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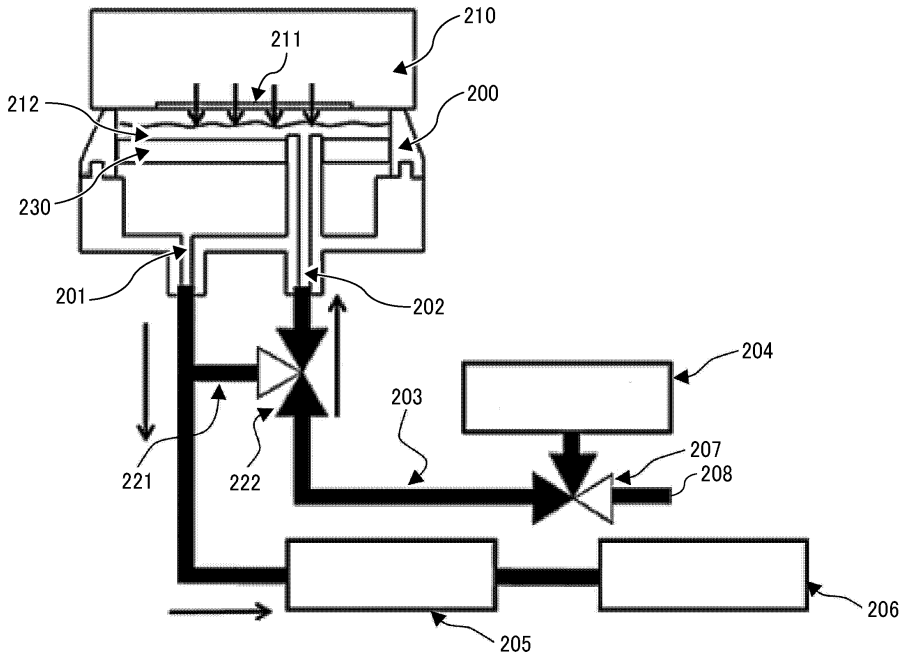
(54) **LIQUID DISCHARGE APPARATUS**

(57) In a liquid discharge apparatus (1), a head (210) discharges a liquid. A suction cap (200) detachably contacts the head (210) and stores the liquid suctioned from the head (210). A tank (206) stores the liquid fed from the suction cap (200). A first path (201) connects the suction cap (200) and the tank (206). A suction device (205) sucks the liquid from the head (210). A second path (202, 203) is connected to the suction cap (200). A first atmosphere path (208) having a first diameter connects the second path (202, 203) to atmosphere. A second atmosphere path (204) having a second diameter smaller than the first diameter connects the second path (202, 203) to the atmosphere. An atmosphere switch (207) switches to connect the second path (202, 203) with the first atmosphere path (208) or connect the second path (202, 203) with the second atmosphere path (204).

FIG. 10



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a liquid discharge apparatus.

Related Art

[0002] A so-called inkjet liquid discharge apparatus may not normally discharge ink (i.e., a liquid) from a discharge head when the ink is thickened or dried. The discharge head may be referred to simply as a "head" in the following description. For example, a discharge failure in which the ink is not discharged from the head, or an abnormal discharge in which the ink is discharged in a direction different from a desired direction may occur. In the related art, a liquid discharge apparatus has a head cleaning function of periodically cleaning the head to prevent the discharge failure and the abnormal discharge.

[0003] Specifically, the liquid discharge apparatus includes a cap, a first path, and a second path. The head has a discharge port (i.e., a nozzle or an opening from which the ink is discharged). The cap covers the discharge port of the head. The first path and the second path are connected to a lower face of the cap. The ink remaining in the discharge port is sucked through the multiple paths, such as the first path and the second path, to perform a head cleaning. In a comparative example, a suction pump is connected to the first path in the head cleaning.

[0004] The suction pump sucks the ink in the discharge port to perform the head cleaning. On the other hand, air is sent to a sealed space between a nozzle face and the cap through the second path. A check valve is disposed on the second path. The check valve supplies the air from the outside into the cap and prevents backflow of the air and the ink. Accordingly, the ink is prevented from flowing out to the outside even when an air release valve disposed below the cap is opened, for example, in a technique in Japanese Unexamined Patent Application Publication No. 2010-046854.

[0005] In the comparative example, a liquid such as ink may overflow from a storage of the cap to the outside. In particular, when the head is removed from the storage, the liquid is likely to overflow from the storage to the outside. Even when a path through which the liquid flows is provided separately from the path for suction, if the liquid remains on the path, the liquid may be difficult to flow and may overflow from the storage to the outside.

SUMMARY

[0006] The present disclosure has been made in view of the above situation, and an object of the present disclosure is to prevent a liquid from overflowing from the storage.

[0007] Embodiments of the present disclosure describe an improved liquid discharge apparatus that includes a head, a suction cap, a tank, a first path, a suction device, a second path, a first atmosphere path, a second atmosphere path, an atmosphere switch. The head discharges a liquid. The suction cap detachably contacts the head and stores the liquid suctioned from the head. The tank is connected to the suction cap to store the liquid fed from the suction cap. The first path connects the suction cap and the tank. The suction device is disposed in the first path between the suction cap and the tank to suck the liquid from the head to the suction cap. The second path is connected to the suction cap. The first atmosphere path having a first diameter connects the second path to atmosphere. The second atmosphere path having a second diameter smaller than the first diameter connects the second path to the atmosphere. The atmosphere switch is disposed between the second path, the first atmosphere path, and the second atmosphere path to switch to connect the second path with the first atmosphere path or connect the second path with the second atmosphere path.

[0008] As a result, according to the present disclosure, the liquid can be prevented from overflowing from the storage to the outside.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic view of an image forming apparatus according to an embodiment of the present disclosure;
FIG. 2 is a diagram illustrating an example of a configuration of an image forming unit of the image forming apparatus;
FIG. 3 is a block diagram illustrating an example of a hardware configuration of a controller of the image forming apparatus;
FIG. 4 is a diagram illustrating an example of an internal structure of the image forming apparatus;
FIG. 5 is a diagram illustrating an example of the image forming unit when a storage is inclined;
FIG. 6 is a schematic view of the storage to which a head is attached;
FIG. 7 is a schematic view of the storage from which the head is removed;
FIG. 8 is a diagram illustrating an example of an internal structure of the image forming apparatus according to another embodiment;
FIG. 9 is a flowchart illustrating an operation example of suction maintenance;

FIG. 10 is a schematic view of the storage in a suction procedure;
FIG. 11 is a schematic view of the storage to which the head is attached when paths are opened to an atmosphere in the suction procedure;
FIG. 12 is a schematic view of the storage from which the head is removed after the paths are switched in the suction procedure;
FIG. 13 is a schematic view of the storage in the suction procedure, illustrating effects of suction; and
FIG. 14 is a diagram illustrating an example of a configuration for wiping a nozzle row of the head.

[0010] The accompanying drawings are intended to depict embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0011] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0012] Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

First Embodiment

[0013] Embodiments of the present disclosure are described below with reference to the accompanying drawings. The embodiments are not limited to the specific examples described below.

Configuration of Liquid Discharge Apparatus

[0014] FIG. 1 is a schematic view of an image forming apparatus 1. The image forming apparatus 1 illustrated in FIG. 1 is described as a liquid discharge apparatus according to an embodiment of the present disclosure. The image forming apparatus 1 discharges ink onto a sheet to form an image. The image forming apparatus 1 includes a sheet feeding unit 10, a pretreatment unit 20, an image forming unit 30, a drying unit 50, a post-processing unit 60, a sheet ejection unit 70, an operation unit 90, and a controller 100.

[0015] In the image forming apparatus 1, the pretreatment unit 20 performs pretreatment on a sheet P fed by the sheet feeding unit 10. After the pretreatment, the image forming unit 30 discharges ink onto the sheet P to form an image on the sheet P. The drying unit 50 dries the ink adhering to the sheet P. After drying, the post-processing unit 60 performs post-processing on the sheet P. After the post-processing, the sheet ejection unit 70 ejects the sheet P. Each unit is individually described below.

Configuration of Sheet Feeding Unit

[0016] The sheet feeding unit 10 includes a sheet feeding tray 11A, a sheet feeding tray 11B, a sheet feeding device 12A, and a sheet feeding device 12B. Multiple sheets P are stacked on the sheet feed tray 11A and the sheet feed tray 11B. The sheet feeding device 12A and the sheet feeding device 12B separate and feed the sheets P one by one. As the sheet feeding devices 12A and 12B, a device using a roller, a device using air suction, and the like may be used. The sheet P is conveyed in a conveyance direction 2 and forwarded to the pretreatment unit 20.

Configuration of Pretreatment Unit

[0017] The pretreatment unit 20 performs the pretreatment on the sheet P fed from the sheet feeding unit 10. Examples of the pretreatment include applying a treatment liquid, which reacts with ink, to the sheet P to reduce bleeding of the ink. The sheet P may be processed in the pretreatment. The pretreatment unit 20 includes a registration roller pair 21 that feeds the sheet P to the image forming unit 30. After the pretreatment, the sheet P is conveyed to the registration roller pair 21. After the sheet P reaches the registration roller pair 21, the registration roller pair 21 adjusts the timing to send the sheet P to the image forming unit 30.

Configuration of Drying Unit

[0018] The drying unit 50 includes a conveyor 51 and a heater 52. The conveyor 51 conveys the sheet P. The heater 52 dries the ink adhering to the sheet P. For example, the heater 52 is a halogen heater, a ceramic heater, or the like. The conveyor 51 receives the sheet P conveyed from the image forming unit 30. Then, the conveyor 51 conveys the sheet P to the heater 52. After drying, the sheet P is conveyed to the post-processing unit 60. The ink on the sheet P is heated by the heater 52 while the sheet P passes through the heater 52. As a result, liquid components such as moisture in the ink are evaporated and the ink is fixed on the sheet P.

Configuration of Post-Processing Unit

[0019] The post-processing unit 60 performs the post-processing on the sheet P. The post-processing unit 60 includes a sheet reverse unit 61. The sheet reverse unit

61 reverses the sheet P and sends the sheet P to the image forming unit 30 again through a reverse passage 62. Thus, the image forming apparatus 1 forms images on both sides of the sheet P. The image forming apparatus 1 may perform post-processing such as reversal, binding, correction, and cooling of the sheet P. Specifically, the binding is a process of binding a plurality of sheets P. The correction is a process of correcting deformation of the sheet P. The cooling is a process of cooling the sheet P.

Configuration of Sheet Ejection Unit

[0020] The sheet ejection unit 70 includes a sheet ejection tray 71 on which multiple sheets P is stacked. The sheets P conveyed from the post-processing unit 60 are sequentially stacked on the sheet ejection tray 71.

Configuration of Operation Unit

[0021] The operation unit 90 includes a touch panel, a keyboard, or the like. The operation unit 90 accepts an operation input by an operator. The operation unit 90 may include a display that displays information for the operator. The operation unit 90 may be installed at any position inside or outside the image forming apparatus 1.

Configuration of Controller

[0022] The controller 100 controls the entire image forming apparatus 1. The controller 100 may be installed at any position inside or outside the image forming apparatus 1.

