



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

(43) Date of publication:
06.02.2019 Bulletin 2019/06

(51) Int Cl.:
B41J 2/175 ^(2006.01) **B41J 2/18** ^(2006.01)
B41J 29/46 ^(2006.01) **B65H 7/20** ^(2006.01)

(21) Application number: **17774073.5**

(86) International application number:
PCT/JP2017/008674

(22) Date of filing: **06.03.2017**

(87) International publication number:
WO 2017/169528 (05.10.2017 Gazette 2017/40)

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

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(30) Priority: **28.03.2016 JP 2016064238**

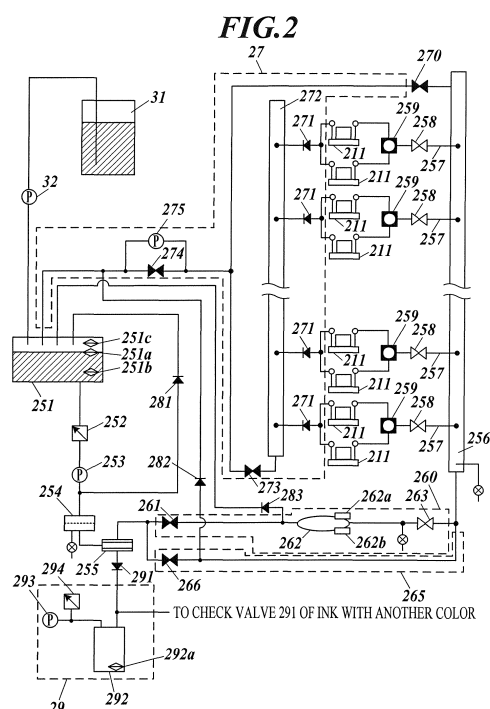
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(54) **INKJET RECORDING DEVICE**

(57) Provided is an inkjet recording device capable of supplying ink to a head while responding to abnormalities in the ink storage level with more appropriate operation efficiency. The present invention is provided with: an inkjet head 211; a main tank 31; a sub-tank 251 for storing supply ink from the main tank 31; a supplying pump 32 for sending ink from the main tank 31 to the sub-tank 251; a liquid delivery pump 253 for sending ink from the sub-tank 251 to the inkjet head 211; a reference sensor 251a, maximum sensor 251c, and minimum sensor 251b for determining whether ink of a prescribed reference storage amount, maximum storage amount, and minimum storage amount, respectively, are stored in the sub-tank 251; and a control unit 40 for determining whether to operate the supplying pump 32 in accordance with the detection result of the reference sensor 251a, and performing a prescribed abnormality response operation in accordance with the detection results of the maximum sensor 251c and the minimum sensor 251b.



Description

Technological Field

[0001] The present invention relates to an inkjet recording device.

Background Art

[0002] Conventionally, there is an inkjet recording device which ejects ink from a nozzle and the ink is landed on a recording medium to form an image. The inkjet recording device is able to form an image on various types of recording mediums, and the device is used widely from household use to industrial use to form images in large amounts.

[0003] Such inkjet recording device includes a device which moves ink from a main ink tank to a sub ink tank and ink is supplied from the sub ink tank depending on the ink ejected from the inkjet head. In such inkjet recording device, when the ink in the sub ink tank decreases, the ink is supplemented from the main ink tank. For example, patent document 1 describes an empty detecting sensor which detects that the sub ink tank is empty and a full detecting sensor which detects that the sub ink tank is full. Patent document 1 describes when empty is detected during image forming by the inkjet head, the ink is supplied from the main ink tank to the sub ink tank until full is detected.

Prior Art Document

Patent Document

[0004] Patent Document 1: Japanese Patent Application Laid-Open Publication No. 2005-306005

Summary

Problems to be Solved by the Invention

[0005] However, when ink is supplied from a first tank as the original ink supplying source and an abnormality occurs in an ink storage amount of a second tank which sends ink to an inkjet head, if the supply of ink is controlled according to detecting empty and full as in conventional techniques, the allowance in the capacity of the second tank becomes small compared to the increasing/decreasing range of the normal ink storage amount. The operation may be stopped immediately even in small abnormalities and the efficiency of the operation decreases. Increasing the number of sensors more than necessary or increasing the capacity of the second tank also leads to decrease in the efficiency of operation.

[0006] The purpose of the present invention is to provide an inkjet recording device which is able to supply ink to the inkjet head while handling abnormalities of the ink storage amount at a more suitable operation efficien-

cy.

Means for Solving the Problem

[0007] To achieve at least one of the abovementioned objects, according to an aspect of the present invention, an inkjet recording device includes: a recording head which ejects ink; a first tank which stores ink; a second tank which stores the ink supplied from the first tank; a first liquid sending unit which sends the ink from the first tank to the second tank; one or a plurality of second liquid sending units which send the ink from the second tank to the recording head; a reference sensor which determines whether the ink stored in the second tank is a predetermined standard storage amount; an upper limit sensor which determines whether the ink stored in the second tank is an upper limit storage amount larger than the standard storage amount; a lower limit sensor which determines whether the ink stored in the second tank is a lower limit storage amount smaller than the standard storage amount; and a controller, wherein, the controller determines whether to operate the first liquid sending unit depending on a detected result of the reference sensor; and the controller performs predetermined abnormality handling operations according to a detected result of the upper limit sensor and the lower limit sensor.

[0008] According to aspect 2, the inkjet recording device according to aspect 1, further includes a collecting flow path which returns the ink from the recording head to the second tank, wherein the difference between the upper limit storage amount and the standard storage amount is larger than an ink capacity of the ink flow path from where the ink is sent out from the second tank to where the ink returns to the second tank.

[0009] According to aspect 3, the inkjet recording device according to aspect 1 or 2, further includes a notification unit which performs a predetermined notification operation, wherein the controller operates the first liquid sending unit when the reference sensor does not detect ink in the standard storage amount and when the reference sensor does not detect ink in the standard storage amount after a predetermined continuing reference time or more passes after operating the first liquid sending unit, the controller controls the notification unit to perform the notification operation.

[0010] According to aspect 4, the inkjet recording device according to any one of aspects 1 to 3, wherein the controller prohibits the ink from being ejected from the recording head as the abnormality handling operation when the lower limit sensor does not detect the ink in the lower limit storage amount.

[0011] According to aspect 5, the inkjet recording device according to any one of aspects 1 to 3, wherein, the lower limit storage amount is set to equal to or larger than a maximum ink amount necessary to form an image in a maximum range that can be set for an image formed by the recording head; and the controller prohibits ink ejection from the recording head after forming the image be-

ing formed at a timing that the lower limit sensor does not detect ink in the lower limit storage amount and before starting the forming of the next image.

[0012] According to aspect 6, the inkjet recording device according to any one of aspects 1 to 5, wherein a maximum liquid sending speed of the ink by the first liquid sending unit is larger than a liquid sending speed of the ink by the second liquid sending unit according to a maximum ink ejecting amount from the recording head when the recording head is in operation.

[0013] According to aspect 7, the inkjet recording device according to any one of aspects 1 to 6, wherein a third tank is provided between the second liquid sending unit and the recording head.

[0014] According to aspect 8, the inkjet recording device according to aspect 3, wherein the controller operates the first liquid sending unit when the reference sensor does not detect ink in the standard storage amount and the controller counts operation time of the first liquid sending unit until the reference sensor detects the standard storage amount again and the controller sets the predetermined continuing reference time based on a result of the counted time counted one or a plurality of times.

Advantageous Effects of Invention

[0015] According to the present invention, it is possible to supply ink to the inkjet head while handling abnormalities of the ink storage amount at a more suitable operation efficiency.

Brief Description of the Drawings

[0016]

FIG. 1 is an entire perspective view showing an inkjet recording device according to an embodiment of the present invention.

FIG. 2 is a diagram which describes an ink flow path of an inkjet recording device.

FIG. 3 is a block diagram showing a functional configuration of an inkjet recording device.

FIG. 4 is a flowchart showing a control process of an ink supply control process.

FIG. 5 is a flowchart showing a modification of an ink supply control process.

Embodiment for Carrying Out the Invention

[0017] An embodiment of the present invention is described with reference to the diagrams.

[0018] FIG. 1 is an entire perspective view of the inkjet recording device 100 according to the present embodiment.

[0019] The inkjet recording device 100 is a device employing a one pass method including a plurality of line heads and is provided with a conveying unit 10, an image forming unit 20, and an ink storage unit 30.

[0020] The conveying unit 10 includes a driving roller 11, a conveying motor 12, and a conveying belt 14. The conveying motor 12 rotates the driving roller 11 at a predetermined speed. A driven roller (not shown) and an endless conveying belt 14 are rolled around the driving roller 11. The conveying belt 14 moves due to the rotation of the driving roller 11. An outer side surface of the conveying belt 14 functions as the conveying surface and the recording medium is placed on the conveying surface. The recording medium is conveyed in a conveying direction due to the circling movement of the conveying belt 14.

[0021] The image forming unit 20 includes a carriage 22 and a carriage raising/lowering unit 23. Such combination of the carriage 22 and the carriage raising/lowering unit 23 is provided in a number of pairs according to the number of colors of ink (here, 8 pairs). The carriage 22 each extend in a direction intersecting with the conveying direction (x-direction) of the recording medium by the conveying unit 10, here the width direction (y-direction) orthogonal to the x-direction. The carriage 22 is positioned above (z-direction) the conveying surface of the recording medium by the conveying unit 10. The structure is a line head structure in which a plurality of inkjet heads 211 (see FIG. 2, recording head) are fixed to be able to eject ink throughout the entire width of the conveyed recording medium. The plurality of carriages 22 are provided in different positions in the conveying direction. The carriage 22 is provided so as to be able to change the distance above from the conveying surface with the carriage raising/lowering unit 23. The distance of the inkjet head 211 from the conveying surface changes together with the movement of the carriage 22.

[0022] The carriage raising/lowering unit 23 changes the distance from the conveying surface of the carriage 22. The carriage raising/lowering unit 23 includes a raising/lowering motor 232, an electromagnetic brake 233, a beam member 234, and a supporting unit 235.

[0023] Two beam members 234 are provided substantially parallel in a direction (here, orthogonal direction, that is, width direction) intersecting with the conveying direction above the conveying belt 14 (conveying surface side of recording medium). The supporting unit 235 is fixed in each edge of the beam members 234. The raising/lowering motor 232, the electromagnetic brake 233, and the carriage 22 are attached to the supporting unit 235.

[0024] The carriage 22 is raised or lowered and the position is determined according to the operation of the raising/lowering motor 232 and the electromagnetic brake 233 driven based on the control signal from the controller 40 (see FIG. 3).

[0025] The raising/lowering motor 232 moves the carriage 22 at a predetermined raising/lowering speed. For example, a servomotor or a stepping motor is used as the raising/lowering motor 232.

