



(12) **EUROPEAN PATENT APPLICATION**
 published in accordance with Art. 153(4) EPC

(43) Date of publication:
25.01.2017 Bulletin 2017/04

(51) Int Cl.:
B41J 2/165^(2006.01) B41J 2/18^(2006.01)

(21) Application number: **15765793.3**

(86) International application number:
PCT/JP2015/051791

(22) Date of filing: **23.01.2015**

(87) International publication number:
WO 2015/141274 (24.09.2015 Gazette 2015/38)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

- **AOIKE Masaaki**
Kyoto-shi
Kyoto 602-8585 (JP)
- **NAGASE Yuichi**
Kyoto-shi
Kyoto 602-8585 (JP)
- **KITAOJI Muneaki**
Kyoto-shi
Kyoto 602-8585 (JP)

(30) Priority: **17.03.2014 JP 2014053520**

(71) Applicant: **SCREEN Holdings Co., Ltd.**
Kyoto 602-8585 (JP)

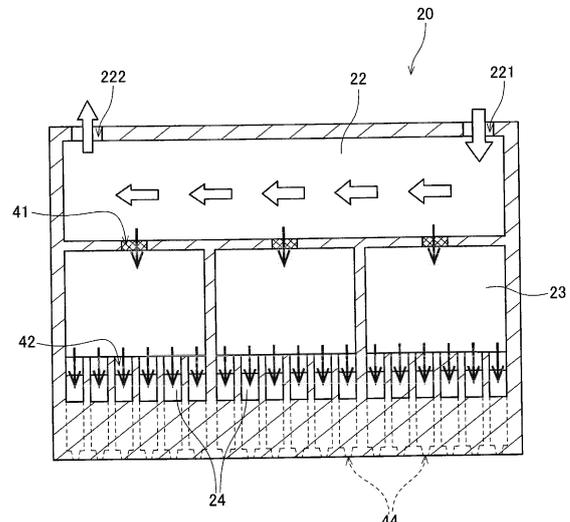
(74) Representative: **Goddard, Heinz J.**
Boehmert & Boehmert
Anwaltpartnerschaft mbB
Patentanwälte Rechtsanwälte
Pettenkoferstrasse 20-22
80336 München (DE)

(72) Inventors:
 • **FUKUI Tamio**
Kyoto-shi
Kyoto 602-8585 (JP)

(54) **FLUID DISCHARGE DEVICE AND CONTROL METHOD THEREFOR**

(57) This liquid ejecting apparatus includes an ejecting head (20), a liquid reservoir, a pressurizing part for the liquid reservoir, a supply passage, and an outlet passage. The ejecting head (20) includes a liquid flow passage (22), liquid filling chambers (23, 24) in communication with the liquid flow passage (22), and a plurality of nozzles (44) provided for the respective liquid filling chambers (24). When the pressurizing part performs pressurization, with the communication through the outlet passage ensured, a liquid in the liquid reservoir flows through the supply passage and is supplied through a supply port (221) to the liquid flow passage (22). Part of the liquid supplied to the liquid flow passage (22) is drained through an outlet port (222). This produces flows of liquid different from those produced during the ejection of the liquid from the nozzles (44) and directed from the supply port (221) toward the outlet port (222). Thus, precipitable ingredients accumulated in the liquid flow passage (22) are efficiently dispersed. That is, the accumulation of the precipitable ingredients in the ejecting head (20) is efficiently eliminated in the liquid ejecting apparatus capable of controlling the ejection of the liquid from the nozzles (44).

Fig. 6



Description

Technical Field

[0001] The present invention relates to a liquid ejecting apparatus and a method of controlling the same.

Background Art

[0002] A liquid ejecting apparatus including a plurality of nozzles and an ejecting head capable of controlling the ejection of droplets from the nozzles has heretofore been known (Japanese Patent Application Laid-Open No. 2013-193008, for example).

[0003] In the liquid ejecting apparatus (printing apparatus) disclosed in Japanese Patent Application Laid-Open No. 2013-193008, an ejecting head includes a plurality of pressure chambers, and a plurality of nozzles provided in the respective pressure chambers. Ink in the pressure chambers is jetted out of the nozzles by the deformation of piezoelectric elements provided in the respective pressure chambers. The ejecting head further includes a liquid flow passage (ink chamber) in communication with the pressure chambers and serving as a supply path for supplying the ink from an ink supply source to the pressure chambers (paragraph 0021 and Fig. 3).

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application Laid-Open No. 2013-193008

Summary of Invention

Technical Problem

[0005] When such an ejecting head ejects a liquid containing precipitable ingredients after a prolonged pause, the precipitable ingredients are prone to precipitate in the liquid flow passage and in the pressure chambers. The precipitation of the precipitable ingredients in the liquid flow passage might give rise to a problem such that flow passages are narrowed down by the precipitable ingredients near communication ports which provide communication between the liquid flow passage and the pressure chambers.

[0006] To solve the problem of the precipitation in the ejecting head, what is called a purge is conventionally performed. In general, known examples of the purge include a pressurized purge such that pressure is applied to the interior of the ejecting head to force a liquid out of the nozzles, and a suction purge such that an external apparatus connected to the nozzles sucks a liquid in the ejecting head out of the nozzles.

[0007] In the conventional purge operation, the flow

rate and flow speed of ink in the ejecting head are much higher than those in a normal ink ejecting operation, but flows of ink are produced in the same direction as in the normal ink ejecting operation. Thus, in regions in the liquid flow passage of the ejecting head where flows of ink are less prone to be produced in the normal ink ejecting operation, that is, where the accumulation of the precipitable ingredients is prone to occur, flows of ink are less prone to be produced also in the purge operation, so that the accumulation of the precipitable ingredients is less prone to be eliminated.

[0008] In view of the foregoing, it is an object of the present invention to provide a technique capable of efficiently eliminating the accumulation of precipitable ingredients in a liquid flow passage of an ejecting head.

Solution to Problem

[0009] To solve the aforementioned problem, a first aspect of the present invention is intended for a liquid ejecting apparatus comprising: an ejecting head having a plurality of nozzles for ejecting a liquid; a liquid reservoir for storing the liquid therein; a pressurizing part for pressurizing the interior of the liquid reservoir; a supply passage for supplying the liquid from the liquid reservoir to the ejecting head; an outlet passage for draining the liquid from the interior of the ejecting head; an open/close part provided in the outlet passage and switchable between an open position in which the communication through the outlet passage is ensured and a closed position in which the communication through the outlet passage is closed off; and a controller for controlling the pressurizing part and the open/close part, the ejecting head including a liquid flow passage having a supply port in communication with the supply passage, and an outlet port in communication with the outlet passage, a liquid filling chamber having a communication port in communication with the liquid flow passage, and the nozzles each having a first end in communication with the liquid filling chamber and a second end exposed to the outside of the ejecting head, the controller causing the pressurizing part to perform the pressurization while holding the open/close part in the open position, wherein, when the pressurization is performed, the liquid stored in the liquid reservoir is supplied through the supply passage to the liquid flow passage, and at least part of the liquid supplied to the liquid flow passage is drained through the outlet port to the outlet passage.

[0010] A second aspect of the present invention is intended for the liquid ejecting apparatus according to the first aspect wherein the liquid filling chamber includes: a first liquid filling chamber having the communication port in direct communication with the liquid flow passage; and a plurality of second liquid filling chambers in direct or indirect communication with the first liquid filling chamber and each in communication with a single one of the nozzles.

[0011] A third aspect of the present invention is intend-

ed for the liquid ejecting apparatus according to the second aspect wherein the second liquid filling chambers include respective pressure generating elements, and wherein, when the pressure generating elements are driven, pressure is applied to the interior of the second liquid filling chambers to eject the liquid in the form of droplets from the nozzles.

[0012] A fourth aspect of the present invention is intended for the liquid ejecting apparatus according to any one of the first to third aspects wherein, when the pressurization is performed, the liquid stored in the liquid reservoir is supplied through the supply passage to the liquid flow passage; part of the liquid supplied to the liquid flow passage is drained through the outlet port to the outlet passage; and another part of the liquid supplied to the liquid flow passage is ejected from the nozzles through the liquid filling chamber.

[0013] A fifth aspect of the present invention is intended for the liquid ejecting apparatus according to the fourth aspect wherein, when the pressurization is performed, the flow rate of the liquid drained from the liquid flow passage through the outlet port to the outlet passage is higher than the total flow rate of the liquid ejected from the nozzles.