Configuration of Image Forming Unit

[0023] FIG. 2 is a diagram illustrating an example of a configuration of the image forming unit 30. The image forming apparatus 1 includes a device including the image forming unit 30 described below. The image forming unit 30 includes a receiving cylinder 34, a drum 31, heads 210, a transfer cylinder 35, a cleaning unit 36, and an in-line sensor 40. The receiving cylinder 34 receives the sheet P conveyed by the pretreatment unit 20. The drum 31 carries the sheet P on an outer circumferential surface thereof to convey the sheet P. The head 210 discharges ink onto the sheet P carried by the drum 31. The transfer cylinder 35 conveys the sheet P to the drying unit 50.

[0024] A leading end of the sheet P is gripped by a sheet gripper disposed on the surface of the receiving cylinder 34, and the sheet P is conveyed along with the movement of the surface of the receiving cylinder 34. The sheet P is transferred to the drum 31 at a position facing the drum 31. A sheet gripper is disposed on the surface of the drum 31. The leading end of the sheet P is gripped by the sheet gripper of the drum 31. A plurality of suction holes is formed on the surface of the drum 31. A suction unit inside the drum 31 generates a suction airflow through the plurality of suction holes toward an interior of the drum 31. The leading end of the sheet P is gripped by the sheet gripper, and the sheet P is attracted to the surface of the drum 31 by the suction airflow. The sheet P is conveyed as the drum 31 rotates.

[0025] The heads 210 discharge ink of four colors of C (cyan), M (magenta), Y (yellow), and K (black) to form an image. The heads 210 includes a liquid discharge head 33A, a liquid discharge head 33B, a liquid discharge head 33C, and a liquid discharge head 33D in accordance with the types of color. The liquid discharge head 33A, the liquid discharge head 33B, the liquid discharge head 33C, and the liquid discharge head 33D are collectively referred to as the "heads 210," each of which is referred to as a "head 210" unless distinguished.

[0026] The head 210 has multiple nozzles arranged over the entire width of the sheet P in a width direction 3 of the sheet P to form an image on the entire sheet P in the width direction 3. The width direction 3 is substantially orthogonal to the conveyance direction 2. As described above, the image forming unit 30 has a line-type configuration that does not move the head 210 (i.e., a full-width head). The head 210 may use a special ink such as white, gold, or silver. The head 210 may perform processing other than image formation by using a surface coating liquid or the like.

[0027] The cleaning unit 36 cleans the head 210. For example, the cleaning unit 36 includes a suction cap, a suction pump, a web, a rubber blade, and the like. The head 210 may be stained by mist of ink. When the head 210 is stained, the cleaning unit 36 cleans the head 210. The cleaning unit 36 is provided for each head 210.

[0028] The head 210 discharge ink based on image data. When the sheet P passes through a position facing the head 210, the head 210 discharges the ink of each color. As the ink is discharged as described above, an image corresponding to the image data is formed on the sheet P.

[0029] The in-line sensor 40 is disposed downstream from the heads 210 in the conveyance direction 2. The in-line sensor 40 scans an image formed on the sheet P. The conveyance direction 2 is a rotation direction of the drum 31. For example, the in-line sensor 40 includes an imaging element such as a charge coupled device (CCD) or a complementary metal oxide semiconductor (CMOS). The in-line sensor 40 outputs a color scanned image.

Hardware Configuration

[0030] FIG. 3 is a block diagram illustrating an example of a hardware configuration of the controller 100. Specifically, the controller 100 as circuitry includes a central processing unit (CPU) 101 and a read only memory (ROM) 102. The controller 100 further includes a random access memory (RAM) 103 and a hard disk drive (HDD) / solid state drive (SSD) 104. The controller 100 further includes an interface (I/F) 105. The hardware resources described above are electrically connected to each other

via a system bus B. Each resource transmits and receives data and signals to and from each of the head 210, the in-line sensor 40, the cleaning unit 36, and the operation unit 90 via the system bus B.

[0031] The CPU 101 uses the RAM 103 as a work area and executes a program stored in the ROM 102. The HDD/SSD 104 is a storage device. The HDD/SSD 104 stores programs, setting values, and data read by the CPU 101. The I/F 105 is an interface with an external personal computer (PC) 110. The controller 100 may further include a calculation device, a control device, a storage device, an input device, an output device, and an auxiliary device inside or outside thereof in addition to the above-described resources.

Structure Example

[0032] FIG. 4 is a diagram illustrating an example of an internal structure of the image forming apparatus 1. Specifically, the image forming apparatus 1 includes a storage 200, a first path 201, a second path 202, a third path 203, a fourth path 204, and a suction device 205. The storage 200 is the suction cap. The storage 200 stores ink. The head 210 is detachably contacts the storage 200. A description is given below of the storage 200 and the surrounding thereof when the head 210 is removed from the storage 200. The first path 201 and the second path 202 are connected to the storage 200.

[0033] The first path 201 is a path through which the ink is sucked from a suction port of the storage 200. The suction port is disposed in a bottom face of the storage 200. The first path 201 is connected to the suction device 205. The suction device 205 is a suction pump. The ink sucked by the suction device 205 is drained to a tank 206. Thus, the tank 206 collects the ink as a waste ink (waste liquid).

[0034] Specifically, the ink is discharged from the head 210 into the suction cap (i.e., the storage 200) by driving the suction pump (i.e., the suction device 205) and applying a negative pressure to a nozzle face, in which the multiple nozzles are arranged, of the head 210. Foreign substances, bubbles, or the like in the head 210 is discharged together with the ink.

[0035] The second path 202 is a path connected to an opening different from the suction port disposed in the bottom face of the storage 200. The opening is referred to as an "atmospheric port" communicating with an atmosphere. The second path 202 and the third path 203 are connected to each other. The second path 202 and the third path 203 is not necessarily separate paths and may be integrated into a single body. Accordingly, the second path 202 and the third path 203 may be collectively referred to as the second path 202 and 203, the second path 202 may be referred to as a first part of the second path 202 and 203, and the third path 203 may be referred to as a second part of the second path 202 and 203.

[0036] The third path 203 is connected to a first atmosphere path 208 or the fourth path 204 (i.e., a second atmosphere path) via an atmosphere switch 207. The first atmosphere path 208 is opened to the atmosphere. The fourth path 204 is a joint or a tube opened to the atmosphere. The first atmosphere path 208 has a first diameter, for example, substantially the same diameter with the third path 203. The fourth path 204 has a second diameter smaller than the first diameter, for example, smaller than a diameter of each of the first path 201, the second path 202, and the third path 203. The first path 201 and the second path 202 may have any diameter. For example, the fourth path 204 preferably has an inner diameter (the second diameter) of 2 mm or less and 0.1 mm or more.

[0037] The fourth path 204 preferably has an inner diameter as small as possible. On the other hand, a component having a path less than 0.1 mm is difficult to manufacture and is often difficult to obtain. Accordingly, when the diameter of the fourth path 204 is 2 mm or less and 0.1 mm or more, the fourth path 140 can be made of an easily available component. Further, with the fourth path 204 having a small inner diameter, when the suction device 205 is driven, the ink can be sucked from the head 210 while air is taken into the second path 202 and the third path 203 through the fourth path 204. Specifically, the fourth path 204 having the diameter of 2 mm or less can generate a flow path resistance sufficient to suck the ink from the head 210.

[0038] The atmosphere switch 207 is disposed between the third path 203, the fourth path 204, the first atmosphere path 208. The atmosphere switch 207 switches to connect the third path 203 with the fourth path 204 or connect the third path 203 with the first atmosphere path 208 to take air into the second path 202 and the third path 203.

[0039] The paths including the fourth path 204 have the flow path resistance satisfying a condition that a negative pressure applied to the nozzle face of the head 210 during suction reaches the negative pressure sufficient for suction maintenance to suck the ink from the head 210. With the paths satisfying this condition, when the suction device 205 (suction pump) sucks the ink, the third path 203 is connected to the fourth path 204 which is open to the atmosphere. As a result, the air taken into the second path 202 and the third path 203 through the fourth path 204 prevents the ink from flowing into the second path 202 when the suction device 205 sucks the ink before the third path is connected to the first atmosphere path 208 directly opened to the atmosphere.

[0040] In this path, the pressure distribution in the second path 202 and the third path 203 causes the air to flow from the outside toward the atmospheric port, which is an opposite direction to the ink flowing into the second path 202 through the atmospheric port, thereby preventing the backflow of the air and the ink. As described above, with the configuration including the fourth path 204, ink is prevented from overflowing.

Configuration of Conveyance Unit and Liquid Discharge Unit

[0041] In the image forming apparatus 1, a conveyance unit that conveys the sheet P is a rotator such as the drum 31 illustrated in FIG. 2. Alternatively, the conveyance unit may be a conveyance belt. The present embodiment can be applied to both a configuration in which the conveyance unit conveys the sheet P with the rotator and a configuration in which the conveyance unit conveys the sheet P with the conveyance belt.

[0042] FIG. 5 is a diagram illustrating an example of a configuration of the image forming unit 30 when the head 310 (and the storage 200) is inclined. Similarly to FIG. 2, the drum 31 conveys the sheet P in FIG. 5. When the sheet P is conveyed by a rotator such as the drum 31, a surface on which the sheet P is conveyed is not a flat surface like when the sheet P is conveyed on a belt, but a curved surface. Accordingly, the head 210 is installed so as to be inclined with respect to a horizontal plane 301 in accordance with the shape of the drum 31.

[0043] Specifically, the liquid discharge head 33A is installed so as to be inclined at an angle θ with respect to the horizontal plane 301. The angle θ is adjusted and set according to a curvature of the drum 31, an installation position of the head 210, or the like. When the sheet P is conveyed by the drum 31 as described above, the storage 200 further has the following configuration.

[0044] FIG. 6 is a schematic view of the storage 200 to which the head 210 is attached. The storage 200 stores ink 212. A path such as the first path 201 is connected to the bottom face of the storage 200 to suck the ink 212. A nozzle row 211, in which the multiple nozzles are arranged, is integrated with the head 210 as a single body. Thus, when the head 210 is attached to and detached from the storage 200, the nozzle row 211 is also attached and detached together with the head 210. A user removes the head 210 from the storage 200 as illustrated in FIG. 7. Alternatively, the image forming apparatus 1 may automatically remove the head 210 from the storage 200.

[0045] FIG. 7 is a schematic view of the storage 200 from which the head 210 is removed. FIG. 7 is different from FIG. 6 in that the head 210 is removed from the storage 200. As illustrated in FIGS. 6 and 7, the head 210 is attachable to and detachable from the storage 200 by operations of the user or the image forming apparatus 1. When the head 210 is removed from the storage 200 as illustrated in FIG. 7, the ink 212 is likely to overflow to the outside of the storage 200. In particular, when the storage 200 is inclined at the angle θ with respect to the horizontal plane 301, the sucked ink 212 remaining in the storage 200 is more likely to overflow to the outside of the storage 200 as compared with a storage horizontally installed.

[0046] Accordingly, the present embodiment is preferably applied to the storage 200 inclined with respect to the horizontal plane 301 in accordance with the shape of the rotator. The configuration according to the present embodiment can omit a process of lowering the level of the ink 212. The process prevents the ink 212 from overflowing to the outside of the storage 200. In addition, the configuration having the fourth path 204 according to the present embodiment prevents the ink 212 from flowing backward even when the ink 212 is sucked from the head 210.

