Ink-jet Recording Apparatus and Recovery Process Method of the Same

DESCRIPTION OF THE INVENTION:

Field of the Invention

The present invention relates to an ink-jet recording apparatus and a recovery process method of the same.

Related Background Art

In an ink-jet recording apparatus, an ink discharge port, such as an orifice provided in a printing head, may be clogged, or bubbles may be mixed in an ink supply path connected to the ink discharge port. This degrades ink droplet discharge performance and causes poor ink discharge.

In conventional ink-jet printing apparatuses, a suction means is provided outside a discharge port to oppose it, and ink is absorbed from the discharge port. Alternatively, a pressure is applied to the interior of the ink supply path, in order to flow the ink at a certain velocity, thus discharging the ink from the discharge port. In this manner, the above-described factors causing poor discharge are eliminated.

In the ink-jet recording apparatuses, however, since a discharge port, a corner or step of a printing head or an ink supply path, or a filter, provided

midway along the supply path, for removing a foreign material has a large flow path resistance, a sufficient flow velocity cannot be obtained. Therefore, if bubbles are present in these portions, they are not discharged but only ink is discharged, and the factors causing poor discharge cannot be eliminated.

In order to eliminate these poor discharge factors, it can also be proposed to increase a suction force of a suction means or a pressure of a pressure means which performs pressurizing, thus maintaining a sufficient flow velocity. For this purpose, however, the overall apparatus is inevitably increased in size.

SUMMARY OF THE INVENTION

According to the present invention a recovery process for an ink jet recording apparatus having a recording head with a discharge port, the process comprising the steps of:

introducing air into the recording head;

applying capping means to the discharge port;

applying suction to the capping means to suck the introduced air and ink through the discharge port.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figs. 1A and 1B are a perspective view of an outer appearance of an ink-jet recording apparatus to which the present invention can be applied, and a front view of an operation panel provided on a front surface of the apparatus;

Figs. 2 and 3 are perspective and plan views, respectively, of a recording section stored in the apparatus shown in Fig. 1A;

Fig. 4 is a schematic diagram of a main part of the apparatus according to an embodiment of the present invention, wherein air is introduced from outside a discharge port;

Fig. 5 is a block diagram of a control system of the embodiment shown in Fig. 4;

Figs. 6A and 6B are flow charts showing a recovery process sequence, respectively, of the control system shown in Fig. 5;

Figs. 7 to 9 are timing charts showing operations of the respective portions in the recovery process;

Fig. 10 is a schematic diagram of a main part of the apparatus according to another embodiment of the present invention;

Fig. 11 is a block diagram of a control system of the embodiment shown in Fig. 11;

Fig. 12 is a flow chart showing a recovery process sequence of the control system shown in Fig. 11;

Figs. 13 to 16 are schematic diagrams of four examples of the present invention wherein the interior of a discharge port is set at a negative pressure and air is taken from the discharge port;

Figs. 17A and 17B are sectional views showing a connection state of an ink supply tube and an ink cartridge;

Figs. 18A and 18B to 21A and 21B are plan views of four examples wherein the position of the ink cartridge shown in Figs. 17A and 17B can be set;

Figs. 22A, 22B, and 22C are front views of three examples of the head front surface arrangement;

Fig. 23 is a schematic diagram of a main part of the apparatus according to still another embodiment of the present invention;

Fig. 24 is a block diagram of a control system in the embodiment shown in Fig. 23;

Fig. 25 is a flow chart of a recovery process sequence of the control system shown in Fig. 24;

Fig. 26 is a schematic diagram of a main part of an apparatus according to still another embodiment of the present invention;

Fig. 27 is a block diagram of a control system of the embodiment shown in Fig. 26;

Fig. 28 is a flow chart of a recovery process sequence of the control system shown in Fig. 27; and

Fig. 29 is a schematic diagram of a modification

of the apparatus shown in Fig. 26.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT:

The present invention will be described in detail with reference to the accompanying drawings.

Figs. 1A and 1B show an outer appearance of an ink-jet recording apparatus to which the present invention can be applied, and an operation panel provided on the front surface of the apparatus, respectively; and Figs. 2 and 3 show a recording section stored in the apparatus shown in Fig. 1A. A so-called serial type ink-jet recording apparatus will be exemplified.

Fig. 1A illustrates an apparatus main body 1000, a power source switch 1100, and an operation panel 1200. The operation panel 1200 can have, as shown in Fig. 1B, an instruction means, such as FF and LF switches 1210 and 1220 and an on-line switch 1230, and a display means, such as an on-line lamp 1250, an alarm lamp 1260, a ready lamp 1270, and so on. The operator requests to convey a recording medium, such as a paper sheet, by means of the switches 1210 and 1220, and inputs an on-line command by means of the on-line switch 1230. The on-line lamp 1250 displays an on-line state of the apparatus. The alarm lamp 1260 alarms an abnormal state. The ready lamp 1270 signals a ready state.

Referring to Figs. 2 and 3, a head 1 has an ink discharge port in its front surface opposing a recording sheet P. The head 1 is mounted on a carriage 22, which moves on a shaft 23 in the direction of arrow S in Fig. 2, together with a subtank 12 which supplies ink to the ink chamber of the head 1 through a tube 17. During movement, the head 1 discharges ink droplets from its discharge port and records on the recording sheet P whose recording surface is regulated by a platen roller 21. An ink cartridge 13 is detachably held by the main body 1200, and has an ink bag 20 and an elastic plug 19. When a hollow needle 18 thrusts the plug 19 till it reaches an appropriate position therein, an ink flow path communicates the ink cartridge 13 and the subtank 12 through a supply tube 14.

The ink supplied to the head 1 is set at a negative pressure relative to the ink level at the discharge port. The supplied ink is constantly substantially maintained at a predetermined level by an ink level adjustment tube 15, and the ink is supplied to the discharge port side by the surface tension. Therefore, the ink is not drawn backward from the discharge port. Ink leakage from the discharge port caused by vibration or the like is also prevented.