[0014] A sixth aspect of the present invention is intended for a method of controlling a liquid ejecting apparatus, the liquid ejecting apparatus including an ejecting head having a plurality of nozzles for ejecting a liquid, a liquid reservoir for storing therein the liquid to be supplied through a supply passage to the ejecting head, an outlet passage for draining the liquid from the ejecting head, and a pressurizing part for pressurizing the interior of the liquid reservoir, wherein the pressurizing part is caused to perform the pressurization while an open/close part provided in the outlet passage is held in an open position to ensure the communication through the outlet passage, and wherein, when the pressurization is performed, the liquid stored in the liquid reservoir is supplied through the supply passage to a liquid flow passage in the ejecting head, and at least part of the liquid supplied to the liquid flow passage is drained to the outlet passage.

[0015] A seventh aspect of the present invention is intended for the method of controlling a liquid ejecting apparatus according to the sixth aspect wherein the ejecting head includes the liquid flow passage having a supply port in communication with the supply passage, and an outlet port in communication with the outlet passage, a liquid filling chamber having a communication port in communication with the liquid flow passage, and the nozzles each having a first end in communication with the liquid filling chamber and a second end exposed to the outside of the ejecting head, and wherein, when the pressurization is performed, part of the liquid supplied to the liquid flow passage is drained through the outlet port to the outlet passage, and another part of the liquid supplied to the liquid flow passage is ejected from the nozzles through the liquid filling chamber.

[0016] An eighth aspect of the present invention is in-

tended for the method of controlling a liquid ejecting apparatus according to the seventh aspect wherein, when the pressurization is performed, the flow rate of the liquid drained from the liquid flow passage through the outlet port to the outlet passage is higher than the total flow rate of the liquid ejected from the nozzles.

Advantageous Effects of Invention

[0017] According to the first to eighth aspects of the present invention, the pressurizing part performs the pressurization to thereby produce flows of liquid directed toward the outlet passage in the liquid flow passage. That is, when the pressurization is performed, the flows of liquid different in direction from those produced during the normal liquid ejection toward the nozzles are produced in the liquid flow passage. Thus, the precipitable ingredients accumulated in the liquid flow passage are efficiently dispersed.

[0018] In particular, according to the fourth and seventh aspects, the pressurizing part performs the pressurization to thereby produce flows of liquid directed from the supply port toward the outlet port in the liquid flow passage and to produce flows of liquid directed from the liquid flow passage through the liquid filling chamber and ejected from the nozzles. Thus, the precipitable ingredients accumulated in the liquid flow passage are dispersed. At the same time, the precipitable ingredients in the liquid filling chamber are eliminated.

[0019] In particular, according to the fifth and eighth aspects, the flow rate of the liquid directed from the supply port toward the outlet port is sufficiently ensured in the liquid flow passage. Thus, the precipitable ingredients accumulated in the liquid flow passage are dispersed more efficiently.

Brief Description of Drawings

[0020]

[fig. 1] Fig. 1 is a diagram conceptually illustrating the configuration of a recording apparatus according to one embodiment.

[fig. 2] Fig. 2 is a vertical sectional view of a recording head according to the one embodiment.

[fig. 3] Fig. 3 is a sectional view of the recording head taken along the line A-A according to the one embodiment.

[fig. 4] Fig. 4 is a block diagram showing an ink supply system in the recording apparatus according to the one embodiment.

[fig. 5] Fig. 5 is a flow diagram showing a procedure for a recovery step according to the one embodiment.

[fig. 6] Fig. 6 is a view showing the recovery step according to the one embodiment.

Description of Embodiments

[0021] An embodiment according to the present invention will now be described with reference to the drawings. A direction in which printing paper 9 is transported is referred to hereinafter as a "transport direction".

<1. Configuration of Recording Apparatus>

[0022] Fig. 1 is a diagram conceptually illustrating the configuration of a recording apparatus 1 which is one embodiment of a liquid ejecting apparatus according to the present invention. Fig. 2 is a vertical sectional view of a recording head 20 in the recording apparatus 1. Fig. 3 is a sectional view of the recording head 20 taken along the line A-A. Fig. 4 is a block diagram showing an ink supply system in the recording apparatus 1.

[0023] This recording apparatus 1 is an inkjet printing apparatus which records a color image on the printing paper 9 that is an elongated strip-shaped recording medium by ejecting ink droplets from a plurality of recording heads 20 onto the printing paper 9 while transporting the printing paper 9. The recording apparatus 1 is capable of performing an image recording step in which an image is recorded on the printing paper 9, and a recovery step in which the maintenance of the recording heads 20 is carried out.

[0024] As shown in Figs. 1 and 2, the recording apparatus 1 includes a transport mechanism 10, the four recording heads 20, and a cap mechanism 30 which are parts related to the image recording step. As shown in Fig. 4, the recording apparatus 1 further includes an ink tank 51, a pump 52, a pressure tank 53, and piping 60 which serve as an ink supply system for supplying ink to each of the recording heads 20. The recording apparatus 1 further includes a controller 80 for controlling the aforementioned parts.

[0025] First, the parts related to the image recording step in the recording apparatus 1 will be described with reference to Figs. 1 to 3.

[0026] The transport mechanism 10 is a mechanism for transporting the printing paper 9 in the transport direction that is the longitudinal direction of the printing paper 9. The transport mechanism 10 according to the present embodiment includes an unwinder 11, a plurality of rollers 12 and a winder 13.

[0027] A motor (not shown) serving as a power source is coupled to the unwinder 11, the plurality of rollers 12 and the winder 13. The unwinder 11, the plurality of rollers 12 and the winder 13 rotate when the controller 80 drives the motor. The printing paper 9 is accordingly unwound from the unwinder 11, and is transported along a transport path formed by the rollers 12 to the winder 13.

[0028] Each of the rollers 12 rotates about a horizontal axis to guide the printing paper 9 downstream in the transport direction. The printing paper 9 comes in contact with the rollers 12, so that tension is applied to the printing paper 9. After being transported, the printing paper 9 is

wound and collected on the winder 13.

[0029] The four recording heads 20 are arranged in spaced apart relation in the transport direction over the transport path of the printing paper 9. The four recording heads 20 are ejecting heads for ejecting ink droplets of yellow (Y), magenta (M), cyan (C) and black (K) onto the upper surface of the printing paper 9.

[0030] The recording apparatus 1 according to the present embodiment is what is called a one-pass type recording apparatus which records a desired image pattern on the printing paper 9 by ejecting ink droplets from the recording heads 20 while the printing paper 9 passes under the recording heads 20 only once. Only the structure of one of the recording heads 20 will be described below because the four recording heads 20 are substantially similar in structure to each other.

[0031] As shown in Figs. 2 and 3, one recording head 20 includes a housing 21, an ink flow passage 22 provided in the housing 21, a plurality of ink chambers 23 provided in the housing 21, and a plurality of pressure chambers 24 provided in the housing 21.

[0032] The ink flow passage 22 is a liquid flow passage which is primarily filled with ink supplied from the outside of the recording head 20. As shown in Fig. 3, the ink flow passage 22 is provided with a supply port 221 and an outlet port 222. Flows of ink through the supply port 221 and the outlet port 222 will be described later.

[0033] Each of the ink chambers 23 is a first liquid filling chamber which is filled with ink secondarily in the recording head 20. As shown in Fig. 3, the recording head 20 according to the present embodiment includes three ink chambers 23. As shown in Figs. 2 and 3, each of the ink chambers 23 is in communication with the ink flow passage 22 through a first communication port 41. The first communication port 41 is provided with a filter 411 for filtering out solid components such as impurities contained in the ink. A perforated metal having small perforations is used for the filter 411 in the present embodiment, but filters of other configurations may be used as the filter 411.

[0034] Each of the pressure chambers 24 is a second liquid filling chamber which is filled with ink tertiarily in the recording head 20. As shown in Fig. 2, each of the pressure chambers 24 includes a second communication port 42, a pressure generating element 43, and a nozzle 44. Although the pressure chambers 24 in the present embodiment are disposed under the ink chambers 23, the pressure chambers 24 may be disposed on the same level as the ink chambers 23.

[0035] The second communication ports 42 respectively provide communication between the interior of the respective pressure chambers 24 and the interior of the ink chambers 23. The second communication ports 42 are disposed under each of the ink chambers 23. That is, each of the ink chambers 23 is in communication with the plurality of pressure chambers 24. When the pressure in the pressure chambers 24 is decreased, ink is supplied from the ink chambers 23 through the second communi-

cation ports 42 to the pressure chambers 24.