Second Embodiment

[0047] FIG. 8 is a diagram illustrating an example of an internal structure of the image forming apparatus 1 according to a second embodiment. The second embodiment is different from the first embodiment in that a fifth path 221 and a path switch 222 are added. Different points are described below, and a redundant description may be omitted.

[0048] The fifth path 221 (i.e., a connection path) is connected to the first path 201. The path switch 222 is a switching valve. The path switch 222 is disposed between the second path 202, the third path 203, and the fifth path 221. The path switch 222 switches between connecting the fifth path 221 and the second path 202 and connecting the third path 203 and the second path 202. Since the path switch 222 contacts the ink 212, a material of the path switch 222 is preferably resistant to the ink 212.

[0049] FIG. 9 is a flowchart illustrating an operation example of the suction maintenance. For example, when the ink 212 is thickened or bubbles are generated in the ink 212, the suction maintenance starts. The image forming apparatus 1 performs the suction maintenance in the following suction procedure based on the result of scanning an image formed with the ink 212 by the image forming apparatus 1.

[0050] In step S0901, after attaching the head 210 to the storage 200, the image forming apparatus 1 sucks the ink 212 from the head 210. FIG. 10 is a schematic view of the storage 200 in the suction procedure. FIG. 10 illustrates the operation example in step S0901. Step S0901 is executed in a state in which the head 210 is attached to the storage 200.

[0051] The path switch 222 connects the third path 203 and the second path 202. Further, the atmosphere switch 207 connects the third path 203 to the fourth path 204 to take air into the second path 202 and the third path 203 through the fourth path 204. In this state, the suction device 205 sucks the ink 212. The ink 212 is sucked from the head 210 by the suction device 205.

[0052] In step S0902, the image forming apparatus 1 opens the third path 203 directly to the atmosphere through the first atmosphere path 208 and sucks the ink 212. FIG. 11 is a schematic view of the storage 200 to which the head 210 is attached when the third path 203 is opened to the atmosphere and the ink 212 is sucked from the storage 200. FIG. 11 is different from FIG. 10 in that the atmosphere switch 207 switches to connect the

third path 203 with the first atmosphere path 208 directly opened to the atmosphere to take air into the second path 202 and the third path 203.

[0053] In such a state, the air is directly taken into the second path 202 and the third path 203 through the first atmosphere path 208. The suction device 205 sucks the ink 212 similarly to step S0901. The suction device 205 sucks the ink 212 remaining in the storage 200.

[0054] The atmosphere switch 207 is operated for draining the ink 212 in the storage 200 (i.e., the suction cap) while the storage 200 caps the head 210. Specifically, when the suction device 205 is driven with the third path 203 connected to the fourth path 204 having the smaller inner diameter, since the fourth path 204 is a resistance, the ink 212 in the storage 200 and the paths is drained, and the ink 212 is newly sucked from the head 210 at the same time.

[0055] On the other hand, when the suction device 205 is driven with the third path 203 directly opened to the atmosphere through the first atmosphere path 208 by the atmosphere switch 207, the resistance is small, and air can be actively taken into the third path 203. Accordingly, the suction device 205 can drain the ink 212 in the storage 200 and the path (e.g., the first path 201) without newly sucking the ink 212 from the head 210.

[0056] In step S0903, the head 210 is removed from the storage 200. In step S0904, the image forming apparatus 1 switches paths and suck the ink 212. FIG. 12 is a schematic view of the storage 200 from which the head 210 is removed after the path switch 222 switches the paths in the suction procedure. FIG. 12 is different from FIG. 11 in that the paths are switched by the path switch 222. FIG. 12 illustrates the storage 200 from which the head 210 is removed in step S0903.

[0057] Accordingly, the ink 212 in each path (i.e., the second path 202, the fifth path 221, and the first path 201) is drained by the suction device 205. The image forming apparatus 1 may perform the suction maintenance periodically. Alternatively, an artificial intelligence (AI) may determine to start the suction maintenance based on an operation by a user or the result of scanning an image.

[0058] As illustrated in FIGS. 10, 11, and 12, the storage 200 may include an absorber 230. FIG. 13 is a schematic view of the storage 200 in the suction procedure, illustrating effects of suction. FIG. 13 is different from FIG. 12 in that an ink residue 240 remains in the second path 202. The ink residue 240 is generated when the ink 212 flows into the second path 202. In particular, in step S0902, a pressure in the second path 202 and the third path 203 is negative, and thus the ink 212 is likely to flow in the second path 202.

[0059] In addition, when the ink 212 drips from the nozzle row 211, the ink 212 may adhere to the atmospheric port and the ink 212 may flow into the second path 202 and the third path 203. For this reason, as illustrated in FIG. 12, after the head 210 is removed, the suction device 205 is driven with the atmospheric port communicating with the suction device 205 through the second path 202, the fifth path 221, and the first path 201. As a result, the ink residue 240 in the path can be drained by suction.

[0060] When the ink residue 240 remains in the path, the path may be clogged with the ink residue 240, thereby hindering air from being taken in. In particular, when the ink 212 is thickened, the air is more difficult to flow due to the ink residue 240, and the hindrance is likely to increase.

[0061] When the absorber 230 is disposed in the storage 200 or paths, the suction force of the suction device 205 for sucking the ink residue 240 may be reduced. For this reason, in the present embodiment, the ink residue 240 remaining in the path can be sucked and drained through the fifth path 221. A pressure applied to the ink residue 240 is higher when the suction device 205 sucks through the fifth path 221 than when air is taken into the second path 202 and the third path 203, thereby draining the ink residue 240 more effectively.

[0062] FIG. 14 is a diagram illustrating an example of a configuration for wiping the nozzle row 211. The image forming apparatus 1 may include a blade 241 and a web 242 to wipe the nozzle row 211. The blade 241 cleans the nozzle face after the web 242 wipes the nozzle face. The web 242 absorbs the ink 212 remaining on the nozzle face after the suction.

Other Embodiments

[0063] The recording medium is, for example, a sheet of paper (also referred to as "plain paper"). However, the recording medium may be an overhead projector sheet, a film, a flexible thin plate, or the like in addition to coated paper, label paper, or the like other than the sheet of paper. In other words, the recording medium is made of a material onto which droplets of ink are at least temporarily adherable, a material onto which droplets of ink adhere and fix, or a material to which droplets of ink adhere and permeate. Specific examples of the recording medium include, but are not limited to, a recording medium such as a sheet, a film, or cloth, an electronic component such as an electronic substrate or a piezoelectric element (which may be referred to as a piezoelectric component), layered powder, an organ model, and a testing cell. In short, the recording medium is made of any material onto which liquid can adhere, such as paper, thread, fiber, fabric, leather, metal, plastic, glass, wood, ceramic, or a combination thereof. The liquid may be any fluid other than the ink in accordance with the above-described application.

[0064] The control method described above is implemented by, for example, causing a computer to execute the processes described above. The control method according to the present disclosure may include processes other than those described above. The control method includes a method in which a part of processes is executed by an external device.

[0065] The above-described control method may be

implemented by a program (including firmware and program equivalents, which are referred to simply as the "program") that executes the above-described processes or processing equivalent to the above-described processes.

[0066] In other words, the above-described control method may be implemented by the program written in a programming language or the like so as to obtain a predetermined result by instructing a computer to execute the processes. A part of the processes executed by the program may be implemented by hardware such as an integrated circuit (IC).

[0067] The program causes an arithmetic device, a control device, a storage device, and the like, which are cooperated with each other, included in a computer to execute the above-described processes. The program is loaded into the storage device and issues a command to the arithmetic device to cause the arithmetic device to perform an arithmetic operation, thereby operating the computer. The program may be provided via a computer-readable storage medium or an electric communication line such as a network.

[0068] Aspects of the present disclosure are, for example, as follows.

Aspect 1

[0069] A liquid discharge apparatus includes a head, a suction cap, a tank, a first path, a suction device, a second path, a first atmosphere path, a second atmosphere path, an atmosphere switch. The head discharges a liquid. The suction cap detachably contacts the head and stores the liquid suctioned from the head. The tank is connected to the suction cap to store the liquid fed from the suction cap. The first path connects the suction cap and the tank. The suction device is disposed in the first path between the suction cap and the tank to suck the liquid from the head to the suction cap. The second path is connected to the suction cap. The first atmosphere path having a first diameter connects the second path to atmosphere. The second atmosphere path having a second diameter smaller than the first diameter connects the second path to the atmosphere. The atmosphere switch is disposed between the second path, the first atmosphere path, and the second atmosphere path to switch to connect the second path with the first atmosphere path or connect the second path with the second atmosphere path.

Aspect 2

[0070] In Aspect 1, the second atmosphere path has the second diameter of 2 mm or less and 0.1 mm or more.

Aspect 3

[0071] In Aspect 1 or 2, the liquid discharge apparatus further includes a connection path and a path switch. The connection path connects the first path with a first part of the second path connected to the suction cap. A second part of the second path (202, 203) is connected to the atmosphere switch. The path switch is disposed between the first part and the second part of the second path and connected to the connection path to switch to connect the first path with the first part of the second path through the connection path or connect the first part with the second part of the second path.

Aspect 4

[0072] In any one of Aspects 1 to 3, the liquid discharge apparatus further includes a drum to convey, to the head, a recording medium on an outer circumferential surface of the drum. The suction cap is inclined with respect to a horizontal plane in accordance with the outer circumferential surface of the drum.

Aspect 5

[0073] In any one of Aspects 1 to 4, the liquid discharge apparatus further includes an image forming unit including the head to discharge the liquid onto a recording medium to form an image.

Aspect 6

[0074] In Aspect 1, the liquid discharge apparatus further includes circuitry causes the suction cap to contact the head, causes the atmosphere switch to connect the second path and the second atmosphere path to connect the second atmosphere path to the suction cap, and causes the suction device to suck the liquid from the head with the suction cap, and drain the liquid in the suction cap to the tank through the first path.

Aspect 7

[0075] In Aspect 6, the circuitry further causes the atmosphere switch to connect the second path and the first atmosphere path to connect the first atmosphere path to the suction cap and causes the suction device to drain the liquid in the suction cap to the tank through the first path.

Aspect 8

[0076] In Aspect 3, the liquid discharge apparatus further includes circuitry causes the suction cap to contact the head, causes the path switch to connect the first part and the second part of the second path, causes the atmosphere switch to connect the second part of the second path and the second atmosphere path to connect the second atmosphere path to the suction cap, and causes the suction device to suck the liquid from the head with the suction cap, and drain the liquid in the suction cap to the tank through the first path.

Aspect 9

[0077] In Aspect 8, the circuitry further causes the path switch to connect the first part and the second part of the second path, causes the atmosphere switch to connect the second part of the second path and the first atmosphere path to connect the first atmosphere path to the suction cap, and causes the suction device to drain the liquid in the suction cap to the tank through the first path.

Aspect 10

[0078] In Aspect 9, the circuitry further causes the suction cap to detach from the head, causes the path switch to connect the first part of the second path to the first path through the connection path and disconnect the first part and the second part of the second path, and causes the suction device to drain the liquid in the suction cap to the tank through the first path and the first part of the second path through the connection path.

