle flow path **Nf** is disposed between the pressure chamber **Ca** and the pressure chamber **Cb** in each individual flow path **PJ**. Here, the pressure chamber **Ca** communicates with the nozzle flow path **Nf** via the first communication flow path **Na1** which extends along the **Z** axis. The pressure chamber **Cb** communicates with the nozzle flow path **Nf** via the second communication flow path **Na2** which extends along the **Z** axis.

(89) In each individual flow path **PJ**, the nozzle flow path **Nf** is a space which extends along the **W** axis. In addition, the plurality of nozzle flow paths **Nf** are arranged along the **V** axis at intervals from each other. The nozzle **N** is provided in each nozzle flow path **Nf**. In each nozzle flow path **Nf**, the ink is ejected from the nozzle **N** by changing the pressure in the pressure chamber **Ca** and the pressure chamber **Cb** described above.

(90) Each of the first communication flow path **Na1** and the second communication flow path **Na2** is a space which extends along the **Z** axis. The first communication flow path **Na1** and the second communication flow path **Na2** may be provided as necessary, and may be removed.

(91) The first common liquid chamber **R1** and the second common liquid chamber **R2** communicate with the plurality of individual flow paths **PJ**. Here, the pressure chamber **Ca** communicates with the first common liquid chamber **R1** via the individual supply flow path **Ra1** which extends along the **Z** axis. The pressure chamber **Cb** communicates with the second common liquid chamber **R2** via the individual discharge flow path **Ra2** which extends along the **Z** axis.

(92) Each of the first common liquid chamber **R1** and the second common liquid chamber **R2** is a space which extends along the **V** axis throughout the entire range in which the plurality of nozzles **N** are distributed. Here, the first common liquid chamber **R1** is coupled to an end of each individual

flow path PJ in the W2 direction. The first common liquid chamber R1 stores the ink for supplying to each individual flow path PJ. Meanwhile, the second common liquid chamber R2 is coupled to an end of each individual flow path PJ in the W1 direction. The second common liquid chamber R2 stores the ink discharged from each individual flow path PJ without being ejected.

(93) The first common liquid chamber R1 is provided with a supply port IO1, a discharge port IO3a, and a discharge port IO3b. The supply port IO1 is a tube path for introducing the ink from the in-holder supply flow path SP1 of the holder 13 into the first common liquid chamber R1. The discharge port IO3a is a tube path for discharging the ink from the first common liquid chamber R1 to the bypass flow path BP1. The discharge port IO3b is a tube path for discharging the ink from the first common liquid chamber R1 to the bypass flow path BP2.

(94) Here, the in-holder supply flow path SP1 is coupled to the circulation mechanism 150 via the in-structure supply flow path CC1 of the flow path structure 11.

(95) The second common liquid chamber R2 is provided with a discharge port 102, an introduction port IO4a, and an introduction port IO4b. The discharge port 102 is a tube path for discharging the ink from the second common liquid chamber R2 to the in-holder discharge flow path DS1 of the holder 13. The introduction port IO4a is a tube path for introducing the ink from the bypass flow path BP1 to the second common liquid chamber R2. The introduction port IO4b is a tube path for introducing the ink from the bypass flow path BP2 into the second common liquid chamber R2.

(96) Here, the in-holder discharge flow path DS1 is coupled to the circulation mechanism 150 via the in-structure discharge flow path CM1 of the flow path structure 11.

(97) FIG. 7 is a cross-sectional view of the head chip 14. FIG. 7 illustrates a cross section of the head chip 14 which is cut in a plane including the W axis and the Z axis. As illustrated in FIG. 7, the head chip 14 has a nozzle substrate 14a, a flow path substrate 14b, a pressure chamber substrate 14c, a vibration plate 14d, a plurality of piezoelectric elements 14e, a case 14f, a protective plate 14g, a wiring substrate 14h, a flexible member 14ja, and a flexible member 14jb.

(98) The nozzle substrate 14a, the flow path substrate 14b, the pressure chamber substrate 14c, and the vibration plate 14d are laminated in this order in the Z1 direction. Each of the members extends along the V axis and is manufactured, for example, by processing a silicon single crystal substrate using a semiconductor processing technique. The members are bonded to each other by an adhesive or the like. It should be noted that another layer such as an adhesive layer or a substrate may be appropriately interposed between two adjacent members among the members.

(99) The plurality of nozzles N are provided on the nozzle substrate 14a. Each of the plurality of nozzles N penetrates the nozzle substrate 14a and is a through hole through which the ink passes. The plurality of nozzles N are arranged in the direction along the V axis.

(100) The flow path substrate 14b is provided with a part of each of the first common liquid chamber R1 and the second common liquid chamber R2 and a portion of the plurality of individual flow paths PJ excluding the pressure chamber Ca and the pressure chamber Cb. That is, the flow path substrate 14b is provided with the nozzle flow path Nf, the first communication flow path Na1, the second communication flow path Na2, the individual supply flow path Ra1, and the individual discharge flow path Ra2.

(101) A part of each of the first common liquid chamber R1 and the second common liquid chamber R2 is a space for penetrating the flow path substrate 14b. The flexible members 14ja and 14jb that blocks the opening by the space are installed on the surface of the flow path substrate 14b facing the Z2 direction. In the following description, the flexible members 14ja and 14jb may be collectively referred to as the flexible member 14j.

(102) The flexible member 14j is a layered member made of an elastic material. One surface of the flexible member 14ja defines a part of the first common liquid chamber R1 and the other surface of the flexible member 14ja faces a space open to the atmosphere, so that the flexible member 14ja absorbs the pressure fluctuation in the first common liquid chamber R1. A surface S14 which is one surface of the flexible member 14jb defines a part of the second common liquid chamber R2 and

the other surface of the flexible member **14jb** faces a space open to the atmosphere, so that the flexible member **14jb** absorbs the pressure fluctuation in the second common liquid chamber R2. Since the flexible member **14j** absorbs the pressure fluctuations of the first common liquid chamber R1 and the second common liquid chamber R2, these pressure fluctuations are less likely to reach the pressure chamber C. By making it difficult for the pressure fluctuations to reach the pressure chamber C, it is possible to improve the quality of the image formed on the medium M.

(103) A width dR2 from a wall surface of the second common liquid chamber R2 in the Z1 direction in the flow path substrate **14b** to the flexible member **14jb** along the Z axis is, for example, about 200  $\mu\text{m}$  in a state in which the flexible member **14jb** is not deformed. “ $\mu\text{m}$ ” indicates micrometer.

(104) The nozzle flow path Nf is a space in a groove provided on a surface of the flow path substrate **14b** facing the Z2 direction. Here, the nozzle substrate **14a** constitutes a part of the wall surface of the nozzle flow path Nf.

(105) Each of the first communication flow path Na1 and the second communication flow path Na2 is a space for penetrating the flow path substrate **14b**.

(106) Each of the individual supply flow path Ra1 and the individual discharge flow path Ra2 is a space for penetrating the flow path substrate **14b**. The individual supply flow path Ra1 causes the first common liquid chamber R1 to communicate with the pressure chamber Ca so as to supply the ink from the first common liquid chamber R1 to the pressure chamber Ca. Here, one end of the individual supply flow path Ra1 is opened on a surface of the flow path substrate **14b** facing the Z1 direction. On the other hand, the other end of the individual supply flow path Ra1 is an upstream end of the individual flow path PJ and is an opening PJi on the wall surface of the first common liquid chamber R1 in the flow path substrate **14b**. On the other hand, the individual discharge flow path Ra2 causes the second common liquid chamber R2 to communicate with the pressure chamber Cb so as to discharge the ink from the pressure chamber Cb to the second common liquid chamber R2. Here, one end of the individual discharge flow path Ra2 is opened on the surface of the flow path substrate **14b** facing the Z1 direction. On the other hand, the other end of the individual discharge flow path Ra2 is a downstream end of the individual flow path PJ, and is an opening PJo of the wall surface of the second common liquid chamber R2 in the flow path substrate **14b**. The width dRa of the individual discharge flow path Ra2 along the W axis is, for example, from 120  $\mu\text{m}$  to 130  $\mu\text{m}$ .

(107) The pressure chamber substrate **14c** is provided with the pressure chambers Ca and the pressure chambers Cb of the plurality of individual flow paths PJ. Each of the pressure chamber Ca and the pressure chamber Cb penetrates the pressure chamber substrate **14c** and is a gap between the flow path substrate **14b** and the vibration plate **14d**.

(108) The vibration plate **14d** is a plate-shaped member which can elastically vibrate. The vibration plate **14d** is a laminate including, for example, a first layer made of silicon oxide ( $\text{SiO}_2$ ) and a second layer made of zirconium oxide ( $\text{ZrO}_2$ ). Here, another layer such as a metal oxide may be interposed between the first layer and the second layer. A part or all of the vibration plate **14d** may be integrally made of the same material as the pressure chamber substrate **14c**. For example, the vibration plate **14d** and the pressure chamber substrate **14c** can be integrally formed by selectively removing a part in a thickness direction of the region corresponding to the pressure chamber C in the plate-shaped member having a predetermined thickness. In addition, the vibration plate **14d** may be constituted of a layer of a single material.

(109) The plurality of piezoelectric elements **14e** corresponding to the pressure chambers C different from each other are installed on a surface of the vibration plate **14d** facing the Z1 direction. Each piezoelectric element **14e** is configured by, for example, laminating a first electrode and a second electrode facing each other and a piezoelectric layer disposed between the two electrodes. Each piezoelectric element **14e** fluctuates the pressure of the ink in the pressure chamber C to eject the ink in the pressure chamber C from the nozzle N. When the drive signal

Com is supplied, the piezoelectric element **14e** vibrates the vibration plate **14d** with its own deformation. With the vibration, the pressure chamber C expands and contracts such that the pressure of the ink in the pressure chamber C fluctuates. The piezoelectric element **14e** is an example of a drive element. However, the head chip **14** may have a heat generating element instead of the piezoelectric element **14e**.