[0036] The pressure generating element 43 is disposed at the upper wall surface of each of the pressure chambers 24. The nozzle 44 is disposed at the lower wall surface of each of the pressure chambers 24 to provide communication between each pressure chamber 24 and exterior space. When no ink is ejected, a liquid surface of ink forms a meniscus inside the nozzle 44. The nozzle 44 has a lower end portion which is exposed at the lower surface of the housing 21.

[0037] The individual nozzles 44 of the recording head 20 are arranged two-dimensionally at the lower surface of the housing 21. In the recording head 20 shown in Figs. 2 and 3, the nozzles 44 are shown as arranged one-dimensionally at the lower surface of the housing 21 for the purpose of facilitating the illustration. The individual nozzles 44 are staggered or offset in a direction orthogonal to the transport direction, so that each of the nozzles 44 is assigned to a region having a width of one pixel on the printing paper 9.

[0038] The recording head 20 according to the present embodiment is an ejecting head of what is called a piezoelectric type. Thus, the pressure generating element 43 according to the present embodiment is a piezoelectric element. When an ejection signal that is an electric signal is sent from the controller 80 to one of the pressure generating elements 43, the pressure generating element 43 is deformed to exert pressure on the ink which fills one of the pressure chambers 24. When the pressure in the pressure chamber 24 is increased, the ink in the pressure chamber 24 is ejected in the form of droplets from the nozzle 44.

[0039] The recording heads according to the present invention are not limited to those of a piezoelectric type. For example, the recording heads according to the present invention may be what is called thermal recording heads in which a heater used as the pressure generating element heats the liquid in each pressure chamber to generate bubbles, thereby increasing the pressure in each pressure chamber.

[0040] As shown in Fig. 2, the cap mechanism 30 includes a cap 31 and a cap moving mechanism 32. The cap 31 covers a surface of the recording head 20 which has the nozzles 44 for a time period during which the recording head 20 performs no recording on the printing paper 9. This suppresses the evaporation of a solvent of the ink from the meniscus surfaces of the ink formed in the nozzles 44 for the time period during which no recording is performed on the printing paper 9, which in turn results in the solidification or agglomeration of the ink near the nozzles 44.

[0041] The cap 31 includes an ink drain mechanism 311. This allows the ejection of ink from the nozzles 44 while the cap 31 covers the nozzles 44. After being ejected from the recording head 20 toward the cap 31, the ink is drained from the interior of the cap 31 through the ink drain mechanism 311.

[0042] The cap moving mechanism 32 places the cap

31 at a nozzle-facing position under the recording head 20 for the time period during which the recording head 20 performs no recording on the printing paper 9. When the recording head 20 performs the recording on the printing paper 9, on the other hand, the cap moving mechanism 32 moves the cap 31 to a standby position (indicated by broken lines in Fig. 2) which does not vertically overlap the recording head 20 before the start of an image recording step. After the completion of the image recording step, the cap moving mechanism 32 moves the cap 31 to the nozzle-facing position under the recording head 20, so that the nozzles 44 are covered with the cap 31.

[0043] Although the cap 31 placed at the nozzle-facing position covers the nozzles 44 in the present embodiment, the present invention is not limited to this. When ink which is less prone to cause the problem of the evaporation from the meniscus surfaces is used, the cap 31 need not fully cover the nozzles 44. Although the cap 31 shown in Fig. 2 does not cover the entire lower surface of the recording head 20, the cap 31 may cover the entire lower surface of the recording head 20.

[0044] When the recording apparatus 1 executes the image recording step, ink droplets are ejected from the nozzles 44 onto the upper surface of the printing paper 9 while the transport mechanism 10 transports the printing paper 9.

[0045] In Figs. 2 and 3, only the three ink chambers 23 and the eighteen pressure chambers 24 are shown as provided in the housing 21 of the recording head 20 for the purpose of facilitating the illustration. However, the number of ink chambers 23 in one recording head 20 may be one, two or greater than three. The number of pressure chambers 24 in communication with each of the ink chambers 23 may be greater than or less than six shown in the present embodiment.

[0046] In each actual recording head 20, the nozzles 44 are positioned in opposed relation to the substantially full width of the upper surface of the printing paper 9. This allows each actual recording head 20 to eject ink droplets across the substantially full width of the upper surface of the printing paper 9.

[0047] The plurality of recording heads 20 may be used to record ink droplets of the same color onto the printing paper 9. For example, two or more recording heads 20 which eject ink droplets of the same color may be disposed in combination along the width of the printing paper 9 to thereby eject ink droplets of that color across the substantially full width of the upper surface of the printing paper 9.

[0048] The four recording heads 20 corresponding to the respective colors sequentially perform such a process of ejecting ink droplets to thereby form a color pattern on the upper surface of the printing paper 9.

[0049] The controller 80 is a section for controlling the operations of each part in the recording apparatus 1. As conceptually shown in Fig. 1, the controller 80 according to the present embodiment includes a computer having an arithmetic processor 81 such as a CPU, a memory 82

such as a RAM, and a storage part 83 such as a hard disk drive. As shown in Figs. 1, 2 and 4, the controller 80 is electrically connected to the transport mechanism 10; the pressure generating elements 43, the ink drain mechanisms 311 and the cap moving mechanisms 32 of the four recording heads 20; and the pump 52, a pressure regulating part 531, a liquid level sensor 532, an on-off valve 611 and an on-off valve 631 which are to be described later.

[0050] The controller 80 temporarily reads a computer program 831 and data 832 which are stored in the storage part 83 onto the memory 82. The arithmetic processor 81 performs arithmetic processing based on the computer program 831 and the data 832, so that the controller 80 controls the operations of the parts in the recording apparatus 1. Thus, the image recording process and a recovery step to be described later in the recording apparatus 1 proceed. It should be noted that the controller 80 may be formed by electronic circuitry.

[0051] For the recording of an image pattern on the upper surface of the printing paper 9, the controller 80 controls the ejection of ink droplets from the nozzles 44. Thus, the controller 80 controls the ejection position and ejection rate of ink droplets from the nozzles 44 in the image recording step.

[0052] In the present embodiment, the control of the ejection position of ink droplets is exercised by controlling the ejection timing of the ink droplets from the nozzles 44. In the present embodiment, ink droplets are ejected from the nozzles 44 while the printing paper 9 is transported at a constant speed. While passing under the recording heads 20, the printing paper 9 receives ink droplets ejected from predetermined nozzles 44 of each of the recording heads 20. Thus, the impact positions of ink droplets on the printing paper 9 in the transport direction are determined by the ejection timing of the ink droplets from the nozzles 44.

[0053] In the present embodiment, the ejection rate and ejection timing of ink droplets are controlled by an ejection signal sent from the controller 80 to the pressure generating elements 43. The controller 80 generates the ejection signal to be outputted to the pressure generating elements 43, based on an inputted image pattern and positional information about the printing paper 9. Other operations of the controller 80 will be described later.

[0054] The controller 80 according to the present embodiment may select the ink droplets for ejection from the nozzles 44 from among ink droplets of three types of liquid volumes: large, medium and small sizes. Specifically, in the image recording step, the controller 80 determines the ejection timing, and selects the liquid volume size to determine the ejection rate, thereby generating the ejection signal to be outputted to the pressure generating elements 43.

[0055] Next, the system for supplying ink to the recording head 20 will be described with reference to Fig. 4. As mentioned above, the recording apparatus 1 includes the ink tank 51, the pump 52, the pressure tank 53, and the

5 piping 60 which serve as the ink supply system for supplying ink to the recording head 20. The piping 60 includes a first supply pipe 61 which connects the ink tank 51 and the pressure tank 53, a second supply pipe 62 which connects the pressure tank 53 and the recording head 20, and a return pipe 63 which connects the recording head 20 and the ink tank 51.

[0056] The ink tank 51 is a liquid reservoir which stores the ink therein. The ink stored in the ink tank 51 is supplied through the first supply pipe 61 to the pressure tank 53. The first supply pipe 61 has a first end connected to and communicated with the interior of the ink tank 51 near the lower end portion of the ink tank 51, and a second end connected to and communicated with the interior of the pressure tank 53.

[0057] The pump 52 is a liquid transport part interposed in the first supply pipe 61. The pump 52 produces a flow of ink directed from the ink tank 51 toward the pressure tank 53 in the first supply pipe 61 in accordance with an operation signal from the controller 80. Thus, the ink stored in the ink tank 51 is supplied to the pressure tank 53.

[0058] In the present embodiment, the on-off valve 611 and a filter 612 are further interposed in the first supply pipe 61. The on-off valve 611 is disposed between the ink tank 51 and the pump 52. The filter 612 is disposed between the pump 52 and the pressure tank 53.