[0079] Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

[0080] The present invention can be implemented in any convenient form, for example using dedicated hardware, or a mixture of dedicated hardware and software. The present invention may be implemented as computer software implemented by one or more networked processing apparatuses. The processing apparatuses include any suitably programmed apparatuses such as a general purpose computer, a personal digital assistant, a Wireless Application Protocol (WAP) or third-generation (3G)-compliant mobile telephone, and so on. Since the present invention can be implemented as software, each and every aspect of the present invention thus encompasses computer software implementable on a programmable device. The computer software can be provided to the programmable device using any conventional carrier medium (carrier means). The carrier medium includes a transient carrier medium such as an electrical, optical, microwave, acoustic or radio frequency signal carrying the computer code. An example of such a transient medium is a Transmission Control Protocol/Internet Protocol (TCP/IP) signal carrying computer code over an IP network, such as the Internet. The carrier medium may also include a storage medium for storing processor readable code such as a floppy disk, a hard disk, a compact disc read-only memory (CD-ROM), a magnetic tape device, or a solid state memory device.

Claims

1. A liquid discharge apparatus (1) comprising:

a head (210) to discharge a liquid;
a suction cap (200) to detachably contact the head (210) and store the liquid suctioned from the head (210);
a tank (206) connected to the suction cap (200) to store the liquid fed from the suction cap (200);
a first path (201) connecting the suction cap (200) and the tank (206);
a suction device (205) in the first path (201) between the suction cap (200) and the tank (206), the suction device (205) to suck the liquid from the head (210) to the suction cap (200);
a second path (202, 203) connected to the suction cap (200);
a first atmosphere path (208) to connect the second path (202, 203) to atmosphere, the first atmosphere path (208) having a first diameter;
a second atmosphere path (204) to connect the second path (202, 203) to the atmosphere, the second atmosphere path (204) having a second diameter smaller than the first diameter;
an atmosphere switch (207) between the second path (202, 203), the first atmosphere path (208), and the second atmosphere path (204), the atmosphere switch (207) to switch to:

connect the second path (202, 203) with the first atmosphere path (208); or
connect the second path (202, 203) with the second atmosphere path (204).

2. The liquid discharge apparatus (1) according to claim 1,
wherein the second atmosphere path (204) has the second diameter of 2 mm or less and 0.1 mm or more.

3. The liquid discharge apparatus (1) according to claim 1 or 2, further comprising:

a connection path (221) to connect the first path (201) with a first part (202) of the second path (202, 203) connected to the suction cap (200),
a second part (203) of the second path (202, 203) connected to the atmosphere switch (207); and
a path switch (222) between the first part (202) and the second part (203) of the second path (202, 203), the path switch (222) connected to the connection path (221), and the path switch (222) to switch to:

connect the first path (201) with the first part (202) of the second path (202, 203) through the connection path (221); or
connect the first part (202) with the second part (203) of the second path (202, 203).

4. The liquid discharge apparatus (1) according to any one of claims 1 to 3, further comprising:

a drum (31) to convey, to the head (210), a re-

cording medium on an outer circumferential surface of the drum (31),
wherein the suction cap (200) is inclined with respect to a horizontal plane (301) in accordance with the outer circumferential surface of the drum (31).

5. The liquid discharge apparatus (1) according to any one of claims 1 to 4, further comprising an image forming unit (30) including the head (210) to discharge the liquid onto a recording medium to form an image on the recording medium.

6. The liquid discharge apparatus (1) according to claim 1, further comprising circuitry (100) configured to:

cause the suction cap (200) to contact the head (210);
cause the atmosphere switch (207) to connect the second path (202, 203) and the second atmosphere path (204) to connect the second atmosphere path (204) to the suction cap (200); and
cause the suction device (205) to:

suck the liquid from the head (210) with the suction cap (200); and
drain the liquid in the suction cap (200) to the tank (206) through the first path (201).

7. The liquid discharge apparatus (1) according to claim 6,
wherein the circuitry (100) is further configured to:

cause the atmosphere switch (207) to connect the second path (202, 203) and the first atmosphere path (208) to connect the first atmosphere path (208) to the suction cap (200); and
cause the suction device (205) to drain the liquid in the suction cap (200) to the tank (206) through the first path (201).

8. The liquid discharge apparatus (1) according to claim 3, further comprising circuitry (100) configured to:

cause the suction cap (200) to contact the head (210);
cause the path switch (222) to connect the first part (202) and the second part (203) of the second path (202, 203);
cause the atmosphere switch (207) to connect the second part (203) of the second path (202, 203) and the second atmosphere path (204) to connect the second atmosphere path (204) to the suction cap (200); and
cause the suction device (205) to:

suck the liquid from the head (210) with the suction cap (200); and
drain the liquid in the suction cap (200) to the tank (206) through the first path (201).

9. The liquid discharge apparatus (1) according to claim 8,
wherein the circuitry (100) is further configured to:

cause the path switch (222) to connect the first part (202) and the second part (203) of the second path (202, 203);
cause the atmosphere switch (207) to connect the second part (202) of the second path (202, 203) and the first atmosphere path (208) to connect the first atmosphere path (208) to the suction cap (200); and
cause the suction device (205) to drain the liquid in the suction cap (200) to the tank (206) through the first path (201).

10. The liquid discharge apparatus (1) according to claim 9,
wherein the circuitry (100) is further configured to:

cause the suction cap (200) to detach from the head (210);
cause the path switch (222) to:

connect the first part (202) of the second path (202, 203) to the first path (201) through the connection path (221); and
disconnect the first part (202) and the second part (203) of the second path (202, 203); and

cause the suction device (205) to drain the liquid in the suction cap (200) to the tank (206) through the first path (201) and the first part (202) of the second path (202, 203) through the connection path (221).

FIG. 1

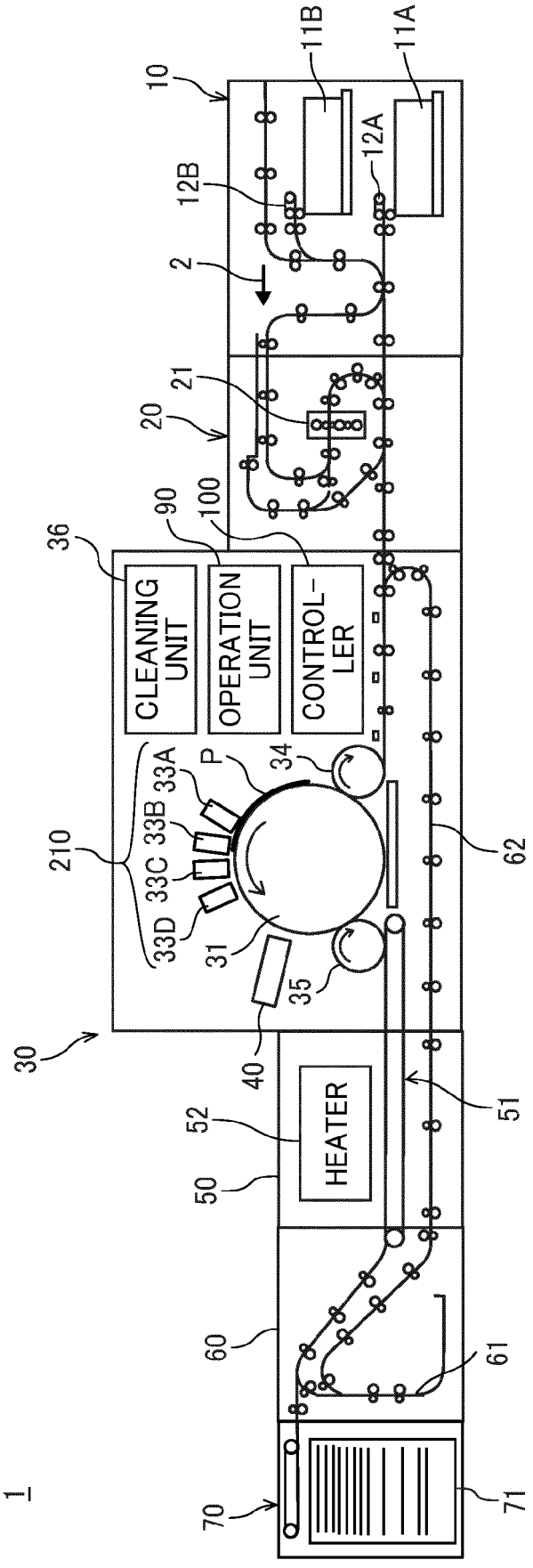

1
10
11B
11A
12A
12B
2
20
21
30
31
33A
33B
33C
33D
34
35
36
40
50
51
52
60
61
62
70
71
90
100
210
P
CLEANING UNIT
OPERATION UNIT
CONTROL-LER
HEATER