(110) The case **14f** is a case that stores the ink. The case **14f** is provided with a space constituting a remaining portion other than a part provided on the flow path substrate **14b** for each of the first common liquid chamber R1 and the second common liquid chamber R2.

(111) The protective plate **14g** is a plate-shaped member installed on the surface of the vibration plate **14d** facing the Z1 direction, protects the plurality of piezoelectric elements **14e**, and reinforces the mechanical strength of the vibration plate **14d**. Here, a space for accommodating the plurality of piezoelectric elements **14e** is formed between the protective plate **14g** and the vibration plate **14d**.

(112) The wiring substrate **14h** is mounted on the surface of the vibration plate **14d** facing the Z1 direction, and is a mount component that electrically couples the control module **120** and the head chip **14**. For example, a flexible wiring substrate **14h** such as a flexible printed circuit (FPC) and a flexible flat cable (FFC) is preferably used. The drive circuit **14i** described above is mounted on the wiring substrate **14h**.

(113) In the head chip **14** having the above-described configuration, the ink flows to the first common liquid chamber R1, the individual supply flow path Ra1, the pressure chamber Ca, the nozzle flow path Nf, the pressure chamber Cb, and the individual discharge flow path Ra2 and the second common liquid chamber R2, in this order, by the operation of the circulation mechanism **150** described above.

(114) The pressure of the pressure chamber Ca and the pressure chamber Cb is caused to fluctuate by simultaneously driving the piezoelectric element **14e** corresponding to both the pressure chamber Ca and the pressure chamber Cb by the drive signal Com from the drive circuit **14i**. Thereby, the ink is ejected from the nozzle N in accordance with the pressure fluctuation thereof.

(115) 1-7. Holder **13**

(116) FIG. **8** is a plan view of the holder **13**. FIG. **9** is a perspective view illustrating the flow path provided in the holder **13** and the head chip **14**. In FIG. **8**, an example of the structure inside the holder **13** as viewed in the Z2 direction is illustrated by a broken line. In FIG. **9**, in addition to the flow path of the holder **13** and the plurality of head chips **14**, the fixing plate **15** is illustrated.

(117) As illustrated in FIGS. **8** and **9**, inside the holder **13**, the in-holder supply flow path SP1, the in-holder supply flow path SP2, three in-holder discharge flow paths DS1, three in-holder discharge flow paths DS2, six bypass flow paths BP1, and six bypass flow paths BP2 are provided.

(118) The in-holder supply flow path SP1 is a flow path having three branched portions for supplying the first ink introduced into the coupling tube **13a** to the three head chips **14**. The in-holder supply flow path SP2 is a flow path having three branched portions for supplying the second ink introduced into the coupling tube **13b** to the three head chips **14**.

(119) The in-holder discharge flow path DS1 is provided for each head chip **14** that uses the first ink, and is a flow path for discharging the first ink introduced from the head chip **14** from the coupling tube **13c**. The in-holder discharge flow path DS2 is provided for each head chip **14** that uses the second ink, and is a flow path for discharging the second ink introduced from the head chip **14** from the coupling tube **13d**.

(120) Each of the bypass flow path BP1 and bypass flow path BP2 is provided for each head chip **14**, and are flow paths through which the above-described first common liquid chamber R1 communicates with the and the above-described second common liquid chamber R2. Here, the bypass flow path BP1 and the bypass flow path BP2 are located opposite each other with respect to the center of the first common liquid chamber R1 or the second common liquid chamber R2 in the direction along the X axis. In an example illustrated in FIG. **8**, the bypass flow path BP1 is located

in the V2 direction with respect to the bypass flow path BP2. In addition, each of the bypass flow path BP1 and the bypass flow path BP2 has a U shape as viewed in the direction along the Z axis. (121) FIG. 10 is a cross-sectional view taken along the line X-X in FIG. 8. In FIG. 10, in addition to the holder 13, the head chip 14 and the fixing plate 15 are illustrated. As illustrated in FIG. 10, the holder 13 has a plate shape that extends in a direction perpendicular to the Z axis. The holder 13 has a layer 31 and a layer 32, which are laminated in this order in the Z2 direction. Each of the layer 31 and the layer 32 is made of, for example, a resin material and is formed by injection molding. The layer 31 and the layer 32 are bonded to each other, for example, with an adhesive. (122) Each of the above-described flow paths included in the holder 13 is provided in a laminate constituted of the layer 31 and the layer 32, and a recessed portion 13f that accommodates the head chip 14 is provided on the surface of the layer 32 facing the Z2 direction. In an example illustrated in FIG. 10, a thickness of the layer 32 is thicker than a thickness of the layer 31. Therefore, the thickness of the layer 32 required for forming the recessed portion 13f can be easily secured. (123) Here, the in-holder supply flow path SP1 has a vertical flow path SPa and a horizontal flow path SPb. The vertical flow path SPa extends in the direction along the Z axis, and is constituted of holes penetrating the layer 32. The horizontal flow path SPb extends in a direction orthogonal to the Z axis, and is provided between the layer 31 and the layer 32. In the example illustrated in FIG. 10, the horizontal flow path SPb is constituted of a groove provided on the surface of the layer 31 facing the Z2 direction and a groove provided on the surface of the layer 32 facing the Z1 direction. Although not illustrated in FIG. 10, the in-holder supply flow path SP2 is configured in the same manner as the in-holder supply flow path SP1.

(124) The bypass flow path BP1 has a first portion BP1a, a second portion BP1b, and a third portion BP1c. Each of the first portion BP1a and the second portion BP1b extends in the direction along the Z axis and is constituted of holes penetrating the layer 32. The third portion BP1c extends in the direction orthogonal to the Z axis, and is provided between the layer 31 and the layer 32. In the example illustrated in FIG. 10, the third portion BP1c is constituted of a groove provided on the surface of the layer 31 facing the Z2 direction and a groove provided on the surface of the layer 32 facing the Z1 direction.

(125) Similarly, the bypass flow path BP2 has a first portion BP2a, a second portion BP2b, and a third portion BP2c. Each of the first portion BP2a and the second portion BP2b extends in the direction along the Z axis and is constituted of holes penetrating the layer 32. The third portion BP2c extends in a direction orthogonal to the Z axis, and is provided between the layer 31 and the layer 32. In the example illustrated in FIG. 10, the third portion BP2c is constituted of a groove provided on the surface of the layer 31 facing the Z2 direction and a groove provided on the surface of the layer 32 facing the Z1 direction.

(126) In one head chip 14, the sum of flow path resistances of the bypass flow path BP is smaller than the sum of flow path resistances of the plurality of individual flow paths PJ. That is, in one head chip 14, the combined resistance of the bypass flow path BP1 and the bypass flow path BP2 is smaller than the combined resistance of the plurality of individual flow paths PJ.

(127) 1-8. Flow Path Structure 11

(128) FIG. 11 is a plan view of the flow path structure 11. In FIG. 11, an example of the structure in the flow path structure 11 as viewed in the Z2 direction is illustrated by a broken line. As illustrated in FIG. 11, inside the flow path structure 11, the in-structure supply flow path CC1, the in-structure supply flow path CC2, the in-structure discharge flow path CM1, the in-structure discharge flow path CM2, a first filter chamber RF1, and a second filter chamber RF2 are provided. The filter 25 is provided inside each of the first filter chamber RF1 and the second filter chamber RF2.

(129) The filter 25 is a plate-shaped or sheet-shaped member that captures foreign matter and the like mixed in the ink while allowing the ink to pass therethrough. The filter 25 is made of, for example, a metal fiber such as a twilled dutch weave or a plain dutch weave. The filter 25 is not limited to the configuration using the metal fiber, and may be made of a resin fiber such as non-



woven fabric, for example. The filter **25** is typically disposed so as to be parallel to the nozzle surface **FN**. Here, the filter **25** may be provided so as to be inclined in a range of 0 degrees or more and 45 degrees or less with respect to the nozzle surface **FN**.

(130) The in-structure supply flow path **CC1** is a flow path for supplying the first ink introduced into the coupling tube **11a** to the holder **13** described above. Here, the in-structure supply flow path **CC1** communicates with an internal space of the coupling tube **11a** via the first filter chamber **RF1**. A discharge port **CE1** coupled to the coupling tube **13a** described above communicates with the in-structure supply flow path **CC1**.

(131) The in-structure supply flow path **CC2** is a flow path for supplying the second ink introduced into the coupling tube **11b** to the holder **13** described above. Here, the in-structure supply flow path **CC2** communicates with an internal space of the coupling tube **11b** via the second filter chamber **RF2**. A discharge port **CE2** coupled to the coupling tube **13b** described above communicates with the in-structure supply flow path **CC2**.

(132) The in-structure discharge flow path **CM1** is a flow path for discharging the first ink from the holder **13** described above from the coupling tube **11c**. An introduction port **CI'** coupled to the three coupling tubes **13c** described above communicates with the in-structure discharge flow path **CM1**.

(133) The in-structure discharge flow path **CM2** is a flow path for discharging the second ink from the holder **13** described above from the coupling tube **11d**. An introduction port **CI2** coupled to the three coupling tubes **13d** described above communicates with the in-structure discharge flow path **CM2**.

