



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
27.03.2013 Bulletin 2013/13

(51) Int Cl.:
B41J 2/18 (2006.01) **B41J 2/19** (2006.01)
B41J 2/175 (2006.01)

(21) Application number: **12184596.0**

(22) Date of filing: **14.09.2012**

(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

(71) Applicant: **Konica Minolta IJ Technologies, Inc.**
Hino-shi
Tokyo 191-8511 (JP)

(72) Inventor: **Mitsuhashi, Taku**
Tokyo, 191-8511 (JP)

(30) Priority: **21.09.2011 JP 2011205435**

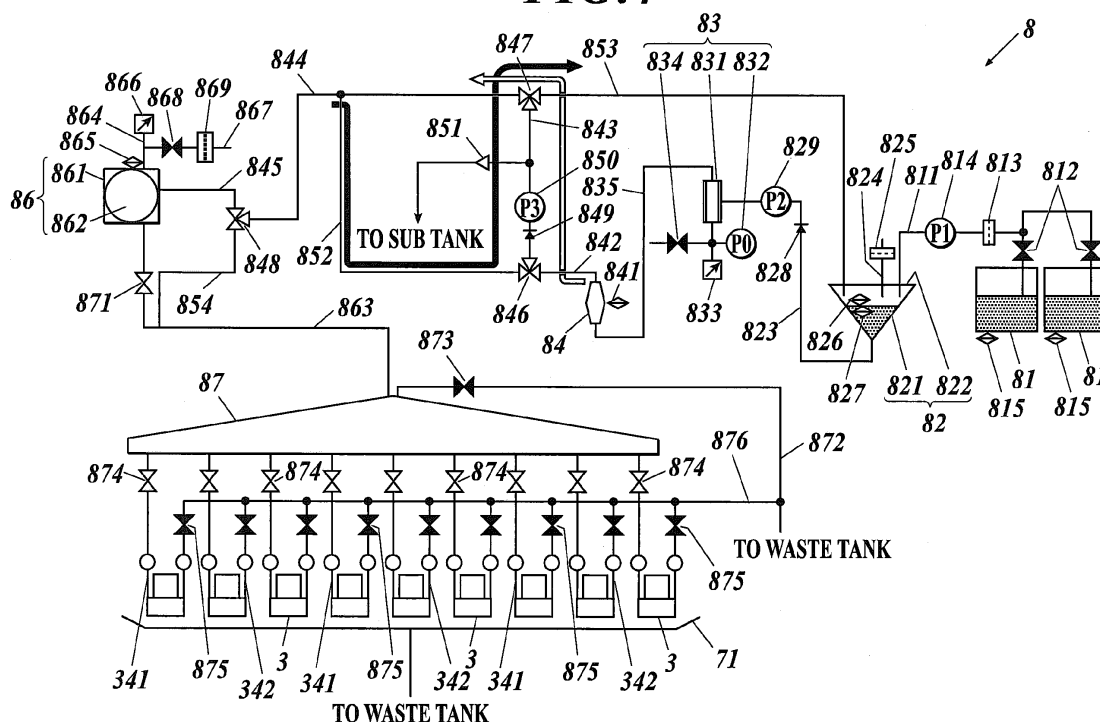
(74) Representative: **Henkel, Breuer & Partner**
Patentanwälte
Maximiliansplatz 21
80333 München (DE)

(54) **Ink supply device and ink supply method for inkjet recording apparatus**

(57) Disclosed is an ink supply device (8) of an inkjet recording apparatus (10) including a first tank (81) which pools ink which is to be supplied to heads (3), a second tank (82) which is provided in a middle of a path to the heads (3) from the first tank (81), a first ink feed unit (814) which feeds the ink to the second tank (82) from the first

tank (81), a second ink feed unit (829) which feeds the ink to the heads side from the second tank (82) and a first ink flow path (811) which connects the first tank (81) and the second tank (82). In the ink supply device (8), an end section of the first ink flow path (811) in the second tank side is connected to the second tank (82) so that the ink flows along an inner wall of the second tank (82).

FIG.4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an ink supply device and an ink supply method for supplying ink to heads, wherein the ink supply device and the ink supply method are to be utilized in an inkjet recording apparatus.

2. Description of Related Art

[0002] Inkjet printer are known as a recording apparatus which can form images on various types of recording mediums such as regular paper sheets and plastic thin plates. Such inkjet printer is provided with heads which discharge ink from nozzle holes. By spraying fine droplets of ink to a recording medium from the nozzle holes of the heads, an image is to be formed on the recording medium.

[0003] The heads are connected to a tank in which ink is pooled and ink is to be supplied to the heads from the tank.

[0004] At that time, if dissolved gas and bubbles are mixed in the ink, this will cause poor spraying of ink in the case where the heads are configured so as to stray the droplets according to volume fluctuation of content. Therefore, in a conventional inkjet printer, gas in the ink is being removed by a degassing module which carries out vacuum degassing provided in between the ink tank and the heads (see JP 2011-079295).

[0005] However, although the degassing module provided in the conventional inkjet printer described in JP 2011-079295 is able to remove dissolved gas included in the ink but cannot remove bubbles having a size that can be visually identified. Therefore, there has been a problem that such bubbles flow into the heads.

SUMMARY OF THE INVENTION

[0006] The object of the present invention is to provide an inkjet recording apparatus and an ink supply method that can effectively remove bubbles in ink having a size that can be visually identified.

[0007] In order to achieve the above object, an ink supply device of an inkjet recording apparatus reflecting one aspect of the present invention includes a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium, a second tank which is provided in a middle of a path to the heads from the first tank, a first ink feed unit which feeds the ink to the second tank from the first tank, a second ink feed unit which feeds the ink to the heads side from the second tank and a first ink flow path which connects the first tank and the second tank, and an end section of the first ink flow path in the second tank side is connected to the second tank so that the ink flows along an inner wall of

the second tank and the second ink feed unit feeds the ink from a lower section of the second tank.

[0008] Preferably, in the ink supply device of the inkjet recording apparatus, at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.

[0009] Preferably, in the ink supply device of the inkjet recording apparatus, the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.

[0010] Preferably, the ink supply device of the inkjet recording apparatus includes at least two or more first tanks and a switching unit which selectively switches between the two first tanks to be connected with the second tank.

[0011] Preferably, the ink supply device of the inkjet recording apparatus further includes a degassing unit which performs vacuum degassing on the ink, the degassing unit being provided in a middle of a path to the heads from the second tank.

[0012] In order to achieve the above object, an ink supply method reflecting one aspect of the present invention is an ink supply method of an inkjet recording apparatus, wherein the inkjet recording apparatus includes a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium, a second tank which is provided in a middle of a path to the heads from the first tank, a first ink feed unit which feeds the ink to the second tank from the first tank, a second ink feed unit which feeds the ink to the heads side from the second tank and a first ink flow path which connects the first tank and the second tank, and the method includes ink supplying to the second tank from an end section of the first ink flow path in a second tank side so that the ink flows along an inner wall of the second tank, and ink feeding from a lower section of the second tank by the second ink feed unit.

[0013] Preferably, in the ink supply method of the inkjet recording apparatus, at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.

[0014] Preferably, in the ink supply method of the inkjet recording apparatus, the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.

[0015] Preferably, in the ink supply method of the inkjet recording apparatus, at least two or more first tanks are included, and the ink is supplied selectively from each of the first tanks to the second tank.

[0016] Preferably, in the ink supply method of the inkjet recording apparatus, the ink is supplied to the heads by being subjected to vacuum degassing by a vacuum degassing device at a middle of a path to the heads from the second tank.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above and other objects, advantages and features of the present invention will become more fully understood from the detailed description given hereinbelow and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein:

FIG. 1 is a schematic image of an inkjet recording apparatus;
 FIG. 2 is a plane view showing an arrangement of heads on a carriage;
 FIG. 3 is a cross sectional view showing an inner structure of a head;
 FIG. 4 is a schematic view showing an outline of an ink supply device;
 FIG. 5 is an explanatory view showing the connected state of a common flow path and each of the heads;
 FIG. 6 is a block diagram showing a control system of the inkjet recoding apparatus;
 FIG. 7 is a flowchart showing an ink surface monitoring control;
 FIG. 8 is a flowchart showing a head maintenance control;
 FIG. 9 is a flowchart showing an ink feed control;
 FIG. 10 is a flowchart showing a back-pressure adjustment control of negative pressure forming unit;
 FIG. 11 is a flowchart showing a wiping control;
 FIG. 12A is a cross-sectional view showing the second example of sub tank; and
 FIG. 12B is a cross-sectional view showing the third example of sub tank.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Outline of an inkjet recording apparatus]

[0018] The inkjet recording apparatus 10 in which an ink supply device of the embodiment is installed will be described based on FIGS. 1 to 11. FIG. 1 is a schematic view showing the entire inkjet recording apparatus 10.

[0019] The inkjet recording apparatus 10 mainly includes a conveyance device 20 which conveys a recording medium along horizontal direction, a carriage 4 in which a plurality of heads 3 (see FIG. 2) which spray ink to the recording medium being conveyed from above, a main moving device 5 which moves the carriage 4 along horizontal direction which is orthogonal to the conveyance direction of the recording medium, a maintenance unit 7 which performs maintenance of each head 3 installed in the carriage 4, a nozzle humidifier unit 6 which maintains humidity of nozzles 311 of each head 3 installed in the carriage 4, an ink supply device 8 (see FIG. 4) which supplies ink to each head 3 installed in the carriage 4, a control device 9 (see FIG. 6) which controls each of the above components and a frame 100 which

supports the entire structure.

[0020] In the following description, it is assumed that the direction along the conveyance direction of recording mediums, which is horizontal direction, is Y axis direction, the direction along the conveyance direction of the carriage 4, which is horizontal direction, is X axis direction or main moving direction, and vertical direction is Z axis direction.

10 [Conveyance device]

[0021] The conveyance device 20 includes a driving roller 21, a follower roller (omitted in the drawings), a driving motor 22 and a conveyance belt 23.

15 **[0022]** The driving roller 21 and the follower roller are pivotally supported so as to rotate, and the driving roller 21 is disposed so as to extend in the main moving direction X. The driving motor 22 is the driving source for rotary driving the driving roller 21 and is attached at one end of the driving roller 21.

20 **[0023]** The conveyance belt 23 is formed so as not to have ends and is crossed between the driving roller 21 and the follower roller. The conveyance belt 23 moves around the driving roller 21 and the follower roller when the driving roller 21 rotates, and conveys the recording medium placed on the conveyance belt in the conveyance direction F along Y axis direction. When the rotation of the driving unit 21 stops, the conveyance belt 23 stops its rotation around the two rollers and stops the conveyance of the recording medium.

30 **[0024]** When the heads 3 finish forward scanning, for one time, along X axis direction according to the control of the control device 9, the driving motor 22 rotates the driving roller 21 for a predetermined amount to convey the recording medium in the conveyance direction for a predetermined distance and stops. When the heads 3 start scanning in the opposite direction of the main scanning direction X and finish the scanning, the driving motor 22 performs so-called intermittent conveyance of the recording medium by repeating conveyance of the recording medium for a predetermined distance in the conveyance direction F by rotating the driving roller 21 again for a predetermined amount and stopping the conveyance.

35 **[0025]** Here, resin films, metals and the like can be used as recording mediums other than paper sheets and fabrics.

[Frame]

50 **[0026]** As shown in FIG. 1, the frame 100 mainly includes a rectangular main body unit 101 which extends in X axis direction, a first base unit 102 which supports one end section of the main body unit 101 in X axis direction, a second base unit 103 which supports the other end section of the main body unit 101 in X axis direction.

55 **[0027]** The first base unit 102 supports one end section of the main body unit 101 from below while housing and holding the maintenance unit 7 therein. Further, the sec-

ond base unit 103 supports the other end section of the main body unit 101 from below while housing and holding the nozzle humidifier unit 6 therein.

[0028] In the main body unit 101, the after-mentioned one pair of carriage rails 51 and 51 of the main moving device 5 is housed and held therein so as to extend along X axis direction, and the carriage 4 is moved along X axis direction in the main body unit 101.

[0029] Moreover, the first base unit 102 and the second base unit 103 are disposed respective at the two ends in X axis direction having the above-mentioned conveyance device 20 therebetween, and the main body unit 101 is bridged above the conveyance device 20. Thereby, while conveying the carriage 4 in the direction that is orthogonal to the conveyance direction of recording mediums being conveyed by the conveyance device 20, image forming can be performed by spraying ink from each of the heads 3 installed in the carriage 4.