A cap unit 100 is arranged at the home position of the carriage 22, and performs capping on the head 1

when the carriage 22 is positioned at the home position. In the cap unit 100, a connecting port 3 has a cap 3A, which is made of an elastic material so that it can be connected with the front surface of the head 1, and which protects the discharge port in the no-recording mode. The connecting port 3 and the cap 3A can be integrally formed. A gear 7A and a positioning cam 7B therefor are shown as examples of a transfer means and constitute a connecting port transfer mechanism for transferring the connecting port 3 in directions T in Fig. 2, thus being connected to/detached from the head 1. Connection/detachment positioning can be performed by turning on/off, e.g., a contact 11B of a switch 11 by the cam 7B.

A discharge means has a pump 6 as a suction means. The pump 6 is connected to the interior of the connecting port 3 and the subtank 12 through a tube 4 defining a suction path and the tube 15 for maintaining the ink level in the subtank 12, respectively, and performs suction. An opening/closing means 8 is provided for an atmosphere open tube 5 for releasing the interior of the connecting port 3 to air, and can use, e.g., an electro-magnetic valve. A closable vent valve 5A is arranged between the electro-magnetic valve 8 of the tube 5 and the connecting port 3. An operation lever 9 has a projection 9A for engaging with a number which closes the vent valve and a pump contact

6A, thus driving the pump 6.

In this embodiment, a lever control member including, e.g., a spring and a latch, is arranged. The lever 9 can be set at on- and off-positions and a medium-position thereof. When the lever 9 is moved from the on-position to off-position and released, it is held at the medium-position. When the lever 9 is moved from the medium-position to off-position and released, it is returned to the off-position. When the lever 9 is at the on-position, the vent valve 5A is closed, and the pump contact 6A is moved down to the lowest position to perform suction. When the lever 9 is at the medium-position, the pump contact 6A is recovered while the vent valve 5A is kept closed. When the lever 9 is at the off-position, the vent valve 5A is opened, and the engagement of the pump contact 6A and the projection 9A is released.

The output of the switch 11 and the shift position of the lever 9 are detected by a controller, as will be described later, and transferring of the connecting port 3, drive of the electro-magnetic valve 8, and so on are controlled.

Fig. 4 shows an arrangement of a main part of the apparatus according to an embodiment of the present invention. In this embodiment, a pressure is externally supplied to the discharge port to introduce air into the recording head 1, and thereafter the pump

6 performs suction, thereby discharging the ink or performing an ink supply recovery process. When a pressure is supplied, the connecting port 3 is repeatedly connected to and detached from the head 1.

Referring to Fig. 4, a vent valve 5A is provided midway along the atmosphere open tube 5. The vent valve 5A is responsive to the operation of the operation lever 9 and can be closed by a portion 9B of the lever 9. An ink absorber 3B is provided in the cap 3A to hold the ink, and is made of a porous material having a liquid-absorbing property. Note that the cap 3A is generally made of a rubber material, such as a silicone rubber and butyl rubber.

A filter 30 is provided midway along the ink supply tube 17, for trapping a foreign material, such as dust, in the supplied ink, thus prohibiting the foreign material from flowing to the recording head 1. A waste ink absorber 16 is arranged in the ink cartridge 13, for receiving the waste ink drawn by the pump 6 through a waste ink tube 10.

Fig. 5 shows an arrangement of a control system of the apparatus according to the embodiment shown in Fig. 4. A controller 200 is, e.g., a microcomputer having a CPU, a ROM, a RAM, and so on, controls the respective portions in accordance with the process sequence stored in the ROM, and drives the head 1 based on the image data received from a host unit or the

like, thus performing recording. A paper sensor PS detects a recording sheet P. When the paper sensor PS detects a paper sheet, the controller 200 drives a platen roller 21 through a paper feeding mechanism 21A including a paper feed motor, thereby controlling paper feed operation. A carriage position sensor CS detects position of the carriage 22. The controller 200 drives the carriage 22 or controls positioning of the carriage 22 to a home position or the like through a carriage motor 22A in accordance with detected position data from the sensor CS.

A transfer mechanism 7 has, in addition to the gear 7A and the cam 7B, a drive member, such as a motor, for transferring the connecting port 3. The controller 200 positions the connecting port 3 with respect to the head 1 in accordance with a contact signal from the switch 11. A command means 1205 and a display means 1255 are provided on the operation panel shown in Fig. 1B. A position sensor LS detects the position of the lever 9 and can be arranged in association with, e.g., the pump contact 6A.

Fig. 6A shows a recovery process sequence by the controller 200 shown in Fig. 5; and Fig. 7 to 9 show operations of the respective sections for performing the recovery process.

First, assume that the carriage 22 is positioned at the home position by turning on of the power source

or at an appropriate timing during recording process. Then, the connecting port 3 is moved to the head 1 in step S1 of Fig. 6A and performs capping. In this state, the operator moves the lever 9 from the off-position to on-position in step S3 (a time point A in Fig. 7), waits for a predetermined period in step S5 until flashing of the alarm lamp ends, and then releases the operation of the lever 9 in step S7. When the lever 9 is moved to the on-position, suction process from a discharge port 2 is performed, and ink fills the connecting port 3 and the suction tube 4. In this case, the electro-magnetic valve 8 is opened for a predetermined period (a period B in Fig. 7) in step S9 in order to prevent excessive ink filling.

Next, the connecting port carrying mechanism 7 is controlled in step S11 to repeat connection/disconnection of the cap 3A and the discharge port 2 several times (a period C of Fig. 7). In this case, air is supplied into the head 1 through the discharge port 2 by means of the elastic cap 3A. Ink fills the cap 3A and the tube 4 to reduce the volume of its free spaces, and filled ink serves as an elastic member. As a result, air is effectively introduced into the cap 3A and the tube 4. When the electro-magnetic valve 8 is opened only immediately before the cap 3A is disconnected from the discharge port 2 during the period C, as shown in Fig. 8, in synchronism with the air-

introduction process of step S11, a negative pressure instantaneously generated in the connecting port 3 immediately before disconnection of the cap 3A can be removed. As a result, introduced air may not be discharged (forward movement of the meniscus) and the ink may not be scattered.