(134) 1-9. Operation at the Time of Filling Ink

(135) A series of processes when the liquid ejecting head **10** is filled with the first ink will be described with reference to FIGS. **12**, **13**, and **14**. With respect to the second ink, the liquid ejecting apparatus **100** executes a series of processes similar to those for the first ink. Hereinafter, a series of processes related to the first ink will be described.

(136) FIG. **12** is a flowchart illustrating a series of processes at the time of filling ink. In step **S2**, the liquid ejecting apparatus **100** controls the circulation mechanism **150** in a state in which the on-off valve **160** is open, and executes a circulation operation of circulating the first ink in the order of the liquid storage portion **151**, the supply flow path **SF1**, the individual flow path **PJ**, the recovery flow path **CF1**, and the liquid storage portion **151**. In the circulation operation, the control module **120** opens the on-off valve **160**, sets the in-apparatus supply flow path **SJ1** to have predetermined positive pressure, sets the in-apparatus recovery flow path **CJ1** to have predetermined negative pressure, and supplies the first ink to each of the plurality of head chips **14**. The flow rate increases as a difference between the upstream pressure and the downstream pressure increases. Therefore, a period required for filling the nozzle **N**, the individual flow path **PJ**, the supply flow path **SF1**, and the recovery flow path **CF1** with the first ink in accordance with an increase in the difference between the upstream pressure and the downstream pressure can be shortened.

(137) When the circulation operation is executed when the first ink is not filled in the plurality of nozzles **N**, the supply flow path **SF1**, the individual flow path **PJ**, and the recovery flow path **CF1**, the plurality of nozzles **N**, the supply flow path **SF1**, the individual flow path **PJ**, and the recovery flow path **CF1** are filled with the first ink, and after the first ink is filled, the first ink circulates in the order of the liquid storage portion **151**, the supply flow path **SF1**, the individual flow path **PJ**, the recovery flow path **CF1**, and the liquid storage portion **151**. By executing the circulation operation, the bubble staying in the supply flow path **SF1**, the individual flow path **PJ**, and the recovery flow path **CF1** can be discharged, but the bubble may not be completely discharged and may stay. A state of the head chip **14\_1** during the circulation operation will be described with reference to FIG. **13**.

(138) FIG. **13** is a view illustrating the state of the head chip **14\_1** during the circulation operation. In FIG. **13** and FIG. **14**, which will be described later, a view of a cross section of the head chip **14\_1** which is parallel to the **Z** axis and the **W** axis and passes through the supply port **IO1** and the

discharge port **102** as viewed from the V2 direction to the V1 direction is illustrated. In addition, in FIGS. **13** and **14**, in order to prevent the drawing from becoming complicated, the wiring substrate **14h** and the drive circuit **14i** are not illustrated, and the in-holder supply flow path **SP1**, the in-apparatus supply flow path **SJ1**, the bypass flow path **BP2**, the in-holder discharge flow path **DS1**, and the in-apparatus recovery flow path **CJ1** are schematically illustrated. Furthermore, in FIGS. **13** and **14**, in order to make it easier to understand the flow of the first ink in the bypass flow path **BP2**, as a display for convenience, the discharge port **IO3a** is displayed by being shifted in the W2 direction from the original, and the introduction port **IO4a** is displayed by being shifted in the W1 direction from the original. In addition, in FIGS. **13** and **14**, for easy understanding, the on-off valve **160** is illustrated as a white figure in a state in which the on-off valve **160** is open, and the on-off valve **160** is illustrated as a black figure in a state in which the on-off valve **160** is closed. In FIG. **13**, the on-off valve **160** is open.

(139) As illustrated in FIG. **13**, the flow **FRa** of the first ink in the supply flow path **SF1**, the flow **FRb** of the first ink in the individual flow path **PJ**, the flow **FRc** of the first ink in the bypass flow path **BP**, and the flow **FRd** of the first ink in the recovery flow path **CF1** are formed by the circulation operation. The flow **FRa** is a flow of the first ink from the liquid storage portion **151** to an opening **PJi** of each of the plurality of individual flow paths **PJ** or the discharge port **IO3b** via the supply flow path **SF1**. The flow **FRb** is a flow of the first ink from the opening **PJi** to the opening **PJo**. The flow **FRc** is a flow of the first ink from the discharge port **IO3b** to the introduction port **IO4b** via the bypass flow path **BP2**. Although not illustrated in FIG. **13**, a flow of the first ink from the discharge port **IO3a** to the introduction port **IO4a** via the bypass flow path **BP1** is also formed by the circulation operation. The flow **FRd** is a flow of the first ink from an opening **PJo** of each of the plurality of individual flow paths **PJ** to the liquid storage portion **151** via the recovery flow path **CF1**.

(140) Since the pressure of the first common liquid chamber **R1** also becomes the positive pressure when the in-apparatus supply flow path **SJ1** has the predetermined positive pressure, as illustrated in FIG. **13**, the flexible member **14ja** is bent in the Z2 direction. On the other hand, since the pressure of the second common liquid chamber **R2** also becomes the negative pressure when the in-apparatus recovery flow path **CJ1** has the predetermined negative pressure, as illustrated in FIG. **13**, the flexible member **14jb** is bent in the Z1 direction. As the flexible member **14jb** is bent in the Z1 direction, the width **dR2** from the wall surface of the second common liquid chamber **R2** in the Z1 direction to the flexible member **14jb** along the Z axis becomes narrower compared to a state in which the flexible member **14jb** is not deformed. For example, in a state in which the flexible member **14jb** is bent in the Z1 direction, the width **dR2** is about 100  $\mu\text{m}$ .

(141) As the width **dR2** becomes narrower, there is a concern that the bubble is likely to stay in the second common liquid chamber **R2**. When the bubble is generated in the second common liquid chamber **R2**, the ink supply amount is insufficient or an ejection abnormality occurs. The ejection abnormality is a state in which the ink cannot be ejected according to an aspect specified by the drive signal **Com** even though an attempt is made to eject the ink from the nozzle **N** by the drive signal **Com**. This is because since the pressure in the individual flow path **PJ** becomes the negative pressure when the ink is ejected from the nozzle **N**, when the ink is drawn from the second common liquid chamber **R2**, the bubble staying in the second common liquid chamber **R2** is also drawn into the individual flow path **PJ** together with the ink in the second common liquid chamber **R2**, so the nozzle **N** is blocked by the bubble. FIG. **13** illustrates a bubble **Ar** staying in the second common liquid chamber **R2**.

(142) The bubble has a property that the smaller the volume of the bubble, the less likely the shape of the bubble is to be deformed. Therefore, when the bubble is sandwiched between a surface **Sr2** of the second common liquid chamber **R2** facing the Z2 direction and the surface **S14** of the flexible member **14jb** facing the Z1 direction as the width **dR2** is narrowed, it may be difficult for the bubble to pass through the second common liquid chamber **R2** because the bubble is difficult to

deform.

(143) Furthermore, it can be said that the bubble is likely to stay in the second common liquid chamber R2 having a width dR2 narrower than that of the individual flow path PJ. When the bubble exists in the individual flow path PJ, the individual flow path PJ may be blocked by the bubble. When the individual flow path PJ is blocked, the pressure applied to an upstream surface of the bubble staying in the individual flow path PJ increases due to the flow FRb of the first ink in the individual flow path PJ, and a difference in pressure between an upstream portion and a downstream portion of the bubble increases, and a force for moving the bubble is generated by this difference in pressure. Therefore, even though the bubble exists in the individual flow path PJ, the bubble moves to the recovery flow path CF1 downstream due to the difference in pressure in which the bubble receives, so that the bubble is less likely to stay in the individual flow path PJ. On the other hand, even though the bubble exists in the second common liquid chamber R2 having a narrow width dR2, it can be said that the possibility that the second common liquid chamber R2 is blocked by the bubble is lower than the possibility that the individual flow path PJ is blocked. This is because, since the second common liquid chamber R2 extends along the V axis, even though the size of the bubble is substantially equal to the width of the second common liquid chamber R2 along the Z axis, the first ink flows in a portion of the second common liquid chamber R2 where the bubble Ar does not exist, that is, the portion in the V1 direction or the V2 direction with respect to the bubble Ar, so that the first ink can flow while avoiding the bubble Ar. Since the first ink collides with the bubble, a difference in pressure is generated between the upstream portion and the downstream portion of the bubble Ar, but it is difficult to generate enough force to deform the bubble Ar and pass through the width dR2. As described above, as the width dR2 is narrowed, the bubble Ar is less likely to be discharged from the second common liquid chamber R2.

(144) In addition, in FIG. 13, the bubble Ar is displayed at a position sandwiched between the surface Sr2 and the surface S14, but a position where the bubble is likely to stay in a state in which the flexible member 14jb is bent in the Z1 direction is not limited to the position illustrated in FIG. 13. When the flexible member 14jb is not deformed, as understood from FIG. 7, an angle formed by the surface Sw1 and the surface S14 defining an end of the second common liquid chamber R2 in the W1 direction is approximately 90 degrees. However, when the flexible member 14jb is bent in the Z1 direction, the angle formed by the surface Sw1 and the surface S14 becomes an acute angle. Therefore, the bubble is sandwiched between the surface Sw1 and the surface S14, and the bubble is likely to stay. A similar phenomenon occurs between a surface defining an end of the second common liquid chamber R2 in the W2 direction and the surface S14.

(145) The description returns to FIG. 12. In step S4, when a predetermined flow rate is circulated by the circulation operation, the control module 120 executes the pressurization discharge operation of discharging the first ink from each of the plurality of nozzles N by closing the on-off valve 160. In the pressurization discharge operation, the control module 120 pressurizes the first ink in the supply flow path SF1 by setting the in-apparatus supply flow path SJ1 to have the predetermined positive pressure by the control of the circulation mechanism 150. However, the pressure of the in-apparatus supply flow path SJ1 during the circulation operation and the pressure of the in-apparatus supply flow path SJ1 during the pressurization discharge operation may be the same value or different values. By closing the on-off valve 160, a place where the first ink is discharged is limited to the nozzle N only. A state of the head chip 14\_1 during the pressurization discharge operation will be described with reference to FIG. 14.