FIG. 2

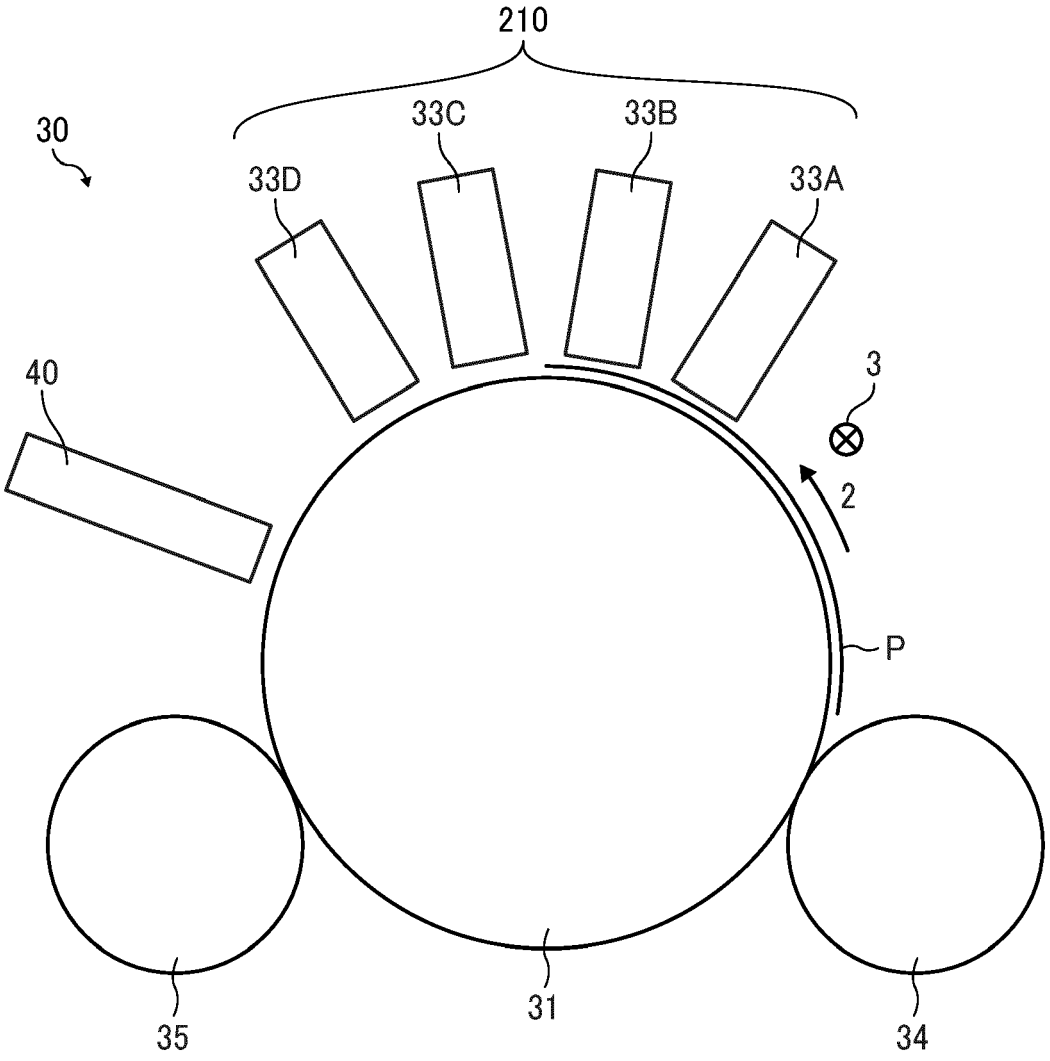


FIG. 3

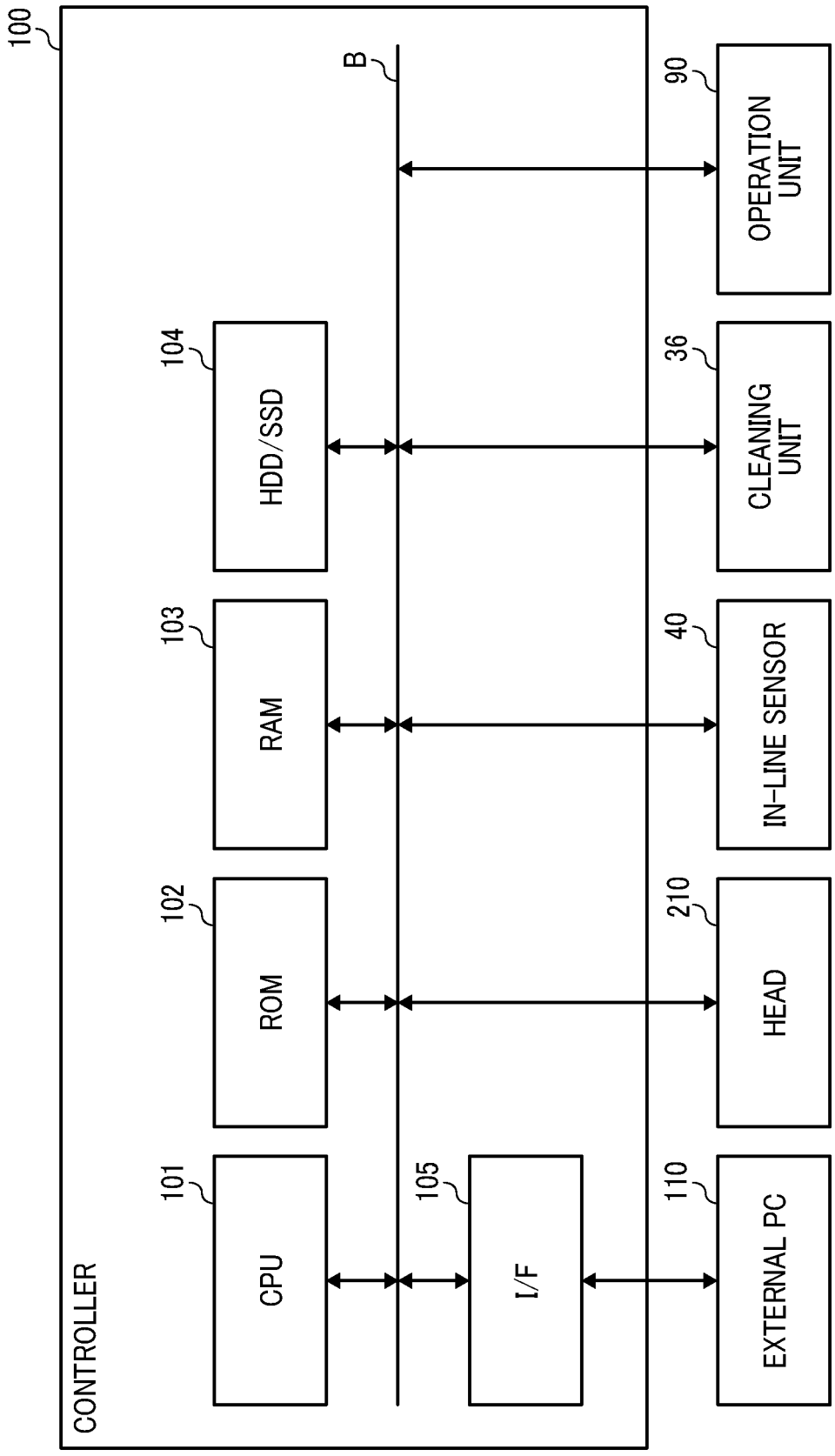

100
CONTROLLER
B
101
CPU
102
ROM
103
RAM
104
HDD/SSD
105
I/F
110
EXTERNAL PC
210
HEAD
40
IN-LINE SENSOR
36
CLEANING UNIT
90
OPERATION UNIT