[Main scanning device and carriage]

[0030] The main moving device 5 includes a pair of carriage rails 51 and 51 in a rod shape which are supported so as to extend in X axis direction in the main body unit 101 of the frame 100. The pair of carriage rails 51 and 51 is provided to as to cross over the conveyance belt 23 of the conveyance device 20. The carriage 4 in a box shape which is supported along the X axis direction so as to reciprocate is supported by the carriage rails 51 and 51.

[0031] The carriage 4 is a rectangular case wherein the upper part is opened and a plurality of heads 3 are installed on the bottom plate. As shown in FIG. 1, in the carriage 4, arm units 42 and 42 extent in both sides in Y axis direction at the upper part of both side surfaces in Y axis direction, and the arm units 42 and 42 are placed on the carriage rails 51 and 51 via linear guides. Thereby, the carriage 4 can slide along X axis direction on the carriage rails 51 and 51.

[0032] Further, linear motors are installed between the carriage rails 51 and 51 and the arm units 42 and 42 of the carriage 4. That is, a stator for the linear motor is provided at each of the carriage rails 51 and 51 and a needle is provided at each of the arm units 42 and 42 of the carriage 4. Due to the current control of the coil in the stators' side, the carriage 4 can move along X axis direction.

[0033] FIG. 2 is a schematic explanatory diagram when the bottom plate 41 of the carriage 4 is seen from above. In the inkjet recording apparatus 10, nine heads 3 are provided for each of nine colors which are Y (yellow), Lm (light magenta), Or (orange), M (magenta), Bk (black), Bl (blue), Lk (light black), C (cyan) and Lc (light cyan) are provided, and total of eighty one heads 3 are attached on the bottom plate of the carriage 4.

[0034] As shown in the drawing, the head groups of the colors are aligned in the order of Y, Lm, Or, M, Bk, Bl, Lk, C and Lc along X axis direction, and the nine heads

3 in each head group are arranged in a staggered manner along Y axis direction.

[0035] Moreover, the bottom plate 41 has slit-shape openings at attachment positions of the heads 3 along Y axis direction, and the heads 3 attached on the bottom plate 41 from above can spray ink droplets just below the carriage through respective corresponding openings.

[0036] Then, as described above, by arranging the nine heads 3 in a staggered manner for each color, ink of each color can be sprayed at an arbitrary position within a range across approximately the entire width in Y axis direction of the bottom plate 41 of the carriage 4.

[Head]

[0037] FIG. 3 is a cross-section diagram showing a schematic configuration of a head 3. A head 3 mainly includes a nozzle plate 31 in which a plurality of nozzles 311 that spray ink are formed, a head chip 32 including a plurality of channels 321 which lead ink to each nozzle 311 and a plurality of piezoelectric elements which make the channels 321 discharge ink by causing volume fluctuation in the channels 321, a wiring substrate 33 which applies driving voltage to each of the piezoelectric elements in the head chip 32 and a manifold 34 for guiding ink to each of the channels 321 of the head chip 32 through a filter 343.

[0038] The nozzle plate 31 is a rectangular flat plate, and when the head 3 is installed in the carriage 4, the flat plate surface of the nozzle plate 31 is to be parallel with X-Y plane and the longitudinal direction of the nozzle plate 31 is to be parallel with Y axis direction.

[0039] Further, a plurality of through holes which become the nozzles 311 are formed in a line along Y axis direction in the nozzle plate 31.

[0040] The head chip 32 is formed in a rectangular solid shape, and a nozzle plate 31 is attached at the bottom surface thereof. Further, a plurality of channels 321 corresponding to the positions of the nozzles 311 of the nozzle plate 31 are formed in the head chip 32 in one line along Y axis direction. Each of the channels 321 is an ink flow path which penetrates the head chip 32 in up-down direction and can guide ink in the manifold 334 to the corresponding nozzle 311 individually. Further, a piezoelectric element 322 is provided adjacent to each channel 321 and voltage can be applied selectively to an arbitrary piezoelectric element 322 to inflate or contract the piezoelectric element 322 and ink can be sprayed from the corresponding nozzle 311.

[0041] The wiring substrate 33 is attached on the upper surface of the head chip 32. The wiring substrate 33 is connected to the head driving circuit (not shown in the drawing) via a flexible substrate, and wiring for applying driving voltage to each of the piezoelectric elements 322 of the head chip 32 from the head driving circuit is provided on the wiring substrate 33.

[0042] Moreover, the wiring substrate 33 is attached to the manifold 34 so as to block the lower part of the

manifold 34 which is opened and a rectangular opening is formed so that ink in the manifold 34 flows to the side of channels 321 of the head chip 32.

[0043] The manifold 34 is a rectangular solid, wherein inside thereof is hollow, disposed in a state where the longitudinal direction thereof aligns Y axis direction. As described above, although the bottom section thereof is opened, the wiring substrate 33 is fitted to block the opened section.

[0044] Further, cylindrical shaped first port 341 and second port 342, which are connected to inside, are formed respectively at the upper sections of the manifold 34 in one end side and in the other end side in Y axis direction.

[0045] Inside of the manifold 34 is divided in two, upper region and lower region, by the filter 343 which filters substances mixed in ink. The upper region is connected with the first port 341 and the second port 342 and the lower region is connected with the head chip 32. That is, ink which is supplied to the manifold 34 from outside through the first port 341 or the second port 342 is filtered by the filter 343 and moves to the head chip 32 side, and then, is sprayed from each of the nozzles 311.

[Maintenance unit]

[0046] The maintenance unit 7 performs maintenance of each head 3 when recording operation is not carried out. The maintenance unit 7 is provided at one end section side of the carriage rails 51 and 51 apart from the conveyance device 20. That is, maintenance is to be performed in a state where the carriage 4 is moved to the place at the one end section of the carriage rails 51 and 51 where the carriage 4 faces the maintenance unit 7.

[0047] The maintenance unit 7 includes a cleaning device which wipes the under surface of the nozzle plate 31 of each head 3 and an ink tray 71 (see FIG. 4) which becomes a tray for the head 3 which is subjected to maintenance when the head 3 discharges ink.

[0048] The cleaning device mainly includes a cleaning roller which can rotate around the rotation axis along X axis direction which is in sliding contact with the under surface of the nozzle plate 31 and a roller conveyance mechanism which conveys the cleaning roller along Y axis direction. Width of the cleaning roller in X axis direction is set so that the cleaning roller can wipe the head groups of three colors among the head groups of nine colors installed in the carriage 4, and performs cleaning of all of the heads 3 of the nine colors by one round trip (forward operation and return operation) and a half (forward operation) of moving operation. In such way, the nozzles 311 are prevented from clogging due to solidifying of ink.

[0049] Further, ink discharge to the ink tray 71 at the time of maintenance is carried out by ink supplying pressure of the ink supply device 8 and not by driving of piezoelectric elements 322 of the heads 3. Thereby, clogging of ink flow paths in the heads 3 can be resolved.

[Nozzle humidifier unit]

[0050] The nozzle humidifier unit 6 is provided at the other end section side of the carriage rails 51 and 51 apart from the conveyance device 20. That is, when the recording operation is not carried out, the carriage 4 moves to the position where the carriage 4 faces the nozzle humidifier unit 6 at the other end section of the carriage rails 51 and 51, and performs humidifying of the nozzles 311 of each head 3 in such state.

[0051] That is, the nozzle humidifier unit 6 closely contacts with the nozzles 311 of the nozzle plate 31 and makes inside of the nozzles be in connected state with the pool section where humidifying liquid is pooled. The nozzle humidifier unit 6 mainly includes the pool section of humidifying liquid and elevating mechanism of the pool section.

[Ink supply device]

[0052] FIG. 4 is an explanatory diagram showing a schematic configuration of the ink supply device 8. In the inkjet recording apparatus 10, the ink supply device 8 is provided for each color.

[0053] The ink supply device 8 mainly includes main tanks 81 and 81 as two first tanks in which ink is pooled, a sub tank 82 as a second tank to which ink is supplied from each of the main tanks 81 and 81, a degassing device 83 which is provided at the downstream side of the sub tank 82 in the ink supplying direction, an intermediate tank 84 in which ink is temporarily pooled which is provided at the downstream side of the degassing device 83 in the ink supplying direction, a negative pressure forming unit 86 which is provided at the downstream side of the intermediate tank 84 in the ink supplying direction and a common flow path 87 for supplying ink to each of the heads 3, the common flow path 87 being connected with the first ports 341 of the heads 3 in parallel.

[0054] In FIG. 4, the ink tray 71 of the maintenance unit 7 is also shown.

[0055] The main tanks 81 and 81 are containers where the upper parts thereof are opened to the air. The two main tanks 81 and 81 are detachable from the inkjet recording apparatus 10 so that they can be replaced when they are empty. Further, because there are two main tanks 81 and 81, even when one of the main tanks is empty or is being replaced, ink can be supplied from the other main tank 81. Therefore, recording operation of the inkjet recording apparatus 10 can be prevented from being interrupted. Here, the number of main tanks 81 to be installed can be more.

[0056] The reference numerals 815 in FIG. 4 refer to residual sensors which detect whether the ink in the main tanks 81 and 81 is empty.

[0057] In between the main tanks 81 and 81 and the sub tank 82, there is provided a first ink flow path 811 in which one end section thereof is branched in two, one for each main tank 81, and the branched flow paths are

combined at the other end section of the first ink flow path 811 and this end section leads to the sub tank 82. A tank valve 812 as a connection switching unit which is an electromagnetic valve capable of switching the open/close state of the path is provided near each main tank 81 in the first ink flow path 811.

[0058] A filter 813 which removes contaminants such as wastes and dusts from ink is provided in the middle of the path in the sub tank 82 side of the first ink flow path 811. Further, a first ink feed pump 814 as a first ink feed unit which feeds ink to the sub tank side is provided in the middle of the path which is in the sub tank 82 side of the first ink flow path 811 closer to the sub tank 82 than the filter 813.

[0059] The sub tank 82 is formed in a funnel shape having a wall portion 821 where the diameter thereof becomes smaller as going down and the upper part thereof is closed with a top plate 822.

[0060] The bottom center of the sub tank 82 is connected with the second ink flow path 823 and the ink in the sub tank 82 is to be supplied to the degassing device 82 side through the second ink flow path 823.

[0061] Moreover, an air open pipe 824 which maintains inside of the sub tank 82 at atmospheric pressure is attached to the top plate 822 of the sub tank 82. The air open pipe 824 is provided with a filter 825 for preventing dusts and wastes from entering.

[0062] Further, a tip section of the first ink flow path 811 is connected to the top plate 822 of the sub tank 82 in a state penetrating the top plate 822 and entering all the way to the inside.

[0063] The tip section of the first ink flow path 811 extends to the position where contacts or almost contacts the inner surface of the side wall 822 of the sub tank 82, and the ink which is supplied from the first ink flow path 811 is to pour into the ink surface in the sub tank 82 along the side wall 822.

[0064] In the sub tank 82, the upper limit position of the ink surface is set by the after-mentioned ink surface monitoring control, and the tip section of the first ink flow path 811 is to pour ink to the side wall 822 at a position higher than the upper limit position of the ink surface.

[0065] By setting the position of the tip section of the first ink flow path 811 in the sub tank 82 as described above, the ink which is supplied from the first ink flow path 811 is to be always poured into the ink surface after flowing along the inner surface of the side wall 822 of the sub tank 82. Therefore, the ink gently flows along the inclined surface to be pooled in the sub tank 82. Thus, when bubbles which can be visually identified are mixed into the ink supplied from the first ink flow path 811, the bubbles stay on the ink surface. Further, because the ink gently flows along the inclined surface, new bubbles can be prevented from being generated at the ink surface and mixed in the ink.

[0066] Moreover, the ink in the sub tank 82 is fed to the downstream side from the bottom, that is, the deepest part the sub tank 82 through the second ink flow path

823. Therefore, bubbles can be removed from the ink which is to be supplied to the downstream side than the sub tank 82.

[0067] That is to say, the sub tank 82 functions as degassing device to remove bubbles from ink.

[0068] Further, in the sub tank 82, a first ink surface sensor 826 which defines the upper limit position of the ink surface and a second ink surface sensor 827 which defines the lower limit position of the ink surface in the after-mentioned ink surface monitoring control are provided.

[0069] Both of the ink surface sensors 826 and 827 are float-type sensors provided with floating elements, and can detect whether the ink surface is above the upper limit position and below the lower limit position by the level of the floating elements. The ink surface monitoring control will be described later.

[0070] The second ink flow path 823 is provided between the sub tank 82 and the degassing device 83. A check valve 828 which prevents ink from flowing backwards to the sub tank 82 from the degassing device 83 and a second ink feed pump 829 as the second ink feed unit which feeds ink to the degassing device 83 from the sub tank 82 are provided in the middle of the second ink flow path 823.