(146) FIG. 14 is a view illustrating the state of the head chip 14\_1 in the pressurization discharge operation. In the pressurization discharge operation, a flow toward the nozzle N is formed because the nozzle N is the only place where the first ink is discharged. Specifically, as illustrated in FIG. 14, by the pressurization discharge operation, the flow FR1 of the first ink from the supply flow path SF1 to the nozzle N via a part of the individual flow path PJ and the flow FR2 of the first ink from the supply flow path SF1 to the nozzle N via the bypass flow path BP, a part of the recovery

flow path CF1, and a part of the individual flow path PJ in this order, are formed. The flow FR1 includes a flow FRa of the first ink in the supply flow path SF1 and a flow FRf of the first ink in a flow path of a part of the individual flow path PJ. The flow FR2 includes a flow FRc of the first ink in the bypass flow path BP2, a flow FRE of the first ink in the second common liquid chamber R2 which is a part of the recovery flow path CF1, and a flow FRg of the first ink in the flow path of the part of the individual flow path PJ. By closing the on-off valve **160**, the recovery flow path CF1 is divided into two flow paths, an upstream flow path and a downstream flow path, with the on-off valve **160** interposed therebetween. The second common liquid chamber R2 is included in the upstream flow path of the two flow paths, that is, a flow path close to the individual flow path PJ. Similar to FIG. **13**, the flow FR2 also includes a flow of the first ink in the bypass flow path BP1. (147) The flow FRE is a flow of the first ink from the introduction port IO4b to the opening PJo of each of the plurality of individual flow paths PJ through the second common liquid chamber R2. The flow FRf is a flow of the first ink from the opening PJi to the nozzle N through the flow path of the part of the individual flow path PJ. Therefore, the flow path of the part of the individual flow path PJ in the flow FRf is the individual supply flow path Ra1, the pressure chamber Ca, the first communication flow path Na1, and a flow path from an end of the nozzle flow path Nf in the W1 direction to a point where it communicates with nozzle N. The flow FRg is the flow of the first ink from the opening PJo to the nozzle N through the flow path of the part of the individual flow path PJ. Therefore, the flow path of the part of the individual flow path PJ in the flow FRg is the individual discharge flow path Ra2, the pressure chamber Cb, the second communication flow path Na2, and a flow path from an end of the nozzle flow path Nf in the W2 direction to a point where it communicates with nozzle N. The first ink is discharged from the nozzle N by the flow FRf and the flow FRg. In FIG. **14**, the first ink being discharged from the nozzle N is illustrated by displaying a droplet DR.

(148) In the pressurization discharge operation, the pressure of the second common liquid chamber R2 is likely to be a positive pressure via the bypass flow path BP. In FIG. **14**, it is assumed that the pressure of the second common liquid chamber R2 is the positive pressure. When the pressure of the second common liquid chamber R2 is a positive pressure, the flexible member **14j** is bent in the Z2 direction as illustrated in FIG. **14**. That is, since the width dR2 becomes wide, the bubble Ar is released from being sandwiched between the surface Sr2 and the surface S14. Therefore, the bubble Ar moves in the second common liquid chamber R2 along the flow FRE, moves in the flow path of the part of the individual flow path PJ along the flow FRg, and is discharged together with the droplet DR. Even when the bubble is sandwiched between the surface Sw1 and the surface S14 in the circulation operation, an angle formed by the surface Sw1 and the surface S14 becomes an obtuse angle, as understood from FIG. **14**. Therefore, the bubble sandwiched between the surface Sw1 and the surface S14 also easily moves and is discharged together with the droplet DR. The bubble sandwiched between the surface S14 and the surface defining an end of the second common liquid chamber R2 in the W2 direction in the circulation operation is also discharged together with the droplet DR in the same manner as the bubble sandwiched between the surface Sw1 and the surface S14.

(149) In addition, as understood from FIGS. **13** and **14**, in the circulation operation and the pressurization discharge operation, the flows of the first ink in the second common liquid chamber R2 are opposite to each other. It may be difficult for the bubble to move in one direction, but it may be easy for the bubble to move in the opposite direction. For example, the surface Sr2 may be inclined in the Z2 direction as it is directed in the W2 direction. When the Z axis is a vertical axis, buoyancy in the Z1 direction is generated in the bubble. Therefore, in the circulation operation, the bubble in contact with the surface Sr2 needs to move against the buoyancy in order to move in the W2 direction. On the other hand, in the pressurization discharge operation, the bubble in contact with the surface Sr2 may move in the W1 direction. When the surface Sr2 is inclined in the Z2 direction as it is directed in the W2 direction, it is easier for the bubble in contact with the surface

Sr2 to move in the W1 direction compared to moving in the W2 direction.

(150) By the pressurization discharge operation, the bubble staying in any of the bypass flow paths BP1 and BP2, the second common liquid chamber R2, and the flow path from the opening PJo to the nozzle N among each of the plurality of individual flow paths PJ is discharged from the nozzle N. Therefore, it is preferable that the control module **120** ends the pressurization discharge operation after at least from the start of the pressurization discharge operation, flowing the first ink of a volume obtained by multiplying the sum of the volumes of the bypass flow paths BP1 and BP2, the second common liquid chamber R2, and the flow path from the opening PJo to the nozzle N among each of the plurality of individual flow paths PJ by the number of the liquid ejecting heads **10** included in the liquid ejecting apparatus **100**, in the flow FR2. After the end of the pressurization discharge operation, the liquid ejecting apparatus **100** ends a series of processes illustrated in FIG. **12**.

(151) In the above description, the liquid ejecting apparatus **100** executes the series of processes illustrated in FIG. **12** in a state in which the plurality of nozzles N, the supply flow path SF1, the individual flow path PJ, and the recovery flow path CF1 are not filled with the first ink, but it is not limited to this. For example, the liquid ejecting apparatus **100** may execute the series of processes illustrated in FIG. **12** as one of the maintenance processes to restore the ink ejection state to normal in a state in which the plurality of nozzles N, the supply flow path SF1, the individual flow path PJ, and the recovery flow path CF1 are filled with the first ink, for example, before and/or after the printing process.

(152) 1-10. Summary of First Embodiment

(153) Hereinafter, the features of the liquid ejecting apparatus **100** will be described using the flow path related to the first ink.

(154) As described above, the liquid ejecting apparatus **100** according to the first embodiment includes the plurality of nozzles N that eject the first ink, the plurality of individual flow paths PJ that communicate with each of the plurality of nozzles N, and a liquid storage portion **151** that stores the first ink to be supplied to each of the plurality of nozzles N, the supply flow path SF1 for supplying the first ink from the liquid storage portion **151** to the plurality of individual flow paths PJ, the recovery flow path CF1 for recovering the first ink from the plurality of individual flow paths PJ to the liquid storage portion **151**, the bypass flow path BP that couples the supply flow path SF1 and the recovery flow path CF1 without passing through any of the plurality of individual flow paths PJ, and the on-off valve **160** that can close and open the recovery flow path CF1. The on-off valve **160** is disposed between the bypass flow path BP and the liquid storage portion **151** in the recovery flow path CF1, and the liquid ejecting apparatus **100** executes the pressurization discharge operation of discharging the first ink from each of the plurality of nozzles N by pressurizing the first ink in the supply flow path SF1 in a state in which the recovery flow path CF1 is closed by the on-off valve **160**.

(155) By pressurizing the first ink in a state in which the recovery flow path CF1 is closed by the on-off valve **160**, a flow FR2 of the first ink flowing toward the nozzle N via the bypass flow paths BP1 and BP2 is formed because the nozzle N is the only place where the first ink is discharged. In the second common liquid chamber R2 which is a part of the recovery flow path CF1, the direction of the flow FRc of the first ink formed by the pressurization discharge operation is opposite to the direction of the flow FRd of the first ink formed by the circulation operation. Therefore, the liquid ejecting apparatus **100** according to the first embodiment can discharge the bubble in the recovery flow path CF1 that cannot be discharged in the circulation operation. That is, the liquid ejecting apparatus **100** according to the first embodiment can easily discharge the bubble staying in the recovery flow path CF1.

(156) In addition, as an aspect for generating a flow in the recovery flow path CF1 in a direction opposite to the direction of the flow FRd, an aspect in which the on-off valve **160** is not provided, the first ink is supplied from the recovery flow path CF1, and the first ink is recovered from the

supply flow path SF1 is also conceivable. Hereinafter, this aspect will be referred to as a “comparative aspect”. However, in the comparative aspect, since the ink that does not pass through the filter 25 is supplied to the individual flow path PJ, there is a possibility that the ejection abnormality due to the foreign matter may occur. In the first embodiment, the bypass flow path BP is provided downstream of the filter 25. Therefore, in the liquid ejecting apparatus 100 according to the first embodiment, the first ink from which the foreign matter is removed by the filter 25 can form the flow FR2 flowing toward the nozzle N via the bypass flow path BP. As described above, the liquid ejecting apparatus 100 according to the first embodiment can suppress the occurrence of the ejection abnormality due to the foreign matter as compared with the comparative aspect, while suppressing the occurrence of the ejection abnormality due to the bubble.

(157) In addition, the liquid ejecting apparatus 100 according to the first embodiment further includes the flexible member 14jb that defines a portion of the recovery flow path CF1 coupled to the bypass flow path BP, and has flexibility. The portion of the recovery flow path CF1 coupled to the bypass flow path BP is the second common liquid chamber R2.