FIG. 4

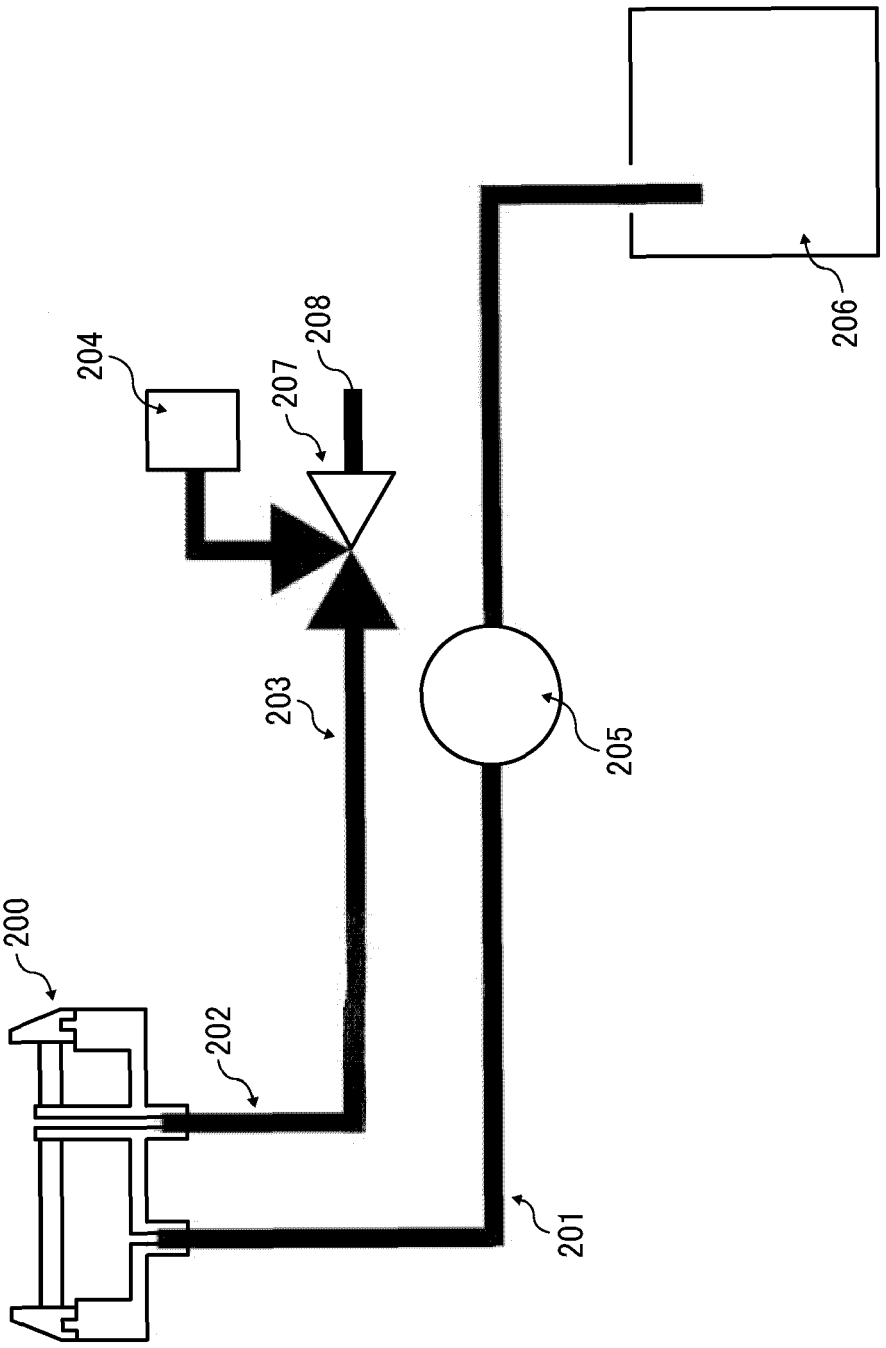


FIG. 5

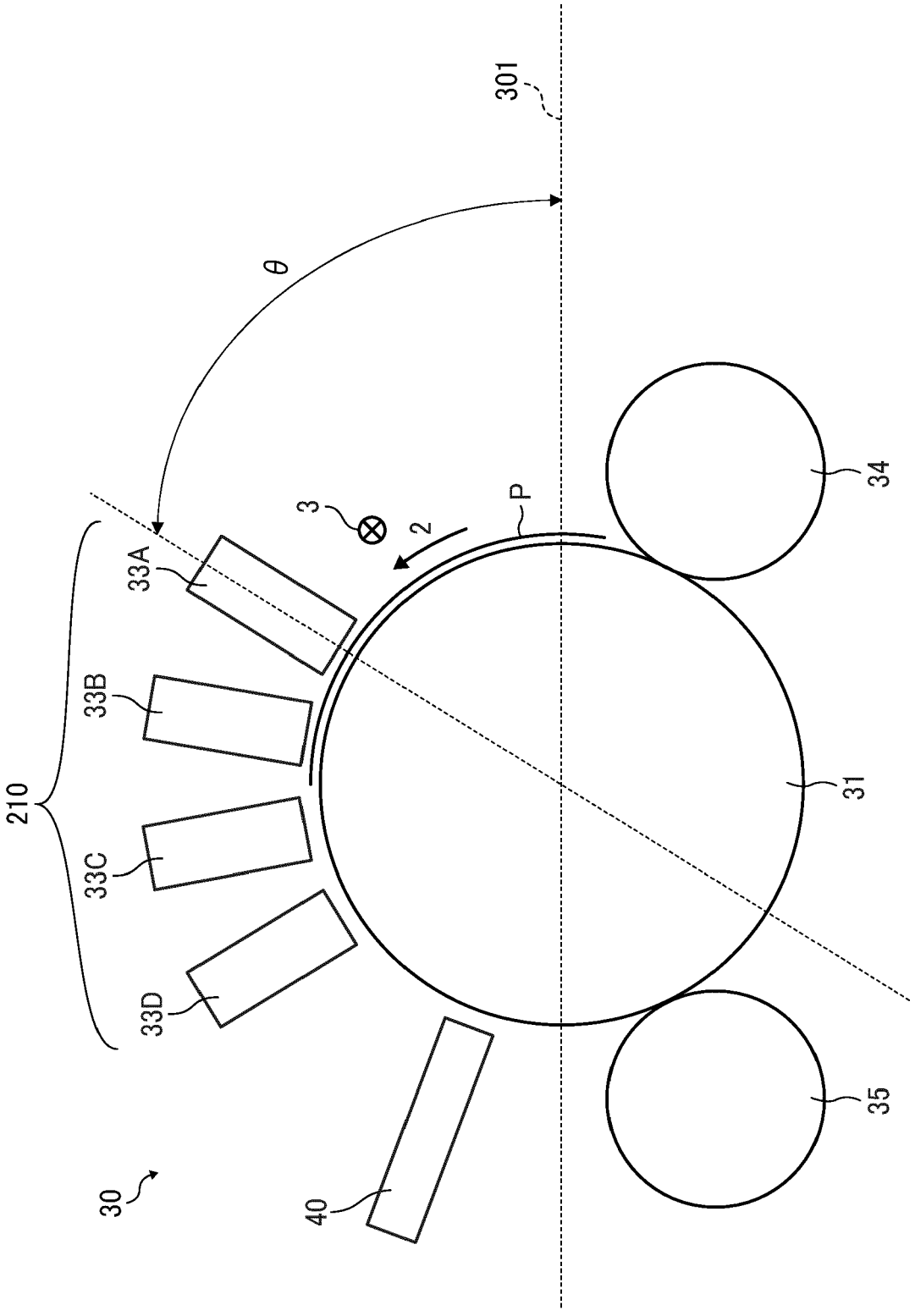


FIG. 6 COMPARATIVE EXAMPLE

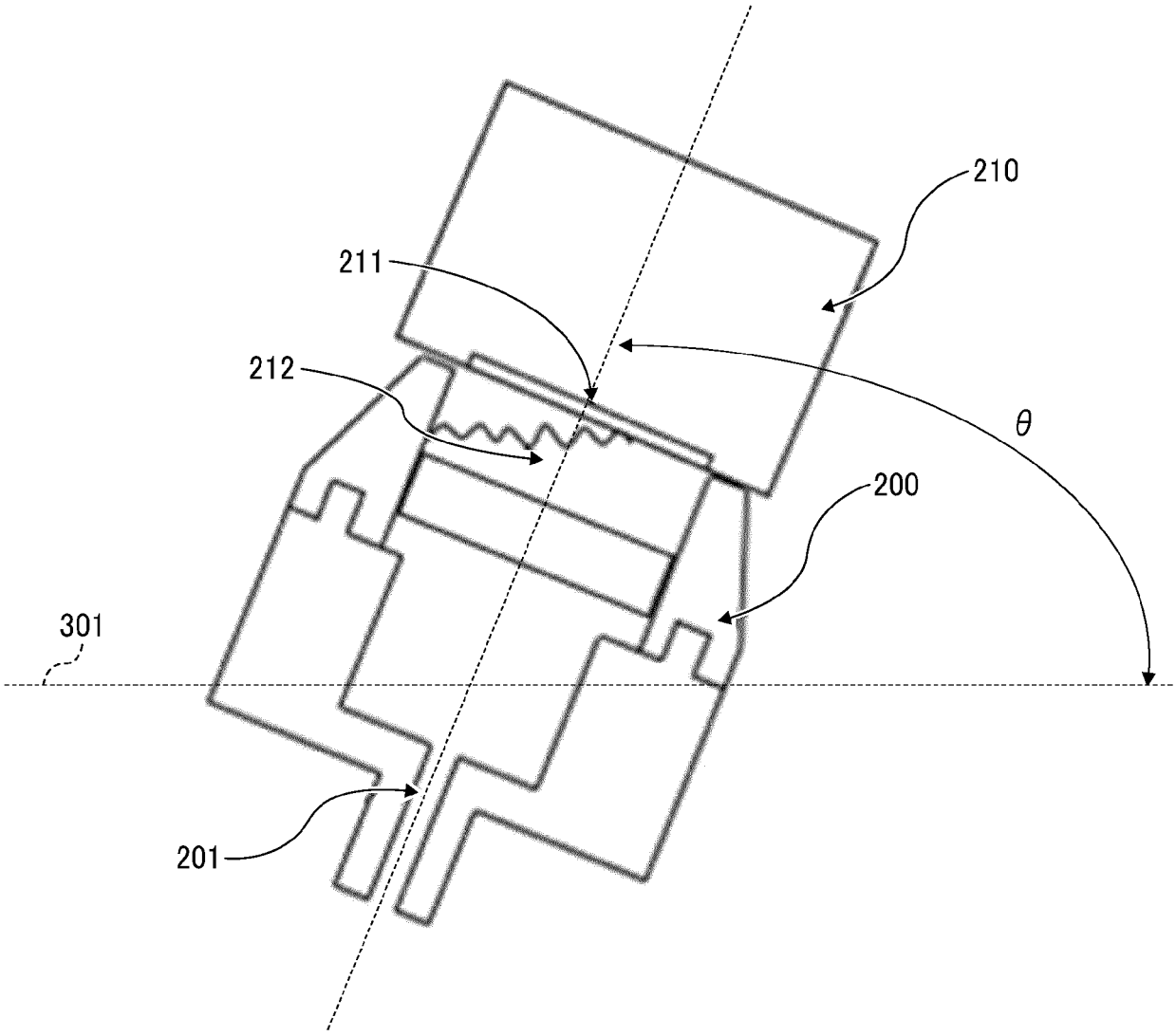


FIG. 7 COMPARATIVE EXAMPLE

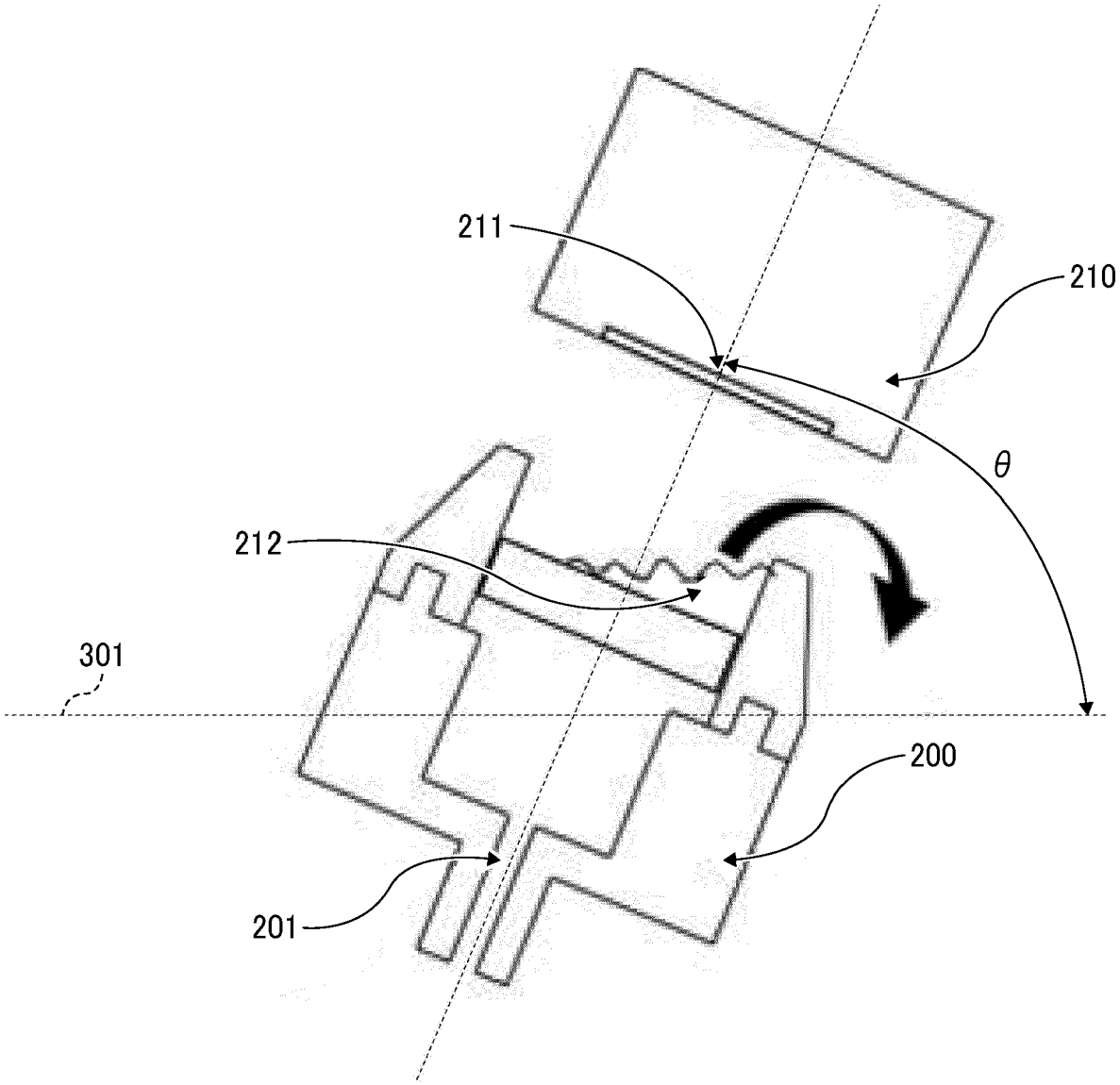