[0059] When the on-off valve 611 is in a closed position, the communication through the first supply pipe 61 is closed off. That is, when the on-off valve 611 is in the closed position, the communication between the ink tank 51 and the pressure tank 53 is closed off. On the other hand, when the on-off valve 611 is in an open position, the communication through the first supply pipe 61 is ensured. The on-off valve 611 is normally in the closed position, and is brought into the open position only when the pump 52 is put into operation to supply ink from the ink tank 51 to the pressure tank 53. This prevents pressure fluctuation in the pressure tank 53 from exerting influence on the ink tank 51.

[0060] The filter 612 removes solid components and foreign materials contained in the ink passing through the first supply pipe 61. This suppresses the contamination of solid components and foreign materials in the ink supplied to the pressure tank 53 and the recording head 20.

[0061] The pressure tank 53 is a liquid reservoir which temporarily stores therein the ink to be supplied to the recording head 20. The pressure tank 53 includes the pressure regulating part 531 and the liquid level sensor 532. The pressure regulating part 531 is a mechanism for regulating the pressure in the pressure tank 53. That is, the pressure regulating part 531 forms a pressurizing part which pressurizes the interior of the pressure tank 53.

[0062] The liquid level sensor 532 is a sensor for detecting the liquid level of the ink stored in the pressure tank 53. Upon judging that the liquid level of the ink stored

in the pressure tank 53 is lower than a predetermined first vertical position, based on a signal from the liquid level sensor 532, the controller 80 opens the on-off valve 611 into the open position, and puts the pump 52 into operation. Upon judging that the liquid level of the ink stored in the pressure tank 53 is higher than a predetermined second vertical position, based on the signal from the liquid level sensor 532, the controller 80 stops the pump 52, and closes the on-off valve 611 into the closed position. Thus, the liquid level in the pressure tank 53 is adjusted to within a previously determined fixed range. In the present embodiment, the second vertical position is higher than the first vertical position. However, the first vertical position and the second vertical position may be the same position.

[0063] The pressure tank 53 is connected through the second supply pipe 62 to the recording head 20. The second supply pipe 62 has a first end connected to and communicated with the interior of the pressure tank 53 near the lower end portion of the pressure tank 53, and a second end connected to the supply port 221 of the recording head 20. Thus, the interior of the pressure tank 53 is connected through the second supply pipe 62 and the supply port 221 to the ink flow passage 22 of the recording head 20.

[0064] That is, the pressure tank 53 is indirectly connected to and communicated with the ink flow passage 22, the ink chambers 23 and the pressure chambers 24 through the second supply pipe 62. Thus, the pressure in the recording head 20 is adjusted by adjusting the pressure in the pressure tank 53. In this manner, the second supply pipe 62 forms a supply passage which supplies the ink from the pressure tank 53 to the recording head 20.

[0065] Pressure in the pressure chambers 24 is adjusted in the image recording step and during a waiting time period except the recovery step so that ink menisci are formed in the nozzles 44. In the present embodiment, the pressure in the pressure tank 53 is adjusted so that the pressure in the ink chambers 23 is a negative pressure because the pressure chambers 24 are disposed under the ink flow passage 22 and the ink chambers 23.

[0066] The return pipe 63 has a first end connected to the outlet port 222 of the recording head 20, and a second end connected for communication with the interior of the ink tank 51. This causes the ink drained from the ink flow passage 22 of the recording head 20 through the outlet port 222 thereof to flow back to the ink tank 51. That is, the return pipe 63 forms an outlet passage which drains the ink from the interior of the recording head 20.

[0067] The on-off valve 631 and a filter 632 are interposed in the return pipe 63. When the on-off valve 631 is in a closed position, the communication through the return pipe 63 is closed off. That is, when the on-off valve 631 is in the closed position, the communication between the ink flow passage 22 of the recording head 20 and the ink tank 51 is closed off. In that case, the ink is not drained from the interior of the recording head 20 through the

outlet port 222 thereof.

[0068] On the other hand, when the on-off valve 631 is in an open position, the communication through the return pipe 63 is ensured. When the pressure in the ink flow passage 22 is higher than a predetermined pressure and the on-off valve 631 is in the open position, the ink is drained from the interior of the ink flow passage 22 through the outlet port 222 to the return pipe 63. The ink drained through the outlet port 222 flows through the on-off valve 631, and is then filtered by the filter 632 so that solid components and the like are removed from the ink. Thereafter, the ink flows back to the ink tank 51. In this manner, the on-off valve 631 forms an open/close part provided in the return pipe 63 serving as the outlet passage and switchable between the open position and the closed position.

[0069] The on-off valve 631 is in the closed position in the image recording step and during the waiting time period except the recovery step. This prevents the ink from flowing from the return pipe 63 through the outlet port 222 into the ink flow passage 22 even when the pressure in the pressure tank 53 is adjusted so that the pressure in the ink chambers 23 is the negative pressure.

[0070] The ejection of ink droplets by means of the pressure generating elements 43 causes a temporary decrease in the pressure in the pressure chambers 24 after the ink ejection. Then, the pressure chambers 24 are replenished with the ink from the ink chambers 23. Thus, the ink is supplied from the ink flow passage 22 to the ink chambers 23, and is further supplied from the pressure tank 53 through the second supply pipe 62 to the ink flow passage 22.

<2. Recovery Step>

[0071] Next, the recovery step of each of the recording heads 20 in the recording apparatus 1 will be described with reference to Figs. 3 to 6. Fig. 5 is a flow diagram showing a procedure for the recovery step according to the present embodiment. Fig. 6 is a view showing one recording head 20 in the recovery step according to the present embodiment.

[0072] In the recording apparatus 1 according to the present embodiment, the ink ejected from the recording head 20 contains precipitable ingredients. For this reason, precipitable ingredients 200 precipitate downwardly and accumulate in the ink flow passage 22 of the recording head 20, as shown in Fig. 3, if no ink is ejected for a long period of time.

[0073] When ink droplets are ejected from the nozzles 44 by means of the pressure generating elements 43, for example, in the image recording step, spitting or flushing, flows of ink directed from the interior of the ink flow passage 22 through the first communication ports 41 toward the ink chambers 23 are produced in the ink flow passage 22, as indicated by solid arrows in Fig. 3. In this case, the precipitable ingredients 200 accumulated near the first communication ports 41 are removed to some extent,

but it is difficult to eliminate all of the precipitable ingredients 200 accumulated in the entire ink flow passage 22. To solve such a problem, the recovery step to be described below is performed in the present invention. The recovery step according to the present embodiment is a kind of what is called pressurized purge which cleans the interior of the recording head 20 by pressurizing the interior of the recording head 20. The procedure for the recovery step will be described with reference to Fig. 5.

[0074] First, the nozzles 44 and the cap 31 are brought into opposed relation (Step S101). Specifically, the controller 80 operates the cap moving mechanism 32 to place the cap 31 at the nozzle-facing position. This causes the ink ejected from the nozzles 44 to be directed toward the interior of the cap 31 in Step S 103 to be described later.

[0075] Next, the controller 80 opens the on-off valve 631 shown in Fig. 4 into the open position (Step S102). This allows the ink to be drained from the interior of the ink flow passage 22 of the recording head 20 through the outlet port 222 and the return pipe 63.

[0076] Then, when the on-off valve 631 is in the open position to ensure the communication through the return pipe 63, the pressure regulating part 531 pressurizes the interior of the pressure tank 53 (Step S103). After the pressure regulating part 531 performs the pressurization, the ink stored in the pressure tank 53 is supplied through the second supply pipe 62 to the ink flow passage 22 of the recording head 20. This increases the pressure in the ink flow passage 22.

[0077] The increase in the pressure in the ink flow passage 22 causes part of the ink supplied to the ink flow passage 22 to be drained through the outlet port 222 to the return pipe 63. The ink drained to the return pipe 63 is filtered by the filter 632 so that foreign materials are removed from the ink. The filtered ink is supplied to the ink tank 51.

[0078] After the ink is drained from the interior of the ink flow passage 22 to the return pipe 63, flows of ink directed from the supply port 221 toward the outlet port 222 are produced, as indicated by hollow arrows in Fig. 6. Thus, the precipitable ingredients 200 accumulated in a lower part of the interior of the ink flow passage 22 are dispersed by the flows of ink. That is, the accumulation of the precipitable ingredients 200 in the ink flow passage 22 is eliminated.