[0026] The electromagnetic brake 233 maintains a fixed state of the carriage 22, and when the fixed state

is released in response to a driving signal, the movement of the carriage 22 by the raising/lowering motor 232 is temporarily possible. That is, in a normal state including when the power is cut off, the electromagnetic brake 233 fixes the carriage 22. As the electromagnetic brake 233, for example, a disk brake is used.

[0027] The ink storage unit 30 stores ink in each color used in forming the image and supplies the ink to the inkjet head 211. The components of the ink storage unit 30, here, are positioned in a dedicated rack 35, and are connected to the image forming unit 20 through piping such as tubes.

[0028] Next, the configuration regarding an ink flow path from the ink storage unit 30 to the image forming unit 20 in the inkjet recording device 100 according to the present embodiment is described.

[0029] FIG. 2 is a diagram describing a configuration of an ink flow path in the inkjet recording device 100 according to the present embodiment.

[0030] The ink storage unit 30 includes a main tank 31 (first tank) and a supplying pump 32 (first liquid sending unit).

[0031] The main tank 31 is provided for each ink color, and is arrayed in the rack 35. The ink of the main tank 31 is sent from the supplying pump 32 to the image forming unit 20. The entire main tank 31 can be exchanged, and the main tank 31 is formed to be detachable from the ink flow path leading to the supplying pump 32 regardless of the operation state of the supplying pump 32. That is, the main tank 31 can be attached while the supplying pump 32 is in a state of operation, and therefore, the ink can be immediately sent to the image forming unit 20 again.

[0032] The supplying pump 32 is not limited, and for example, a diaphragm pump or a tube pump can be used.

[0033] In the image forming unit 20, the ink sent from the main tank 31 by the supplying pump 32 is stored in a sub-tank 251 (second tank). For such sub-tank 251, after the ink sent out from the sub-tank 251 reaches the inkjet head 211, the ink flow path returning to the sub-tank 251 again is provided (circulating flow path).

[0034] A flowmeter 252, a liquid sending pump 253 (second liquid sending unit), a filter 254, a deaerating module 255, and a liquid sending common flow path 256 are provided from the sub-tank 251 to the inkjet head 211 (liquid sending flow path). A plurality of individual flow paths 257 are divided from the liquid sending common flow path 256. The ink passes through the individual supplying valve 258 and the damper 259 to be sent to the inkjet head 211. The dampers 259 are connected to the inkjet head 211 in pairs.

[0035] Between the deaerating module 255 and the liquid sending common flow path 256, the ink flow path is divided between an intermediate tank flow path 260 and a maintenance flow path 265. The intermediate tank flow path 260 is provided with an intermediate tank distributing valve 261, an intermediate tank 262 (third tank), and a common supplying valve 263.

[0036] The maintenance flow path 265 is provided with a maintenance flow path distributing valve 266.

[0037] In a collecting flow path 27 from a collection opening (outlet) of the inkjet head 211 to the sub-tank 251, first, after the flow paths of the ink discharged from two inkjet heads 211 divided in the damper 259 are joined, the joined flow path passes the check valve 271 to be joined with the collecting common flow path 272. Then, from the collecting common flow path 272, the ink flows through the collecting valve 273 and the circulating valve 274 so that the ink returns to the sub-tank 251. The collecting pump 275 is provided parallel with the circulating valve 274.

[0038] An edge of the liquid sending common flow path 256 opposite to the ink inflow side is connected directly to the downstream side of the collecting valve 273 through the bypass valve 270.

[0039] A release flow path which returns the ink to the sub-tank 251 is provided in between the liquid sending pump 253 and the filter 254, on the downstream side than the maintenance flow path distributing valve 266 of the maintenance flow path 265, and on the downstream side than an intermediate tank distributing valve 261 of the intermediate tank flow path 260, the ink passing through the check valves 281, 282, and 283, respectively. When ink sent out from the sub-tank 251 by the liquid sending pump 253 cannot flow to the inkjet head 211 due to problems in the filter 254, the deaerating module 255, the intermediate tank 262, or the liquid sending common flow path 256, or when the ink cannot flow and the ink accumulating midway of the liquid sending flow path increases resulting in increase of the ink pressure, if the ink pressure exceeds a predetermined pressure threshold, the check valves 281 to 283 as the relief valves are opened to return the ink to the sub-tank 251.

[0040] The capacity of the sub-tank 251 is smaller than the capacity of the main tank 31. In order to detect the ink storage amount, the sub-tank 251 is provided with a reference sensor 251a, a lower limit sensor 251b, and an upper limit sensor 251c. The reference sensor 251a detects whether a standard storage amount of ink is stored to determine whether to supply ink from the main tank 31 to the sub-tank 251 with the supplying pump 32 (whether the supplying pump 32 is operated). That is, when the ink storage amount is smaller than the standard storage amount, the supplying pump 32 is operated and when the ink storage amount is larger than the standard storage amount, the supplying pump is stopped.

[0041] The lower limit sensor 251b detects whether a lower limit storage amount of ink is stored to determine whether to prohibit operation of the inkjet head 211. That is, the lower limit storage amount is smaller than the standard storage amount, and when the ink storage amount is smaller than the lower limit storage amount, the operation ((ink ejection) of the inkjet head 211 is prohibited. When the ink is suitably supplied from the main tank 31 to the sub-tank 251, the ink amount of the sub-tank 251 does not decrease greatly from the standard

storage amount. Therefore, when the amount of ink is smaller than the lower limit storage amount, this means that there is an abnormality such as there is no ink supply.

[0042] The upper limit sensor 251c detects whether ink is stored in the amount of an upper limit storage amount which shows danger of the sub-tank 251 overflowing. The upper limit storage amount is set to be larger than the total of the standard storage amount and the ink capacity of the entire circulating flow path (liquid sending flow path, inkjet head 211 and collecting flow path 27). That is, even if the ink is not ejected from the nozzle of the inkjet head 211 at all and all of the ink is returned to the sub-tank 251, the amount of ink still does not exceed the upper limit storage amount. Therefore, when the amount of ink is larger than the upper limit storage amount, this shows an abnormality such as excess ink supply or something other than ink is mixed.

[0043] In the inkjet recording device 100 according to the present embodiment, the sub-tank 251 is exposed to the atmosphere and the pressure on the ink is normally maintained to atmospheric pressure.

[0044] The flowmeter 252 detects and outputs the amount of liquid sent from the sub-tank 251 to the inkjet head 211 side by the liquid sending pump 253. The value measured by the flowmeter 252 here is used for displaying the status on the operation/display unit 42 (see FIG. 3) and holding history information, and is not used for detecting abnormalities, but the value can be used for calculating notification reference time described later.

[0045] The liquid sending pump 253 sends the ink inside the sub-tank 251 at a predetermined liquid sending speed (amount of liquid sent for a unit of time) to the filter 254 and its downstream side, that is, the side of the inkjet head 211 (liquid sending flow path). One liquid sending pump 253 is provided for the sub-tank 251 and this supplies ink to all of the inkjet heads 211. Alternatively, the inkjet heads 211 can be divided into a plurality of blocks including a predetermined number of inkjet heads 211 and a separate liquid sending pump 253 can be provided for each block to supply the ink from the sub-tank 251. The liquid sending abilities of the liquid sending pump 253 is to be able to sufficiently supply the maximum ink ejecting amount ejected by the inkjet head 211 for each unit of time when the image is formed. The liquid sending speed of the ink according to such maximum ink ejecting amount is slower than the maximum liquid sending speed of the ink of the supplying pump 32. Therefore, the liquid sending abilities of the liquid sending pump 253 does not have to be as good as the supplying pump 32, but a pump which is equal to the supplying pump 32, that is, the same type can be used. In this case, even if the maximum amount of ink is ejected from the inkjet head 211 (a solid image is formed, for example), the liquid sending pump 253 does not have to operate at the maximum liquid sending speed of the ink.

[0046] The filter 254 removes foreign matter and impurities such as debris and dust or large bubbles in the ink. As described above, the sub-tank 251 is exposed to

the atmosphere and the foreign matter, impurities, and bubbles may be mixed. Therefore, the filter 254 prevents the above from being sent to the inkjet head 211.

[0047] The deaerating module 255 removes air (gas) included in the ink. For example, the deaerating module 255 places the ink in contact with a vacuum region through a deaerating film and the air in the ink can be selectively absorbed in the vacuum region side. As the deaerating film, in order to effectively increase the area in contact with the ink and to more evenly come into contact with the ink, for example, a structure with a large number of microscopic threads with a vacuum state inside can be employed.

[0048] Here, the vacuum pump 293 absorbs the air on the vacuum region side of the deaerating module 255. The vacuum region here does not have to be an ultra-high vacuum state and a predetermined pressure sufficiently lower than the atmospheric pressure is set in advance. The pressure sensor 294 measures the pressure on the vacuum region side and the operation of the vacuum pump 293 is controlled according to the measurement value of the pressure sensor 294.

[0049] The vacuum region side of the deaerating module 255 is connected to the chamber 292 through the check valve 291. The slight amount of ink which may pass the deaerating film or the ink which may leak to the vacuum region side at once when the deaerating film breaks flows to the bottom of the chamber 292 and is stored. The ink which gathers at the bottom of the chamber 292 is detected by a liquid amount sensor 292a to determine whether there is an abnormal amount of the leak of ink. When an abnormality is detected, the operation of the vacuum pump 293 and each unit is stopped, and the vacuum region is in communication with the atmosphere. As described above, the chamber 292 is used as a trap for the leaked ink, and this prevents the leaked ink from reaching the vacuum pump 293. As a result, this prevents the vacuum pump 293 from malfunctioning or being damaged.

[0050] Other than a device which directly measures the liquid amount, the following can be used as the liquid amount sensor 292a, a device which measures the change in the weight of the chamber 292 or a device which optically, electrically, or magnetically measures the signal output in response to the deforming from a member which changes in response to the change in weight, for example, the actuator which deforms by the load according to the weight of the chamber 292.

[0051] An absorbing unit 29 including the chamber 292, liquid amount sensor 292a, pressure sensor 294, and vacuum pump 293 is provided commonly in the deaerating module 255 in the circulating flow path provided for each ink color and the flow is joined downstream of the check valve 291 (chamber 292 side). That is, when an ink with a certain color leaks from the deaerating module 255, the check valve 291 prevents the ink with the certain color from flowing into the vacuum region side of the deaerating module 255 in the circulating flow path of

the ink with another color.