FIG. 8

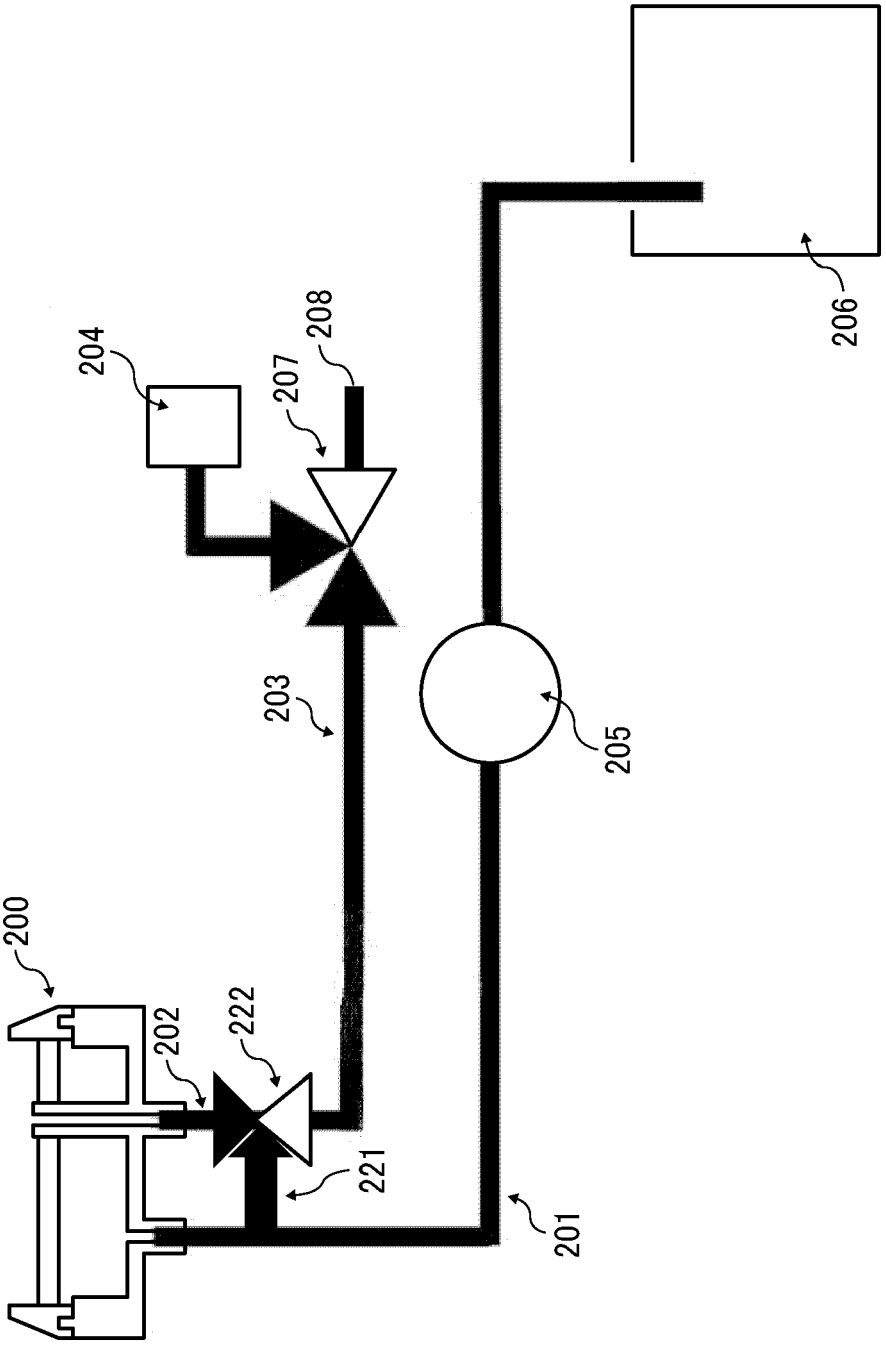


FIG. 9

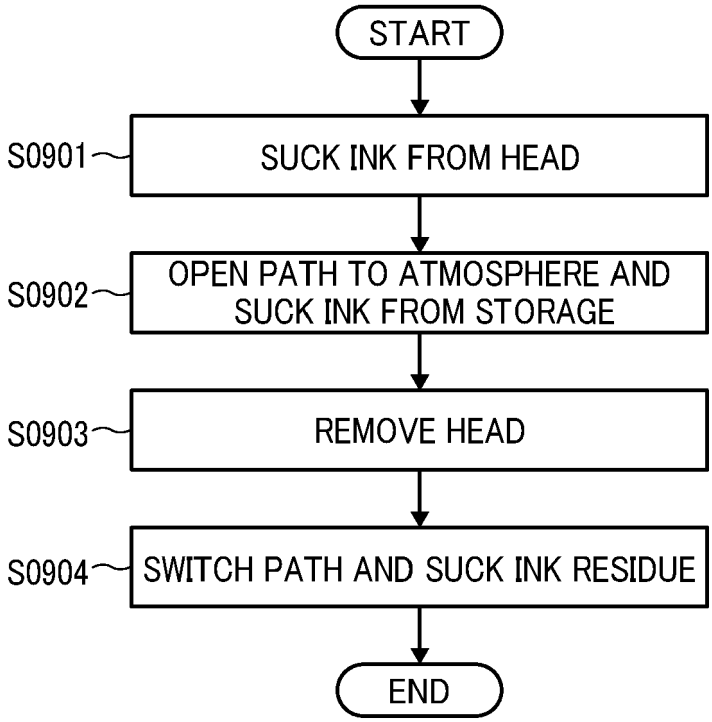

START
S0901
SUCK INK FROM HEAD
S0902
OPEN PATH TO ATMOSPHERE AND SUCK INK FROM STORAGE
S0903
REMOVE HEAD
S0904
SWITCH PATH AND SUCK INK RESIDUE
END