[0071] The degassing device 83 includes a degassing module 831 to which the end of the second ink flow path 823 is connected, a vacuum pump 832 which performs vacuum drawing on the degassing module 831, a vacuum pressure sensor 833 which detects the pressure in the degassing module 831 and a leak valve 834 which is a magnetic valve which opens inside of the degassing module 831 to the air.

[0072] The degassing module 831 includes a vacuum container in which vacuum is drawn by the vacuum pump 832 and a hollow fiber membrane which allows the ink to path though toward inside in the vacuum container, and has a configuration where the dissolved gas in the ink is to be aspirated outside via the hollow fiber membrane due to the vacuum drawing.

[0073] The vacuum pressure sensor 833 is a detection device for measuring whether the pressure is decreased to the target pressure at the time of vacuum drawing. Further, open control of the leak valve 834 is performed by the control device 9 so that the degassing module 831 will be in the atmospheric pressure state from the vacuum state in order to protect the degassing module 831 when the inkjet recording apparatus 10 is in the power off state.

[0074] A third ink flow path 835 is provided between the degassing module 831 and the intermediate tank 84. Ink is supplied to the intermediate tank 84 by the supplying pressure of the second ink feed pump 829 through the second and the third ink flow paths 823 and 835.

[0075] The intermediate tank 84 is formed of a flexible bag, and is to expand and contract by the pooled amount of ink fluctuating.

[0076] Further, an ink amount sensor 841 which detects the state of ink when a defined amount of ink is

pooled is also installed with the intermediate tank 84. When ink is supplied from the sub tank 82, ink is to be supplied by the second ink feed pump 829 until the ink amount sensor 841 detects that the ink reached the defined amount.

[0077] Fourth to seventh ink flow paths 842 to 845 are provided between the intermediate tank 84 and the negative pressure forming unit 86, and ink is to be supplied through these ink flow paths. A first three-way switching valve 846 which is an electromagnetic valve is intervened between the fourth ink flow path 842 and the fifth ink flow path 843, a second three-way switching valve 847 which is an electromagnetic valve is intervened between the fifth ink flow path 843 and the sixth ink flow path 844 and a third three-way switching valve 848 which is an electromagnetic valve is intervened between the sixth ink flow path 844 and the seventh ink flow path 845.

[0078] Moreover, the fifth ink flow path 843 is provided with a check valve 849 which only allows the flow toward the second three-way switching valve 847 from the first three-way switching valve 846, a third ink feed pump 850 which feeds ink to the direction which is same as the direction of flow allowed by the check valve 849 and a relief valve 851 which returns the ink to the sub tank 82 when the pressure at the downstream side of the third ink feed pump 850 exceeds the defined pressure.

[0079] One end section of the branched flow path 852 is connected to the sixth ink flow path 844 at the middle thereof, and the other end section of the branched flow path 852 is connected to the first three-way switching valve 846. The first three-way switching valve 846 can switch between the state where the fifth ink flow path 843 is connected to the fourth ink flow path 842 and the state where the fifth ink flow path 843 is connected to the branched flow path 852 by the controlling of the control device 9.

[0080] The second three-way switching valve 847 is also connected to the return flow path 853 for returning the ink to the sub tank 82. The second three-way switching valve 847 can switch between the state where the fifth ink flow path 843 is connected to the sixth ink flow path 844 and the state where the fifth ink flow path 843 is connected to the return flow path 853 by the controlling of the control device 9.

[0081] Switching control of the first and the second three-way switching valves 846 and 847 is performed at the same time in combination by the control device 9 to switch between the supply connection state where ink is fed to the negative pressure forming unit 86 side from the intermediate tank 84 through the fourth, fifth and sixth ink flow paths 842, 843 and 844 (shown by white arrow in FIG. 4) and the return connection state where ink is fed to the sub tank 82 side from the negative pressure forming unit 86 through the branched flow path 852, the fifth ink flow path 843 and the return flow path 853 (shown by black arrow in FIG. 4).

[0082] In other words, by using the feeding pressure of the third ink feed pump 850, the supplying of ink to the

negative pressure forming unit 86 side and the retrieving of ink from the negative pressure forming unit 86 side can be executed freely and selectively.

[0083] The third three-way switching valve 848 is also connected to the detour flow path 854 which performs ink supply to the side of heads without passing through the negative pressure forming unit 86, and the third three-way switching valve 848 can switch between the state where the sixth ink flow path 844 is connected to the seventh ink flow path 845 and the state where the sixth ink flow path 844 is connected to the detour flow path 854 by the controlling of the control device 9.

[0084] In other words, in the above switching, switching can be carried out between the state where ink supply and ink retrieving to and from the negative pressure forming unit 86 can be executed and the state where ink supply and ink retrieving to and from the heads 3 side (specifically, to and from the common flow path 87) can be executed.

[0085] The negative pressure forming unit 86 mainly includes a rectangular main container 861 in which a wide opening is formed in the front side thereof, a film member 862 formed of a flexible resin film which blocks the opening of the main container 861 and a spring (not shown in the drawing) which presses the center of the film member 862 toward outside from inside of the main container 861.

[0086] The main container 861 is connected to the seventh ink flow path 845 and the eighth ink flow path 863 which connects to the common flow path 87 to which all of the first ports 341 of the nine heads 3 are connected in parallel.

[0087] Further, because the center part of the film member 862 is pressed outside by the spring, the film member 862 is in an approximately conical shape.

[0088] After ink is filled in the main container 861 at the pressure same as the atmospheric pressure, by making the first and the second three-way switching valves 846 and 847 be in the return connection state to retrieve the ink from the main container 861, inside of each of the heads 3 is to be in a negative pressure state via the common flow path 87. When the heads 3 are at the atmospheric pressure, ink can easily leak from the nozzles 311 and poor spraying and variation in dot diameter can easily occur because ink can easily adhere around the nozzles 311. Therefore, the reason for maintaining inside of the heads 3 at negative pressure is to prevent the above problems.

[0089] Here, the target pressure of the negative pressure can be controlled by adjusting the retrieving amount of ink in the main container 861.

[0090] At the top part section of the main container 861 of the negative pressure forming unit 86, a communication pipe 864 which communicates with inside of the main container 861 and extends upward is provided. An ink surface sensor 865 is attached at the end section of the communication pipe 864 in the main container 861 side and a pressure sensor 866 is attached at the upper end section of the communication pipe 864. A branched pipe

867 in which one end thereof is opened to the atmosphere and which extends horizontally is connected to the middle section of the communication pipe 864, and an open valve 868 which opens/closes the branched pipe 867 and an air filter 869 which filters the air are connected in the middle of the branched pipe 867.

[0091] The above configuration is used when controlling the main container 861 to be at a predetermined negative pressure by supplying ink in the main container 861. That is, ink is supplied into the main container 861 until the ink surface is detected by the ink surface sensor 865 in the state where the open valve 868 is opened, and then, the open valve 868 is closed and the ink is retrieved from the main container 861 until the pressure sensor 866 indicates the target negative pressure. In such way, each head 3 can be in the state of a predetermined negative pressure through the negative pressure forming unit 86.

[0092] The eighth ink flow path 863 which extends from the negative pressure forming unit 86 is combined with the detour flow path 854 in the middle thereof and is connected to the common flow path 87. Further, a protection valve 871 which is an electromagnetic valve which is normally opened is provided in the eighth ink flow path 863 at a position more to the negative pressure forming unit 86 side than the position where the eighth ink flow path 863 combines with the detour flow path 854.

[0093] The common flow path 87 is a hollow container in a flat plate shape where the front side is shaped in an approximately isosceles triangle (specifically, a pentagon shape where two corners at the bottom of the isosceles triangle are cut along vertical direction), and the common flow path 87 is installed in the carriage 4 so that the bottom thereof is disposed along horizontal direction. The eighth ink flow path 863 is connected to the common flow path 87 at the part corresponding to the apex of the isosceles triangle and the first ports 341 of the nine heads 3 of the same color are connected to the part corresponding to the bottom of the isosceles triangle.

[0094] In the common flow path 87, ink pass through the inner space where the isosceles triangle shape similar to the outer shape is made into three-dimensional shape. At that time, because ink is supplied from the apex position, ink is supplied equally to each head 3 connected to each part at the bottom of the common flow path 87 without great bias.

[0095] Outside shape of the common flow path 87 does not need to be approximately isosceles triangle shape as long as the front shape of the inner space where ink is supplied is in an approximately isosceles triangle shape.

[0096] Further, a waste flow path 872 which leads to a waste tank (not shown in the drawing) is connected near the apex position of the common flow path 87. A waste valve 873 which is an electromagnetic valve which is normally opened is provided at the waste flow path 872, and the waste flow path 872 is a flow path for discharging ink in order to exhaust bubbles by opening the

waste valve 872 at the time when filling the common flow path 87 with ink. Because the waste flow path 872 is connected at the apex which is the upper end section of the common flow path 87, by further supplying ink to the common flow path 87 in the state where the common flow path 87 is filled with ink, bubbles will float at the upper part in the common flow path 87 and can be effectively exhausted along with ink. In such way, bubbles which cause poor spraying of ink can be removed and a stable ink spraying can be performed.

[0097] FIG. 5 is an explanatory diagram showing the connected state of the common flow path 87 and each of the heads 3. As shown in FIGS. 4 and 5, the common flow path 87 is connected with the first port 341 of each head 3 via the recording operation valves 874 which are an electromagnetic valve which is normally opened.

[0098] Further, the second port 342 of each head 3 is connected to the common waste flow path 876 via the maintenance valves 875 which are normally opened in parallel with each other. The common waste flow path 876 is combined with the waste flow path 872 at the downstream side of the waste valve 873 and is connected to the waste tank.

[Control device]

[0099] FIG. 6 is a block diagram showing the control system of the ink supply device 8. The control device 9 shown in FIG. 6 carries out the controlling of the entire inkjet recording apparatus 10. However, only the configuration of the ink supply device 8 is shown here and other configurations are omitted in the drawing. Further, as for the configuration including a plurality of same structure, only one thereof will be described.

[0100] The control device 9 also controls the driving of each part of the inkjet recording apparatus 10 such as converting of image data of an image to be recorded on a recording medium input from an external device into data corresponding to each nozzle 311 of each head 3 and such like other than controlling of the ink supply device 8.

[0101] As shown in FIG. 6, the control device 9 is configured of a computer of general purpose in which a CPU 91, a ROM 92, a RAM 93, an input/output interface (not shown in the drawing) and the like are connected to a bus.

[0102] The first to the third ink feed pumps 814, 829 and 850, the vacuum pump 832, the tank valve 812, the leak valve 834, the first to the third three-way switching valves 846, 847 and 848, the open valve 868, the protection valve 871, the waste valve 873, the recording operation valves 874 and the maintenance valves 875 are connected to the control device 9, and these are subjected to be controlled by the control device 9.

[0103] Moreover, the residual sensor 815, the first and the second ink surface sensors 826 and 827, the ink amount sensor 841, the ink surface sensor 865, the vacuum pressure sensor 833 and the pressure sensor 866 are connected to the control device 9, and various types

of signals are input from the above parts.

[0104] Further, an input operation unit 94 which supports and inputs execution or the like of various types of operations operated by an operator, a display unit 95 which displays various types of information such as error information, and such like are also connected to the control device 9.

[0105] The control device 9 carries out the ink surface monitoring control of the sub tank 82, maintenance control of the heads 3 and the like on the above described control subjects according to the detected information.

[Ink surface monitoring control]

[0106] The ink surface monitoring control in the sub tank 82 which is performed by the control device 9 will be described in detail based on the flowchart of FIG. 7.

[0107] The ink surface monitoring control is a control to supplying ink to the sub tank 82 from the main tank 81 and to maintain and assure a constant ink amount in the sub tank 82. The ink surface monitoring control is repeatedly performed on a predetermined cycle.

[0108] In the ink surface monitoring control, it is assumed that the tank valve 812 of one of the main tanks 81 and 81 is opened and the other tank valve 812 is closed.

[0109] First, the control device 9 initializes the timer counter which is used to determine whether the main tank 81 which is currently connected to the sub tank 82 is empty (step S1).

[0110] Next, whether the ink in the sub tank 82 is at the detection level of the first ink surface sensor 826 which indicates that the ink in the sub tank 82 is full is determined by the first ink surface sensor 826 (step S3).

[0111] As a result, when it is detected that the ink is at the detection level of the first ink surface sensor 826, the control device 9 ends the ink surface monitoring control because the ink in the sub tank 82 is at the target amount.

[0112] On the other hand, when it is detected that the ink is not at the detection level of the first ink surface sensor 826, the control device 9 starts counting of the timer to determined whether the main tank 81 is empty and activates the first ink feed pump 814 to execute ink supply to the sub tank 82 from the main tank 81 (step S5).