[0052] An intermediate tank distributing valve 261 is provided near an entrance of the intermediate tank flow path 260 separated from the maintenance flow path 265 downstream of the deaerating module 255 and opens and closes according to whether the ink can flow to the intermediate tank flow path 260. The intermediate tank flow path 260 is open when the ink is supplied to the inkjet head 211 in normal image forming. As the valve to control the intermediate tank distributing valve 261 and the open/close state, although not limited, here an electromagnetic valve is used, for example, a solenoid valve which switches open and close of the flow path by moving the plunger (movable iron) provided in the ink flow path by electromagnetic force or spring force. The open/close movement is performed according to the voltage applied by control from the controller 40 (see FIG. 3). The black colored valve in FIG. 2 such as the intermediate tank distributing valve 261 is a valve in a closed state in the normal state (in ground voltage supplying state or when voltage is not supplied). The outlined valve in FIG. 2 such as the common supplying valve 263 is the valve in the open state in the normal state.

[0053] The intermediate tank 262 is a tank with a smaller capacity than the sub-tank 251 and is used to maintain the ink in the inkjet head 211 to a suitable back pressure (negative pressure), that is, pressure lower than the atmospheric pressure. Therefore, the intermediate tank 262 is formed with a flexible material and can suitably deform by the difference in pressure between the ink pressure and the outside pressure. The intermediate tank 262 is provided in a position slightly lower in the vertical direction than the nozzle surface on which the nozzle opening of the inkjet head 211 is aligned. As a result, by applying further pressure to the ink by the liquid sending pump 253 and the pressure chamber in the inkjet head 211, the ink does not leak out naturally from the nozzle opening other than when the ink is ejected intentionally. When the ink is ejected from the nozzle opening and the ink of the inkjet head 211 decreases, the ink flows from the intermediate tank 262 to the inkjet head 211 according to the reduction amount (ink ejecting amount).

[0054] The intermediate tank 262 is provided with an intermediate upper limit sensor 262a and an intermediate reference sensor 262b.

[0055] The intermediate reference sensor 262b detects the intermediate reference ink amount suitably set to obtain the suitable back pressure. The operation of the liquid sending pump 253 is suitably controlled according to whether the ink is detected in the intermediate reference ink amount by the intermediate reference sensor 262b. The intermediate upper limit sensor 262a detects the upper limit ink amount determined so as not to be dangerous to maintain the intermediate tank 262. Normally, when the ink amount in the intermediate tank 262 rises more than normal and the pressure of the ink rises, the check valve 283 is released and the ink is returned to the sub-tank 251. When the check valve 283 does not

function normally, the process regarding the operation of supplying ink can be paused entirely or other suitable processes can be performed depending on the detection by the intermediate upper limit sensor 262a.

[0056] The maintenance flow path distributing valve 266 switches whether the ink sent out from the liquid sending pump 253 is flown into the maintenance flow path 265. As shown here, the maintenance flow path distributing valve 266 and the intermediate tank distributing valve 261 can be closed at the same time. For example, when the image is formed, if the ink amount in the intermediate tank 262 is within a suitable range and there is no need to additionally supply ink to the intermediate tank 262 with the liquid sending pump 253, both the maintenance flow path distributing valve 266 and the intermediate tank distributing valve 261 are closed.

[0057] The maintenance flow path 265 is used when the ink is pressured and sent by the liquid sending pump 253 as is to the liquid sending common flow path 256 and the inkjet head 211 for the purpose of introducing ink, ejecting air (bubbles) and flowing the factors causing clogging. For example, when all of the individual supplying valves 258 are closed and the pressured ink is sent while opening the bypass valve 270, the ink is introduced to the liquid sending common flow path 256 and the ink is flown to flow the internal air to the collecting flow path 27 and the sub-tank 251. When the pressured ink is sent by the liquid sending pump 253 in a state with all of the individual supplying valves 258 and the collecting valves 273 open, the ink is filled in the ink flow path in each inkjet head 211. When the pressured ink is sent by the liquid sending pump 253 with the individual supplying valve 258 opened and the collecting valve 273 closed, the pressured ink is ejected from the nozzles of the inkjet head 211, and the bubbles in the nozzle are discharged. With this, the cause of clogging in the nozzle opening such as solidified mass of ink is discharged and the clogging is solved.

[0058] The common supplying valve 263 switches whether ink is supplied from the intermediate tank 262 to the liquid sending common flow path 256 and the inkjet head 211. In the closed state, when the pressured ink is supplied to the common flow path through the maintenance flow path 265, the common supplying valve 263 prevents the ink from flowing backward to the intermediate tank 262.

[0059] The individual supplying valve 258 switches whether ink is supplied from the liquid sending common flow path 256 to the individual flow path 257 which communicates with the plurality of inkjet heads 211 and which is separated from the liquid sending common flow path 256. In normal image forming, all of these individual supplying valves 258 are opened. When the ink in the intermediate tank 262 and the liquid sending common flow path 256 is not ejected outside but is returned to the sub-tank 251 and collected, the individual supplying valves 258 are closed and the bypass valve 270 is opened. When ink is selectively supplied to some of the inkjet

heads 211 for inspection or cleaning of the some of the inkjet heads 211, only the individual supplying valve 258 provided in the individual flow path 257 communicating with the above-described some of the inkjet heads 211 is opened, and the other individual supplying valve 258 is closed.

[0060] Here, four individual flow paths 257 are shown as an example. This number can be suitably set as long as problems do not occur when the ink is supplied to the inkjet head 211 or when ink is ejected from the nozzle.

[0061] The damper 259 is a buffer which reduces the pressure change according to the status of the ink ejecting from the plurality of inkjet heads 211 and the status of the liquid sent (pressured ink) from the liquid sending pump 253. As described above, by suppressing the spread of the change in pressure regarding the operation of the other inkjet heads 211 and the liquid sending pump 253, and by providing pressure in a suitable pressure pattern to the ink in the inkjet head 211 when the ink is ejected from the inkjet head 211, the ink can be ejected normally.

[0062] A plurality of nozzles are arrayed in the inkjet head 211. The ink supplied from the damper 259 to the inkjet head 211 is further divided to ink flow paths communicating with each nozzle. The ink flow path is provided with a pressure chamber (not shown). By providing pressure in a suitable waveform to the ink in the pressure chamber, the ink is ejected or the ink which is not ejected is suitably shaken in the nozzle to prevent drying or deteriorating of the ink. The method to apply pressure to the ink in the pressure chamber can be selected from various well-known methods. Here, the piezo method is employed, and voltage is applied using a piezoelectric element or vibrating plate to deform the pressure chamber to change the pressure on the ink.

[0063] The check valve 271 allows the discharged ink which is not ejected by the nozzle from the inkjet head 211 to flow to the common collecting common flow path 272 and prevents the ink from flowing backward from the collecting common flow path 272 to the inkjet head 211. That is, the ink discharged from some of the inkjet heads 211 do not flow backwards to the other inkjet heads 211.

[0064] The collecting common flow path 272 which joins the discharged ink which is not ejected from the inkjet head 211 and flows the ink to the sub-tank 251 side has substantially the same configuration as the liquid sending common flow path 256 and for example, is shaped in a tube shape. Both the liquid sending common flow path 256 and the collecting common flow path 272 are formed sufficiently larger (cross-sectional area is larger) than the individual flow path 257. This suppresses the influence from the change in the flow amount and the ink pressure regarding the change in the ink supply amount to the individual flow path 257 from spreading.

[0065] The collecting valve 273 switches whether to return the ink from the collecting common flow path 272 to the sub-tank 251. The collecting valve 273 is closed when the bypass valve 270 is opened so that the ink

flowing from the liquid sending common flow path 256 to the bypass valve 270 does not return to the collecting common flow path 272.

[0066] The ink passing the bypass valve 270 or the collecting valve 273 passes the circulating valve 274 or the collecting pump 275 and returns to the sub-tank 251. When the ink sent out from the liquid sending pump 253 and not ejected from the nozzle of the inkjet head 211 is drawn and returned to the sub-tank 251, the circulating valve 274 is closed and the collecting pump 275 is operated. With this, the ink remaining in the inkjet head 211 or in each unit such as the intermediate tank 262 is drawn and returned to the sub-tank 251. Therefore, the ink can be removed from the inkjet head 211 and inside the intermediate tank 262.

[0067] Further, the collecting pump 275 not only draws the ink but also draws the air in the ink flow path. When the ink is not supplied to the circulating flow path, such as in the default state or when restarted after maintenance, the collecting pump 275 draws the air in the circulating flow path. Specifically, by removing almost all of the air in the intermediate tank 262 and then introducing the ink in the intermediate tank 262 with the liquid sending pump 253, it is possible to prevent the air remaining in the intermediate tank 262 causing unnecessary pressure or the air being mixed with the ink and flown to the inkjet head 211 causing trouble in ejecting ink. Normally, when the ink is introduced, the removal of air and the collecting of ink by the collecting pump 275 and the introduction of ink by the liquid sending pump 253 is repeated a plurality of times. With this, it is possible to easily introduce ink while reliably preventing the air from remaining in the circulating flow path, specifically, between the sub-tank 251 and the inkjet head 211.

[0068] When there is no need to remove the ink inside the inkjet head 211 and the intermediate tank 262, and the ink sent by the liquid sending pump 253 is simply circulated, the circulating valve 274 is opened without operating the collecting pump 275. With this, the circulating flow of the ink is caused only by the liquid sending pressure of the liquid sending pump 253.

[0069] A discharge valve is provided on the downstream side of the filter 254, downstream of the intermediate tank 262, and in the liquid sending common flow path 256. The user opens the discharge valve as necessary so as to be able to discharge ink.

[0070] Next, the functional configuration of the inkjet recording device 100 according to the present embodiment is described.

[0071] FIG. 3 is a block diagram showing a functional configuration of the inkjet recording device 100.

[0072] The inkjet recording device 100 is provided with the following which are described above, the conveying motor 12, the supplying pump 32, the liquid sending pump 253, the collecting pump 275, the vacuum pump 293, the reference sensor 251a, the lower limit sensor 251b, the upper limit sensor 251c, the intermediate upper limit sensor 262a, the intermediate reference sensor 262b, the

pressure sensor 294, the liquid amount sensor 292a, the intermediate tank distributing valve 261, the maintenance flow path distributing valve 266, the common supplying valve 263, the individual supplying valve 258, the bypass valve 270, the collecting valve 273, the circulating valve 274, the electromagnetic brake 233, and the raising/lowering motor 232. In addition to the above, the inkjet recording device 100 is provided with a controller 40, a communicating unit 41, an operation/display unit 42, a head driving unit 24, a motor driver 231, and a notification operating unit 43 (notifying unit).

[0073] The controller 40 centrally controls the entire operation of the inkjet recording device 100 and controls the operation of each unit. The controller 40 includes a CPU 401 (Central Processing Unit), a RAM 402 (Random Access Memory), a ROM 403 (Read Only Memory) and a memory 404.