(158) As described above, the flexible member 14jb is bent in the Z1 direction, so that bubble is likely to stay in the second common liquid chamber R2. In the liquid ejecting apparatus 100 according to the first embodiment, since the flexible member 14jb can be bent in the Z2 direction in the pressurization discharge operation, the bubble staying in the second common liquid chamber R2 can be discharged.

(159) In addition, instead of the flexible member 14jb, an aspect having a member having no flexibility is also conceivable. However, in this aspect, since the pressure fluctuation of the second common liquid chamber R2 easily reaches the pressure chamber C, the ejection abnormality is likely to occur. Therefore, the liquid ejecting apparatus 100 according to the first embodiment can suppress the occurrence of the ejection abnormality due to the bubble while improving the quality of the image formed on the medium M by having the flexible member 14jb.

(160) In addition, during the execution of the pressurization discharge operation, the pressure of the first ink flowing upstream from the on-off valve 160 in the recovery flow path CF1 is the positive pressure with respect to the atmospheric pressure. The first ink flowing upstream of the on-off valve 160 in the recovery flow path CF1 means the first ink flowing upstream of the on-off valve 160 in the circulation operation, and typically, is the first ink in the second common liquid chamber R2. In other words, it can be said that the first ink in the second common liquid chamber R2 flows a downstream portion of the bypass flow path BP in the recovery flow path CF1 in the pressurization discharge operation, as illustrated by the flow FR2 in FIG. 14.

(161) When the pressure of the first ink is the positive pressure, in the liquid ejecting apparatus 100 according to the first embodiment, the flexible member 14jb can be bent in the Z2 direction during the pressurization discharge operation.

(162) In addition, by the pressurization discharge operation, the flow FR1 of the first ink from the supply flow path SF1 to the nozzle N via a part of the individual flow path PJ and the flow FR2 of the first ink from the supply flow path SF1 to the nozzle N via the bypass flow path BP, the second common liquid chamber R2, which is a part of the recovery flow path CF1, and a part of the individual flow path PJ in this order, are formed.

(163) By forming the flow FR2, the liquid ejecting apparatus 100 according to the first embodiment can generate a flow in the second common liquid chamber R2 in the direction opposite to the direction of the flow FRd.

(164) In addition, the liquid ejecting apparatus 100 according to the first embodiment executes the circulation operation of circulating the first ink in the order of the liquid storage portion 151, the supply flow path SF1, the individual flow path PJ, the recovery flow path CF1, and the liquid storage portion 151.

(165) In addition, the liquid ejecting apparatus 100 according to the first embodiment starts the pressurization discharge operation by closing the recovery flow path CF1 by the on-off valve 160

while the circulation operation is being executed.

(166) By closing the on-off valve **160** while the circulation operation is being executed, it is possible to instantaneously generate pressure for the first ink in the recovery flow path CF1 toward the nozzle N. Therefore, in the liquid ejecting apparatus **100** according to the first embodiment, a period required for discharging the bubble can be shortened as compared with an aspect in which the on-off valve **160** is closed after the circulation operation is temporarily stopped by the circulation mechanism **150**, and the first ink in the supply flow path SF1 is pressurized by the circulation mechanism **150** after the on-off valve **160** is closed. Since the period required for discharging the bubble is shortened, in the liquid ejecting apparatus **100** according to the first embodiment, the amount of the ink discharged from the nozzle N during the pressurization discharge operation can be reduced because the period required for the pressurization discharge operation is shortened.

(167) In addition, the liquid ejecting apparatus **100** according to the first embodiment includes a compressor **152** that pressurizes the ink in the supply flow path SF1 so as to flow the ink in the supply flow path SF1 only in a direction in which the first ink flows from the liquid storage portion **151** to the plurality of individual flow paths PJ via the supply flow path SF1 by the circulation operation.

(168) In the liquid ejecting apparatus **100** according to the first embodiment, since it is not necessary to change the flow direction of the first ink in the recovery flow path CF1 to the opposite direction by the compressor **152**, the configuration of the liquid ejecting apparatus **100** can be simplified as compared with an aspect in which the flow direction of the first ink in the recovery flow path CF1 can be changed in the opposite direction by the compressor **152**. In addition, in the above-described comparative aspect, the flow directions are changed in the opposite directions in the supply flow path SF1, the individual flow path PJ, the bypass flow path BP, and the recovery flow path CF1. On the other hand, in the liquid ejecting apparatus **100** according to the first embodiment, the flow direction is changed only in the second common liquid chamber R2 and a part of the individual flow path PJ. Therefore, in the liquid ejecting apparatus **100** according to the first embodiment, as compared with the comparative aspect, a range of changing the flow direction among the supply flow path SF1, the individual flow path PJ, the bypass flow path BP, and the recovery flow path CF1 can be narrowed, so that the period required for discharging the bubble can be shortened.

(169) In addition, the supply flow path SF1 has the first common liquid chamber R1 coupled to the plurality of individual flow paths PJ, the recovery flow path CF1 has a second common liquid chamber R2 coupled to the plurality of individual flow paths PJ. The bypass flow path BP causes the first common liquid chamber R1 to communicate with the second common liquid chamber R2. In other words, the bypass flow path BP is coupled to the second common liquid chamber R2 in the recovery flow path CF1.

(170) In the liquid ejecting apparatus **100** according to the first embodiment, a range of changing the flow direction in the recovery flow path CF1 can be narrowed as compared with an aspect in which the bypass flow path BP is coupled to any of the in-holder discharge flow path DS1 and the in-structure discharge flow path CM1 other than the second common liquid chamber R2 in the recovery flow path CF1. In the liquid ejecting apparatus **100** according to the first embodiment, by shortening a range of changing the flow direction in the recovery flow path CF1, a period required for discharging the bubble can be shortened, and an ink consumption amount can also be reduced. That is, it is preferable that a flow path length from a coupling position between the bypass flow path BP and the recovery flow path CF1 to the on-off valve **160** is shorter than a flow path length from the coupling position to the opening PJo which is one end of the individual flow path PJ.

(171) The flow path resistance of the bypass flow path BP is smaller than the sum of flow path resistances of the plurality of individual flow paths PJ.

(172) In the liquid ejecting apparatus **100** according to the first embodiment, the pressure of the

second common liquid chamber **R2** can be easily set to the positive pressure as compared with an aspect in which the flow path resistance of the bypass flow path **BP** is larger than the sum of flow path resistances of the plurality of individual flow paths **PJ**.

(173) According to the above description, the liquid ejecting apparatus **100** according to the first embodiment can also be specified as a liquid discharging method for executing the pressurization discharge operation of discharging the first ink from each of the plurality of nozzles **N** by pressurizing the first ink in the supply flow path **SF1** in a state in which the recovery flow path **CF1** is closed by the on-off valve **160**.

## 2. MODIFICATION EXAMPLE

(174) Each form exemplified above can be variously modified. Specific modification aspects are exemplified below. Two or more aspects optionally selected from the following examples can be appropriately combined within a scope where the aspects do not contradict each other.

### 2.1. First Modification Example

(175) The liquid storage portion **151** according to the first embodiment includes the first sub tank **1512** that stores ink to be supplied to each of the plurality of liquid ejecting heads **10**, and the second sub tank **1516** that recovers the ink from each of the plurality of liquid ejecting heads **10**, but the present disclosure is not limited to this. Specifically, the sub tank that stores the ink to be supplied to each of the plurality of liquid ejecting heads **10** and the sub tank that recovers the ink from each of the plurality of liquid ejecting heads **10** may be the same.

(176) FIG. **15** is a view illustrating a circulation mechanism **150-A** in a first modification example. A liquid ejecting apparatus **100-A** according to the first modification example differs from the liquid ejecting apparatus **100** in that it has a circulation mechanism **150-A** instead of the circulation mechanism **150**, an in-apparatus supply flow path **SJ1-A** instead of the in-apparatus supply flow path **SJ1**, and an in-apparatus recovery flow path **CJ1-A** instead of the in-apparatus recovery flow path **CJ1**.

(177) The circulation mechanism **150-A** differs from the circulation mechanism **150** in that it has a sub tank **1510** instead of the liquid storage portion **151**, does not have the compressor **152**, the regulator **153**, the vacuum pump **154**, the regulator **155**, the pressure sensor **156**, and the pressure sensor **157**, and uses the pump **159**. In the first modification example, the sub tank **1510** is an example of the “liquid storage portion”, and the pump **159** is an example of the “pressurizing mechanism”.

(178) The sub tank **1510** stores the first ink to be supplied to each of the plurality of liquid ejecting heads **10**. In the sub tank **1510**, the first ink replenished from the main tank **110** and the first ink recovered from each of the plurality of liquid ejecting heads **10** are stored.

(179) The in-apparatus supply flow path **SJ1-A** differs from the in-apparatus supply flow path **SJ1** in that a pump **159** is provided instead of the pressure sensor **156**. The pump **159** pressurizes the first ink in the in-apparatus supply flow path **SJ1-A**. The in-apparatus recovery flow path **CJ1-A** differs from the in-apparatus recovery flow path **CJ1** in that it does not have the pressure sensor **157**.

### 2-2. Second Modification Example

(180) In the first embodiment and the first modification example, the on-off valve **160** is provided outside the liquid ejecting head **10**, but may be provided inside the liquid ejecting head **10**.

(181) FIG. **16** is a schematic view illustrating a flow path in a liquid ejecting apparatus **100-B** in a second modification example. FIG. **16** illustrates the flow path through which the first ink flows. In the second modification example, since the flow path through which the second ink flows is the same as the flow path through which the first ink flows, the description thereof will be omitted.