[0113] Next, the control device 9 determines whether the ink in the sub tank 82 is at the detection level of the second ink surface sensor 827 which indicates that the ink in the sub tank 82 is almost empty by the second ink surface sensor 827 (step S7).

[0114] As a result, when it is detected that the ink is at the detection level of the second ink surface sensor 827, the control device 9 determines whether the timer indicates that a predetermined ink feeding time has elapsed (step S9).

[0115] When the timer does not indicate that the predetermined ink feeding time has elapsed, the control device 9 returns to step S3 and determines whether the sub tank 82 is full or not.

[0116] The ink feeding time in the determination of step S9 is set to a time period sufficient to fill up the sub tank 82 with the ink feeding ability of the first ink feed pump. That is, when the sub tank 82 is not full even when the ink feeding time has elapsed, it is presumed that the main tank 81 is already empty.

[0117] Therefore, the control device 9 stops the driving of the first ink feed pump 814 (step S11), determines that the main tank 81 is empty (step S13) and closes the tank valve 812 which is currently open and opens the other tank valve 812 to executed switching of the main tanks from which ink is to be supplied to the sub tank 82 (step S15). At this time, a display control can be performed to notify that the one of the main tanks is empty in the display unit 95.

[0118] Further, after the main tanks 81 are switched, the control device 9 returns the processing to step S1 again and restarts ink supply to the sub tank 82.

[0119] When the sub tank 82 is detected as being empty by the second ink surface sensor 827 in step S7 even when feeding of ink is carried out by the first ink feed pump 814 (step S7; NO), this condition indicates that both of the main tanks 81 and 81 are empty and that all of the ink in the main tanks 81 and 81 and the sub tank 82 are nearly used up. Therefore, the control device 9 stops all of the recording operation of the inkjet recording apparatus 10 when the inkjet recording apparatus 10 is in the middle of recording operation in order to prevent the recording operation to be performed poorly. Further, at this time, a display control to execute a notification display indicating that the operation is stopped due to an error and a warning display indicating that the tanks are empty can be carried out in the display unit 95.

[Maintenance control]

[0120] The maintenance control of the heads 3 which is performed by the control device 9 will be described in detail based on the flowchart of FIG. 8. Here, it is assumed that the heads 3 to which maintenance needs to be performed are specified by carrying out spraying test on all of the heads 3 in advance and that the heads 3 which are subjected to maintenance are already input by the input operation unit 94.

[0121] Further, it is assumed that the carriage 4 is on stand-by right above the maintenance unit 7.

[0122] First, the control device 9 switches the first and the second three-way valves 846 and 847 so as to be in the supply connection state (connection shown by the white arrow in FIG. 4) and also switches the third three-way switching valve 848 to be connected to the detour flow path 854 from the sixth ink flow path 844 (step S21).

[0123] Then, the control device 9 controls so as to open the waste valve 873 of the common flow path 87, close the protection valve 871 and close the recording operation valves 874 of all of the heads 3 (step S23).

[0124] Thereafter, the control device 9 executes feed-

ing control of ink (step S25).

[0125] Here, the feeding control will be described based on the flowchart of FIG. 9.

[0126] At the time of feeding, the control device operates the third ink feed pump 859 (step S251), and determines whether the preset operation time period T1 has elapsed (step S253) while maintaining the operation of the third ink feed pump 850 and, continues the operation of the third ink feed pump 850 until the operation time period T1 elapses.

[0127] By such operation of the third ink feed pump 850, the ink in the intermediate tank 84 bypasses the negative pressure forming unit 86 and is supplied directly to the common flow path 87. At this time, because the recording operation valves 874 of all of the heads 3 are closed and the maintenance valves 875 of all of the heads 3 are normally opened, ink is not supplied to each of the heads 3 and the common flow path 87 is to be filled with ink. Further, when the common flow path 87 is filled with ink, extra ink is to be discharged from the waste flow path 872. Due to such supply being continued for a certain time period, bubbles in the common flow path 87 float at the upper section in the common flow path 87 and are exhausted from the waste flow path 872.

[0128] Then, when the operation time period T1 elapses, the control device 9 stops the operation of the third ink feed pump 850 (step S255) and the third ink feed pump 850 is to be on stand-by until the waiting time period T2 elapses. In such way, the bubbles which are generated due to ink being poured into the common flow path 87 float and are collected at the upper section in the common flow path 87.

[0129] When the waiting time period T2 elapses, the control device 9 determines whether the number of times the ink supply and waiting are repeated reached the preset target number of times N (step S259).

[0130] When the repeated number of times has not yet reached the target number of times, the control device 9 returns the processing to step S251 and executes the ink supply and waiting again.

[0131] Here, the operation time period T1, the waiting time period T2 and the target number of times N can be set with respect to the control device 9 by the input operation unit 94 in advance. The target number of time N of the repeating is preferred to be set to at least two times or more so that the bubbles floated to the upper section in the common flow path 87 during the waiting time can be exhausted in the next ink supplying.

[0132] The description returns to FIG. 8 again.

[0133] When the ink feeding control ends, the control device 9 controls so as to close the waste valve 873 of the common flow path 87 (step S27) and to open the recording operation valves 874 and the maintenance valves 875 of the heads 3 which are subjected to maintenance (step S29).

[0134] Then, the control device 9 executes the ink feeding control again (step S31). The operation time period T1, the waiting time period T2 and the target number

of times N at this time can be the same values as in step S25 or can be set to different values.

[0135] In the above ink supply, ink is supplied to the heads 3 which are subjected to maintenance from the common flow path through the first ports 314. The supplied ink is discharged to the common waste flow path 876 through the second ports 342, and a part of the ink is discharged to the ink tray 71 from the nozzles 311 of the heads 3.

[0136] When the second time ink feeding control ends, the control device 9 closes the maintenance valves 875 of the heads 3 which are subjected to maintenance (step S33).

[0137] Then, the control device 9 executes the third time ink feeding control (step S35). Similarly, the operation time period T1, the waiting time period T2 and the target number of times N at this time can be the same values as in steps S25 and S31 or can be set to different values.

[0138] In the above ink supply, ink is supplied into the heads 3 which are subjected to maintenance from the common flow path 87 through the first ports 341 and is discharged to the ink tray 71 from the nozzles of the heads 3. At this time, supplying pressure of ink acts entirely on discharging of ink through the nozzles 311. Therefore, foreign substances and the like are pushed out in the nozzles 311 which were clogged and the clogging can be resolved, for example.

[0139] When the third time ink feeding control ends, the control device 9 opens all of the recording operation valves 874 of all of the heads 3 except for the heads 3 which are subjected to maintenance (step S37). Further, the control device 9 opens the protection valve 871 and switches the third three-way switching valve 848 so that the sixth ink flow path 844 and the seventh ink flow path 845 are connected (step S39).

[0140] Then, the control device 9 executes back-pressure adjusting control of the negative pressure forming unit (step S41) and ends the maintenance control by executing wiping control of each of the heads 3 (step S43).

[0141] Here, the back-pressure adjusting control of the negative pressure forming unit will be described in detail based on the flowchart of FIG. 10.

[0142] First, the control device 9 switches so as to open the open valve 868 and close the protection valve 871 (step S411).

[0143] Next, the control device 9 sets the current pressure of the pressure sensor 866 in the negative pressure forming unit 86 to the atmospheric pressure (step S412).

[0144] Then, the control device 9 starts the operation of the third ink feed pump 850 (step S413) and determines whether the ink supplied in the main container 861 of the negative pressure forming unit 86 reached the ink surface sensor 865 which is positioned at the upper end section of the main container 861 (step S414).

[0145] When the ink has not yet reached the upper end section of the main container 861, ink supply to the main container 861 continues, and when the ink reached the

upper end section of the main container 861, the operation of the third ink feed pump 850 is stopped (step S415).

[0146] Thereafter, the control device 9 closes the open valve 868 (step S416) and performs the control to switch the first and the second three-way switching valves 846 and 847 to be in the return connection state (the black arrow in FIG. 4) (step S417).

[0147] Then, when the control device 9 operates the third ink feed pump 850 again (step S418), the ink inside the main container 861 of the negative pressure forming unit 86 is discharged. As a result, inside pressure in the main container 861 declines.

[0148] The pressure value of the negative pressure suited for ink spraying by each of the heads 3 is set in advance, and when it is detected that the pressure is declined to the pressure value of negative pressure suited for ink spray by the pressure sensor 866 (step S419), the operation of the third ink feed pump 850 is stopped (step S420).

[0149] Then, the control device 9 opens the protection valve 871 (step S421), and thereby, the negative pressure forming unit 86 and each of the heads 3 are connected via the eighth ink flow path 863 and the common flow path 87. Therefore, inside of each of the heads 3 is to be at negative pressure same as inside of the negative pressure forming unit 86.

[0150] Thereafter, the control device 9 controls so as to switch the first and the second three-way switching valves 846 and 847 so as to be in the supply connection state (the white arrow in FIG. 4) (step S422) and ends the back-pressure adjusting control of the negative pressure forming unit.

[0151] The wiping control will be described based on the flowchart of FIG. 11. In the wiping control, periphery of each of the nozzles 311 of all of the heads 3 on the carriage 4 is to be wiped.

[0152] Wiping of each nozzle 311 is carried out by conveying the wiping roller, which rotary drives around the rotary axis along X axis direction, along Y axis direction while making the wiping roller be in sliding contact with the under surface of the nozzle plate 31.

[0153] On the other hand, because nine heads 3 for each of the nine colors are installed in the carriage 4 in the inkjet recording apparatus 10, the area where wiping needs to be carried out is very large. Therefore, when attempting to complete the wiping by conveying the wiping roller for one way, the wiping roller needs to be made long in its rotary axis direction, and this may easily cause warping and an effective wiping may not be able to take place.

[0154] Thus, the wiping roller is made so as to be approximately in same size as the width of the heads 3 for three colors in X axis direction, and the wiping roller carries out wiping of the nozzles of all of the heads 3 of nine colors in three times of conveyance.

[0155] Hereinafter, the operation control will be described.

[0156] First, the control device 9 executes the convey-

ance of the wiping roller for one way (forward) from its stand-by position while rotating the wiping roller (step S431). In such way, wiping is carried out on the heads 3 corresponding to three colors.

5 [0157] Next, the control device 9 moves the carriage 4 for the distance same as the width of the heads 3 corresponding to three colors in X axis direction (step S433) and executes the conveyance of the wiping roller for one way (returning) while rotating the wiping roller (step S435). In such way, wiping is carried out on the heads 3 corresponding to the next three colors.

10 [0158] Further, the control device 9 moves the carriage 4 for the distance same as the width of the heads 3 corresponding to three colors in X axis direction (step S437) and executes conveyance of the wiping roller for one way (forward) while rotating the wiping roller (step S439). In such way, wiping is carried out on the heads 3 corresponding to the last three colors.

15 [0159] Furthermore, the wiping is repeatedly carried out for the number of times set in advance. Therefore, when wiping is finished for the heads 3 of all nine colors, the control device 9 compares the current number of times wiping has been executed and the preset repeating number of times (step S441). As a result, when the current number of times wiping has been executed has not yet reached the preset repeating number of times, the control device returns the processing to step S431 and starts the wiping operation again.

20 [0160] On the other hand, when the current number of times wiping has been executed reached the preset repeating number of times, the wiping control ends.

[Technical advantages in the embodiment of the present invention]

25 [0161] The ink supply device 8 of the inkjet recording apparatus 10 is provided with the sub tank 82 having a funnel shape in the middle of the path to the heads 3 from the main tank 81, and ink is supplied to the sub tank 82 from the main tank 81 so that the ink is poured along the inclined inner wall surface of the sub tank 82. Further, the ink is fed to each of the heads 3 from the bottom section of the sub tank 82 via the intermediate tank 84, the negative pressure forming unit 86, the common flow path 87 and the like.

30 [0162] Therefore, because ink is supplied into the sub tank 82 by being poured along the inclined inner wall surface, generation of bubbles can be reduced due to the ink being calmly poured comparing to when ink is poured so as to hit the ink surface. Further, even when bubbles are already mixed, the bubbles in the ink which is calmly poured in the sub tank 82 remain at the ink surface of the pooled ink, and by the ink being fed from the bottom section of the sub tank 82, only the bubbles remain in the sub tank 82 and bubbles can be removed from the ink which is to be fed toward the downstream.

35 [0163] In such way, bubbles having a size which is visually identifiable can be effectively removed from ink and

a stable ink droplet spraying can be carried out at each of the heads 3.

[0164] Further, by providing two main tanks 81 and carrying out ink supply to the sub tank 82 from either one of the main tanks 81, the tank can be promptly switched to the other main tank 81 when ink in the selected main tank 81 runs out. Therefore, interruption of ink spraying operation can be avoided and continuous spraying can be realized.