[0074] The CPU 401 performs various calculating processes and controls the conveying of the recording medium, supplying of the ink, ejecting of the ink, maintenance operation and the like in the inkjet recording device 100. The CPU 401 performs various processes regarding the image forming based on the image data, and status signals and clock signals of each unit according to the programs read from the ROM 403.

[0075] The RAM 402 provides a memory space for work in the CPU 401 and stores temporary data.

[0076] The ROM 403 stores the control program and the default setting data. The control program includes the above-described program regarding the control of the ink supply. The initial setting data includes the initial value of the notification reference time (predetermined continuing reference time). The notification reference time is the reference time regarding detecting the abnormality in the operation time (continuing time of the liquid sending operation) of the supplying pump 32 when the ink is supplied from the main tank 31 to the sub-tank 251. That is, if the operation time of the supplying pump 32 exceeds the notification reference time but the ink is not stored to a level that the operation of the supplying pump 32 is stopped, that is, the ink is not stored to the standard storage amount, it is determined that there is an abnormality in the supplying of ink, mainly, the main tank 31 lacks ink. As the initial value of the notification reference time, the following amount of time can be set, an amount of time in which there is some time added to the time necessary to recover the ink amount to the standard storage amount according to the assumed maximum operation time, for example, the difference between the ink consumption speed (ink ejected amount for a unit of time) when the image is formed in the most ink consuming style (that is, solid image) and the liquid sending speed of ink when the supplying pump 32 operates normally.

[0077] ROM 403 includes a rewritable nonvolatile memory and stores a notification reference time 403b which holds the newest setting of the notification reference time updated and maintained as necessary and supply time history data 403a which is continuing time of

the liquid sending operation when the supplying pump 32 is operated, that is, history data of ink supply time to the sub-tank 251. As history data, it is possible to set the data so that only data within a recent predetermined term or within a predetermined number of times (1 or a plurality of times) is held. The memory 404 includes a RAM which temporarily stores image data to be formed. In the image actually formed, the ink consumption speed is smaller than the above-described forming of the image which consumes most ink, and therefore, the continuation time of the liquid sending operation by the supplying pump 32 necessary to recover the ink amount of the standard storage amount is assumed to become short. Therefore, by obtaining the actual measured value (calculation result) of the continuing time while the same image is output to set and adjust the notification reference time, it is possible to notify abnormalities more suitably and immediately when it is assumed that there will be a lack of ink. The specific method of adjustment is not limited and the following can be employed, for example, a maximum value among the actual measured value obtained recently within a predetermined number of times, multiplying a predetermined coefficient to a maximum value or average value, a weighted average between the previously set notification reference time or the notification reference time divided by a predetermined coefficient and an average value or maximum value of the recent predetermined number of times, or multiplying a predetermined coefficient to the weighted average value.

[0078] When the image to be formed is switched, the actual measured values stored in the supply time history data 403a is erased, and the notification reference time can be returned to the initial value.

[0079] The head driving unit 24 generates and outputs a driving voltage signal which deforms the pressure chamber (piezoelectric element) to suitably eject the ink from the nozzle in each inkjet head 211. The head driving unit 24 selects a voltage waveform pattern stored in advance based on the control signal from the controller 40 and generates the driving voltage signal with the power amplified. The head driving unit 24 switches whether to output the driving voltage signal on each piezoelectric element according to the image data input from the memory 404.

[0080] The wiring regarding the head driving unit 24 is formed collectively with the ink flow path in the inkjet head 211, and a portion is formed separately.

[0081] The motor driver 231 outputs a driving signal to the electromagnetic brake 233 and the raising/lowering motor 232 according to the control signal from the controller 40. With this, the carriage is moved to a predetermined position by loosening the electromagnetic brake 233 and operating the raising/lowering motor 232. Alternatively, the raising/lowering motor 232 is stopped to fix the carriage with the electromagnetic brake 233.

[0082] The communicating unit 41 is the communication interface which controls the communication operation with the external devices. One or a plurality of com-

munication interfaces such as a LAN board, a LAN card or the like which can handle various communication protocols are included. The communicating unit 41 obtains image data to be formed or setting data (job data) regarding the image forming from external devices based on control of the controller 40. The communicating unit 41 can also transmit status information to the external devices.

[0083] The operation/display unit 42 displays the status of the inkjet recording device 100 and the operating menu according to the control signal from the controller 40 and receives the operation by the user to be output to the controller 40. For example, the operation/display unit 42 includes a liquid crystal display provided with a touch sensor as the operation receiving unit overlapped with the display screen as a display unit. The controller 40 displays on the liquid crystal display the status or various menus to receive instructions on the touch sensor. The controller 40 controls each unit of the inkjet recording device 100 to perform processes according to the information of the contents and position of the displayed menu and the touch operation by the user detected by the touch sensor.

[0084] The notification operating unit 43 performs predetermined notification operation according to the control signal of the controller 40. For example, the configuration which performs the notification operation includes, an LED lamp which emits light at a predetermined color and/or a beep sound generating unit which generates a beep sound.

[0085] In addition to the above, the inkjet recording device 100 may include a reading unit such as a line sensor which detects abnormalities (problems) in the image quality of the image formed on the recording medium or a placement abnormality detecting sensor which detects that the supplied recording medium is not placed on the conveying surface normally.

[0086] The bus 49 is a path electrically connected to the components to communicate signals.

[0087] Next, the ink supply control process in the inkjet recording device 100 according to the present embodiment is described.

[0088] The inkjet recording device 100 controls the operation of the supplying pump 32 according to only whether the ink is detected in the standard storage amount by the reference sensor 251a. The inkjet recording device 100 determines the ink supply abnormality from the main tank 31 based on the detected result of the lower limit sensor 251b, that is, mainly whether the ink in the main tank 31 is empty and determines whether to operate the inkjet head 211. The inkjet recording device 100 detects the abnormality in the flow of ink to the sub-tank 251 according to the detected result of the upper limit sensor 251c. As the operation in response to the abnormalities (abnormality handling operation), the notification operation and control of the operation of the units are performed.

[0089] FIG. 4 is a flowchart showing a control process

by the controller 40 of the ink supply control process performed in the inkjet recording device 100 according to the present embodiment.

[0090] Such ink supply control process starts when the operation of the inkjet recording device 100 is started and is continued until the operation returns to normal or the operation stops due to detection of the abnormality.

[0091] When the ink supply control process starts, the controller 40 (CPU 401) first determines whether the detecting result of the upper limit sensor 251c is the off state, that is, the upper limit storage amount of ink is not detected (the ink storage amount of the sub-tank 251 is less than the upper limit storage amount) (step S101). When it is determined that it is not the off state ("NO" in step S101), the ink storage amount is equal to or more than the upper limit storage amount. Therefore, the controller 40 stops the inkjet head 211 and all operation of the pumps, and the controller 40 controls the display screen of the operation/display unit 42 and notification operating unit 43 to perform the predetermined notification process (step S102). Then, the controller 40 ends the ink supply control process.

[0092] When it is determined that the detecting result of the upper limit sensor 251c is the off state ("YES" in step S101), the controller 40 determines whether the detecting result of the lower limit sensor 251b is the on state, that is, ink in the lower limit storage amount is detected (the ink storage amount of the sub-tank 251 is equal to or more than the lower limit amount) (step S111). When it is determined that it is not the on state ("NO" in step S111), the ink storage amount is less than the lower limit storage amount. Therefore, the controller 40 prohibits the operation of the inkjet head 211, and when the image forming is in motion, the operation of the inkjet head 211 is stopped. The controller 40 controls the display screen of the operation/display unit 42 and notification operating unit 43 to perform the predetermined notification process (step S112). Then, the process of the controller 40 advances to step S122.

[0093] Here, the controller 40 can stop the operation of the supplying pump 32. In this case, alternatively, when the operation of the supplying pump 32 is already stopped before the operation of step S112, after exchanging the main tank 31, the user needs to resume the operation of the supplying pump 32 by the predetermined input operation on the operation/display unit 42. When the operation of the inkjet head 211 is reset at the time the operation of the supplying pump 32 is resumed, the user also performs the instruction to form the image again.

[0094] When it is determined that the detecting result of the lower limit sensor 251b is the on state ("YES" in step S111), the controller 40 determines whether the detecting result of the reference sensor is the on state, that is, ink in the standard storage amount is detected (the ink storage amount of the sub-tank 251 is equal to or more than the standard storage amount) (step S121). When it is determined that it is not the on state ("NO" in step S121), the controller 40 determines whether the sup-

plying pump 32 is sending the liquid (step S122). When it is determined that the liquid sending operation is not in progress ("NO" in step S122), the controller 40 starts the liquid sending operation by the supplying pump 32 and starts counting the liquid sending operation time (step S123). Then, the process of the controller 40 returns to step S101.

[0095] When it is determined that the liquid sending operation by the supplying pump 32 is in progress ("YES" in step S122), the controller 40 determines whether the counted liquid sending operation time is within the notification reference time (step S124). When it is determined that it is within the notification reference time ("YES" in step S124), the process of the controller 40 returns to step S101. When it is determined that it is not within the notification reference time, that is, exceeding the notification reference time ("NO" in step S124), the controller 40 controls the display screen of the operation/display unit 42 and notification operating unit 43 to perform the predetermined notification process showing there is an abnormality in the ink supply, or more directly, that the main tank 31 needs to be exchanged (step S125). Then, the process of the controller 40 returns to step S101. Here, the inkjet recording device 100 according to the present embodiment continues the operation of the supplying pump 32. Therefore, when the main tank 31 is exchanged, the ink supply is immediately resumed. When the ink amount returns to the standard storage amount, the reference sensor 251a returns to the on state. After the process of step S125, before dividing to "NO" in the determination process of step S111 without exchanging the main tank 31 or supplying the ink to the sub-tank 251, the operation of the supplying pump 32 can be stopped at a predetermined operation upper limit time. In this case, as described above, the user needs to perform a predetermined input on the operation/display unit 42 to resume the operation of the supplying pump 32.

[0096] In the determining process of step S121, when it is determined that the determining result of the reference sensor 251a is in the on state ("YES" in step S121), the controller 40 determines whether the supplying pump 32 is sending the liquid (step S126). When it is determined that the liquid sending operation is not in progress ("NO" in step S126), the process of the controller 40 returns to step S101.

[0097] When it is determined that the liquid sending operation by the supplying pump 32 is in progress ("YES" in step S126), the controller 40 stops the liquid sending operation by the supplying pump 32 (step S127). The controller 40 obtains the counted operation time of the supplying pump and adds the time to the supply time history data 403a or updates the supply time history data 403a, updates the setting of the notification reference time using the newest supply time history data 403a as necessary, and stores the time as the notification reference time 403b (step S128).

[0098] Then, the process by the controller 40 returns

to step S101.

[Modification]

5 **[0099]** FIG. 5 is a flowchart showing a modification of the ink supply control process.