Subsequently, in step S13, the alarm and on-line lamps 1260 and 1250 are flashed in turn, so that they are used as an air introduction alarming means to inform the operator of the end of the air-introduction process. After the lapse of a period D, when the operator moves the lever 9 from the medium-position to on-position (a time point E) in step S15, the suction process is initiated, and the electro-magnetic valve 8 is opened after a predetermined period lapses (a time point F) in step S17. Then, the operator moves the lever 9 to the off-position in step S19, and the electro-magnetic valve 8 is closed in step S21.

In this case, air is introduced to the rear portion of the discharge port 2, i.e., in the head 1 and the supply tube 17. Thus, when negative pressure suction is performed in this state by the pump 6, air is discharged from the discharge port 2 at once, and a flow path resistance is substantially decreased, thereby providing a large suction force. Therefore, factors causing poor discharge in the ink supply path from the subtank 12 to the discharge port 2, i.e., a

foreign material such as bubbles present in the filter 30 or in the corner or step of the supply path can be reliably removed.

Note that ink suction is performed and the cap 3A and the suction tube 4 are filled with ink in steps S3 to S7 so that an increased pressure, generated by connection of the cap 3A, reliably acts on the discharge port 2 during the air-introduction of the rear portion of the discharge port 2. Also, the timing for opening the electro-magnetic valve 8 in step S17 is delayed from the timing for moving the lever 9 to the on-position for the following reasons.

Assume that while the discharge port 2 is completely closed by the cap 3A and the vent and electro-magnetic valves 5A and 8 are closed, the pump 6 is turned on (operative state) at the time point E of Figs. 7, 8, and 9. Then, suction is performed through the suction tube 4, a negative pressure (ink suction negative pressure) is generated in the cap 3A and the atmosphere open tube 5, and suction process from the discharge port 2 is performed.

In this case, the ink drawn from the discharge port 2 together with air fills the cap 3A and leaks from the ink absorber 3B. The ink can also fill the atmosphere open tube 5. This state, however, can inversely affect subsequent ink discharge.

In order to prevent this, in this embodiment, the

electro-magnetic valve 8 is turned on (open state) at a time point F after a predetermined period laspes from the time point E, and the atmosphere open tube 5 is communicated with the atmosphere. Then, the ink leaking from the ink absorber 3B and in the atmosphere open tube 5 is supplied to the pump 6 through the suction tube 4.

As shown in Fig. 9, the pressure (suction pressure waveshape) in the cap 3A becomes a negative pressure with a slight transition delay angle at the time point E when the pump 6 is turned on, and is abruptly returned to the atmospheric pressure at a time point F when the electro-magnetic valve 8 is turned on (opened). Therefore, no ink suction is performed after the time point F.

The period (F - E) between the time point E at which the pump 6 is turned on and the time point F at which the electro-magnetic valve 8 is turned on can be controlled by the controller 200, or by a timer which controls opening/closing of the electro-magnetic valve 8. The period (F - E), i.e., the ink suction period can be arbitrarily changed by adjusting the controller 200 or the timer.

In the above embodiment, the lever 9 is manually operated by the operator. However, it can be operated quite easily by an appropriate command and drive means or by a drive means during control. When the lever 9

is manually operated, a start switch or the like which starts operation from the broken line in Figs. 7 and 8 at the time point A can be provided, thus simplifying the recovery operation.

In this embodiment, pressurization for introducing air from the discharge port is performed by the cap 3A which prevents clogging of the nozzle or dust from being introduced to the supply path. However, a pressurization cap for introducing air from the discharge port 2 can be provided independently of the cap 3A.

If sufficient air is introduced by a single connection operation, repeated connection operation is not needed and only a single connection operation may be performed.

In the above embodiment, pressure is applied from outside the discharge port 2 to introduce air. However, air introduction can be performed by setting the interior of the discharge port 2 at a negative pressure.

Fig. 6B shows another example of a recovery process sequence performed by the controller 200 shown in Fig. 5.

Assume that the carriage 22 is positioned at the home position when the power source is turned on or at an appropriate timing during recording process. Then, the connecting port 3 is moved toward the head 1 to perform capping in step S601. Subsequently, the

electro-magnetic valve 8 is closed in step S603, and the ink cartridge 13 is positioned at a second mount position (a position for blocking the ink supply path) in order to block the ink supply path from the ink cartridge 13 in step S605.

In this state, the lever 9 is moved from off-position to on-position and is released in step S607. At this time, upon movement of the lever 9 to the on-position, the vent valve 5A is closed, and the interior of the ink supply path, extending from the interior of the cap 3A, the subtank 12, to the discharge port 2, is set at a negative pressure through the suction tube 15. Then, the electro-magnetic valve 8 is opened to draw air from the discharge port 2 through the atmosphere open tube 5 in step S609. Subsequently, the ink cartridge 13 is positioned at a first position (a position for communicating the supply path) in step S611, the electro-magnetic valve 8 is closed in step S613, and the lever 9 is moved from the medium-position to off-position in step S615, thereby initiating the suction process.

In this case, air is introduced to the rear portion of the discharge port 2, i.e., in the head 1 and the supply tube 17. Thus, when negative pressure suction is performed in this state by the pump 6, air is discharged from the discharge port 2 at once, and a flow path resistance is substantially decreased,

thereby providing a large suction force. Therefore, factors causing poor discharge in the ink supply path from the subtank 12 to the discharge port 2, i.e., a foreign material such as bubbles present in the filter 30 or in the corner or step of the supply path can be reliably removed.

Fig. 10 shows another embodiment of the main part of the present invention. Referring to Fig. 10, a control means 40 is arranged midway along a supply path 14, for blocking or decreasing an ink supply, and can be, e.g., an electro-magnetic valve. In this embodiment, when the electro-magnetic valve 40 is closed and a pump 6 is operated in this state, a supply path extending from a subtank 12 to a discharge port 2 is set at a negative pressure, thus enabling ink suction from the discharge port 2.

Referring to Fig. 10, a vent valve 5A is provided midway along an atmosphere open tube 5. The vent valve 5A is responsive to the operation of an operation lever 9 and can be closed by a portion 9B of the lever 9. An ink absorber 3B is provided in a cap 3A to hold the ink, and is made of a porous material having a liquid-absorbing property. Note that the cap 3A is generally made of a rubber material, such as a silicone rubber and butyl rubber.