(182) The liquid ejecting apparatus **100-B** differs from the liquid ejecting apparatus **100** in that it has a recovery flow path **CF1-B** instead of the recovery flow path **CF1**. The recovery flow path **CF1-B** differs from the recovery flow path **CF1** in that it has an in-structure discharge flow path **CM1-B** instead of the in-structure discharge flow path **CM1**, and has an in-apparatus recovery flow



path **CJ1-B** instead of the in-apparatus recovery flow path **CJ1**. The in-structure discharge flow path **CM1-B** is provided in the liquid ejecting head **10-B** in the second modification example. Therefore, the liquid ejecting head **10-B** differs from the liquid ejecting head **10** in that the in-structure discharge flow path **CM1-B** is provided instead of the in-structure discharge flow path **CM1**.

(183) The in-structure discharge flow path **CM1-B** differs from the in-structure discharge flow path **CM1** in that an on-off valve **160** is provided. In the second modification example, the on-off valve **160** is provided for each of the liquid ejecting heads **10-B**.

(184) The in-apparatus recovery flow path **CJ1-B** differs from the in-apparatus recovery flow path **CJ1** in that the on-off valve **160** is not provided.

(185) As understood from the first embodiment and the second modification example, since the flow of the ink is reversed via the bypass flow path **BP** in the pressurization discharge operation, the on-off valve **160** may be located downstream of the bypass flow path **BP** in the circulation operation. One on-off valve **160** may be provided in the liquid ejecting apparatus **100** as in the first embodiment, may be provided for each of the liquid ejecting heads **10-B** as illustrated in FIG. **16**, or may be provided for each head chip **14**. As an example in which the on-off valve **160** is provided for each head chip **14**, in FIG. **16**, the on-off valve **160** is provided in the in-structure discharge flow path **CM1-B**, but the on-off valve **160** may be provided in each of the three in-holder discharge flow paths **DS1**.

### 2-3. Third Modification Example

(186) In the first embodiment, the first modification example, and the second modification example, the bypass flow path **BP** is provided inside the liquid ejecting head **10**, **10-B**, **10-C**, but as it is located upstream of the on-off valve **160**, the bypass flow path **BP** may be provided outside the liquid ejecting head **10**, **10-B**, **10-C**.

(187) FIG. **17** is a schematic view illustrating a flow path in a liquid ejecting apparatus **100-C** in a third modification example. FIG. **17** illustrates the flow path through which the first ink flows. In the third modification example, since the flow path through which the second ink flows is the same as the flow path through which the first ink flows, the description thereof will be omitted.

(188) The liquid ejecting apparatus **100-C** differs from the liquid ejecting apparatus **100** in that it has a supply flow path **SF1-C** instead of the supply flow path **SF1** and has a recovery flow path **CF1-C** instead of the recovery flow path **CF1**.

(189) The supply flow path **SF1-C** differs from the supply flow path **SF1** in that it has an in-apparatus supply flow path **SJ1-C** instead of the in-apparatus supply flow path **SJ1** and has an in-structure supply flow path **CC1-C** instead of the in-structure supply flow path **CC1**. The recovery flow path **CF1-C** differs from the recovery flow path **CF1** in that the in-apparatus recovery flow path **CJ1-C** is provided instead of the in-apparatus recovery flow path **CJ1**. The in-structure supply flow path **CC1-C** is provided in the liquid ejecting head **10-C** in the third modification example. Therefore, the liquid ejecting head **10-C** differs from the liquid ejecting head **10** in that the in-structure supply flow path **CC1-C** is provided instead of the in-structure supply flow path **CC1**. Furthermore, the liquid ejecting head **10-C** differs from the liquid ejecting head **10** in that it has a plurality of head chips **14-C** instead of the plurality of head chips **14**.

(190) The in-apparatus supply flow path **SJ1-C** differs from the in-apparatus supply flow path **SJ1** in that a filter is provided and is further coupled by a bypass flow path **BP-C**. The in-apparatus recovery flow path **CJ1-C** differs from the in-apparatus recovery flow path **CJ1** in that it is coupled by the bypass flow path **BP-C**. The in-structure supply flow path **CC1-C** differs from the in-structure supply flow path **CC1** in that the filter **25** is not provided.

(191) As illustrated in FIG. **17**, a first coupling position **Pb1** between the bypass flow path **BP-C** and the in-apparatus supply flow path **SJ1-C** is located upstream of the first common liquid chamber **R1**. Furthermore, the first coupling position **Pb1** is located downstream of the filter **25**.

(192) As illustrated in FIG. **17**, a second coupling position **Pb2** between the bypass flow path **BP-C**

and the in-apparatus recovery flow path CJ1-C is located downstream of the second common liquid chamber R2. Furthermore, the second coupling position Pb2 is located upstream of the on-off valve **160**.

(193) The flow path resistance from the second coupling position Pb2 to the nozzle N is smaller than the flow path resistance from the first coupling position Pb1 to the nozzle N. In the following, for the easy description, the flow path resistance from the first coupling position Pb1 to the nozzle N may be described as “first flow path resistance”, and the flow path resistance from the second coupling position Pb2 to the nozzle N may be described as “second flow path resistance”.

(194) FIG. **17** illustrates a flow FR1-C and a flow FR2-C formed by the pressurization discharge operation when the on-off valve **160** is closed. The flow FR1-C is a flow of the first ink from the supply flow path SF1-C to the nozzle N via a part of the individual flow path PJ. The flow FR2-C is a flow of the first ink from the first coupling position Pb1 of the supply flow path SF1-C to the nozzle N via the bypass flow path BP-C, a part of the recovery flow path CF1-C, and a part of the individual flow path PJ in this order.

(195) The flow FR1-C has a flow FRa-C and a flow FRf. The flow FRa-C is a flow of the first ink reaching the first common liquid chamber R1 via the flow path from the first coupling position Pb1 in the in-apparatus supply flow path SJ1-C to the liquid supply port Pin of the liquid ejecting head **10-C**, the in-structure supply flow path CC1-C, and the in-holder supply flow path SP1 in this order. The flow FRf is the same as in the first embodiment.

(196) The flow FR2-C has a flow FRh and a flow FRg. The flow FRh is a flow of the first ink reaching the second common liquid chamber R2 via the bypass flow path BP-C, a flow path from the second coupling position Pb2 in the in-apparatus recovery flow path CJ1-C to the liquid discharge port Pout of the liquid ejecting head **10-C**, the in-structure discharge flow path CM1, and the in-holder discharge flow path DS1 in this order. The flow FRg is the same as in the first embodiment.

(197) In the pressurization discharge operation, as indicated by the flow FR2-C, the second coupling position Pb2 is located upstream of the second common liquid chamber R2.

(198) As understood from FIG. **17**, the flexible member **14jb** in the third modification example defines the second common liquid chamber R2 which is a part of the recovery flow path CF1-C located upstream of the second coupling position Pb2 between the bypass flow path BP-C and the recovery flow path CF1-C.

(199) As understood from the first embodiment and the third modification example, in order to prevent the ink not passing through the filter **25** from being supplied to the individual flow path PJ, the filter **25** may be located upstream of the bypass flow path BP, BP-C in the circulation operation. As illustrated in FIG. **17**, one filter **25** may be provided in the liquid ejecting apparatus **100**, may be provided for each of the liquid ejecting heads **10** as in the first embodiment, or may be provided for each head chip **14**. However, the liquid ejecting apparatus **100-C** may not have the filter **25**. Similarly, one bypass flow path BP may be provided in the liquid ejecting apparatus **100-C** as illustrated in FIG. **17**, may be provided for each of the liquid ejecting heads **10-C** as in the first embodiment, or may be provided for each head chip **14**.

(200) As described above, in the liquid ejecting apparatus **100-C** according to the third modification example, the supply flow path SF1-C has the first common liquid chamber R1 coupled to the plurality of individual flow paths PJ, the recovery flow path CF1-C has the second common liquid chamber R2 coupled to the plurality of individual flow paths PJ, the first coupling position Pb1 between the bypass flow path BP-C and the supply flow path SF1-C is located upstream of the first common liquid chamber R1, the second coupling position Pb2 between the bypass flow path BP-C and the recovery flow path CF1-C is located downstream of the second common liquid chamber R2, and the second flow path resistance from the second coupling position Pb2 to the nozzle N is smaller than the first flow path resistance from the first coupling position Pb1 to the nozzle N.

(201) The nozzle N discharges the first ink that flows according to the flow FR1-C and the first ink that flows according to the flow FR2-C. In the pressurization discharge operation, since the bubble contained in the flow FR2-C is discharged, the amount of the first ink discharged by the flow FR2-C is preferably larger than the amount of the ink discharged by the flow FR1-C. Since the second flow path resistance is smaller than the first flow path resistance, the ink discharged by the flow FR2-C is larger than the ink discharged by the flow FR1-C as compared with the aspect in which the second flow path resistance is larger than the first flow path resistance. As described above, in the liquid ejecting apparatus **100-C** according to the third modification example, the bubble contained in the flow FR2-C can be easily discharged as compared with the aspect in which the second flow path resistance is larger than the first flow path resistance.

#### 2-4. Fourth Modification Example

(202) The second common liquid chamber R2 of the head chip **14** in each of the above-described aspects is partitioned by the flexible member **14jb** having flexibility, but may be partitioned by a member having no flexibility. As described above, it may be difficult for the bubble to move in one direction, but it may be easy for the bubble to move in the opposite direction. The liquid ejecting apparatus **100** according to the fourth modification example can discharge the bubble, which is difficult to be discharged in the circulation operation, by the pressurization discharge operation.