[0165] Moreover, by including the degassing device 83 in the middle of the path to the heads 3 from the sub tank 82, fine bubbles and dissolved gas in the ink which cannot be visually identified can also be removed and even more stable ink droplet spraying can be carried out at each of the heads 3.

[Others]

[0166] In the above embodiment, the sub tank 82 in a funnel shape is shown as an example. However, sub tank is not limited to the above example as long as the configuration allows ink to be poured from the first ink flow path 811 along the inner wall surface of the sub tank.

[0167] For example, as shown in the sub tank 82A in FIG. 12A which is the second example, the tank may be in a cylinder shape or a rectangular parallelepiped shape and the tip section of the first ink flow path 811 may be disposed near or so as to contact the inner wall surface of the sub tank 82A so that ink will be poured along the inner wall surface along vertical direction. In such case, because ink flows along the vertical surface in the sub tank 82A, ink is to flow at faster speed than in the case of inclined wall. However, generation of bubbles can be reduced sufficiently comparing to the case where ink is directly poured into the ink surface and bubbles can be removed from the ink which is supplied toward downstream side of the sub tank 82 by the bubbled being remained at the ink surface.

[0168] Moreover, as shown in the sub tank 82B in FIG. 12B which is the third example, differently from the sub tank 82, the tank may have a configuration where only the part where the ink supplied from the first ink flow path 811 flows along is formed as an inclined surface and not the entire wall surface of the tank, and the part where the ink does not flow along may be vertically upright. In such case, because the ink in the sub tank 82 is calmly poured along the inclined surface, advantages similar to those obtained by the sub tank 82 can also be obtained.

[0169] The present invention is not limited to the above descriptions of the embodiment, and can be arbitrarily modified within the scope of the invention.

[0170] According to one aspect of the preferred embodiment of the present invention, there is provided an ink supply device of an inkjet recording apparatus including a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium, a second tank which is provided in a middle of a path to the heads from the first tank, a first ink feed unit

which feeds the ink to the second tank from the first tank, a second ink feed unit which feeds the ink to the heads side from the second tank and a first ink flow path which connects the first tank and the second tank, and an end section of the first ink flow path in the second tank side is connected to the second tank so that the ink flows along an inner wall of the second tank and the second ink feed unit feeds the ink from a lower section of the second tank.

[0171] In the ink supply device of the inkjet recording apparatus, the second tank is provided in the middle of the path to the heads from the first tank, ink is supplied to the second tank from the first tank so as to flow along the inner wall of the second tank and the inks is fed to the heads from the lower section of the second tank.

[0172] Therefore, because ink is supplied into the second tank is poured along the inner wall, generation of bubbles can be reduced due to the ink being calmly poured comparing to when ink is poured so as to hit the ink surface. Further, even when bubbles are already mixed, the bubbles in the ink which is calmly poured in the second tank remain at the ink surface of the pooled ink, and by the ink being fed from the lower section of the second tank, only the bubbles remain in the second tank and bubbles can be removed from the ink which is to be fed toward the heads side.

[0173] In such way, bubbles having a size which is visually identifiable can be effectively removed from ink and a stable ink droplet spraying can be carried out at the heads.

[0174] Preferably, at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.

[0175] In the ink supply device of the inkjet recording apparatus, by making the part of the inner wall of the second tank where the ink is supplied from the first ink flow path be inclined, the supplied ink is poured calmly. Therefore, generation of bubbles and mixing of gas can be prevented even more.

[0176] Preferably, the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.

[0177] In the ink supply device of the inkjet recording apparatus, by forming the second tank in a funnel shape, ink can be poured along the inclined surface regardless of the position in the inner wall where the ink is supplied. Therefore, the position where ink is supplied from the first ink flow path into the second tank can be adjusted easily.

[0178] Preferably, the ink supply device of the inkjet recording apparatus includes at least two or more first tanks and a switching unit which selectively switches between the two first tanks to be connected with the second tank.

[0179] In the ink supply device of the inkjet recording device, by including two or more first tanks and by selectively supplying ink to the second tank, the first tanks can

be switched promptly, from one tank to the other, when the selected first tank runs out of ink. Therefore, interruption of ink spraying operation can be avoided and continuous spraying can be realized.

[0180] Preferably, the ink supply device of the inkjet recording apparatus further includes a degassing unit which performs vacuum degassing on the ink, the degassing unit being provided in a middle of a path to the heads from the second tank.

[0181] In the ink supply device of the inkjet recording apparatus, by providing the degassing unit in the middle of the path to the heads from the second tank, fine bubbles and dissolved gas in the ink which cannot be visually identified can also be removed and even more stable ink droplet spraying can be carried out at the heads.

[0182] According to another aspect of the preferred embodiment of the present invention, there is provided an ink supply method of an inkjet recording apparatus, wherein the inkjet recording apparatus including a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium, a second tank which is provided in a middle of a path to the heads from the first tank, a first ink feed unit which feeds the ink to the second tank from the first tank, a second ink feed unit which feeds the ink to the heads side from the second tank and a first ink flow path which connects the first tank and the second tank, and the method including ink supplying to the second tank from an end section of the first ink flow path in a second tank side so that the ink flows along an inner wall of the second tank, and ink feeding from a lower section of the second tank by the second ink feed unit.

[0183] In the ink supply method of the inkjet recording apparatus, the second tank is provided in the middle of the path to the heads from the first tank, ink is supplied to the second tank from the first tank so as to flow along the inner wall of the second tank and the ink is fed to the heads from the lower section of the second tank.

[0184] Therefore, because ink is supplied into the second tank is poured along the inner wall, generation of bubbles can be reduced due to the ink being calmly poured comparing to when ink is poured so as to hit the ink surface. Further, even when bubbles are already mixed, the bubbles in the ink which is calmly poured in the second tank remain at the ink surface of the pooled ink, and by the ink being fed from the lower section of the second tank, only the bubbles remain in the second tank and bubbles can be removed from the ink which is to be fed toward the heads side.

[0185] In such way, bubbles having a size which is visually identifiable can be effectively removed from ink and a stable ink droplet spraying can be carried out at the heads.

[0186] Preferably, the ink supply method of the inkjet recording apparatus includes ink supply wherein at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.

[0187] In the ink supply method of the inkjet recording apparatus, by making the part of the inner wall of the second tank where the ink is supplied from the first ink flow path be inclined, the supplied ink is poured calmly. Therefore, generation of bubbles and mixing of gas can be prevented even more.

[0188] Preferably, the ink supply method of the inkjet recording apparatus includes ink supply wherein the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.

[0189] In the ink supply method of the inkjet recording apparatus, by forming the second tank in a funnel shape, ink can be poured along the inclined surface regardless of the position in the inner wall where the ink is supplied. Therefore, the position where ink is supplied from the first ink flow path into the second tank can be adjusted easily.

[0190] Preferably, the ink supply method of the inkjet recording apparatus includes ink supply wherein at least two or more first tanks are included and the ink is supplied selectively from each of the first tanks to the second tank.

[0191] In the ink supply method of the inkjet recording device, by including two or more first tanks and by selectively supplying ink to the second tank, the first tanks can be switched promptly, from one tank to the other, when the selected first tank runs out of ink. Therefore, interruption of ink spraying operation can be avoided and continuous spraying can be realized.

[0192] Preferably, the ink supply method of the inkjet recording apparatus includes ink supply wherein the ink is supplied to the heads by being subjected to vacuum degassing by a vacuum degassing device at a middle of a path to the heads from the second tank.

[0193] In the ink supply method of the inkjet recording apparatus, by providing the degassing unit in the middle of the path to the heads from the second tank, fine bubbles and dissolved gas in the ink which cannot be visually identified can also be removed and even more stable ink droplet spraying can be carried out at the heads.

Claims

1. An ink supply device of an inkjet recording apparatus, comprising:

a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium;

a second tank which is provided in a middle of a path to the heads from the first tank;

a first ink feed unit which feeds the ink to the second tank from the first tank;

a second ink feed unit which feeds the ink to the heads side from the second tank; and

a first ink flow path which connects the first tank and the second tank,

- wherein
 an end section of the first ink flow path in the second tank side is connected to the second tank so that the ink flows along an inner wall of the second tank and the second ink feed unit feeds the ink from a lower section of the second tank.
2. The ink supply device of the inkjet recording apparatus of claim 1, wherein
 at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.
 3. The ink supply device of the inkjet recording apparatus of claim 2, wherein
 the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.
 4. The ink supply device of the inkjet recording apparatus of at least one of claims 1 to 3, comprising:
 at least two or more first tanks; and
 a switching unit which selectively switches between the two first tanks to be connected with the second tank.
 5. The ink supply device of the inkjet recording apparatus of at least one of claims 1 to 4, further comprising a degassing unit which performs vacuum degassing on the ink, the degassing unit being provided in a middle of a path to the heads from the second tank.
 6. An ink supply method of an inkjet recording apparatus, wherein the inkjet recording apparatus comprising:
 a first tank which pools ink which is to be supplied to heads, the heads spraying the ink onto a recording medium;
 a second tank which is provided in a middle of a path to the heads from the first tank;
 a first ink feed unit which feeds the ink to the second tank from the first tank;
 a second ink feed unit which feeds the ink to the heads side from the second tank; and
 a first ink flow path which connects the first tank and the second tank, and
 the method including:
 ink supplying to the second tank from an end section of the first ink flow path in a second tank side so that the ink flows along an inner wall of the second tank, and
 ink feeding from a lower section of the second tank by the second ink feed unit.
 7. The ink supply method of the inkjet recording apparatus of claim 6, wherein
 at least a part of the inner wall of the second tank where the ink is supplied from the first ink flow path is inclined so that the ink flows along the inner wall.
 8. The ink supply method of the inkjet recording apparatus of claim 7, wherein
 the second tank is formed in a funnel shape and the ink is supplied from the first ink flow path so as to flow along the inner wall of the second tank.
 9. The ink supply method of the inkjet recording apparatus of at least one of claim 6 to 8, wherein
 at least two or more first tanks are included, and the ink is supplied selectively from each of the first tanks to the second tank.
 10. The ink supply method of the inkjet recording apparatus of at least one of claims 6 to 9, wherein
 the ink is supplied to the heads by being subjected to vacuum degassing by a vacuum degassing device at a middle of a path to the heads from the second tank.