[0100] When the flowchart of the modification is performed, the lower limit storage amount detected by the lower limit sensor 251b is set slightly higher than the above case. That is, the image forming may continue within a predetermined limit even after the amount becomes smaller than the lower limit storage amount. The lower limit storage amount is set higher in the amount corresponding to the predetermined limit.

10 **[0101]** According to the ink supply control process of the modification, compared to the above-described ink supply control process, the process in step S112 is divided into the processes of steps S112a to S112c, the processes in steps S123 to S125 are replaced with the processes in steps S123a to S125a, and the processes of steps S131, S132, S141, S142, S151 are added. Further, the order of some of the processes is changed. The other processes are the same, and the processes with the same contents are referred to with the same reference numerals and the detailed description is omitted.

20 **[0102]** In the ink supply control process according to the modification, when it is determined that the lower limit sensor is not in the on state in the determining process of step S111 ("NO" in step S111), the controller 40 performs the notification operation that there is an ink lack (step S112a). The controller determines whether the forming of the image being formed is finished, that is, whether it is a good timing to pause image forming (step S112b).

30 **[0103]** The image being formed here means, a unit of image data set for each formed range, for example, an entire formed image corresponding to an entire image forming possible range of a recording medium divided in a unit of one sheet, one image forming range when the same image is repeatedly formed a plurality of times. This can include a plurality of individual partial images or a plurality of the same image patterns. That is, the lower limit storage amount is set to be equal to or more than a maximum ink amount (that is, ink amount necessary for a solid image) necessary to form an image with a maximum size (maximum range) that can be set in the inkjet recording device 100 as the unit of image data.

40 **[0104]** When it is determined that the forming of the image being formed is not finished (the image forming is in progress) ("NO" in step S112b), the process of the controller 40 advances to step S131. When it is determined that the forming of the image being formed ended (the image forming is in a break point, after the image being formed is formed, before the next image is formed) ("YES" in step S112b), the controller 40 prohibits the operation of the inkjet head 211 from then after, and the inkjet head 211 in operation is stopped (step S112c). Then, the process of the controller 40 advances to step S131.

[0105] In the determining process of step S121, when it is determined that the reference sensor is not in the off state ("NO" in step S121), the process of the controller 40 advances to step S131.

[0106] When the process advances to step S131, the controller 40 determines whether the elapsed time from when the reference sensor becomes the off state is "0" (step S131). When it is determined that the elapsed time is "0" ("YES" in step S131), the controller 40 starts the operation of the supplying pump 32 and starts the counting of the elapsed time and the liquid sending operation time (operation time) of the supplying pump 32 (step S132). Then, the process of the controller 40 returns to step S101.

[0107] When it is determined that the elapsed time is not "0" ("NO" in step S131), the controller 40 determines whether the elapsed time is the notification reference time (step S124a). The equal "=" here does not mean strictly the same, but means that the elapsed time is the first determining process after the notification reference time passed. When it is determined that it is the notification reference time ("YES" in step S124a), the controller 40 controls the display screen of the operation/display unit 42 and the notification operating unit 43 to perform the notification operation to urge the exchange of the main tank and stops the operation of the supplying pump 32 (step S125a). Here, the counting of the liquid sending operation time is stopped and the value is initialized. Then, the process of the controller 40 returns to step S101.

[0108] When it is determined that the elapsed time is not the timing of the notification reference time, that is, the elapsed time is less than the notification reference time or already passed the notification reference time (already determined that it is the notification reference time) ("NO" in step S124a), the controller 40 determines whether the supplying pump 32 is in operation (step S122). When it is determined that it is in operation ("YES" in step S122), the controller 40 determines whether the liquid sending operation time of the supplying pump 32 is equal to or more than a continuing upper limit time (step S141). The continuing upper limit time corresponds to the time of the maximum assumed time which is the time assumed that the reference sensor 251a will be on by operating the supplying pump 32 in each situation or the maximum assumed time with some time added. That is, when the elapsed time becomes long, there is a possibility that the ink storage amount is even smaller than the standard storage amount. Therefore, the continuing upper limit time is a variable which becomes longer according to the continuing time. The maximum assumed time is calculated as the time necessary to recover the ink amount from the smallest ink storage amount assumed according to the elapsed time to the standard storage amount when the supplying pump 32 is continuously operated to form an image in which the maximum ink amount is consumed.

[0109] When it is determined that the liquid sending

operation time is not equal to or more than the continuing upper limit time ("NO" in step S141), the process by the controller 40 returns to step S101. When it is determined that it is equal to or more than the continuing upper limit time ("YES" in step S141), the controller 40 stops the operation of the supplying pump 32 (step S142). The controller 40 stops the counting of the liquid sending operation time and initializes the value of the liquid sending operation time. Then, the process of the controller 40 returns to step S101.

[0110] In the determining process in step S122, when it is determined that the supplying pump 32 is not in operation ("NO" in step S122), the controller 40 determines whether the operation resume instruction of the supplying pump 32 is obtained based on the input operation on the operation/display unit 42 or whether it is the timing to resume the operation of the supplying pump 32 (step S151). Here, the operation resume instruction is received as necessary when the user exchanges the main tank 31 and performs a predetermined operation on the operation/display unit 42. As described above, when the reference sensor 251a is in the off state and the operation of the supplying pump 32 is stopped, the operation of the supplying pump 32 automatically resumes after a predetermined amount of time elapses. Such predetermined amount of time can be a fixed amount of time from the timing that the operation stops, or a fixed amount of time from the timing when the previous operation started or resumed. Alternatively, the predetermined amount of time can be made longer each time the start/resume and stop of the operation of the supplying pump 32 is repeated.

[0111] When the operation resume instruction is not obtained, and it is determined that it is not the operation resume timing of the supplying pump 32 ("NO" in step S151), the process of the controller 40 returns to step S101. When the operation resume instruction is obtained or it is determined that it is the operation resume timing of the supplying pump 32 ("YES" in step S151), the controller 40 resumes the operation of the supplying pump 32 and starts the counting of the liquid sending operation time from "0" again (step S123a). Then, the process of the control unit 40 returns to step S101.

[0112] When it is determined that the reference sensor 251a is turned on in step S121 ("YES" in step S121), the counting of the elapsed time is stopped and the value is initialized. When the operation of the supplying pump stops in the process of step S127, the counting of the liquid sending operation time stops and the value is initialized.

[0113] As described above, the inkjet recording device 100 according to the present embodiment includes, the inkjet head 211 which ejects ink, the main tank 31 which stores ink, a sub-tank 251 which stores the ink supplied from the main tank 31, a supplying pump which sends ink from the main tank 31 to the sub-tank 251, one or a plurality of liquid sending pumps 253 which send ink from the sub-tank to the inkjet head 211, a reference sensor

251a which determines whether a predetermined standard storage amount of ink is stored in the sub-tank 251, an upper limit sensor 251c which determines whether ink is stored in the sub-tank in an upper limit storage amount larger than the standard storage amount, a lower limit sensor 251b which determines whether ink is stored in the sub-tank 251 in the lower limit storage amount smaller than the standard storage amount and the controller 40. The controller 40 determines whether the supplying pump 32 operates according to the detecting result of the reference sensor 251a and performs predetermined abnormality operation according to the detecting result of the upper limit sensor 251c and the lower limit sensor 251b.

[0114] As described above, the inkjet recording device 100 determines the operation of the supplying pump 32 according to the detection by the reference sensor 251a which detects the standard storage amount. Therefore, the operation control can be easily performed without using the plurality of parameters. Moreover, it is not necessary to increase the number of sensors necessary to determine whether to operate the supplying pump 32 more than necessary.

[0115] Normally, the ink storage amount is not greatly different from the standard storage amount. Therefore, compared to the capacity of the sub-tank, the margin (difference in value) to the upper limit storage amount and the lower limit storage amount determined above and below the standard storage amount can be easily made large. With this, there is no need to stop the operation of the inkjet head 211 immediately when a slight abnormality such as abnormality of ink supply due to lack of ink in the main tank 31 occurs. On the other hand, it is possible to securely detect the ink storage amount at a level which causes problems in the operation of the inkjet recording device 100 such as equal to or more than the upper limit storage amount and less than the lower limit storage amount. Therefore, it is possible to suitably perform operations to cope with abnormalities such as notification operation or prohibiting operation of the inkjet head 211.

[0116] Therefore, according to the inkjet recording device 100, the abnormality of the ink storage amount in the sub-tank 251 can be handled at a suitable efficiency, while supplying ink to the inkjet head.

[0117] Moreover, a storage amount sensor does not have to be provided in the main tank 31. Therefore, the configuration of the main tank 31 which is exchanged becomes simple, and the attaching and detaching of the main tank 31 when the main tank 31 is exchanged becomes easy. Similarly, there is no need to integrate the flow amount from the main tank 31 and to obtain the remaining amount of the main tank 31. Therefore, the error in the remaining amount can be suppressed and it is possible to perform notification operation at a suitable timing. Further, it is possible to prohibit ink ejection operation of the inkjet head 211.

[0118] The collecting flow path 27 which returns the

ink from the inkjet head to the sub-tank 251 is provided, and the difference between the upper limit storage amount and the standard storage amount is larger than the ink capacity of the flow path of the ink sent out from the sub-tank 251 until the ink returns to the sub-tank 251.

[0119] Therefore, according to the inkjet recording device 100, all of the ink in the ink flow path (circulating flow path) can be correctly collected in the sub-tank 251 during maintenance and an abnormal situation such as the possibility of the sub-tank 251 actually overflowing due to the abnormality of the supplying pump 32 or the sub-tank 251 can be suitably determined. Normally, it is not assumed that the ink storage amount greatly increases than the amount around the standard storage amount with only the reference sensor 251a. Therefore, even if the ink of the ink flow path may be collected, the capacity margin of the sub-tank 251 does not have to be larger than necessary and the device can be made in a suitable size.

[0120] The notification operating unit 43 which performs the predetermined notification operation is provided. The controller 40 operates the supplying pump 32 when the reference sensor 251a does not detect the ink in the standard storage amount. When the reference sensor 251a does not detect the ink in the standard storage amount through a predetermined continuing reference time or more from when the supplying pump 32 is operated, the notification operating unit 43 performs the notification operation.

[0121] That is, when the ink storage amount of the sub-tank 251 is not recovered as assumed, there is an abnormality in the ink supply, mainly a lack of ink in the main tank 31. Therefore, this can be easily and immediately be detected by detection performed by only the reference sensor 251a. With this, the user is notified of the abnormality, and it is possible to urge the user to exchange the main tank 31. Here, by setting the range of the normal ink storage amount within a narrow range, the range from when the abnormality is detected to the lower limit storage amount in which the normal ink supply to the inkjet head 211 becomes actually difficult is large compared to the size of the sub-tank 251. Therefore, it is possible to urge the user to exchange the main tank 31 well in advance.