A filter 30 is provided midway along an ink supply tube 17, for trapping a foreign material, such as dust,

in the supplied ink, thus prohibiting the foreign material from flowing to a recording head 1. A waste ink absorber 16 is arranged in the cartridge 13, for receiving the waste ink drawn by the pump 6 through a waste ink tube 10.

Fig. 11 shows an arrangement of a control system of the apparatus according to the embodiment shown in Fig. 10. A controller 300 is, e.g., a microcomputer having a CPU, a ROM, a RAM, and so on, controls the respective portions in accordance with the process sequence stored in the ROM, and drives the head 1 based on the image data received from a host unit or the like, thus performing recording. A paper sensor PS detects a recording sheet P. When the paper sensor PS detects a paper sheet, the controller 300 drives a platen roller 21 through a paper feeding mechanism 21A including a paper feed motor, thereby controlling paper feed operation. A carriage position sensor CS detects position of the carriage 22. The controller 300 drives the carriage 22 or controls positioning of the carriage 22 to a home position or the like through a carriage motor 22A in accordance with detected position data from the sensor CS.

The controller 300 uses a carrying mechanism 7 having, in addition to a gear 7A and a cam 7B, a drive member, such as a motor, for transferring a connecting port 3. With the carrying mechanism 7, the controller 300 positions the connecting port 3 with respect to the

head 1 in accordance with a contact signal from a switch 11. Command and display means 1205 and 1255 are provided on the operation panel shown in Fig. 1B. A position sensor LS can be arranged to operated in association with the lever 9 or a pump contact 6A. Furthermore, the controller 300 controls opening/-closing of an electro-magnetic valve 40 during a recovery process.

Fig. 12 shows another example of a recovery process sequence performed by the controller 300 shown in Fig. 11.

Assume that the carriage 22 is positioned at the home position when the power source is turned on or at an appropriate timing during recording process. Then, the connecting port 3 is moved toward the head 1 to perform capping in step S101. Subsequently, the electro-magnetic valve 8 is closed in step S103, and the electro-magnetic valve 40 is closed in order to block the ink supply path from the ink cartridge 13 in step S103.

In this state, the lever 9 is moved from off-position to on-position and is released in step S107. At this time, upon movement of the lever 9 to the on-position, a vent valve 5A is closed, and the interior of the ink supply path, extending from the interior of the cap 3A, the subtank 12, to the discharge port 2, is set at a negative pressure through the suction tube 15.

Then, the electro-magnetic valve 8 is opened to draw air from the discharge port 2 through an atmosphere open tube 5 in step S109. Subsequently, the electro-magnetic valves 40 and 8 are opened and closed in steps S111 and S113, respectively, and the lever 9 is moved from the medium-position to off-position in step S115, thereby initiating suction process.

In this case, air is introduced to the rear portion of the discharge port 2, i.e., in the head 1 and the supply tube 17. Thus, when negative pressure suction is performed in this state by the pump 6, air is discharged from the discharge port 2 at once, and a flow path resistance is substantially decreased, thereby providing a large suction force. Therefore, factors causing poor discharge in the ink supply path from the subtank 12 to the discharge port 2, i.e., a foreign material such as bubbles present in the filter 30 or in the corner or step of the supply path can be reliably removed.

As shown in Fig. 13, an opening/closing means 42 for a suction path, such as an electro-magnetic valve, which can be controlled by the controller, can be provided midway along the suction tube 4 in addition to the electro-magnetic valve 40, and the air-introduction process can be performed thereby.

More specifically, for example, when the electro-magnetic valve 40 is closed and thereafter the

electro-magnetic valves 8 and 42 are opened and closed, respectively, in order to operate the pump 6, a large negative pressure is generated in the head 1 through the tube 15. As a result, the ink in the head 1 is inversely flown to the subtank 12 through the supply tube 17, and air is drawn from the discharge port 2.

Thereafter, the electro-magnetic valves 40 and 42 are opened and the electro-magnetic valve 8 is closed, respectively, and the pump 6 is operated in this state, thereby obtaining the same effect as that described above.

As shown in Fig. 14, a three-way valve 44 can be provided midway along the suction tube 4 in addition to the electro-magnetic valve 40, and a bypass tube 46 for communicating the three-way valve 44 and an intermediate portion, e.g., a portion 17A, of the supply tube 17 can be provided. In this case, the three-way valve 44 is appropriately switched to select the suction tube 4 side or the bypass tube 46 side as the suction path, thus performing air-introduction process.

More specifically, for example, assume that the electro-magnetic valves 40 and 8 are closed and opened, respectively, thereafter the suction path is switched to the bypass tube 46 side by the three-way valve 44, and the pump 6 is operated in this state. Then, air can be drawn from the discharge port 2 to at least the

portion 17A.

Then, when the electro-magnetic valves 40 and 8 are opened and closed, respectively, and the three-way valve 44 is switched to the suction tube 4 side, thus operating the pump 6, the same effect as that described above can be obtained.

Furthermore, as shown in Fig. 15, a communication tube 52 which communicates the supply tube 17 with the suction tube 4 can be provided. In this case, a three-way valve 54 can be provided to the connecting port of the communication tube 52 with the supply tube 17. The three-way valve 54 can be switched between a position for communicating the subtank 12 side with the head 1 side and a position for communicating the communication tube 52 side with the head 1 side. A three-way valve 56 can also be provided at a connecting port of the communication tube 52 with the suction tube 4. The three-way valve 56 can be switched between a position for communicating the connecting port 3 side with the pump 6 side and a position for communicating the communication tube 52 side and the pump 6 side. Air-introduction process can be performed with this arrangement.

More specifically, the three-way valve 54 is normally set in a state to communicate the subtank 12 with the printing head and hence enable ink supply to the head 1, and the three-way valve 56 is set in a

state to communicate the three-way valve 56 with the port 3 and the pump 6.

For a recovery process, the three-way valve 54 is switched to the position for communicating the head 1 with the communication tube 52, and the three-way valve 56 is set at the position for communicating the communication tube 52 with the pump 6. In other words, the head 1 is allowed to communicate with the pump 6 by the two three-way valves through part of the supply tube 17, the communication tube 52, and the suction tube 4.