[0079] Also, the increase in the pressure in the ink flow passage 22 causes another part of the ink supplied to the ink flow passage 22 to flow through the ink chambers 23 and the pressure chambers 24 and to be ejected from the nozzles 44, as indicated by solid arrows in Fig. 6.

[0080] The controller 80 operates the ink drain mechanism 311 during a time interval between an instant before or after the start of Step S103 and an instant after the completion of Step S103. Thus, the ink ejected from the nozzles 44 toward the cap 31 is drained from the interior of the cap 31 by the ink drain mechanism 311, and is discarded or recycled.

[0081] In this manner, the ink is ejected from the noz-

zles 44 in the recovery step, so that the precipitable ingredients 200 accumulated in the ink chambers 23 and the pressure chambers 24 are drained. Thus, the accumulation of the precipitable ingredients 200 in the ink chambers 23 and the pressure chambers 24 is eliminated at the same time that the precipitable ingredients 200 in the ink flow passage 22 are dispersed.

[0082] After the completion of the pressurization, the controller 80 closes the on-off valve 631 into the closed position (Step S104). Then, the pressure regulating part 531 regulates the pressures in the pressure tank 53 and in the recording head 20 to the same pressures as in the image recording step. Thereafter, the ink adhering to the lower surface of the recording head 20 is wiped off by a wiping mechanism (not shown) (Step S105). This cleans the exposed surfaces of the nozzles 44.

[0083] In the present embodiment, the flow rate of the ink drained from the ink flow passage 22 through the outlet port 222 to the return pipe 63 in the recovery step is higher than the total flow rate of the ink ejected from all of the nozzles 44. This ensures the sufficient flow rate of the ink directed from the supply port 221 toward the outlet port 222 in the ink flow passage 22. Thus, the precipitable ingredients 200 accumulated in the ink flow passage 22 are dispersed more efficiently.

[0084] For the higher flow rate of the ink drained through the outlet port 222, the cross-sectional area of the flow passage of the outlet port 222 and the return pipe 63 may be made greater. In this case, the flow passage resistance of the ink flowing from the ink flow passage 22 through the outlet port 222 and the return pipe 63 is lower than the flow passage resistance of the ink flowing from the ink flow passage 22 through the first communication ports 41, the ink chambers 23, the second communication ports 42, the pressure chambers 24 and the nozzles 44.

[0085] This causes the flow rate of the ink drained through the outlet port 222 to the return pipe 63 to be further higher than the total flow rate of the ink ejected from all of the nozzles 44. Thus, the precipitable ingredients 200 accumulated in the ink flow passage 22 are dispersed further efficiently.

[0086] In the present embodiment, the ink drained from the recording head 20 to the return pipe 63 flows back to the ink tank 51, as mentioned above. Thus, the ink drained from the interior of the ink flow passage 22 through the outlet port 222 in the recovery step is collected into the ink tank 51, and may be recycled for the subsequent image recording step and the recovery step. This suppresses the amount of ink discarded in the recovery step.

<3. Modifications>

[0087] While the one embodiment according to the present invention has been described hereinabove, the present invention is not limited to the aforementioned embodiment.

[0088] In the aforementioned one embodiment, the two liquid filling chambers, i.e. the ink chamber 23 and the pressure chamber 24, are interposed between the ink flow passage 22 and each of the nozzles 44. However, the present invention is not limited to this. The ink flow passage 22 and each of the pressure chambers 24 may be in direct communication with each other, so that only one liquid filling chamber, i.e. the pressure chamber 24, may be interposed between the ink flow passage 22 and each of the nozzles 44. Also, a plurality of ink chambers 23 may be interposed between the ink flow passage 22 and each of the pressure chambers 24. That is, three or more liquid filling chambers, i.e. two or more ink chambers 23 and the pressure chamber 24, may be interposed between the ink flow passage 22 and each of the nozzles 44.

[0089] Although the cap 31 is moved relative to the recording head 20, with the recording head 20 fixed in position, in the aforementioned one embodiment, the present invention is not limited to this. With the cap 31 at a fixed position, the recording head 20 may be moved between a standby position opposed to the cap 31 and a printing position opposed to the printing paper 9.

[0090] In the aforementioned one embodiment, with the recording head 20 fixed in position, the ink is ejected toward the printing paper 9 while the printing paper 9 is moved relative to the recording head 20. Instead, with the printing paper 9 fixed in position, the ink may be ejected toward the printing paper 9 while the recording head 20 is moved relative to the printing paper 9.

[0091] In the aforementioned one embodiment, the open/close part provided in the return pipe 63 is the on-off valve 631. However, the open/close part provided in the outlet passage may be a pump in which communication therethrough is closed during a stoppage period, such as a diaphragm pump and a tubing pump. According to the present invention, the open/close part other than the on-off valve may be used so long as the open/close part is switchable between an open position in which the communication through the outlet passage is ensured and a closed position in which the communication through the outlet passage is closed off.

[0092] In the case where such a pump is used as the open/close part provided in the outlet passage, the flow rate of the ink drained from the recording head to the outlet passage may be controlled by controlling the rate of flow through the pump when the pump is driven (in the open position). In this case, the total flow rate of the ink ejected from the nozzles and the flow rate of the ink drained from the recording head to the outlet passage are controlled more precisely.

[0093] Although the ink drained from the outlet port 222 of the recording head 20 flows back to the ink tank 51 in the aforementioned one embodiment, the present invention is not limited to this. The ink drained from the outlet port 222 of the recording head 20 in the recovery step may be designed to be drained through the outlet passage to the outside of the recording apparatus 1 without

flowing back to the ink tank 51.

[0094] In the aforementioned one embodiment, the size of the ink droplets ejected from the nozzles 44 may be selected from among the three types: large, medium and small sizes. However, the size of the ink droplets ejectable from the nozzles 44 may be of one or two types or of not less than four types.

[0095] The aforementioned recording apparatus 1 records an image on the printing paper 9 serving as a recording medium. However, the recording apparatus according to the present invention may be configured to record a pattern of an image and the like on a sheet-like recording medium other than general paper (for example, a film made of resin and the like).

[0096] The components described in the aforementioned embodiment and in the modifications may be consistently combined together, as appropriate.

Reference Signs List

[0097]

1	Recording apparatus
9	Printing paper
10	Transport mechanism
20	Recording heads
22	Ink flow passage
23	Ink chambers
24	Pressure chambers
30	31 Cap
41	First communication ports
42	Second communication ports
43	Pressure generating elements
44	Nozzles
35	61 First supply pipe
62	Second supply pipe
63	Return pipe
80	Controller
200	Precipitable ingredients
40	221 Supply port
222	Outlet port
51	Ink tank
52	Pump
53	Pressure tank
45	531 Pressure regulating part
532	Liquid level sensor
631	On-off valve
632	Filter

Claims

1. A liquid ejecting apparatus comprising:

- an ejecting head having a plurality of nozzles for ejecting a liquid;
- a liquid reservoir for storing said liquid therein;
- a pressurizing part for pressurizing the interior