[0122] The controller 40 prohibits the ink ejection from the inkjet head 211 as an operation in response to the abnormality when the lower limit sensor 251b does not detect ink in the lower limit storage amount. That is, there is some time after the reference sensor 251a detects the ink supply abnormality until the ink ejection operation by the inkjet head 211 actually needs to be prohibited. Therefore, even if the main tank 31 lacks ink, the user is able to exchange the main tank 31 well in advance without pausing the image forming in operation, and the ink supply can be resumed and continued.

[0123] The lower limit storage amount is determined to be equal to or more than the maximum ink amount necessary to form the image at the maximum range that

can be set as the image formed by the ink-jet head 211. After forming the image being formed at the timing that the lower limit sensor 251b does not detect ink in the lower limit storage amount, the controller 40 prohibits the ink ejection from the inkjet head 211 before starting the next image forming. That is, when the main tank 31 lacks ink, it is possible to urge the user to exchange the main tank 31 in advance before normal ink supply to the inkjet head 211 actually becomes impossible. Further, even if the ink storage amount of the sub-tank 251 becomes lower than the lower limit storage amount without exchanging the main tank 31, the ink ejection is stopped after ending the forming of the image which is being formed. Therefore, the recording medium and the ink are not wasted by discontinuing the operation in the middle of the image forming.

[0124] The maximum liquid sending speed of the ink by the supplying pump 32 is larger than the liquid sending speed of the ink by the liquid sending pump 253 according to the maximum ink ejecting amount from the inkjet head 211 during the operation of the inkjet head 211. Therefore, when the image forming operation is performed at the maximum ability of the inkjet head 211, the ink amount of the sub-tank 251 can be surely recovered to the standard storage amount when the ink is supplied normally from the main tank 31 to the sub-tank 251 or the ink is supplied to the sub-tank 251 after exchanging the main tank 31.

[0125] An intermediate tank 262 is provided between the liquid sending pump 253 and the inkjet head 211. Therefore, the ink pressured and sent out with the liquid sending pump 253 from the sub-tank 251 is easily and suitably pressured to be supplied to the inkjet head 211 regardless of the ink storage amount in the sub-tank 251.

[0126] The controller 40 operates the supplying pump 32 when the reference sensor 251a does not detect the ink in the standard storage amount, counts the operation time of the supplying pump 32 until the reference sensor detects the standard storage amount again, and sets the continuing reference time regarding the detecting of the abnormality in the supply from the main tank 31 to the sub-tank 251 based on the result of the one or the plurality of calculations.

[0127] That is, as the initial value, setting the maximum time corresponding to when the ink ejecting amount becomes largest by the inkjet head 211 as the continuing reference time is most reliable. However, the ink ejecting amount is different depending on the actual image to be formed. Therefore, by setting a shorter continuing reference time based on the actual measured value according to the different ink ejecting amount, the abnormality in the supply of ink can be detected more swiftly and reliably and the abnormality can be notified to the user.

[0128] The present invention is not limited to the above-described embodiments and various modifications are possible.

[0129] For example, according to the present embodiment, operation in response to abnormalities include,

predetermined notification operation which can be performed by the display screen of the operation/display unit 42 and the notification operating unit 43, or prohibiting operation of each unit of the inkjet recording device 100 and the inkjet head 211. Other than the above, various operations such as transmitting e-mail or a message through the communicating unit 41 are possible.

[0130] According to the above-described embodiment, the upper limit storage amount corresponding to the upper limit sensor 251c is a level not detected even when all of the ink in the ink flow path (circulating flow path) returns. Alternatively, the upper limit storage amount can be a level detected in the above situation. Preferably, the capacity of the sub-tank 251 is larger than the total of the standard storage amount and the ink capacity.

[0131] According to the above-described embodiment, whether the supplying pump 32 is operated is determined at real time based on the results detected in real time by the reference sensor 251a. Alternatively, the detecting data can be obtained at a predetermined detecting interval, and the operation of the supplying pump 32 can be switched at a time step according to the detecting interval. Alternatively, the detecting result itself can be obtained in real time, but once after the operation of the supplying pump 32 is switched, the operation may continue for a predetermined amount of time. The detecting interval and the predetermined amount of time is sufficiently shorter than the time necessary for the ink storage amount to change from the standard storage amount to the lower limit storage amount or the upper limit storage amount due to the sending of the liquid by the liquid sending pump 253 or the supply of the ink by the supplying pump 32.

[0132] According to the above-described embodiment, examples are described using an initial value (fixed value) according to the assumed maximum time and the updated value based on the actual measured time as the predetermined continuing reference time. Alternatively, this can be changed in coordination with the operation state of the liquid sending pump 253.

[0133] According to the above-described embodiment, the operation of the inkjet head 211 is prohibited (stopped) immediately when the ink storage amount becomes below the lower limit storage amount or the operation is prohibited after the image is formed to a good timing. When the operation is prohibited immediately, after the ink supply from the main tank 31 is resumed and the prohibiting of the operation is canceled, the image forming can be resumed from the position where the image forming is paused and the image being formed can be completely formed.

[0134] According to the above-described embodiment, back pressure control in the nozzle of the inkjet head 211 is performed using the intermediate tank 262, but the method of back pressure control is not limited to the above method.

[0135] According to the above-described embodiment, the ink flow path is a circulating flow path, but the present invention can be applied even if there is no collecting flow

path to return the ink to the sub-tank 251.

[0136] According to the above-described embodiment, the main tank 31 is exchanged by exchanging the entire case, but the ink can be inserted in the case of the main tank 31 to be filled with ink.

[0137] According to the above-described embodiment, as the first liquid sending unit to supply ink from the main tank 31 to the sub-tank 251, the supplying pump 32 is used, but the present invention is not limited to the above. As the relative positioning which can flow the ink in the main tank 31 to the sub-tank 251 by gravity, a configuration which switches the supply of ink to the sub-tank 251 by controlling opening/closing of an ink supplying valve provided in the ink flow path can be employed.

[0138] According to the above-described embodiment, the capacity of the sub-tank 251 is smaller than the capacity of the main tank 31, but the present invention is not limited to the above. The capacity of the sub-tank 251 can be larger than the main tank 31, and the time that the image forming can be performed after detecting that the main tank 31 is empty can be set to be longer. With this, the exchange and the filling of the main tank 31 can be performed well in advance.

[0139] According to the above-described embodiment, the inkjet recording device including a line head which ejects ink with a plurality of colors is described. Alternatively, the present invention can be applied to the image forming of a single color, and this includes the inkjet recording device performing the coating of the recording medium by ink without color. The number and arrangement of the nozzles in the inkjet head 211 and the number and arrangement of the plurality of inkjet heads can be determined freely. The present invention can be applied to the scan-type inkjet recording device in which the image is formed on the recording medium while moving (scanning) the recording medium with the inkjet head 211.

[0140] The specific details of the configuration, positions, and contents of control shown in the above-described embodiment can be suitably changed without leaving the scope of the present invention.

Industrial Applicability

[0141] The present invention can be used in inkjet recording devices.

Description of Reference Numerals

[0142]

100 inkjet recording device
10 conveying unit
11 driving roller
12 conveying motor
14 conveying belt
20 image forming unit
211 inkjet head

22 carriage
23 carriage raising/lowering unit
231 motor driver
232 raising/lowering motor
233 electromagnetic brake
234 beam member
235 supporting unit
24 head driving unit
251 sub-tank
251a reference sensor
251b lower limit sensor
251c upper limit sensor
252 flowmeter
253 liquid sending pump
254 filter
255 deaerating module
256 liquid sending common flow path
257 individual flow path
258 individual supplying valve
259 damper
260 intermediate tank flow path
261 intermediate tank distributing valve
262 intermediate tank
262a intermediate upper limit sensor
262b intermediate reference sensor
263 common supplying valve
265 maintenance flow path
266 maintenance flow path distributing valve
27 collecting flow path
270 bypass valve
271 check valve
272 collecting common flow path
273 collecting valve
274 circulating valve
275 collecting pump
281 to 283 check valve
29 absorbing unit
291 check valve
292 chamber
292a liquid amount sensor
293 vacuum pump
294 pressure sensor
30 ink storage unit
31 main tank
32 supplying pump
35 rack
40 controller
401 CPU
402 RAM
403 ROM
403a supply time history data
403b notification reference time
404 memory
41 communicating unit
42 operation/display unit
43 notification operating unit
49 bus

Claims**1.** An inkjet recording device comprising:

a recording head which ejects ink;
 a first tank which stores ink;
 a second tank which stores the ink supplied from the first tank;
 a first liquid sending unit which sends the ink from the first tank to the second tank;
 one or a plurality of second liquid sending units which send the ink from the second tank to the recording head;
 a reference sensor which determines whether the ink stored in the second tank is a predetermined standard storage amount;
 an upper limit sensor which determines whether the ink stored in the second tank is an upper limit storage amount larger than the standard storage amount;
 a lower limit sensor which determines whether the ink stored in the second tank is a lower limit storage amount smaller than the standard storage amount; and
 a controller,

wherein, the controller determines whether to operate the first liquid sending unit depending on a detected result of the reference sensor; and the controller performs predetermined abnormality handling operations according to a detected result of the upper limit sensor and the lower limit sensor.

2. The inkjet recording device according to claim 1, further comprising a collecting flow path which returns the ink from the recording head to the second tank, wherein the difference between the upper limit storage amount and the standard storage amount is larger than an ink capacity of the ink flow path from where the ink is sent out from the second tank to where the ink returns to the second tank.**3.** The inkjet recording device according to claim 1 or 2, further comprising a notification unit which performs a predetermined notification operation, wherein the controller operates the first liquid sending unit when the reference sensor does not detect ink in the standard storage amount and when the reference sensor does not detect ink in the standard storage amount after a predetermined continuing reference time or more passes after operating the first liquid sending unit, the controller controls the notification unit to perform the notification operation.**4.** The inkjet recording device according to any one of claims 1 to 3, wherein the controller prohibits the ink from being ejected from the recording head as the abnormality handling operation when the lower limit

sensor does not detect the ink in the lower limit storage amount.

5. The inkjet recording device according to any one of claims 1 to 3, wherein, the lower limit storage amount is set to equal to or larger than a maximum ink amount necessary to form an image in a maximum range that can be set for an image formed by the recording head; and the controller prohibits ink ejection from the recording head after forming the image being formed at a timing that the lower limit sensor does not detect ink in the lower limit storage amount and before starting the forming of the next image.**6.** The inkjet recording device according to any one of claims 1 to 5, wherein a maximum liquid sending speed of the ink by the first liquid sending unit is larger than a liquid sending speed of the ink by the second liquid sending unit according to a maximum ink ejecting amount from the recording head when the recording head is in operation.**7.** The inkjet recording device according to any one of claims 1 to 6, wherein a third tank is provided between the second liquid sending unit and the recording head.**8.** The inkjet recording device according to claim 3, wherein the controller operates the first liquid sending unit when the reference sensor does not detect ink in the standard storage amount and the controller counts operation time of the first liquid sending unit until the reference sensor detects the standard storage amount again and the controller sets the predetermined continuing reference time based on a result of the counted time counted one or a plurality of times.