In this state, when the pump 6 is operated while the connecting port 3 is kept detached from the head 1 or while the electro-magnetic valve 8 is opened and the cap 3A is kept connected to the head 1, the ink in the head 1 is drawn by suction from the supply tube side, and air is drawn into the head 1 from the discharge port 2.

Subsequently, when the three-way valves 54 and 56 are returned to normal states and the recovery operation is performed in a similar manner to that described above, the same effect as described above can be obtained.

In the embodiments shown in Figs. 10 to 15, the pump 6 also serves as a negative pressure generation means for introducing air into the head 1. However, another negative pressure generation means can also be

used instead.

Fig. 16 shows an example of another negative pressure generation means. Referring to Fig. 16, a three-way valve 64 is provided midway along the supply tube 17, and is communicated with a waste ink absorber 16 through a pump 66 as a negative pressure generation means and a waste ink tube 67. The three-way valve 64 can define a path for communicating the head 1 side with the pump 66 side. An operation lever 63 is a lever for operating the pump 66.

With this arrangement, the three-way valve 64 normally communicates the subtank 12 with the head 1 so as to maintain the ink supply enabled state. When a recovery process is performed, the three-way valve 64 is switched to a position for communicating the head 1 with the pump 66, and the pump 66 is operated by the operation lever 63 so as to generate a negative pressure, thus drawing air from the discharge port 2 into the head 1. In this case, the connecting port 3 is kept in a state detached from the head 1, or the electro-magnetic valve 8 is opened and the connecting port 3 is kept in a state connected to the head 1.

The ink drawn by the pump 66 is recovered by the waste ink absorber 16 in the ink tank 13 through the waste ink tube 67. Then, the three-way valve 64 is returned to a normal state, and a recovery process similar to that described above may be performed.

In the embodiments shown in Figs. 10 to 16, when a negative pressure is generated inside the discharge port 2 and air is introduced from the discharge port 2, an electro-magnetic or three-way valve is provided at an appropriate position in the ink supply path. This valve is arbitrarily switched to perform recovery process. However, considering that ink is supplied when the hollow needle 18 is thrusted into the elastic plug 19 of the ink bag 20, the recovery process can also be performed in the following manner.

Figs. 17A and 17B show examples, respectively, of a connecting port of the supply tube 14 and the ink cartridge 13. Normally, a needle hole 18A of the needle 18 thrusts into a space 19A in the plug 19 of the ink bag 20, thus allowing communication of the ink. In contrast to this, when the recovery process is performed, if the positional relationship of the ink cartridge 13 and the needle 18 is set such that the needle hole 18A of the needle 18 is positioned in the elastic member of the plug 19, as shown in Fig. 17B, the needle hole 18A is closed by the plug 19.

Figs. 18 to 21 show examples of an apparatus wherein position setting shown in Fig. 17 can be performed.

Referring to Figs. 18A and 18B, click points 24A and 24B are provided to an engagement guide 24 of the apparatus main body 1000 which receives the ink

cartridge 13. The click points 24A and 24B hold the ink cartridge 13 at two positions, i.e., a position (second mount position) for blocking the supply path, and a position (first mount position) for communicating the supply path. A stop portion 13A is provided for the ink cartridge 13 to be stopped by the click points 24A and 24B. A needle position fix member 29 is fixed to the main body 1000.

With this arrangement, when the ink cartridge 13 is positioned by the operator or by a given drive means in association with the recovery process, an ink block state (Fig. 18B) by the click point 24A or a communication state (Fig. 18A) by the click point 24B can be obtained.

Referring to Figs. 19A and 19B, a vertically movable stopper 25 is provided under a portion of an engagement path with the ink cartridge 13. When the stopper 25 is at a lower position, an ink communication state (Fig. 19A) can be obtained; when the stopper 25 is at an upper position, an ink block state (Fig. 19B) can be obtained. Note that the stopper 25 can also be provided at an appropriate portion other than the engagement path, e.g., the engagement guide 24.

Referring to Figs. 20A and 20B, when an alignment mark 26 provided on the ink cartridge 13 is aligned with an alignment mark 27 provided in the vicinity of the engagement portion of the main body 1000, an ink

block state (Fig. 20B) is thus obtained. If the marks are not aligned with each other and the needle 18 is engaged at the deepest portion of the ink cartridge 13, a communication state as shown in Fig. 20A can be obtained.

Position setting can be performed by aligning the main body side mark and the end of the cartridge 13.

Figs. 21A and 21B show an example wherein an attachment 28 is detachably provided to the ink cartridge 13, thereby performing positioning. When the attachment 28 is attached, the block state (Fig. 21B) can be obtained; when the attachment 28 is detached, the communication state (Fig. 21A) can be obtained.

In the examples shown in Figs. 17 to 21, the ink supply path can be reliably blocked with considerable ease. These examples can be widely applied to a unit for performing ink suction from outside the discharge port 2, as well as to a unit for performing a recovery process by pressurizing the interior of the discharge port and ejecting the ink.

In the above examples, air is introduced from outside the discharge port 2. However, since the discharge port 2 has a large flow path resistance, as described above, air-introduction process may not be performed quickly in some cases. In order to prevent this, in Figs. 22A, 22B, and 22C, a front surface 1A of the head 1 is arranged in the following manner.

Figs. 22A, 22B, and 22C show three examples of the arrangement of the head front surface 1A. Fig. 22A shows an example of a general arrangement of the head front surface 1A. This arrangement can be adopted when air-introduction process need not be performed quickly. When a quick, reliable air-introduction process must be performed, however, a dummy discharge port 2A having a larger sectional area than the discharge port 2 but not used for actual recording may be provided, as shown in Figs. 22B and 22C.

More specifically, the tension force of the meniscus at a discharge port is defined by a surface tension. Therefore, the larger the sectional area (a radius r if the discharge port is circular), the smaller the tension force of the meniscus, and the easier the air drawing when a positive or negative air pressure is to be introduced. Note that the number or positions of the dummy discharge ports 2A can be arbitrarily selected as required.