FIG.1

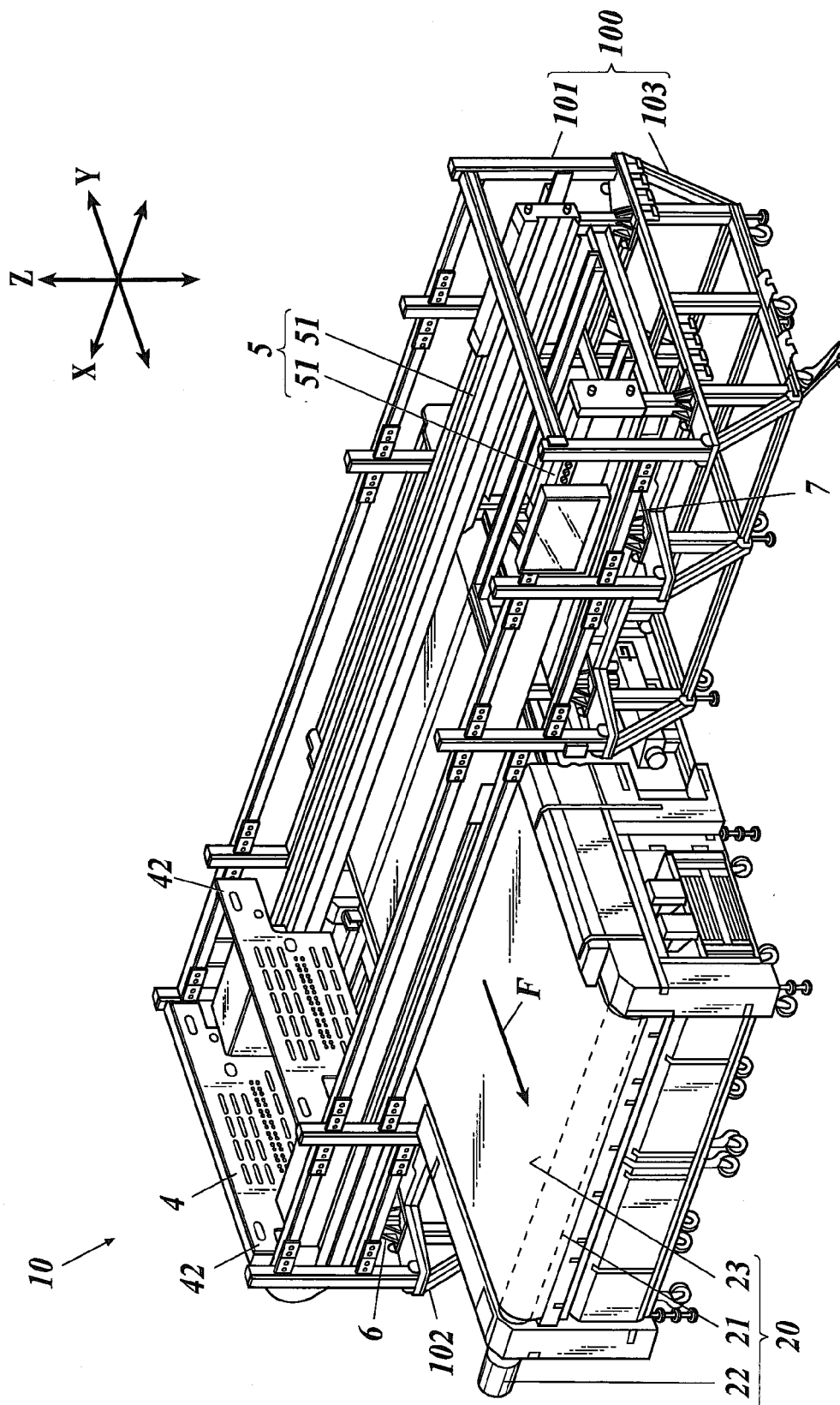


FIG.2

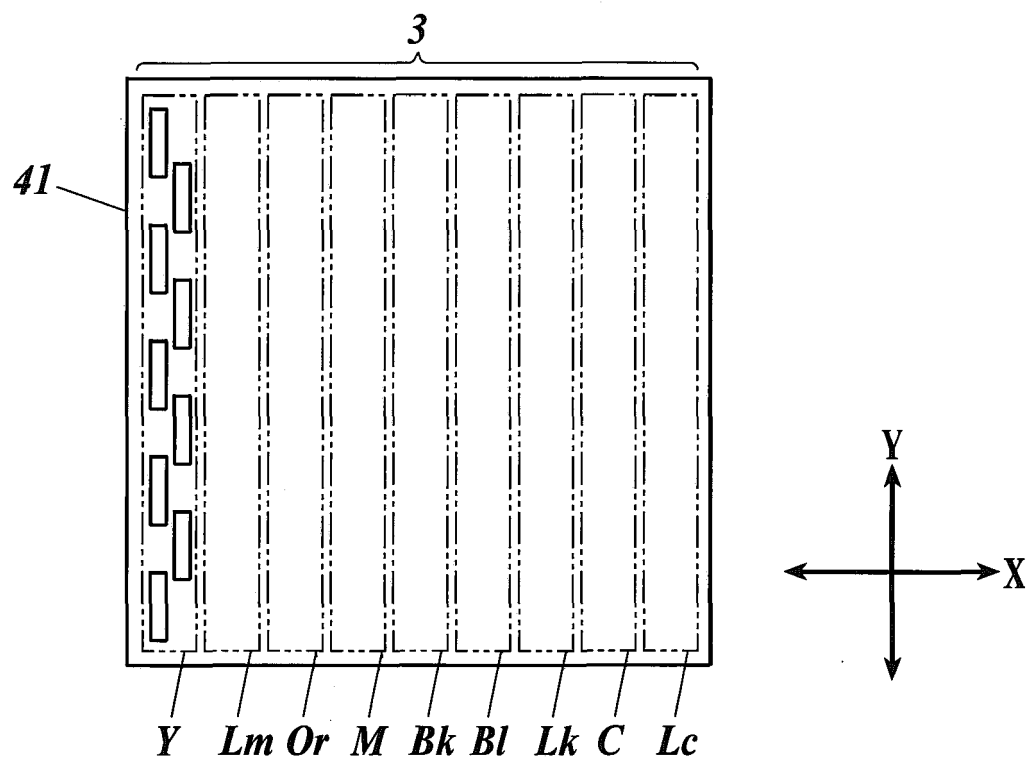


FIG.3

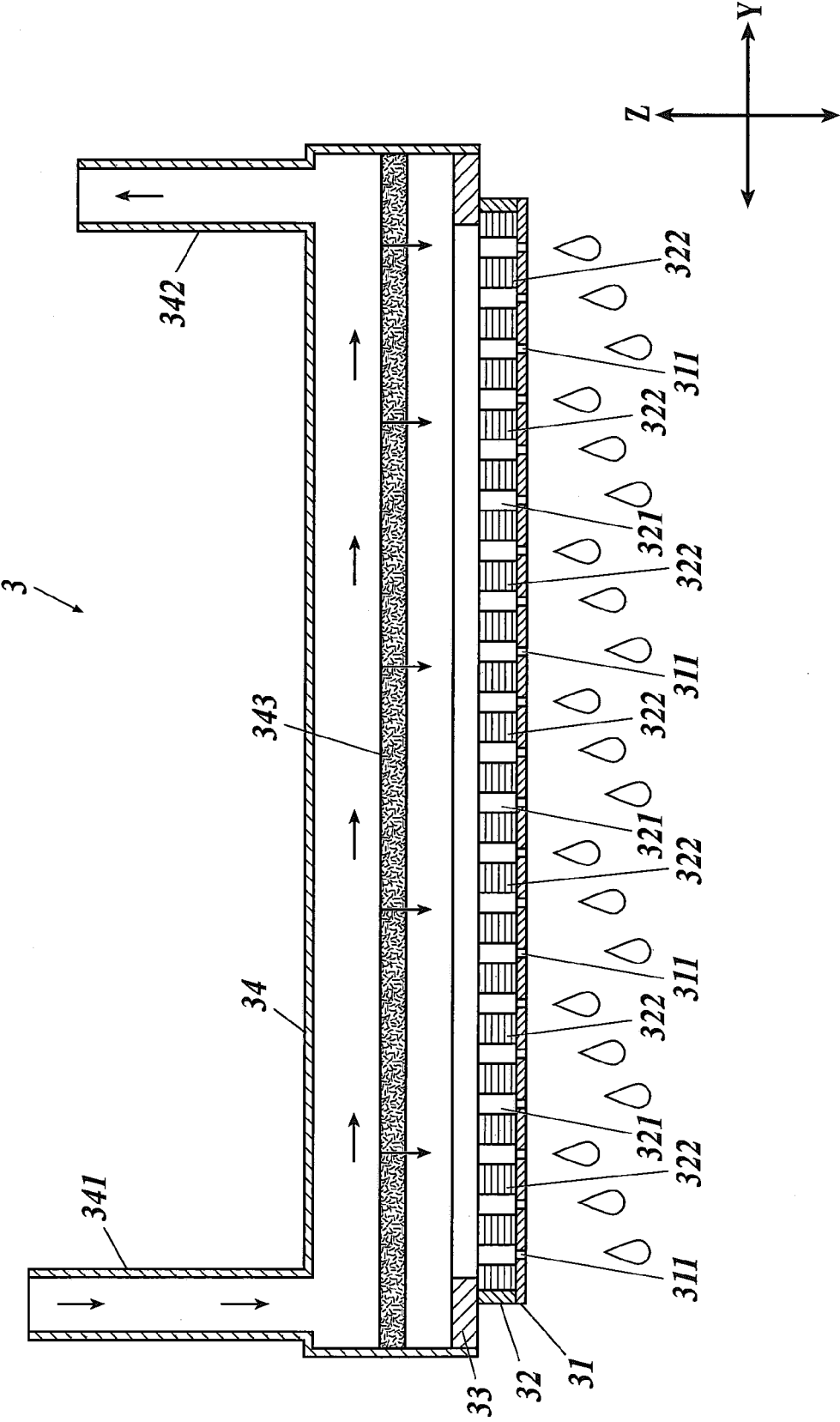


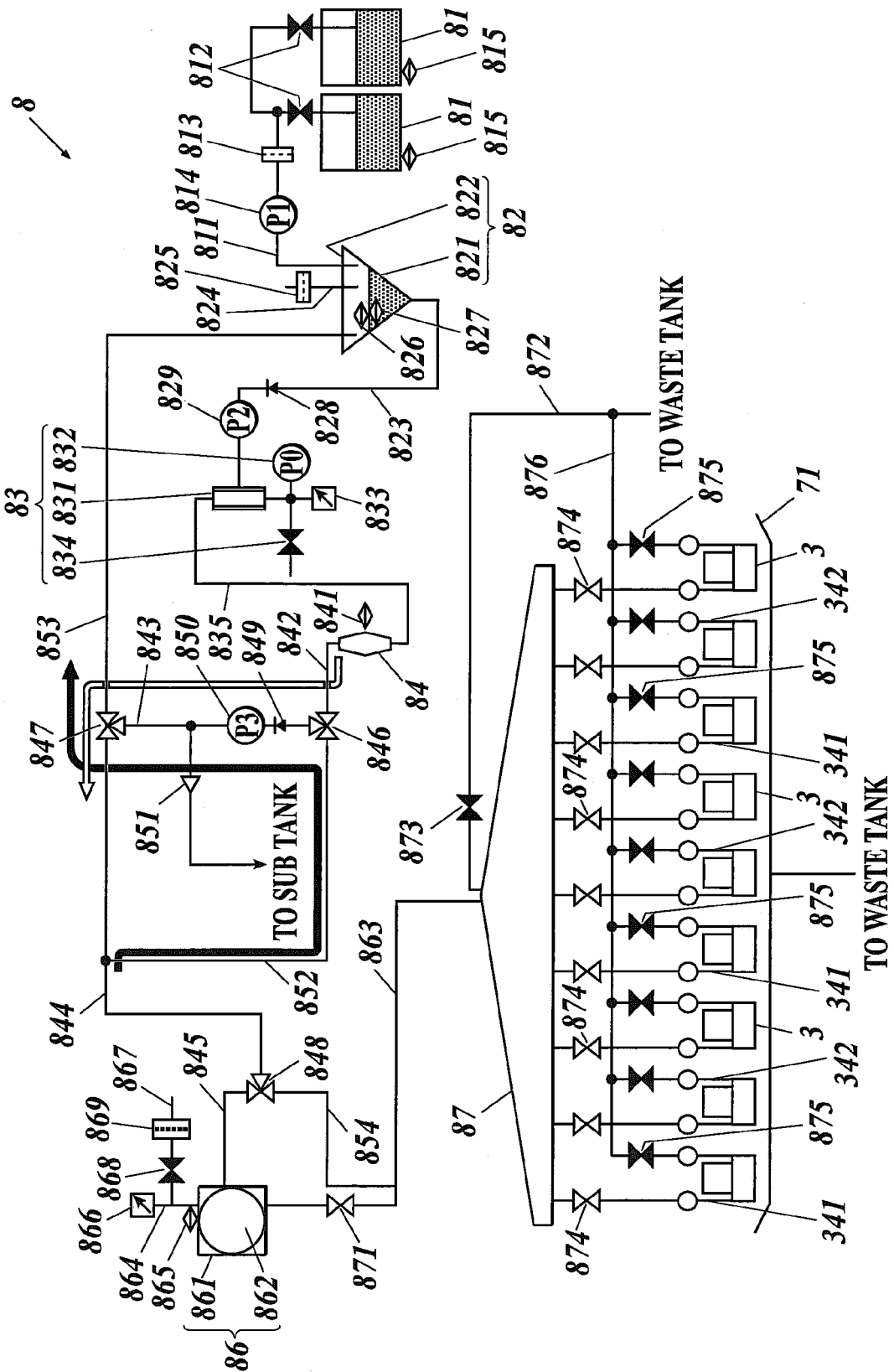
FIG. 4

FIG.5

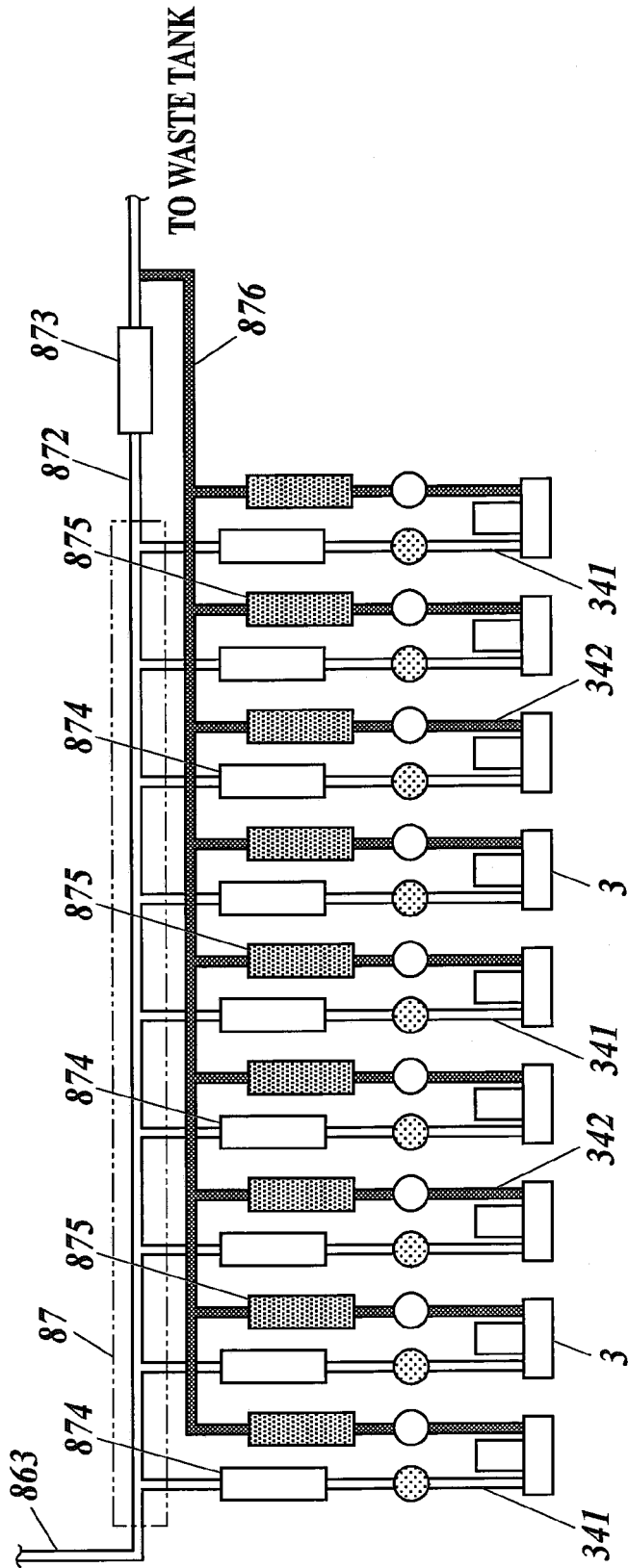


FIG. 6

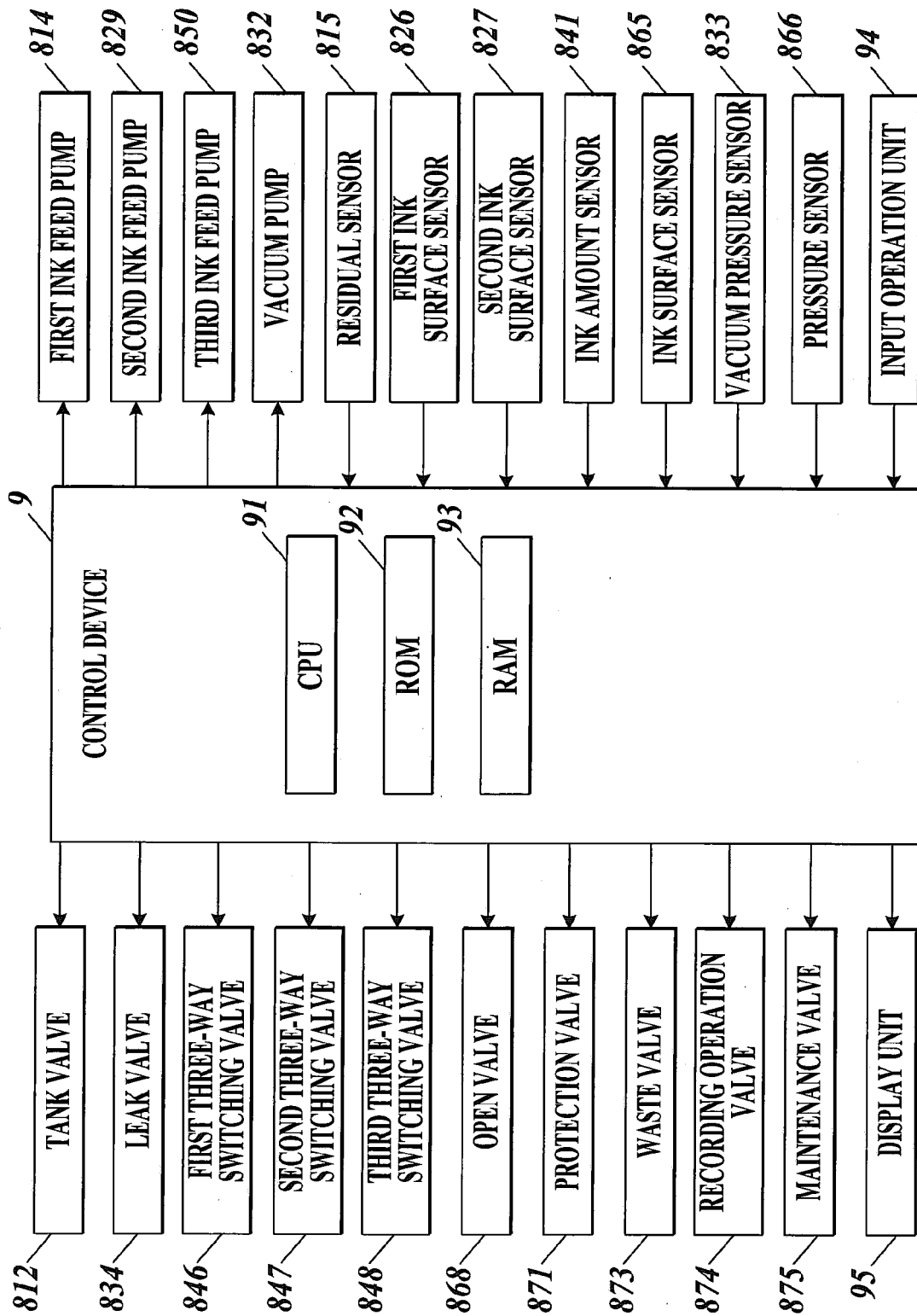