FIG. 10

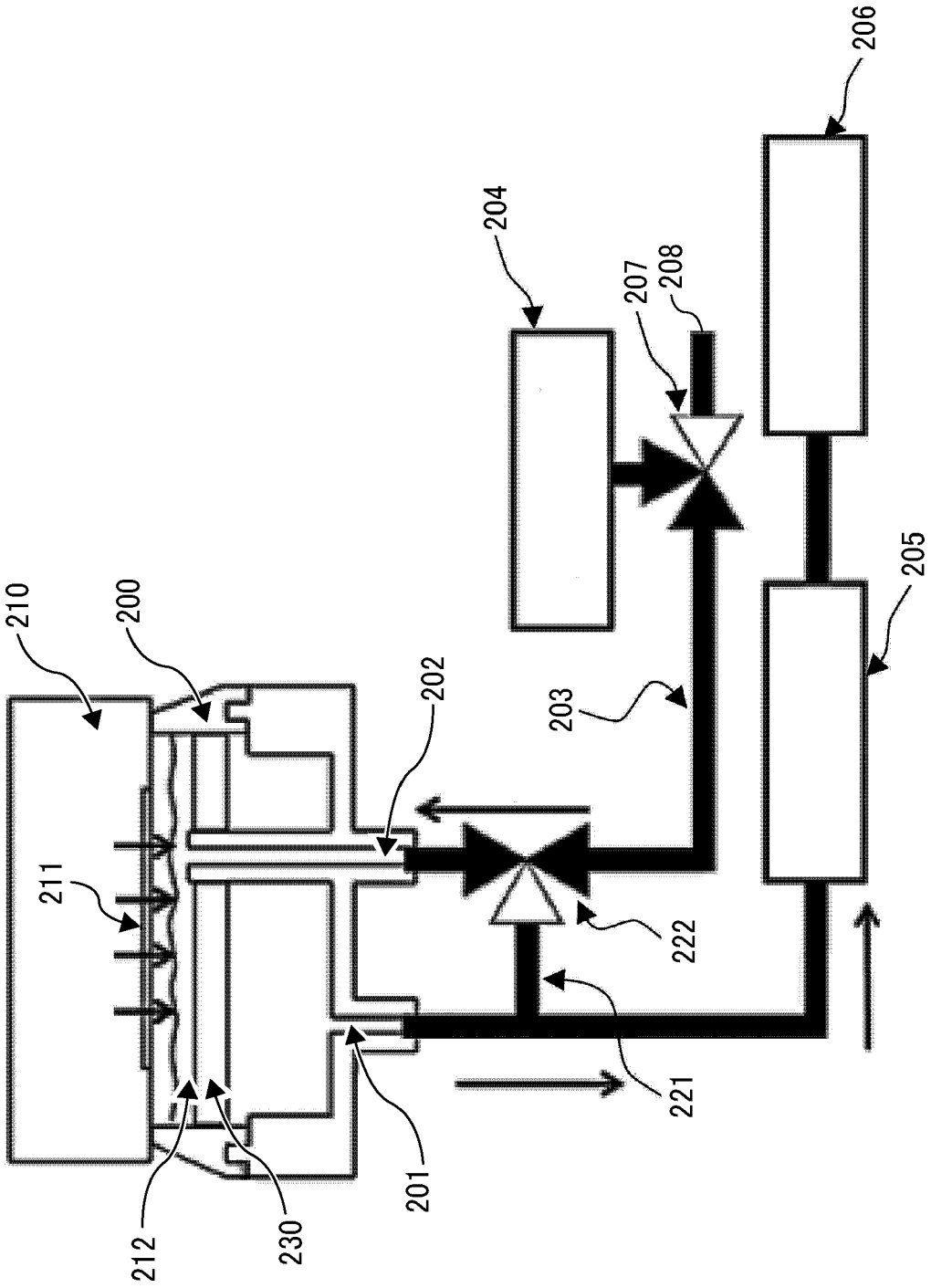


FIG. 11

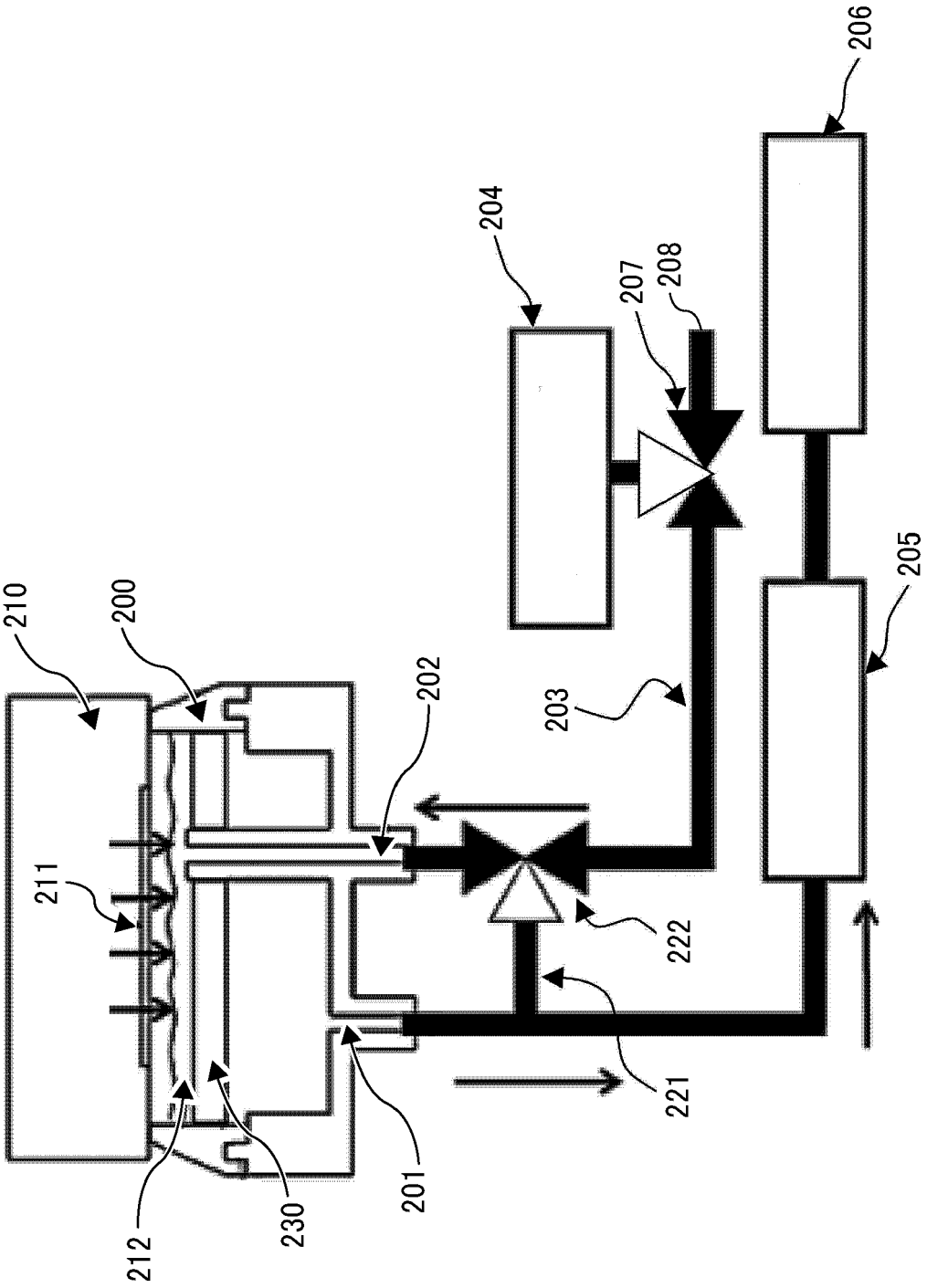


FIG. 12

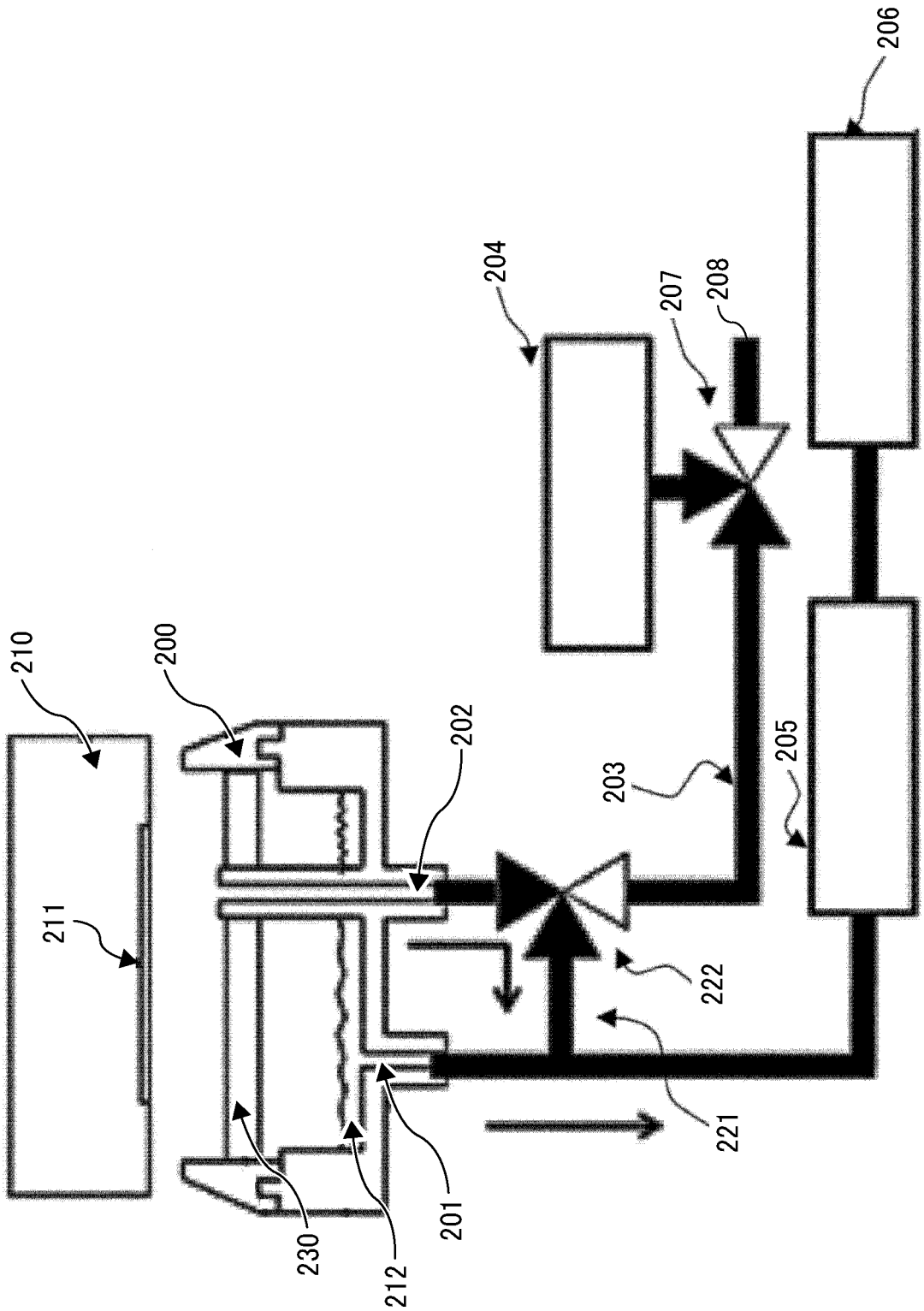


FIG. 13

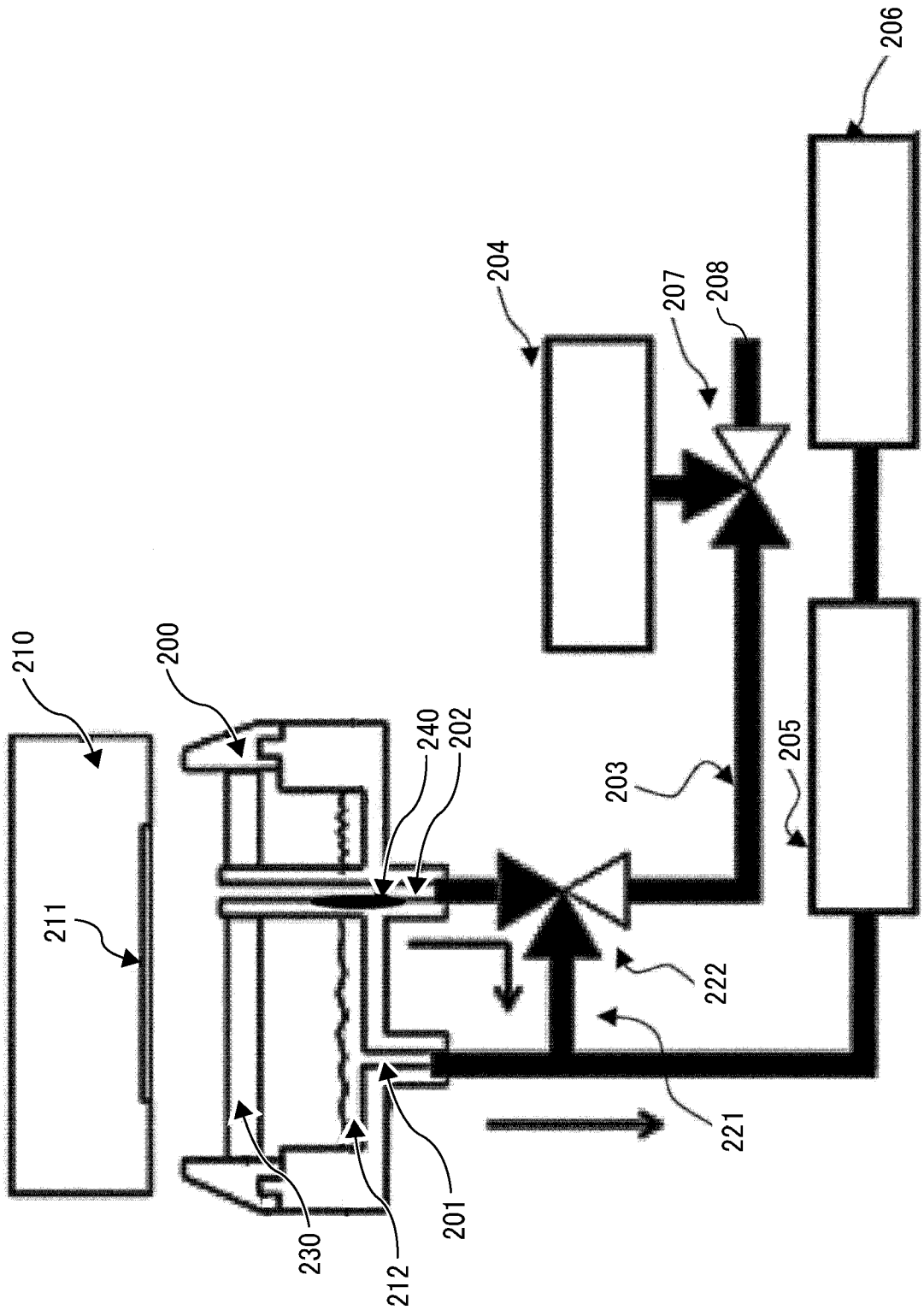
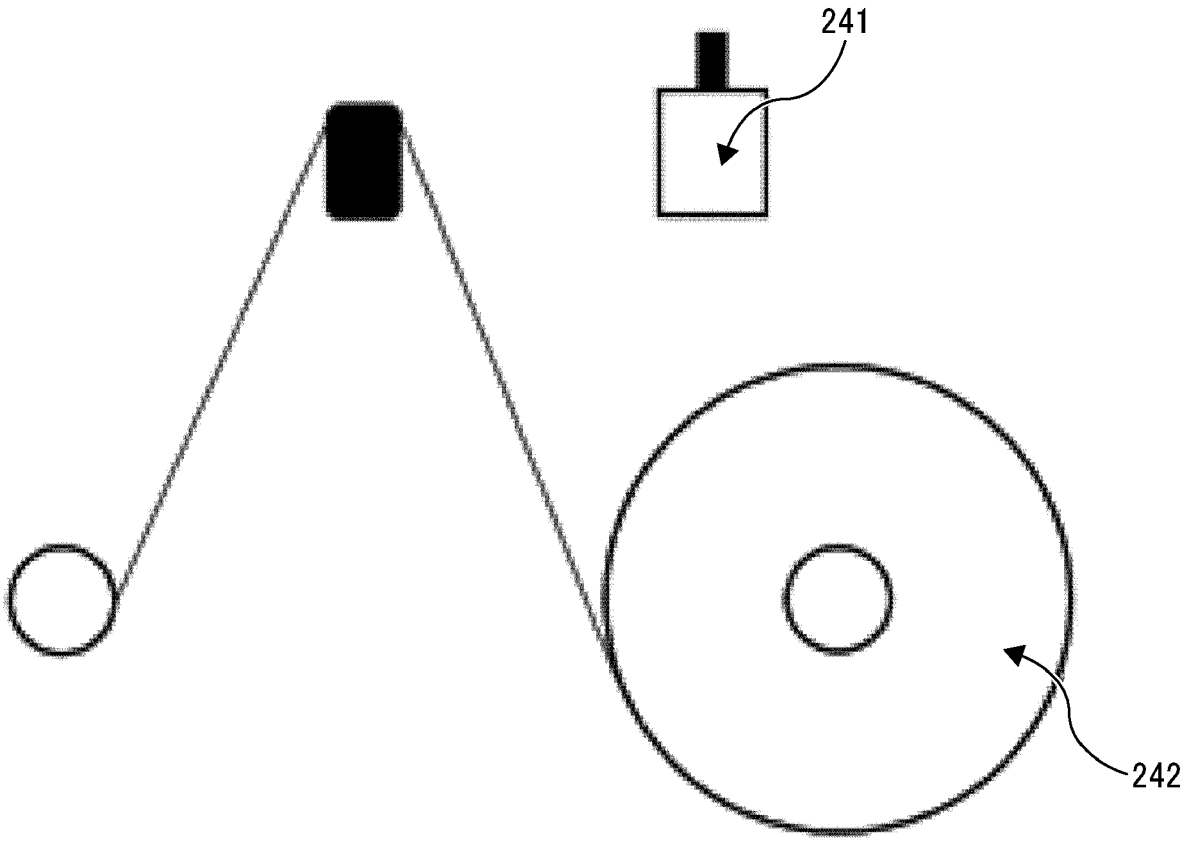


FIG. 14



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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 5308

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2012/133707 A1 (KIKKAWA FUMITAKA [JP] ET AL) 31 May 2012 (2012-05-31) * figures 9, 18-20 * * paragraph [0194] - paragraph [0196] *	1-10	INV. B41J2/165
A	US 5 086 305 A (TERASAWA KOJI [JP]) 4 February 1992 (1992-02-04) * figures 5-6 * * column 6, line 19 - line 58 *	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 November 2023	João, César

CATEGORY OF CITED DOCUMENTS

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13-11-2023

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

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