- of said liquid reservoir;
 a supply passage for supplying said liquid from said liquid reservoir to said ejecting head;
 an outlet passage for draining said liquid from the interior of said ejecting head;
 an open/close part provided in said outlet passage and switchable between an open position in which the communication through said outlet passage is ensured and a closed position in which the communication through said outlet passage is closed off; and
 a controller for controlling said pressurizing part and said open/close part, said ejecting head including
 a liquid flow passage having a supply port in communication with said supply passage, and an outlet port in communication with said outlet passage,
 a liquid filling chamber having a communication port in communication with said liquid flow passage, and
 said nozzles each having a first end in communication with said liquid filling chamber and a second end exposed to the outside of said ejecting head,
 said controller causing said pressurizing part to perform the pressurization while holding said open/close part in said open position, wherein, when said pressurization is performed, said liquid stored in said liquid reservoir is supplied through said supply passage to said liquid flow passage, and at least part of said liquid supplied to said liquid flow passage is drained through said outlet port to said outlet passage.
2. The liquid ejecting apparatus according to Claim 1, wherein said liquid filling chamber includes:
- a first liquid filling chamber having said communication port in direct communication with said liquid flow passage; and
 a plurality of second liquid filling chambers in direct or indirect communication with said first liquid filling chamber and each in communication with a single one of said nozzles.
3. The liquid ejecting apparatus according to Claim 2, wherein said second liquid filling chambers include respective pressure generating elements, and wherein, when said pressure generating elements are driven, pressure is applied to the interior of said second liquid filling chambers to eject said liquid in the form of droplets from said nozzles.
4. The liquid ejecting apparatus according to any one of Claims 1 to 3, wherein, when said pressurization is performed, said liquid stored in said liquid reservoir is supplied
- through said supply passage to said liquid flow passage; part of said liquid supplied to said liquid flow passage is drained through said outlet port to said outlet passage; and another part of said liquid supplied to said liquid flow passage is ejected from said nozzles through said liquid filling chamber.
5. The liquid ejecting apparatus according to Claim 4, wherein, when said pressurization is performed, the flow rate of said liquid drained from said liquid flow passage through said outlet port to said outlet passage is higher than the total flow rate of said liquid ejected from said nozzles.
6. A method of controlling a liquid ejecting apparatus, the liquid ejecting apparatus including an ejecting head having a plurality of nozzles for ejecting a liquid, a liquid reservoir for storing therein said liquid to be supplied through a supply passage to said ejecting head, an outlet passage for draining said liquid from said ejecting head, and a pressurizing part for pressurizing the interior of said liquid reservoir, wherein said pressurizing part is caused to perform the pressurization while an open/close part provided in said outlet passage is held in an open position to ensure the communication through said outlet passage, and wherein, when said pressurization is performed, said liquid stored in said liquid reservoir is supplied through said supply passage to a liquid flow passage in said ejecting head, and at least part of said liquid supplied to said liquid flow passage is drained to said outlet passage.
7. The method of controlling a liquid ejecting apparatus according to Claim 6, wherein said ejecting head includes said liquid flow passage having a supply port in communication with said supply passage, and an outlet port in communication with said outlet passage, a liquid filling chamber having a communication port in communication with said liquid flow passage, and said nozzles each having a first end in communication with said liquid filling chamber and a second end exposed to the outside of said ejecting head, and wherein, when said pressurization is performed, part of said liquid supplied to said liquid flow passage is drained through said outlet port to said outlet passage, and another part of said liquid supplied to said liquid flow passage is ejected from said nozzles through said liquid filling chamber.
8. The method of controlling a liquid ejecting apparatus according to Claim 7, wherein, when said pressurization is performed, the flow rate of said liquid drained from said liquid flow passage through said outlet port to said outlet passage is higher than the total flow rate of said liquid

ejected from said nozzles.