In the above examples, the exterior of the discharge port is pressurized or the interior thereof is evacuated, and air is introduced through the discharge port. However, air introduction can be performed in the following manner.

Fig. 23 shows an example of a main part of the apparatus according to still another embodiment of the present invention. In this case, a three-way valve 72

is arranged midway along an ink supply tube 17, e.g., a position of the supply tube 17 closer to the discharge port 2, i.e., at an intermediate position between a head 1 and a filter 30, and the interior of the supply tube 17 is opened to the atmosphere. Usually, the atmosphere side of the three-way valve 72 is closed, and the supply tube 17 can supply the ink to the nozzle.

An atmosphere open valve 5A is provided midway along an atmosphere open tube 5. The atmosphere open valve 5A is responsive to the operation of an operation lever 9 and can be closed by its portion 9B. An ink absorber 3B is provided in a cap 3A to hold the ink, and is made of a porous material having a liquid-absorbing property. Note that the cap 3A is generally made of a rubber material, such as a silicone rubber and butyl rubber.

The filter 30 is provided midway along the ink supply tube 17, for trapping a foreign material, such as dust, in the supplied ink, thus prohibiting the foreign material from flowing to the recording head 1 side. A waste ink absorber 16 is arranged in a cartridge 13, for receiving the waste ink drawn by the pump 6 through a waste ink tube 10.

Fig. 24 shows an arrangement of a control system of the apparatus according to the embodiment shown in Fig. 23. A controller 400 is, e.g., a microcomputer

having a CPU, a ROM, a RAM, and so on, controls the respective portions in accordance with the process sequence stored in the ROM, and drives the head 1 based on the image data received from a host unit or the like, thus performing recording. A paper sensor PS detects a recording sheet P. When the paper sensor PS detects a paper sheet, the controller 400 drives a platen roller 21 through a paper feeding mechanism 21A including a paper feed motor, thereby controlling paper feed operation. A carriage position sensor CS detects position of a carriage 22. The controller 400 drives the carriage 22 or controls positioning of the carriage 22 to a home position or the like through a carriage motor 22A in accordance with detected position data from the sensor CS.

The controller 400 uses a carrying mechanism 7 having, in addition to a gear 7A and a cam 7B, a drive member, such as a motor, for transferring a connecting port 3. With the carrying mechanism 7, the controller 400 positions the connecting port 3 with respect to the head 1 in accordance with a contact signal from a switch 11. Command and display means 1205 and 1255 are provided on the operation panel shown in Fig. 1B. A position sensor LS can be arranged to operate in association with the lever 9 or a pump contact 6A. Furthermore, the controller 400 controls switching of the three-way valve 72.

Fig. 25 shows another example of a recovery process procedure performed by the controller 400 shown in Fig. 24.

When the power source is turned on or the discharge property is degraded, and hence a recovery operation must be performed, the three-way valve 72 is switched to open the tube 17 to the atmosphere in step S210, and a lapse of a predetermined period is waited for in step S203. In this case, since the ink in the supply tube 17 is at a negative pressure, when the tube 17 is opened, the ink is drawn backward to the subtank 12 side, and air is introduced into the supply tube 17. Thereafter, capping of the cap 3A is performed in step S205, an electro-magnetic valve 8 is opened in step S207, and the pump 6 is operated in step S209.

In this case, air fills the supply tube 17. Thus, when negative pressure suction is performed in this state by the pump 6, air is discharged from the discharge port 2 at once, and a flow path resistance is substantially decreased, thereby providing a large suction force. Therefore, factors causing poor discharge in the ink supply path from a subtank 12 to the discharge port 2, i.e., a foreign material such as bubbles present in the filter 30 or in the corner or step of the supply path can be reliably removed.

In the arrangement shown in Fig. 23, a three-way valve is provided between the filter 30 of the ink

supply tube 17 and the head 1 in order to switch the ink flow path. However, an opening means, such as an electro-magnetic valve, can be provided instead in order to open the ink flow path. Alternatively, as shown by a broken line L in Fig. 23, a three-way valve can be provided between the filter 30 of the ink supply tube and the subtank 12. The three-way valve can also be arranged at a position to open the liquid chamber in the head 1, e.g., a position indicated by a broken line I in Fig. 23. Such an opening means can be manually operated by the operator when the recovery process is performed.

When the pump 6 is operated to perform ink suction from the discharge port 2 while the supply tube 17 is open to the atmosphere, the effect of this embodiment is enhanced. Additionally, this embodiment can also be effectively applied to an apparatus which does not perform ink supply using a negative pressure. Air introduction can be performed by a given pressure means through a three-way valve or the like.

Fig. 26 shows another example of a main body of the apparatus according to still another embodiment of the present invention. In this embodiment, ink discharge is performed by bypassing a discharge port having a large flow path resistance, without introducing air to inside the discharge port, thereby performing a recovery process.

Referring to Fig. 26, a branch tube 82 branches from a supply tube 17. A connected portion 86, which can be connected with a cap 3A, is formed on the distal end of the branch tube 82. A three-way valve 80 is provided on the branch portion in order to switch the ink flow path from a subtank 12 between the head 1 side and the connected portion 86 side.

A vent valve 5A is provided midway along an atmosphere open tube 5. The vent valve 5A is responsive to the operation of an operation lever 9 and can be closed by a portion 9B of the lever 9. An ink absorber 3B is provided in a cap 3A to hold the ink, and is made of a porous material having a liquid-absorbing property. Note that the cap 3A is generally made of a rubber material, such as a silicone rubber and butyl rubber.

A filter 30 is provided midway along the ink supply tube 17, for trapping a foreign material, such as dust, in the supplied ink, thus prohibiting the foreign material from flowing to the recording head 1 side. A waste ink absorber 16 is arranged in a cartridge 13, for receiving the waste ink drawn by the pump 6 through a waste ink tube 10.