FIG.1

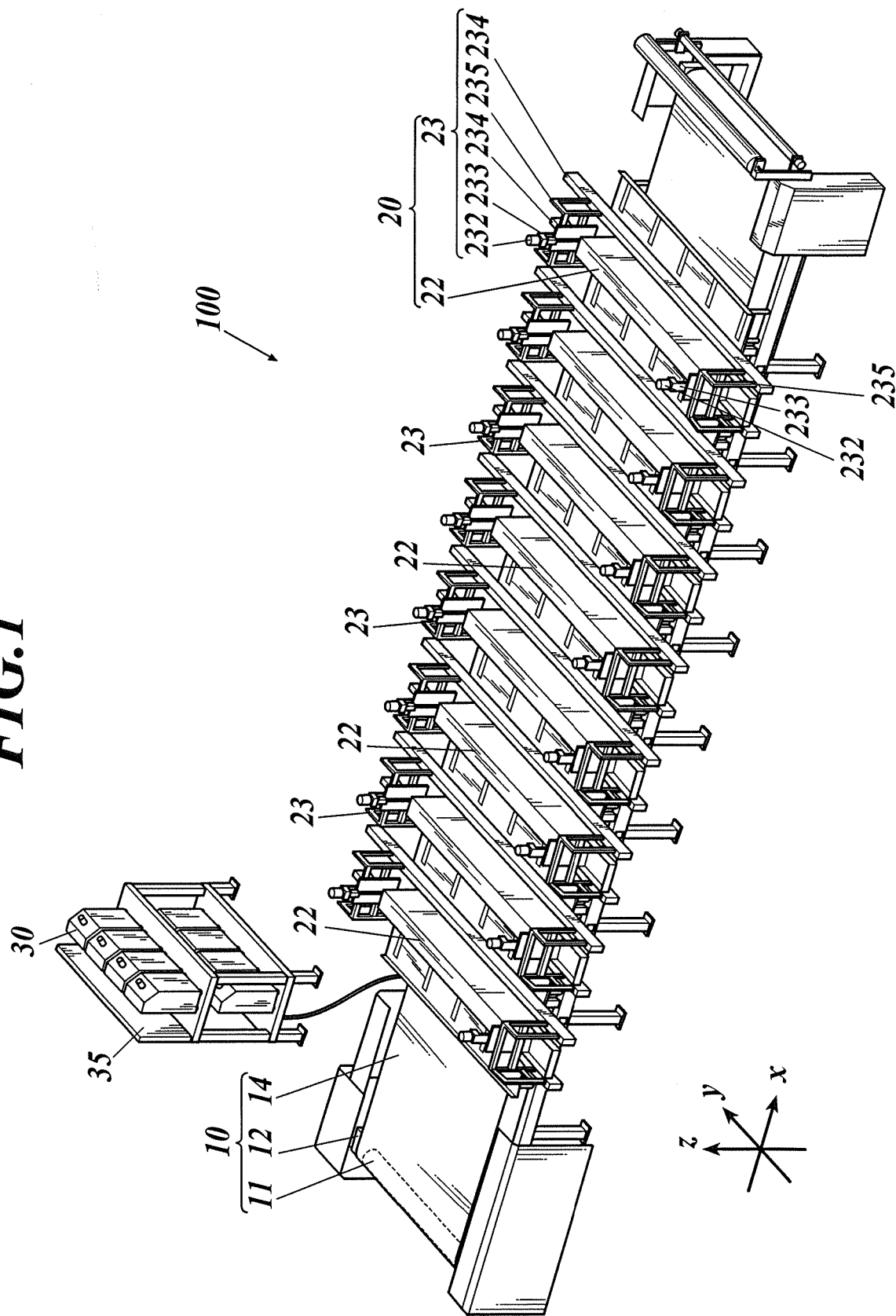


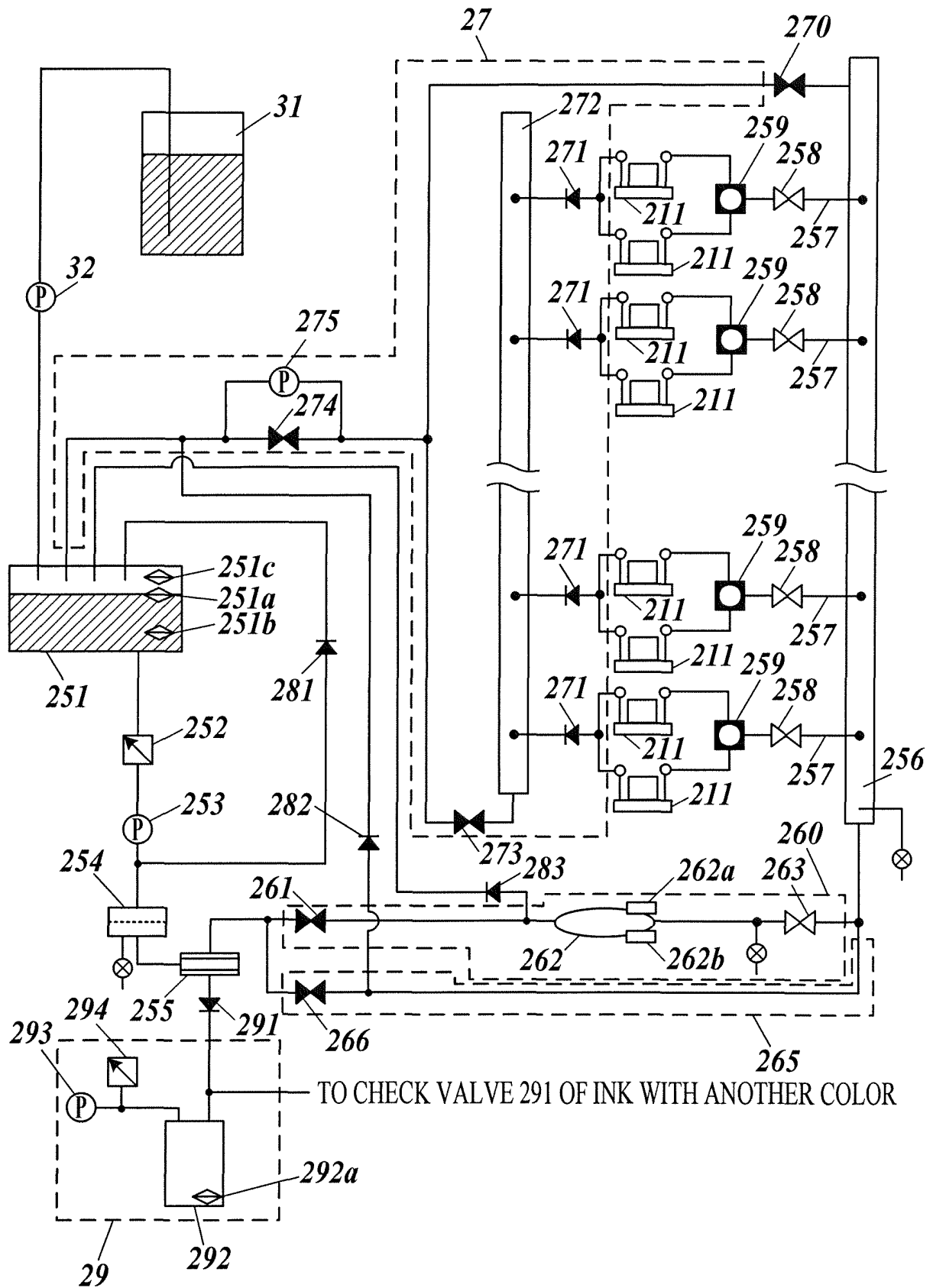
FIG. 2

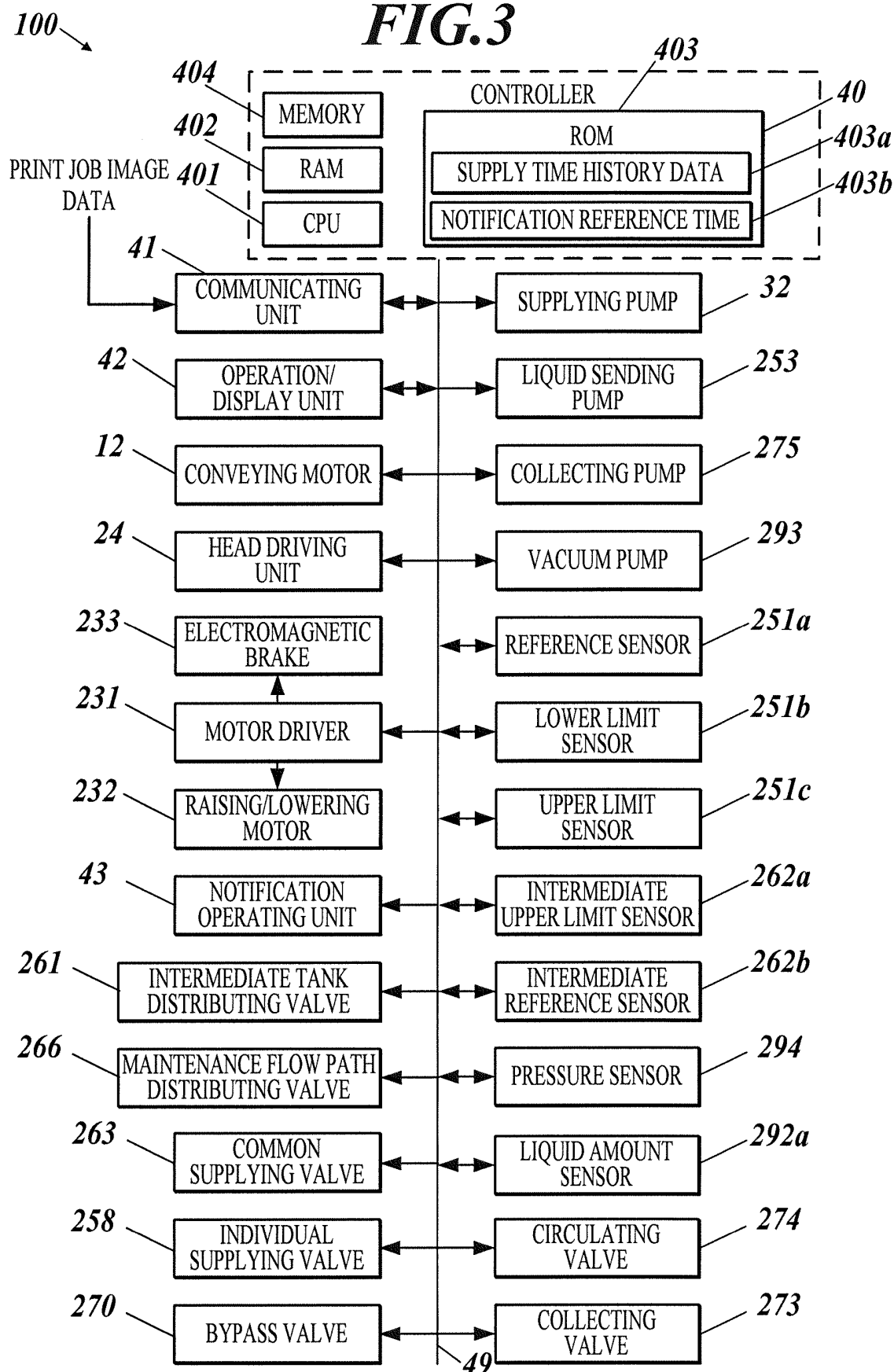
FIG. 3

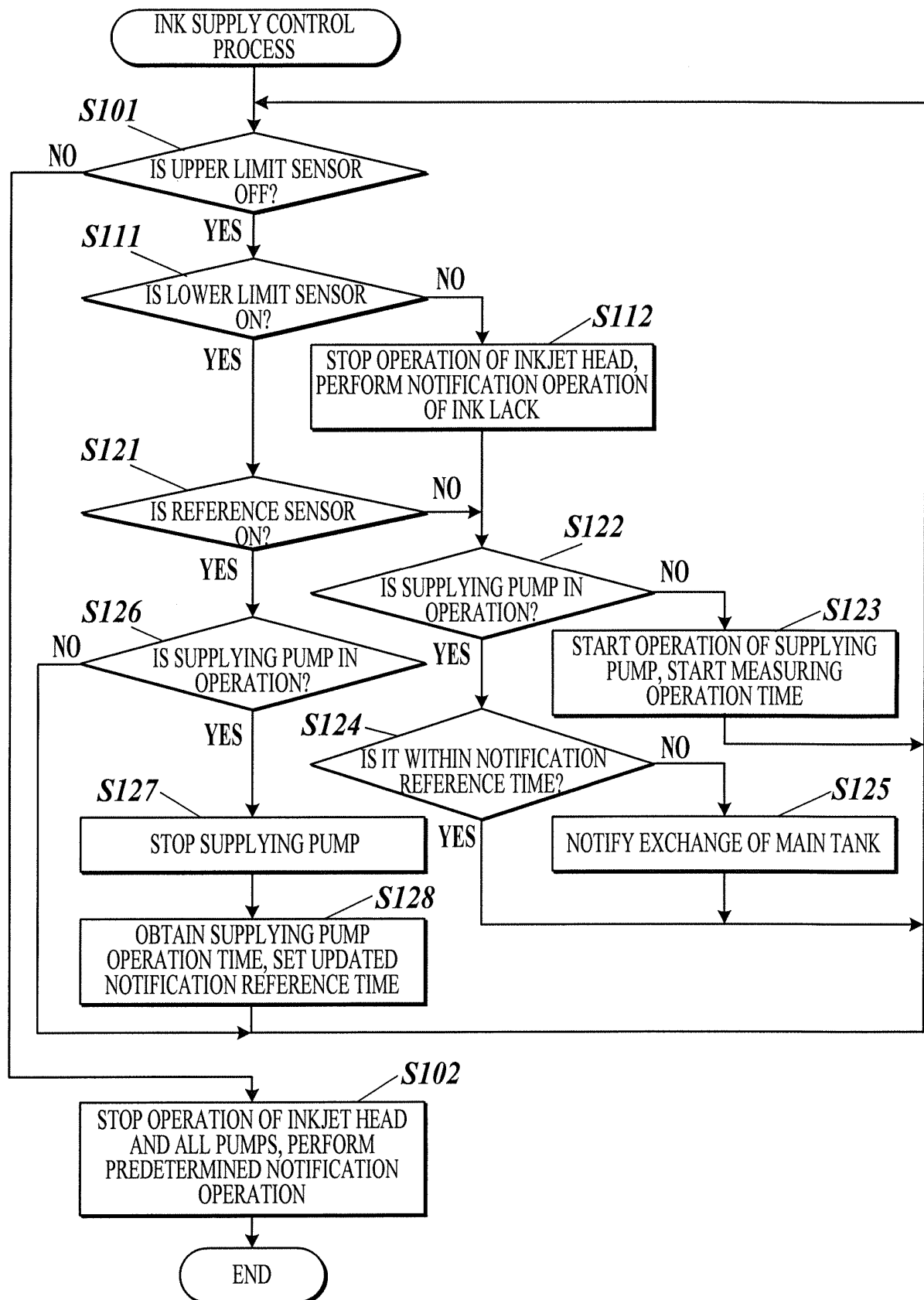
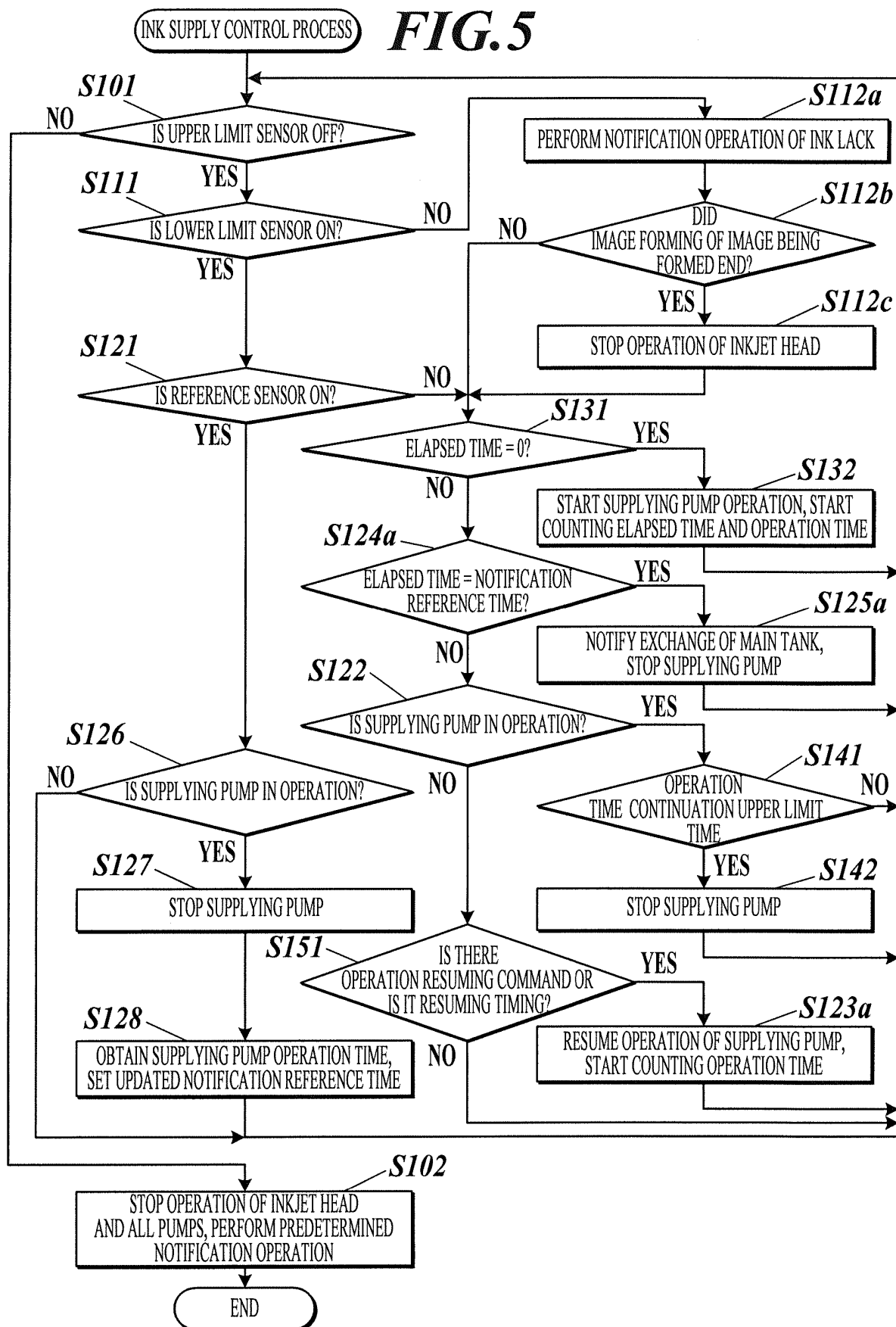
FIG.4

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/008674

A. CLASSIFICATION OF SUBJECT MATTER

B41J2/175(2006.01)i, B41J2/18(2006.01)i, B41J29/46(2006.01)i, B65H7/20(2006.01)n

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B41J2/175, B41J2/18, B41J29/46, B65H7/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2015/098220 A1 (Konica Minolta, Inc.), 02 July 2015 (02.07.2015), paragraphs [0037] to [0043], [0059] to [0069]; fig. 3 & EP 3088186 A1 paragraphs [0057] to [0072], [0094] to [0109]; fig. 3 & CN 105829110 A	1-4, 6-7
Y	JP 2011-201176 A (Dainippon Screen Mfg. Co., Ltd.), 13 October 2011 (13.10.2011), paragraphs [0084] to [0092]; fig. 4 (Family: none)	1-4, 6-7

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

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"&" document member of the same patent family

Date of the actual completion of the international search
11 April 2017 (11.04.17)

Date of mailing of the international search report
18 April 2017 (18.04.17)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/008674

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005-219376 A (Fuji Photo Film Co., Ltd.), 18 August 2005 (18.08.2005), paragraphs [0097] to [0101]; fig. 7 (Family: none)	1-4, 6-7
Y	JP 11-42795 A (Canon Inc.), 16 February 1999 (16.02.1999), paragraphs [0104] to [0109] & US 2001/0017642 A1 paragraphs [0188] to [0194]	2-4, 6-7
Y	JP 2000-318184 A (Canon Inc.), 21 November 2000 (21.11.2000), paragraphs [0149] to [0153] (Family: none)	2-4, 6-7
A	JP 2006-198969 A (Ricoh Co., Ltd.), 03 August 2006 (03.08.2006), paragraph [0040] (Family: none)	5
A	US 2011/0279495 A1 (TOSHIBA TEC KABUSHIKI KAISHA), 17 November 2011 (17.11.2011), entire text; all drawings (Family: none)	1-8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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