#### 2-5. Fifth Modification Example

(203) In each of the above-described aspects, the pressurization discharge operation is started by closing the recovery flow path CF1 by the on-off valve **160** during execution of the circulation operation, but the on-off valve **160** may be closed after the circulation operation by the circulation mechanism **150** is temporarily stopped, and then the first ink in the supply flow path SF1 may be pressurized by the circulation mechanism **150**.

#### 2-6. Sixth Modification Example

(204) In each of the above-described aspects, the flow path resistance of the bypass flow path BP is smaller than the sum of the flow path resistances of the plurality of individual flow paths PJ, but the flow path resistance of the bypass flow path BP may be larger than the sum of the flow path resistances of the plurality of individual flow paths PJ.

#### 2-7. Seventh Modification Example

(205) In each of the above-described aspects, the two pressure chambers C communicate with one nozzle N, but the present disclosure is not limited thereto. For example, the number of pressure chambers C communicating with one nozzle N may be one or three or more, for example, four.

#### 2-8. Eighth Modification Example

(206) As illustrated in FIG. **1**, the liquid ejecting apparatus **100** in each of the above-described aspects is a so-called line type liquid ejecting apparatus in which the plurality of liquid ejecting heads **10** are fixed to the support body **41** and printing is performed simply by transporting the medium M, but the configuration of the liquid ejecting apparatus is not limited to that described above. For example, the present disclosure can also be applied to a so-called serial type liquid ejecting apparatus in which the plurality of liquid ejecting heads **10** are mounted on a carriage, the plurality of the liquid ejecting heads **10** are reciprocated along the X axis direction, and printing is performed by transporting the medium M.

#### 2-9. Other Modification Examples

(207) The above-described liquid ejecting apparatus can be adopted in various apparatuses such as a facsimile machine and a copier, in addition to an apparatus dedicated to printing. However, the application of the liquid ejecting apparatus of the present disclosure is not limited to printing. For example, the liquid ejecting apparatus that ejects a solution of a coloring material is used as a manufacturing apparatus for forming a color filter of a liquid crystal display device. In addition, a liquid ejecting apparatus that ejects a solution of a conductive material is used as a manufacturing apparatus for forming wiring and electrodes of a wiring substrate.

### 3. APPENDIX

(208) From the above-exemplified embodiment, for example, the following configuration can be grasped.

(209) A liquid ejecting apparatus according to Aspect 1, which is a preferred aspect, includes: a plurality of nozzles that eject liquid; a plurality of individual flow paths that communicate with each of the plurality of nozzles; a liquid storage portion that stores the liquid to be supplied to each of the plurality of nozzles; a supply flow path for supplying the liquid from the liquid storage portion to the plurality of individual flow paths; a recovery flow path for recovering the liquid from the plurality of individual flow paths to the liquid storage portion; a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the plurality of individual flow paths; and an on-off valve configured to close and open the recovery flow path, in which the on-off valve is disposed between the bypass flow path and the liquid storage portion in the recovery flow path, and a pressurization discharge operation of discharging the liquid from each of the plurality of nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve is executed.

(210) By pressurizing the liquid in a state in which the recovery flow path is closed by the on-off valve, a flow of the liquid flowing toward the nozzle via the bypass flow path and a part of the recovery flow path is formed because the nozzle is the only place where the liquid is discharged. In the part of the recovery flow path, the direction of the flow of the liquid formed by the pressurization discharge operation is opposite to the direction of the flow of the liquid formed in a state in which the recovery flow path is opened by the on-off valve. Therefore, according to the Aspect 1, the bubble in the recovery flow path that cannot be discharged in the state the recovery flow path is opened by the on-off valve can be discharged. That is, according to the Aspect 1, the bubble staying in the recovery flow path can be easily discharged.

(211) In Aspect 2 which is a specific example of the Aspect 1, the liquid ejecting apparatus further includes a flexible member that defines a part of the recovery flow path upstream from a coupling position between the bypass flow path and the recovery flow path or a portion of the recovery flow path coupled to the bypass flow path and that has flexibility.

(212) In the Aspect 2, the flexible member is bent in a direction of narrowing a width of a flow path of the part of the recovery flow path, so that the bubble is likely to stay in the recovery flow path. In the Aspect 2, since the flexible member can be bent in the direction of widening the width of the flow path of the part of the recovery flow path in the pressurization discharge operation, the bubble staying in the recovery flow path can be discharged.

(213) In Aspect 3 which is a specific example of the Aspect 2, during the execution of the pressurization discharge operation, pressure of the liquid flowing upstream of the on-off valve in the recovery flow path is positive pressure with respect to atmospheric pressure.

(214) According to the Aspect 3, since the pressure of the liquid is the positive pressure, the flexible member can be bent in a direction of widening the width of the flow path of the part of the recovery flow path during the pressurization discharge operation.

(215) In Aspect 4 which is a specific example of the Aspect 1, a flow of the liquid from the supply flow path to the nozzle via a part of the individual flow path and a flow of the liquid from the supply flow path to the nozzle via the bypass flow path, a part of the recovery flow path, and a part of the individual flow path in this order are formed by the pressurization discharge operation.

(216) According to the Aspect 4, the flow of the liquid from the supply flow path to the nozzle via the bypass flow path, the part of the recovery flow path, and the part of the individual flow path in this order is formed, so that it is possible to generate a flow in a direction opposite to a direction from the recovery flow path to the liquid storage portion in the part of the recovery flow path.

(217) In Aspect 5 which is a specific example of the Aspect 1, a circulation operation of circulating the liquid in an order of the liquid storage portion, the supply flow path, the individual flow path, the recovery flow path, and the liquid storage portion is executed.

(218) In Aspect 6 which is a specific example of the Aspect 5, during the execution of the

circulation operation, the pressurization discharge operation is started by closing the recovery flow path by the on-off valve.

(219) By closing the recovery circuit with the on-off valve while the circulation operation is being executed, it is possible to instantaneously generate the pressure for the liquid in the recovery flow path toward the nozzle. Therefore, according to the Aspect 6, a period required for discharging the bubble can be shortened as compared with an aspect in which the recovery flow path is closed by the on-off valve after the circulation operation is temporarily stopped, and the liquid in the supply flow path is pressurized after the recovery flow path is closed.

(220) In Aspect 7 which is a specific example of the Aspect 5, the liquid ejecting apparatus further includes a pressurizing mechanism that pressurizes the liquid in the supply flow path such that the liquid in the supply flow path flows only in a direction in which the liquid flows from the liquid storage portion to the plurality of individual flow paths via the supply flow path by the circulation operation.

(221) According to the Aspect 7, since it is not necessary to change the direction of the liquid flow in the recovery flow path to the opposite direction by the pressurizing mechanism, the configuration of the liquid ejecting apparatus can be simplified as compared with an aspect in which the direction of the liquid flow in the recovery flow path can be changed in the opposite direction by the pressurizing mechanism.

(222) In Aspect 8 which is a specific example of the Aspect 1, the supply flow path has a first common liquid chamber coupled to the plurality of individual flow paths, the recovery flow path has a second common liquid chamber coupled to the plurality of individual flow paths, and the bypass flow path causes the first common liquid chamber to communicate with the second common liquid chamber.

(223) In the liquid ejecting apparatus according to the Aspect 8, as compared with an aspect in which the bypass flow path is coupled to the flow path other than the second common liquid chamber in the recovery flow path, a range of changing the flow direction in the recovery flow path can be shortened. Therefore, according to the Aspect 8, by shortening the range of changing the flow direction in the recovery flow path, the period required for discharging the bubble can be shortened, and a liquid consumption amount can also be reduced.

(224) In Aspect 9 which is a specific example of the Aspect 1, a flow path resistance of the bypass flow path is smaller than a sum of flow path resistances of the plurality of individual flow paths.

(225) According to the Aspect 9, pressure of the second common liquid chamber can be easily set to positive pressure as compared with an aspect in which the flow path resistance of the bypass flow path is larger than the sum of the flow path resistances of the plurality of individual flow paths.

(226) In Aspect 10 which is a specific example of the Aspect 1, the supply flow path has a first common liquid chamber coupled to the plurality of individual flow paths, the recovery flow path has a second common liquid chamber coupled to the plurality of individual flow paths, a first coupling position between the bypass flow path and the supply flow path is located upstream of the first common liquid chamber, a second coupling position between the bypass flow path and the recovery flow path is located downstream of the second common liquid chamber, and a flow path resistance from the second coupling position to the nozzle is smaller than a flow path resistance from the first coupling position to the nozzle.

(227) According to the Aspect 10, the bubble included in the recovery flow path is easily discharged as compared with an aspect in which the flow path resistance from the second coupling position to the nozzle is larger than the flow path resistance from the first coupling position to the nozzle.

(228) A liquid discharging method of a liquid ejecting apparatus according to Aspect 11, which is another preferred aspect, is a liquid discharging method of a liquid ejecting apparatus including a plurality of nozzles that eject liquid, a plurality of individual flow paths that communicate with

each of the plurality of nozzles, a liquid storage portion that stores the liquid to be supplied to each of the plurality of nozzles, a supply flow path for supplying the liquid from the liquid storage portion to the plurality of individual flow paths, a recovery flow path for recovering the liquid from the plurality of individual flow paths to the liquid storage portion, a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the plurality of individual flow paths, and an on-off valve configured to close and open the recovery flow path, the method includes disposing the on-off valve between the bypass flow path and the liquid storage portion in the recovery flow path, and executing a pressurization discharge operation of discharging the liquid from each of the plurality of nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve, by the liquid ejecting apparatus.

(229) According to the Aspect 11, the same effect as that of the Aspect 1 can be obtained.