Fig. 27 shows an arrangement of a control system of the apparatus according to the embodiment shown in Fig. 26. A controller 500 is, e.g., a microcomputer having a CPU, a ROM, a RAM, and so on, controls the

respective portions in accordance with the process sequence stored in the ROM, and drives the head 1 based on the image data received from a host unit or the like, thus performing recording. A paper sensor PS detects a recording sheet P. When the paper sensor PS detects a paper sheet, the controller 500 drives a platen roller 21 through a paper feeding mechanism 21A including a paper feed motor, thereby controlling paper feed operation. A carriage position sensor CS detects a position of a carriage 22. The controller 500 drives the carriage 22 or controls positioning of the carriage 22 to a home position or the like through a carriage motor 22A in accordance with detected position data from the sensor CS.

The controller 500 uses a transfer mechanism 7 having, in addition to a gear 7A and a cam 7B, a drive member, such as a motor, for transferring a connecting port 3. With the transfer mechanism 7, the controller 500 positions the connecting port 3 with respect to the head 1 in accordance with a contact signal from a switch 11. Command and display means 1205 and 1255 are provided on the operation panel shown in Fig. 1B. A position sensor LS can be arranged to operate in association with a lever 9 or a pump contact 6A. Furthermore, the controller 500 controls switching of the three-way valve 80 for a recovery process.

Fig. 28 shows an example of a recovery process by

the controller 500 shown in Fig. 27. First, when the carriage 22 is positioned at the home position while the power source is turned on or at an appropriate timing during a recording process, the head 1 is moved toward the connecting port 3 and capping is performed in step S301. In this case, the electro-magnetic valve 8 is closed.

In this state, the lever 9 is moved from the off- to on-position and is released in step S303. At this time, a vent valve 5A is closed, and ink suction is performed in accordance with the movement of the lever 9 to the on-position.

Subsequently, an electro-magnetic valve 8 is opened for a predetermined period to open the connecting port to the atmosphere in step S305, thereafter the connecting port 3 is detached from the head 1 in step S307, the carriage 22 is driven to oppose a connected portion 86 with the connecting port 3, capping is performed, and a three-way valve 80 is controlled to switch the ink flow path to the connected portion 86 side. Then, the lever 9 is operated in step S309 and suction process from the connected portion 86 side is performed. Namely, with this operation, the ink is discharged at once from the connected portion 86 having a smaller flow path resistance. As a result, factors causing poor discharge in the ink supply path from the subtank 12 to at least the three-way valve 80,

e.g., a foreign material such as bubbles present in the filter 30 or in the corner or step of the ink supply path, can be reliably removed.

After such a suction process, the electro-magnetic valve 8 is opened for a predetermined period in step S311, capping is performed on the head 1 and the flow path is switched by the three-way valve 80 to the head 1 side in step S313, thus ending the process, and a following recording process is waited for.

In this embodiment, a first suction process from the head 1 is performed, and thereafter a second suction process from the connected portion 86 is performed. However, such a second suction process can be performed when necessary, e.g., only when the first suction process is insufficient. Also, in this embodiment, the pump 6 and the connecting port 3 serve as common means for performing ink suction from the head 1 and the connected portion 86. However, separate pumps and connection portions can be provided, and the suction path can be selected by switching a three-way valve. Furthermore, the branch tube from the three-way valve can be directly introduced to the suction tube 4 or the pump 6.

In addition, the connected portion 86 can be integrally provided in the head 1, as shown in Fig. 29. In this case, control can be performed more easily.

In the above description, the present invention

is applied to a serial-type ink-jet recording apparatus. However, the present invention can be applied to any type of ink-jet recording apparatuses which perform recording by discharging ink from discharge ports. For example, the present invention can be applied to a full multi-type apparatus having a plurality of discharge units along the width of a recording paper sheet.

In the above description, operation of the pump and so on is manually performed. However, a given drive means can be used with ease to operate the pump and so on during control.

CLAIMS

1. A recovery process for an ink jet recording apparatus having a recording head with a discharge port, the process comprising the steps of:
introducing air into the recording head;
applying capping means to the discharge port;
applying suction to the capping means to suck the introduced air and ink through the discharge port.

2. A process as claimed in claim 1, wherein the air introduction step is performed by applying the capping means to the port and introducing air into the head through the port.

3. A process as claimed in claim 1, wherein the air introduction step is performed by introducing air to a location in a supply line between the recording head and an ink source therefor.

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4. A process as claimed in claim 1, further comprising the steps of:

separating the capping means from said recording head and thereafter connecting said capping means with the recording head after ink is introduced into a suction path which communicates the capping means with a suction pump; and

thereafter, opening an open/closure means for communicating the interior of the capping means with atmosphere under the state that the capping means connects with said recording head after the lapse of a predetermined time period from the operation of said suction pump; to communicate the interior of the capping means with atmosphere, together with the operation of the suction pump.

5. A process according to claim 4, wherein said open/closure means is opened just before the capping means is separated from said recording head and is closed when said capping means is connected to said recording head.

6. A process according to claim 4 or 5, wherein said connection/separation of the capping means is performed a plurality of times.

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7. A process according to any of claims 4 to 6, further comprising the step of providing an indication when the connection/separation of the capping means has been completed.

8. A process as claimed in claim 1, further comprising the steps of:

causing, after application of the capping means, the pressure of an ink supply path to become negative by means of a pump, acting through the capping means under the condition that said ink supply path through which ink is supplied to said recording head is closed or the quantity of the ink flow in said ink supply path is decreased;

thereafter, opening open/closure means for communicating the interior of said capping means to atmoshphere, and;

thereafter, performing a suction operation for sucking air and/or ink from said discharge port through said capping means by the pump under the condition that said open/closure means is closed, after the conduction of said ink supply path.

9. A process according to claim 8, wherein said closure of said ink supply path or the decrease of the quantity of the ink flow in said ink supply path is

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performed by the movement of an ink cartridge for storing ink.

10. A process according to claim 8, wherein said closure of said ink supply path or the decrease of the quantity of the ink flow in said ink supply path is performed by operation of a valve.

11. A process according to any of claims 8 to 10, wherein a suction line open/closure means is opened when said pump is operated for causing the pressure of said ink supply path to become negative.