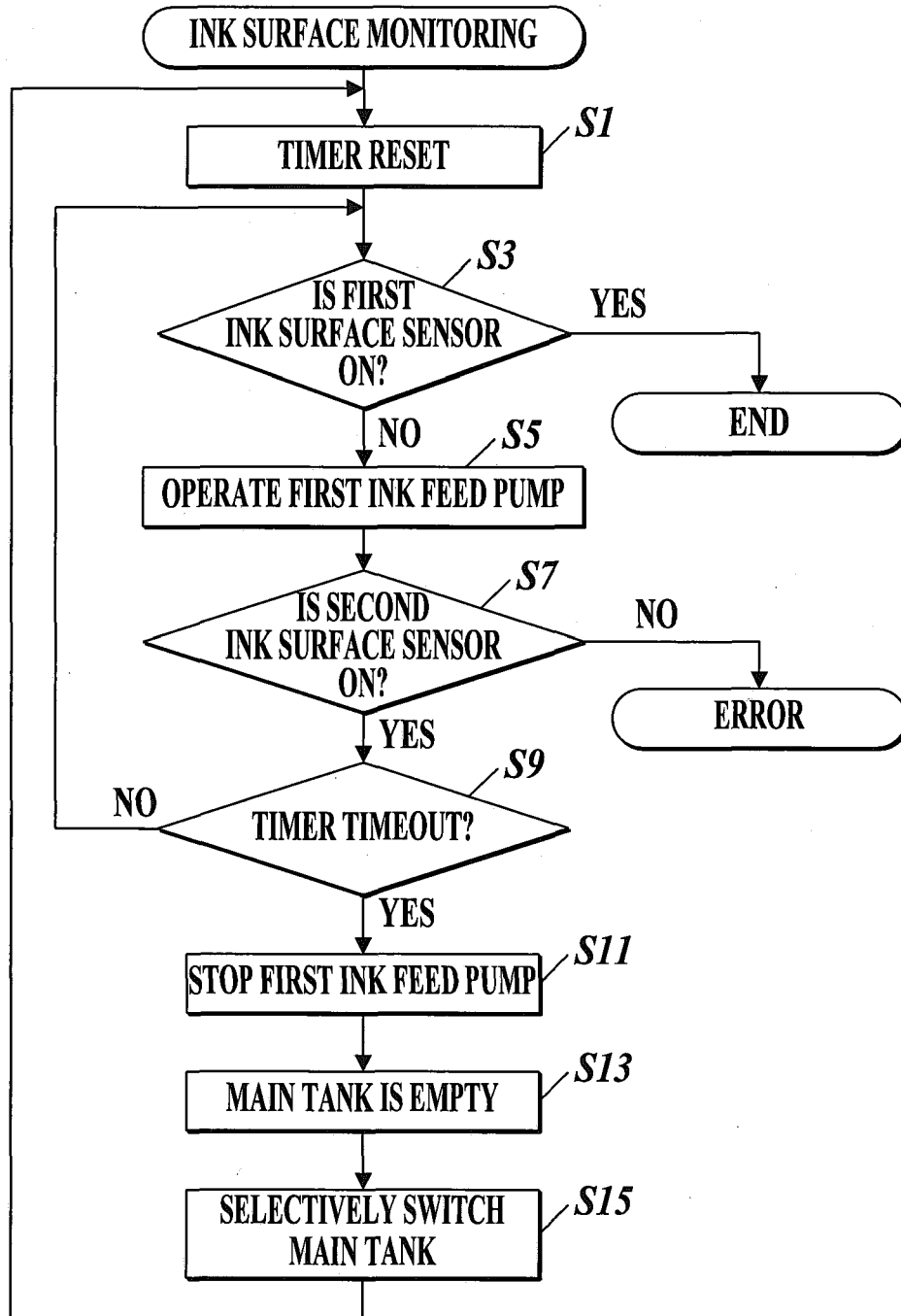
FIG. 7

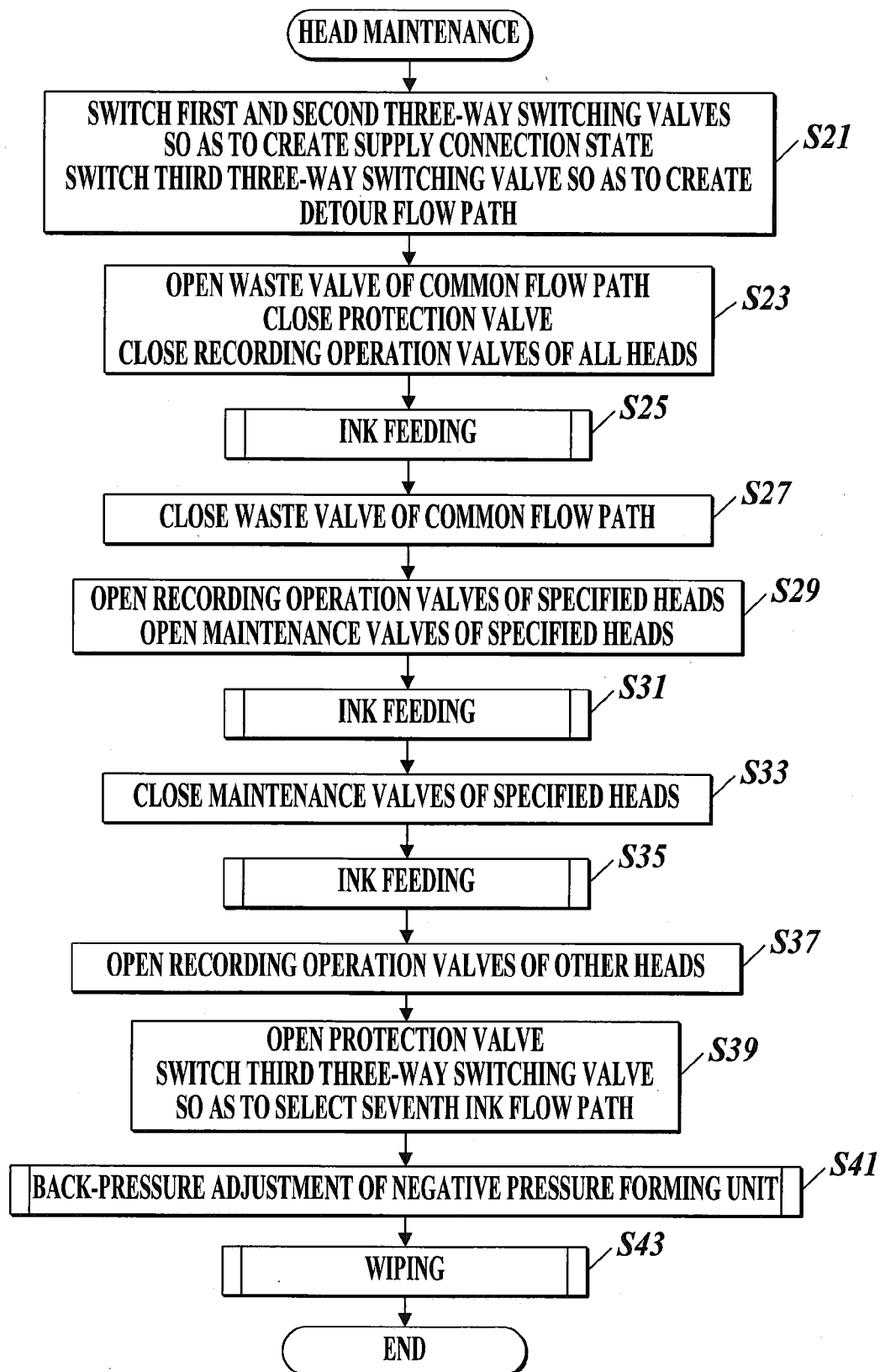
FIG. 8

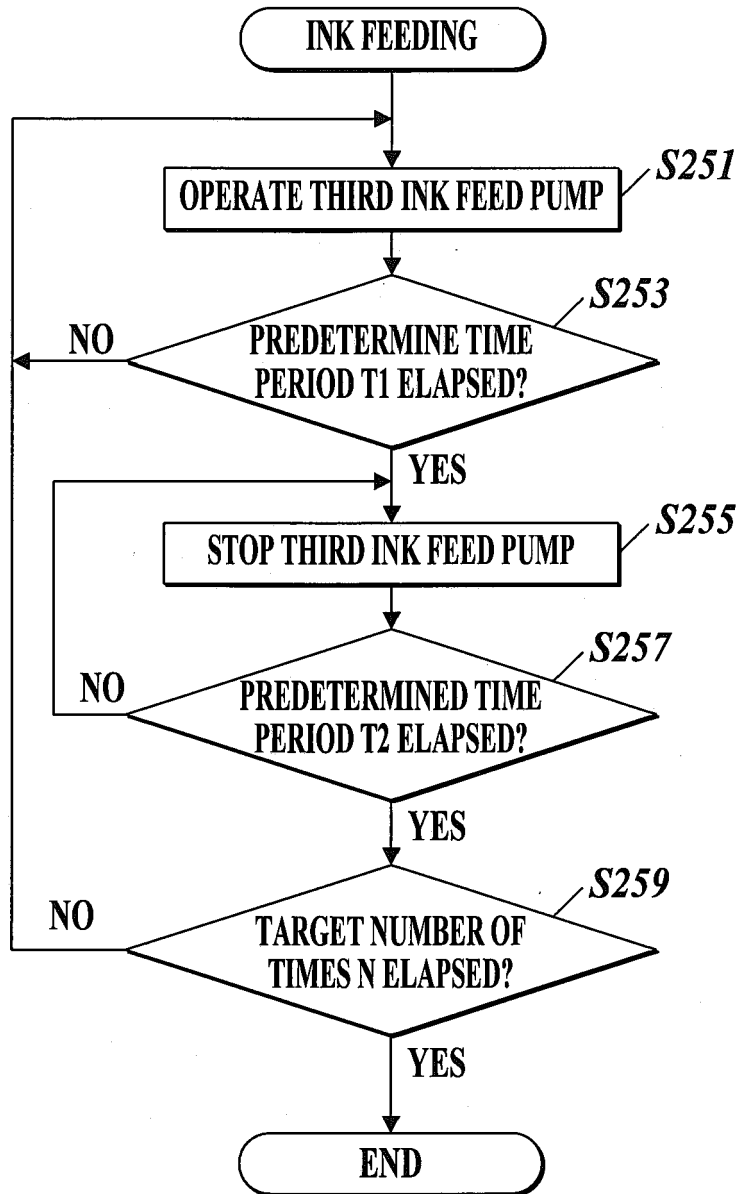
FIG. 9

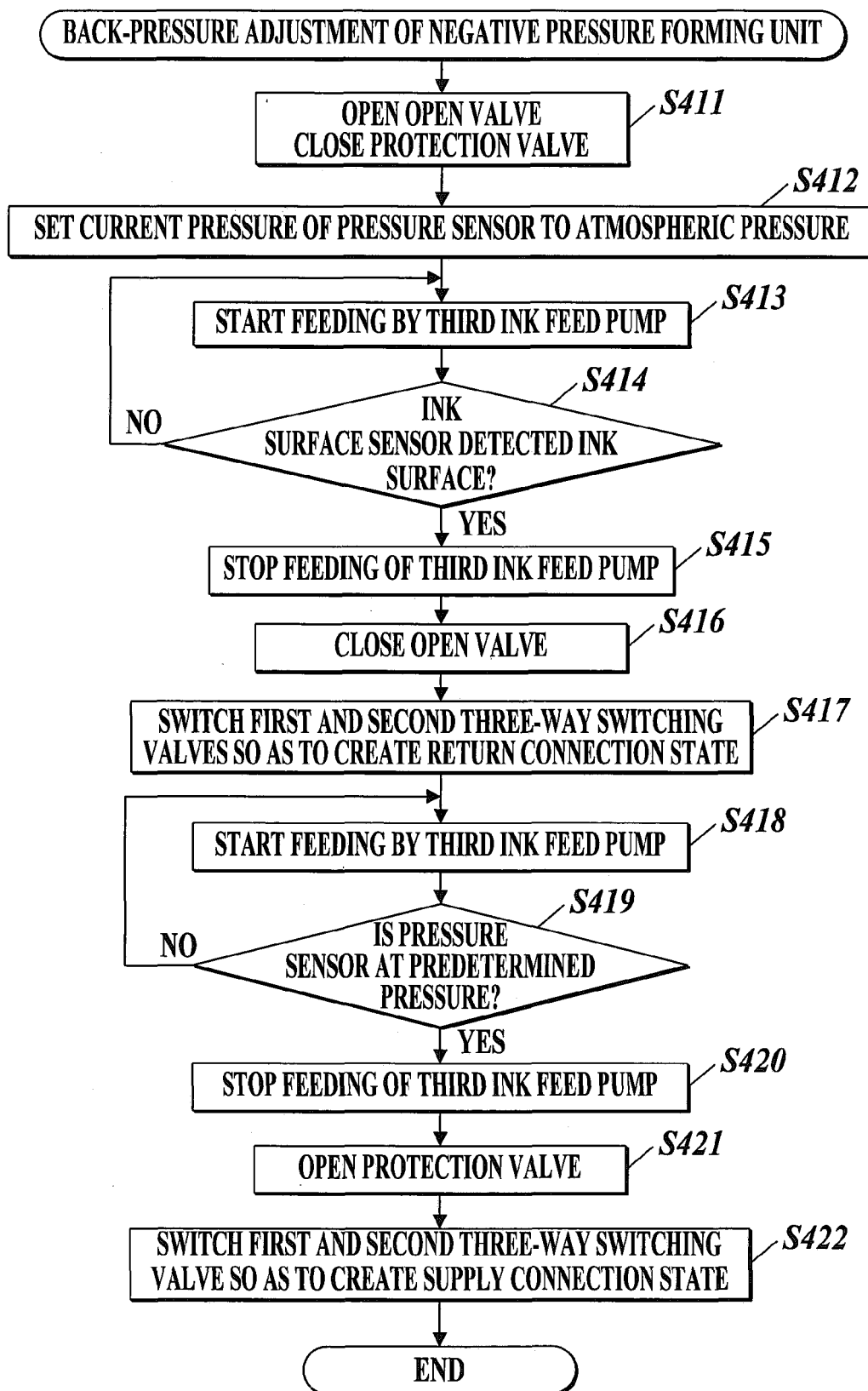
FIG. 10

FIG.11

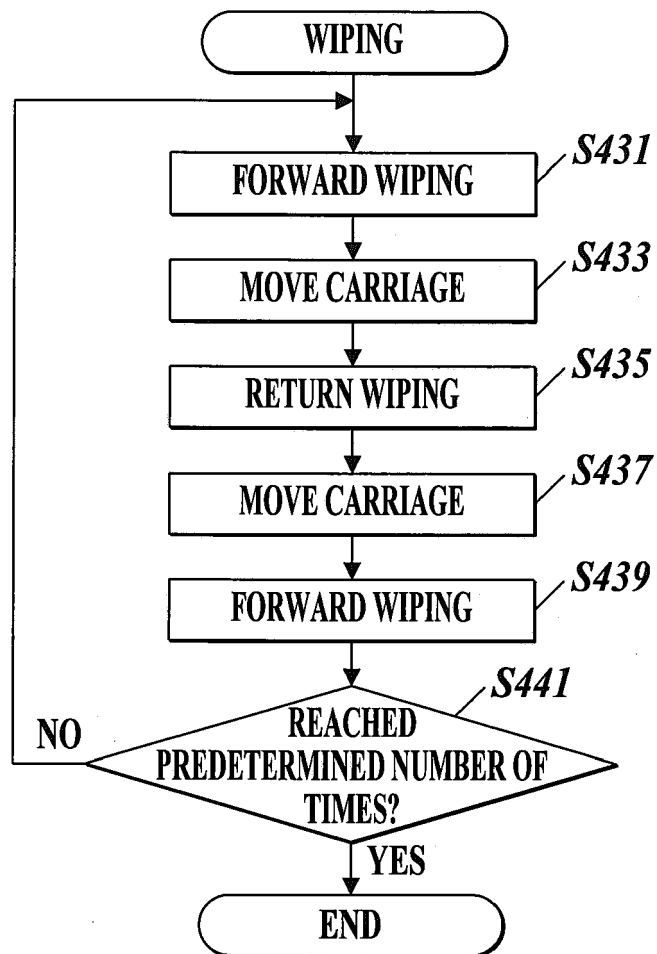


FIG.12A

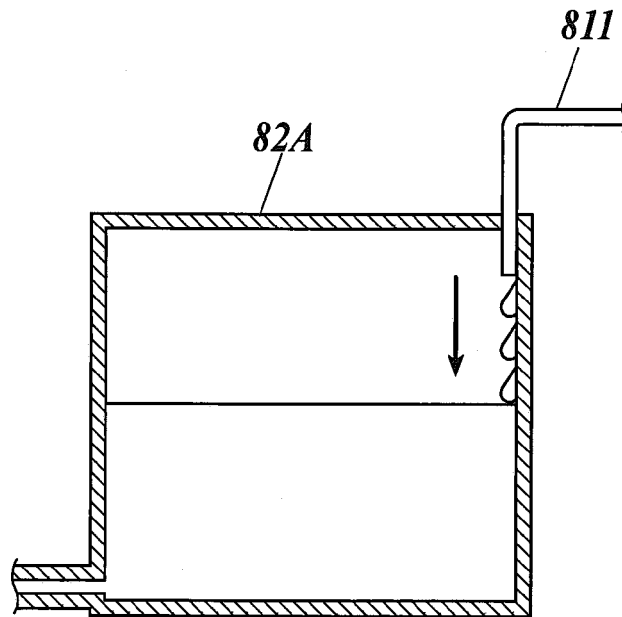