(230) In Aspect 12 which is a specific example of the Aspect 11, the liquid ejecting apparatus further includes a flexible member that defines a part of the recovery flow path upstream from a coupling position between the bypass flow path and the recovery flow path or a portion of the recovery flow path coupled to the bypass flow path and that has flexibility.

(231) According to the Aspect 12, the same effect as that of the Aspect 2 can be obtained.

(232) In Aspect 13 which is a specific example of the Aspect 11, during the execution of the pressurization discharge operation, pressure of the liquid flowing upstream of the on-off valve in the recovery flow path is positive pressure with respect to atmospheric pressure.

(233) According to the Aspect 13, the same effect as that of the Aspect 3 can be obtained.

(234) In Aspect 14 which is a specific example of the Aspect 11, a flow of the liquid from the supply flow path to the nozzle via a part of the individual flow path and a flow of the liquid from the supply flow path to the nozzle via the bypass flow path, a part of the recovery flow path, and a part of the individual flow path in this order are formed by the pressurization discharge operation.

(235) According to the Aspect 14, the same effect as that of the Aspect 4 can be obtained.

(236) In Aspect 15 which is a specific example of the Aspect 11, the liquid ejecting apparatus executes a circulation operation of circulating the liquid in an order of the liquid storage portion, the supply flow path, the individual flow path, the recovery flow path, and the liquid storage portion.

(237) According to the Aspect 15, the same effect as that of the Aspect 5 can be obtained.

(238) In Aspect 16 which is a specific example of the Aspect 15, the liquid ejecting apparatus starts the pressurization discharge operation by closing the recovery flow path by the on-off valve during the execution of the circulation operation.

(239) According to the Aspect 16, the same effect as that of the Aspect 6 can be obtained.

(240) In Aspect 17 which is a specific example of the Aspect 15, the liquid ejecting apparatus further includes a pressurizing mechanism that pressurizes the liquid in the supply flow path such that the liquid in the supply flow path flows only in a direction in which the liquid flows from the liquid storage portion to the plurality of individual flow paths via the supply flow path by the circulation operation.

(241) According to the Aspect 17, the same effect as that of the Aspect 7 can be obtained.

(242) In Aspect 18 which is a specific example of the Aspect 11, the supply flow path has a first common liquid chamber coupled to the plurality of individual flow paths, the recovery flow path has a second common liquid chamber coupled to the plurality of individual flow paths, and the bypass flow path causes the first common liquid chamber to communicate with the second common liquid chamber.

(243) According to the Aspect 18, the same effect as that of the Aspect 8 can be obtained.

(244) In Aspect 19 which is a specific example of the Aspect 11, a flow path resistance of the bypass flow path is smaller than a sum of flow path resistances of the plurality of individual flow paths.

(245) According to the Aspect 19, the same effect as that of the Aspect 9 can be obtained.

(246) In Aspect 20 which is a specific example of the Aspect 11, the supply flow path has a first common liquid chamber coupled to the plurality of individual flow paths, the recovery flow path has a second common liquid chamber coupled to the plurality of individual flow paths, a first coupling position between the bypass flow path and the supply flow path is located upstream of the first common liquid chamber, a second coupling position between the bypass flow path and the recovery flow path is located downstream of the second common liquid chamber, and a flow path resistance from the second coupling position to the nozzle is smaller than a flow path resistance from the first coupling position to the nozzle.

(247) According to the Aspect 20, the same effect as that of the Aspect 10 can be obtained.

## Claims

1. A liquid ejecting apparatus comprising: nozzles configured to eject liquid; individual flow paths communicating with each of the nozzles; a liquid storage portion storing the liquid to be supplied to each of the nozzles; a supply flow path for supplying the liquid from the liquid storage portion to the individual flow paths; a recovery flow path for recovering the liquid from the individual flow paths to the liquid storage portion; a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the individual flow paths; and an on-off valve configured to close and open the recovery flow path, wherein the on-off valve is disposed between the bypass flow path and the liquid storage portion in the recovery flow path, and a pressurization discharge operation of discharging the liquid from each of the nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve is executed.

2. The liquid ejecting apparatus according to claim 1, further comprising: a flexible member that defines a part of the recovery flow path upstream from a coupling position between the bypass flow path and the recovery flow path or a portion of the recovery flow path coupled to the bypass flow path and that has flexibility.

3. The liquid ejecting apparatus according to claim 2, wherein during the execution of the pressurization discharge operation, pressure of the liquid flowing upstream of the on-off valve in the recovery flow path is positive pressure with respect to atmospheric pressure.

4. The liquid ejecting apparatus according to claim 1, wherein a flow of the liquid from the supply flow path to the nozzle via a part of the individual flow path and a flow of the liquid from the supply flow path to the nozzle via the bypass flow path, a part of the recovery flow path, and a part of the individual flow path in this order are formed by the pressurization discharge operation.

5. The liquid ejecting apparatus according to claim 1, wherein a circulation operation of circulating the liquid in an order of the liquid storage portion, the supply flow path, the individual flow path, the recovery flow path, and the liquid storage portion is executed.

6. The liquid ejecting apparatus according to claim 5, wherein during the execution of the circulation operation, the pressurization discharge operation is started by closing the recovery flow path by the on-off valve.

7. The liquid ejecting apparatus according to claim 5, further comprising: a pressurizing mechanism that pressurizes the liquid in the supply flow path such that the liquid in the supply flow path flows only in a direction in which the liquid flows from the liquid storage portion to the individual flow paths via the supply flow path by the circulation operation.

8. The liquid ejecting apparatus according to claim 1, wherein the supply flow path has a first common liquid chamber coupled to the individual flow paths, the recovery flow path has a second common liquid chamber coupled to the individual flow paths, and the bypass flow path makes the first common liquid chamber communicate with the second common liquid chamber.

9. The liquid ejecting apparatus according to claim 1, wherein a flow path resistance of the bypass

flow path is smaller than a sum of flow path resistances of the individual flow paths.

10. The liquid ejecting apparatus according to claim 1, wherein the supply flow path has a first common liquid chamber coupled to the individual flow paths, the recovery flow path has a second common liquid chamber coupled to the individual flow paths, a first coupling position between the bypass flow path and the supply flow path is located upstream of the first common liquid chamber, a second coupling position between the bypass flow path and the recovery flow path is located downstream of the second common liquid chamber, and a flow path resistance from the second coupling position to the nozzle is smaller than a flow path resistance from the first coupling position to the nozzle.

11. A liquid discharging method of a liquid ejecting apparatus including nozzles configured to eject liquid, individual flow paths communicating with each of the nozzles, a liquid storage portion storing the liquid to be supplied to each of the nozzles, a supply flow path for supplying the liquid from the liquid storage portion to the individual flow paths, a recovery flow path for recovering the liquid from the individual flow paths to the liquid storage portion, a bypass flow path that couples the supply flow path and the recovery flow path without passing through any of the individual flow paths, and an on-off valve configured to close and open the recovery flow path, the method comprising: disposing the on-off valve between the bypass flow path and the liquid storage portion in the recovery flow path; and executing a pressurization discharge operation of discharging the liquid from each of the nozzles by pressurizing the liquid in the supply flow path in a state in which the recovery flow path is closed by the on-off valve, by the liquid ejecting apparatus.

12. The liquid discharging method according to claim 11, wherein the liquid ejecting apparatus further includes a flexible member that defines a part of the recovery flow path upstream from a coupling position between the bypass flow path and the recovery flow path or a portion of the recovery flow path coupled to the bypass flow path and that has flexibility.

13. The liquid discharging method according to claim 12, wherein during the execution of the pressurization discharge operation, pressure of the liquid flowing upstream of the on-off valve in the recovery flow path is positive pressure with respect to atmospheric pressure.

14. The liquid discharging method according to claim 11, wherein a flow of the liquid from the supply flow path to the nozzle via a part of the individual flow path and a flow of the liquid from the supply flow path to the nozzle via the bypass flow path, a part of the recovery flow path, and a part of the individual flow path in this order are formed by the pressurization discharge operation.

15. The liquid discharging method according to claim 11, wherein the liquid ejecting apparatus executes a circulation operation of circulating the liquid in an order of the liquid storage portion, the supply flow path, the individual flow path, the recovery flow path, and the liquid storage portion.

16. The liquid discharging method according to claim 15, wherein the liquid ejecting apparatus starts the pressurization discharge operation by closing the recovery flow path by the on-off valve during the execution of the circulation operation.

17. The liquid discharging method according to claim 15, wherein the liquid ejecting apparatus includes a pressurizing mechanism that pressurizes the liquid in the supply flow path such that the liquid in the supply flow path flows only in a direction in which the liquid flows from the liquid storage portion to the individual flow paths via the supply flow path by the circulation operation.

18. The liquid discharging method according to claim 11, wherein the supply flow path has a first common liquid chamber coupled to the individual flow paths, the recovery flow path has a second common liquid chamber coupled to the individual flow paths, and the bypass flow path makes the first common liquid chamber communicate with the second common liquid chamber.

19. The liquid discharging method according to claim 11, wherein a flow path resistance of the bypass flow path is smaller than a sum of flow path resistances of the individual flow paths.

20. The liquid discharging method according to claim 11, wherein the supply flow path has a first common liquid chamber coupled to the individual flow paths, the recovery flow path has a second



common liquid chamber coupled to the individual flow paths, a first coupling position between the bypass flow path and the supply flow path is located upstream of the first common liquid chamber, a second coupling position between the bypass flow path and the recovery flow path is located downstream of the second common liquid chamber, and a flow path resistance from the second coupling position to the nozzle is smaller than a flow path resistance from the first coupling position to the nozzle.

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