5

10

15

20

25

30

35

40

45

50

55

Fig. 1

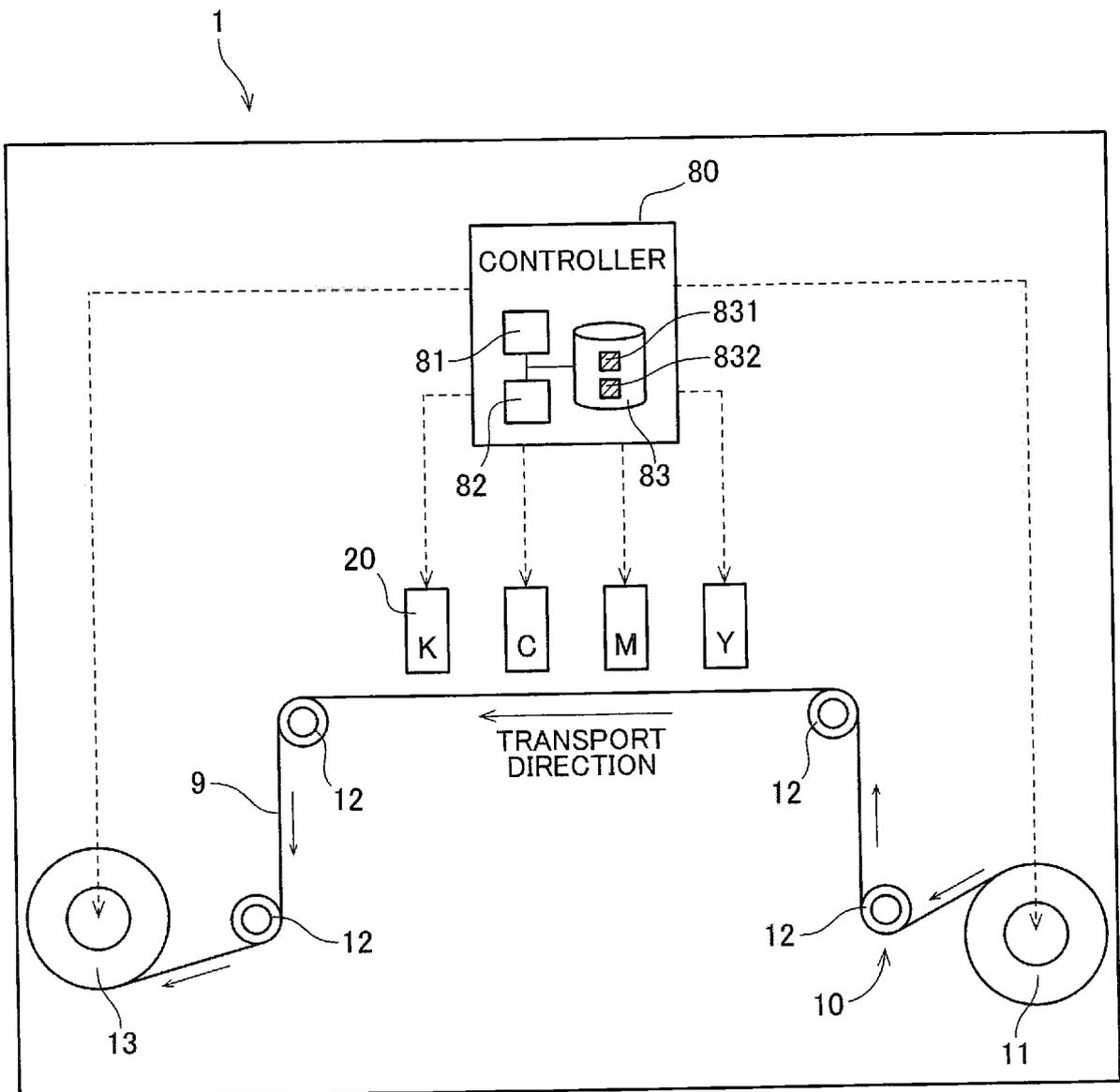


Fig. 2

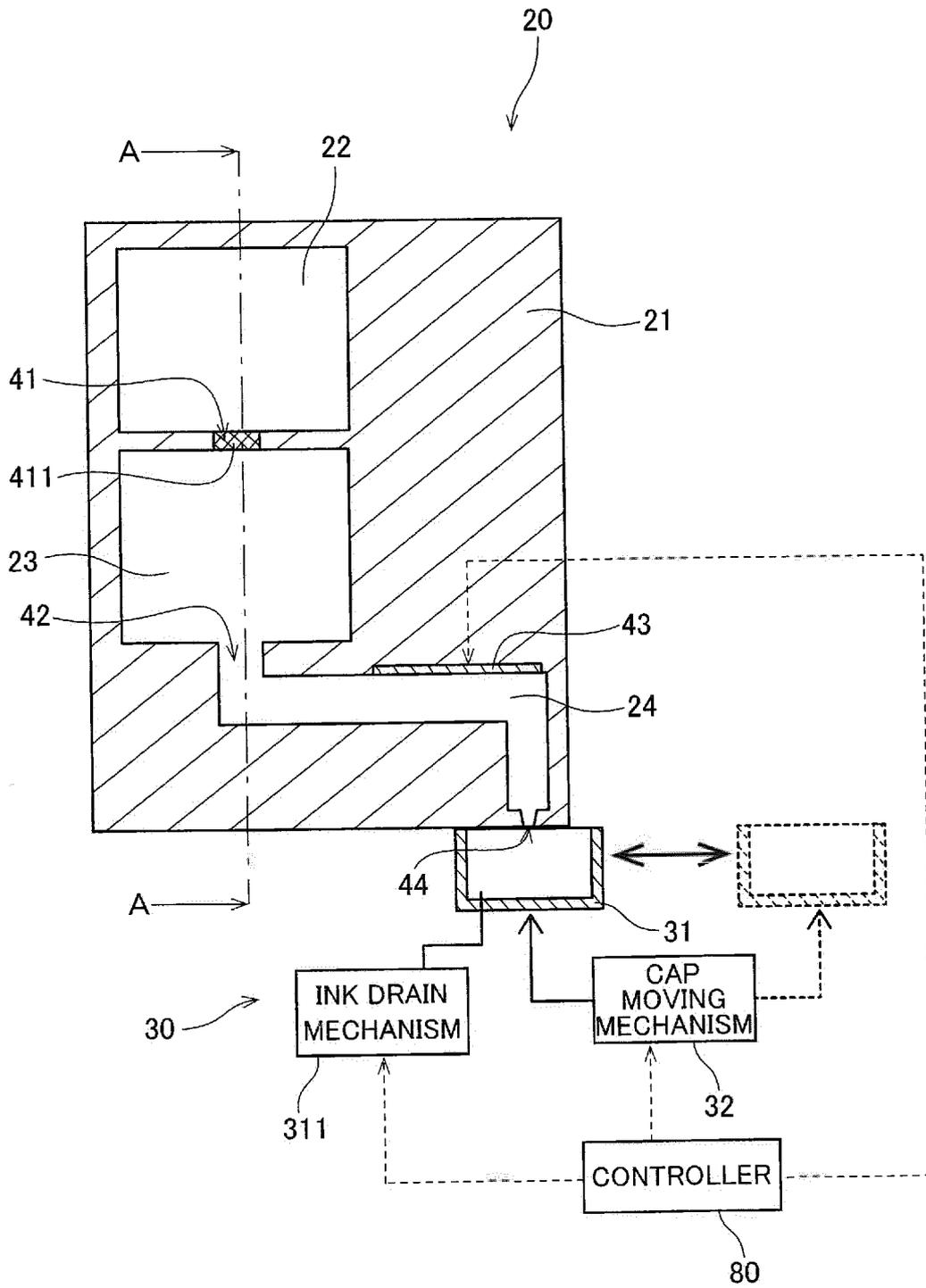


Fig. 3

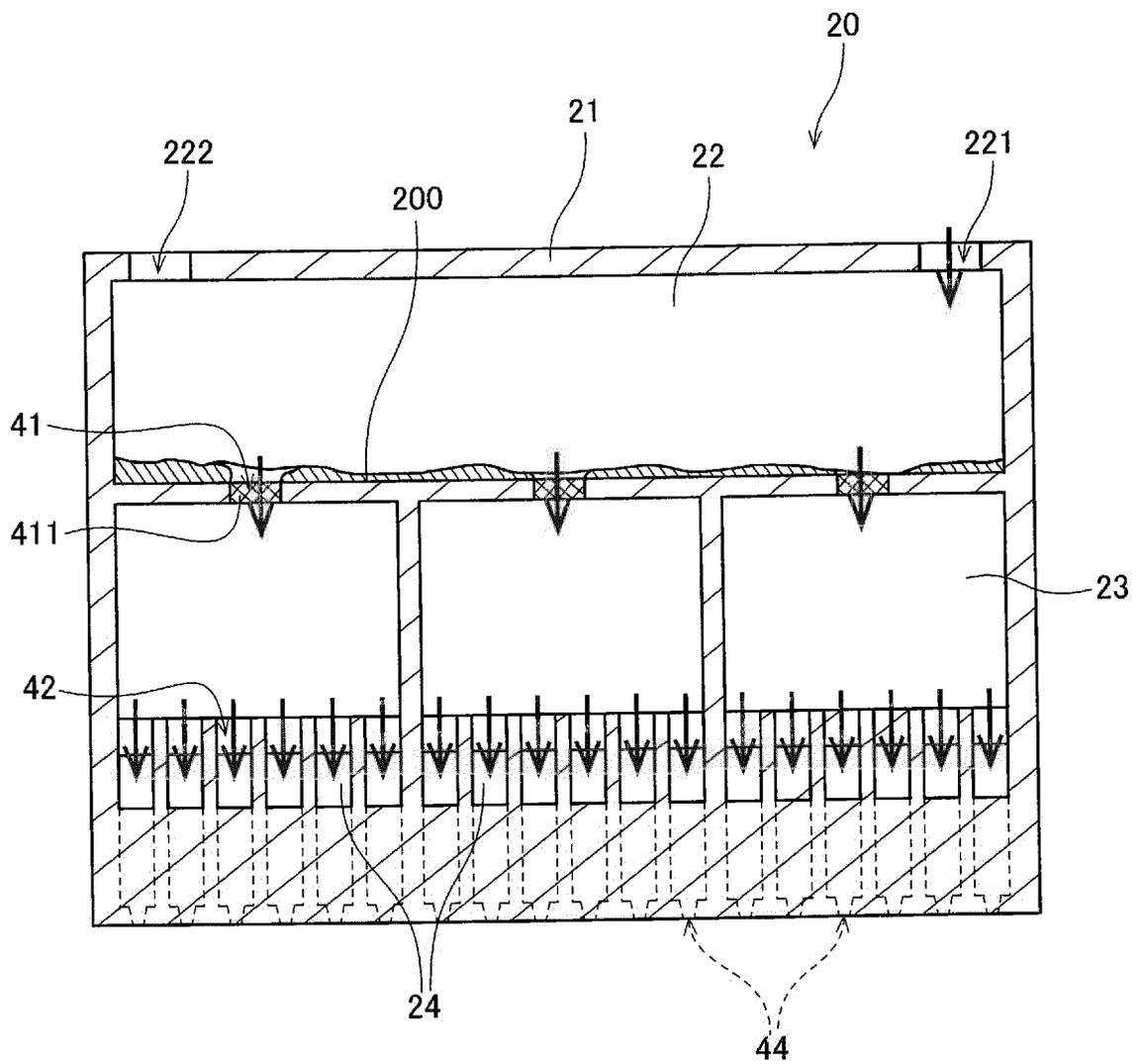


Fig. 4

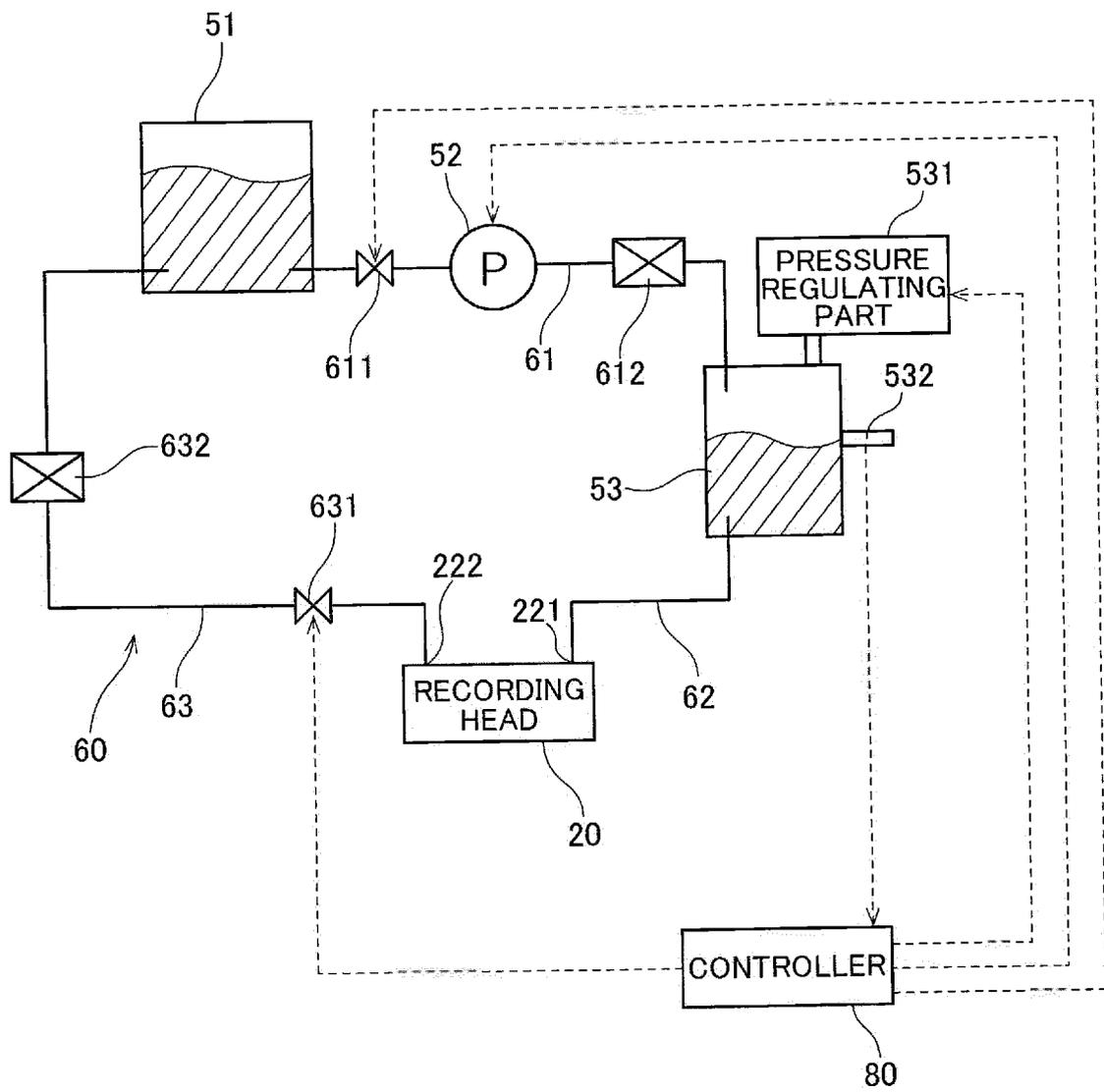


Fig. 5

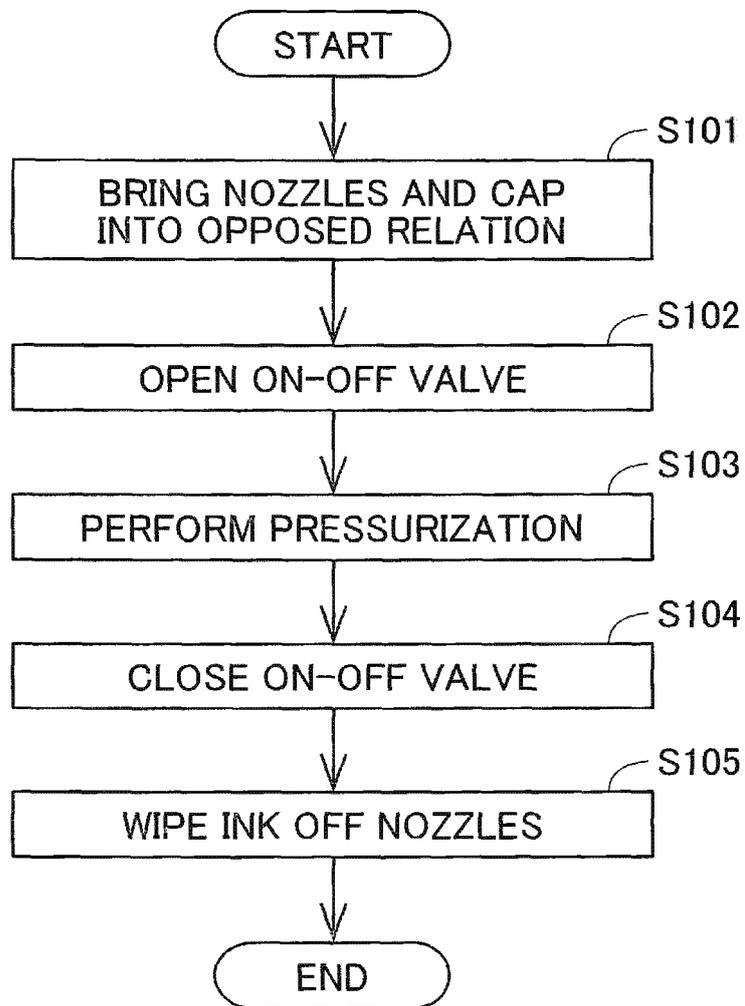
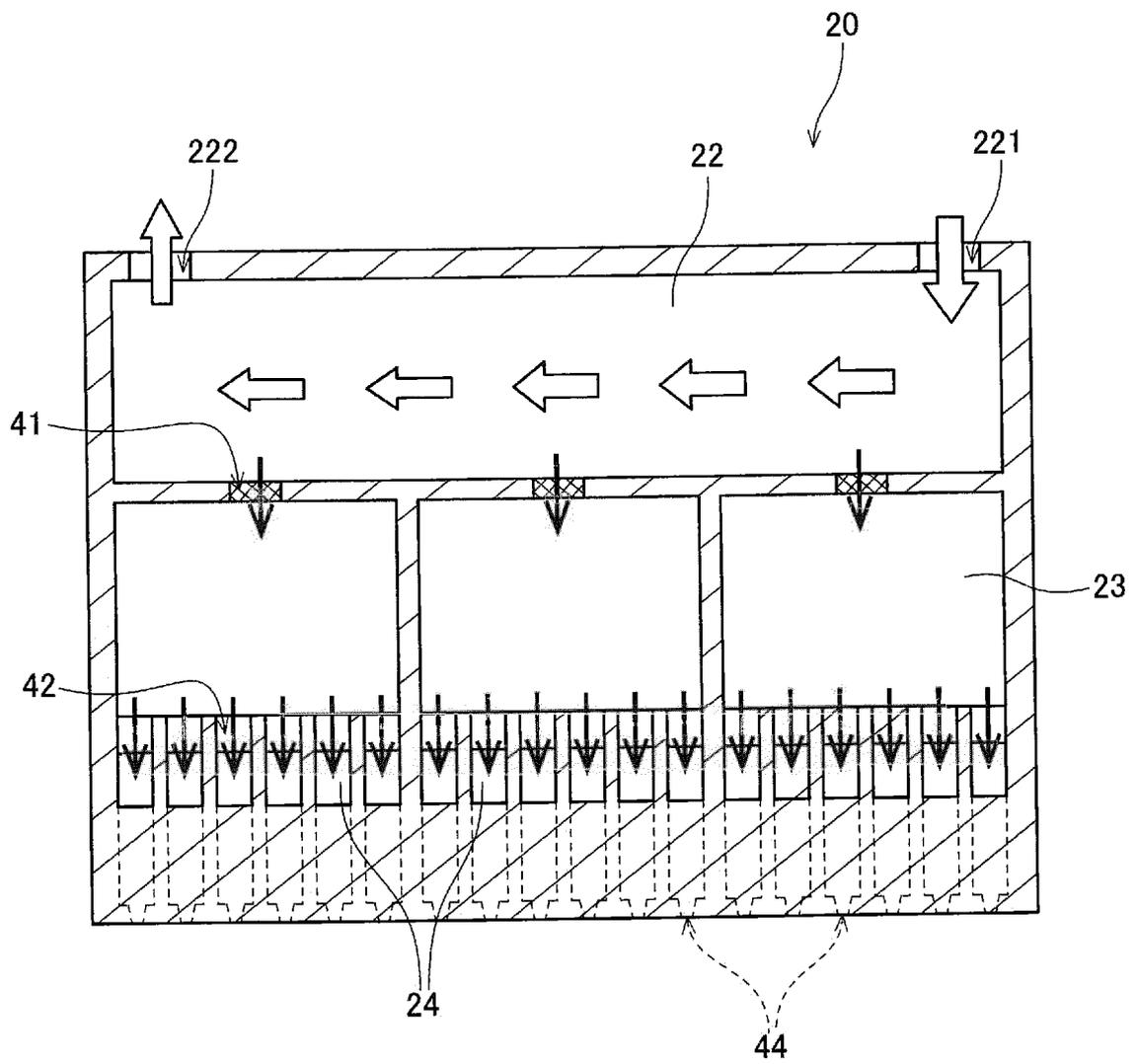


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/051791

5	A. CLASSIFICATION OF SUBJECT MATTER B41J2/165(2006.01)i, B41J2/18(2006.01)i		
	According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B41J2/01-B41J2/215		
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015 Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015		
20	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
25	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	
		Relevant to claim No.	
25	Y	JP 2008-213281 A (Sharp Corp.), 18 September 2008 (18.09.2008), paragraphs [0064] to [0086], [0093] to [0101], [0104] to [0106], [0110] to [0114]; fig. 1, 4 & WO 2008/108245 A1	1-8
30	Y	JP 2009-285900 A (Konica Minolta Holdings, Inc.), 10 December 2009 (10.12.2009), paragraphs [0011] to [0012], [0021] to [0025], [0033]; fig. 2, 6 to 8 (Family: none)	1-8
35	A	JP 2008-230152 A (Toshiba Tec Corp.), 02 October 2008 (02.10.2008), entire text; all drawings (Family: none)	1-8
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
45	* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
	"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
	"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family	
	"O" document referring to an oral disclosure, use, exhibition or other means		
	"P" document published prior to the international filing date but later than the priority date claimed		
50	Date of the actual completion of the international search 17 March 2015 (17.03.15)	Date of mailing of the international search report 24 March 2015 (24.03.15)	
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.	

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/051791

5

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

10

15

20

25

30

35

40

45

50

55

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-122814 A (Ulvac, Inc.), 18 May 2006 (18.05.2006), entire text; all drawings & US 2007/0216739 A1 & EP 1806615 A1 & WO 2006/046447 A1 & KR 10-2007-0073818 A	1-8

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013193008 A [0002] [0003] [0004]