12. A process as claimed in claim 1, further comprising the steps of:

causing an ink supply path through which ink is supplied to said recording head to be closed after application of the capping means;

thereafter, opening open/closure means for communicating the interior of the capping means to atmosphere to communicate the interior of said connecting part to atmosphere;

thereafter, performing the operation of a suction pump to suck ink from said discharge port through the capping means;

thereafter, opening said suction path and said ink

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supply path, and closing said open/closure means, and thereafter performing a suction operation with the suction pump.

13. A process as claimed in claim 1, further comprising the steps of:

opening, after application of the capping means, a open/closure means for communicating the interior of said capping means to atmosphere,

thereafter, closing an ink supply path for supplying ink to said recording head therethrough or decreasing the quantity of ink supply;

thereafter, operating a pump for generating suction power with which ink is sucked from said discharge port through said capping means under the condition that said supply path is communicating with a suction path,

for communicating said capping means with said pump therethrough;

thereafter, opening said supply path and closing said open/closure means; and

thereafter, shutting off the communication between said suction path and said supply path, and thereafter, operating said pump.

14. A recovery process according to claim 1, wherein

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said ink supply path is provided with a filter and air is introduced up to the filter.

15. A recovery process according to claim 1, wherein said recording head has a stepped portion and air is introduced up to the stepped portion.

16. A recovery process according to claim 1, wherein a valve portion is closed to keep the interior of the cap communicating with atmosphere and air is introduced in a state that the head is in contact with the cap, and the valve portion is used at an opened state when the head is left at a capping state and at a closed state when capping is released.

17. A recovery process for an ink jet recording apparatus, substantially as described with reference to the drawings.

18. An ink jet recording apparatus adapted to perform the process of any preceding claim and characterised by:

a branch path branching from a middle point of an ink supply path through which ink is supplied to said recording head; and

removing means for removing a foreign material in said

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ink supply path by flowing out the ink through said branch path.

19. An apparatus according to claim 18, wherein said branch flow path communicates with said ink supply path through a valve.

20. An ink jet recording apparatus adapted to perform the process of any of claims 1 to 17, and including:
introducing means for introducing air from said discharge port in to the interior of said recording head, said introducing means including the capping means transfer means for connecting or separating the capping means to or from said recording head, and
control means for controlling said connection or separation operation performed by said transfer means to cause said transfer means to repeatedly perform said operation a plurality of times; and
discharge means for discharging the ink and/or the introduced air from said discharge port.

21. An apparatus according to claim 20, wherein said discharge means includes suction means connected to the capping means.

22. An apparatus according to any of claims 18 to 21,

wherein said capping means has an ink absorbing member for absorbing ink.

23. An apparatus according to claim 20, wherein said recording head has an opening provided on a surface on which said recording head has said discharge port, said opening having an area larger than that of said discharge port and communicating with the ink supply path through which ink is supplied to said recording head, and said opening may be covered with said capping means having no-connection with the discharge of said ink.

24. An ink jet recording apparatus adapted to perform the process of any of claims 1 to 17, and comprising:

transfer means for performing the connection and separation of said capping means to and from said recording head;

control means for controlling said transfer means to perform said connection and separation of said capping means;

said control means introducing gas from said discharge port of said recording head in to the interior of said recording head by the connection of said capping means to said recording head;

opening/closing means for communicating the interior of said capping means with atmosphere prior to the release of said connection; and

discharge means for discharging gas introduced in the interior of said discharge port together with the ink from said discharge port.

25. An apparatus according to claim 24, wherein said opening/closing means comprises a valve.

26. An apparatus according to claim 24 or 25, wherein said recording head includes an opening provided on a surface on which said recording head has said discharge port, having an area larger than that of said discharge port, and communicating with said ink supply path of said recording head, said opening being covered with said capping means having no-connection with said recording.

27. An apparatus adapted to perform the process of any of claims 1 to 17, and comprising:

a branch path provided midway along an ink supply path for supplying the ink to said recording head therethrough, one end of said branch path opening to atmosphere; and

a pump for generating suction power for said ink

supplied to said recording head and/or gas introduced into the interior of said ink supply path from the discharge port, the capping means and the branch path.

28. An apparatus according to claim 27, wherein said branch path has opening means capable of communicating the middle point of said ink supply path with atmosphere.

29. An apparatus according to claim 27 or 28, wherein said ink supply path has an ink storing means which functions as an ink supply source, and a storage member for temporarily storing ink supplied from said ink storing means to supply the supplied ink to said discharge port.

30. An ink jet recording apparatus adapted to perform the process of any of claims 1 to 17, and comprising:

transfer means for causing said capping means to connect and separate to and from said recording head;

control means for controlling said transfer means to cause said capping means to connect and separate to and from said discharge port, and for introducing gas

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into the interior of said discharge port by said connection;

discharge means for discharging liquid present in the interior of said discharge port from said discharge port; and

discharge control means for causing said capping means to connect to said discharge port prior to the connection for said introduction of gas, to drive said discharge means.

31. An apparatus according to claim 30, wherein said discharge means has suction means connected to said connecting part.

32. An ink jet recording apparatus adapted to perform the method of any of claims 1 to 17, and comprising:

limit means provided midway along an ink supply path through which ink is supplied to said recording head, for limitting the quantity of ink to be supplied to said recording head;

introducing means for causing the pressure of the portion between said limit means and said recording head to become negative during the limit operation of said limit means to suck and introduce gas from said discharge port; and

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discharge means for releasing said limit operation after the introduction of gas, to discharge the introduced gas together with the ink.

33. An apparatus according to claim 32, wherein said introducing means includes suction means and a communicating member for communicating said suction means with said portion.

34. An apparatus according to claim 32, wherein said limit means comprises a valve.

35. An apparatus according to claim 32 or 33, wherein said limit means has a holding member for holding said one end of said ink supply path at a first mounting position at which ink from an ink storing member for storing said ink is pulled out, and for holding said one end at a second mounting position at which said pull-out of said ink is blocked.

36. An apparatus according to claim 35, wherein said ink storing member comprises a bag member in which ink is stored, and a closure member made of an elastic member, and said ink supply path has a needle member which has hollow to shape at said one end.

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37. An apparatus according to any of claims 18 to 36, wherein at least one part of said capping means is made of material selected from a silicon rubber and a butyl rubber.

38. An ink jet recording apparatus substantially as described with reference to the drawings.

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