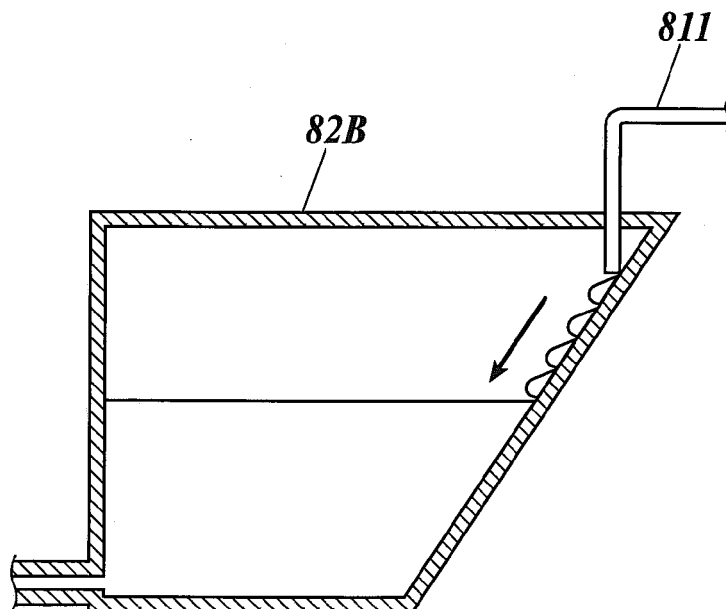


FIG.12B





EUROPEAN SEARCH REPORT

Application Number
EP 12 18 4596

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/239027 A1 (KINASE ATSUSHI [JP] ET AL) 2 October 2008 (2008-10-02)	1,6	INV. B41J2/18 B41J2/19 B41J2/175
A	* paragraph [0044] - paragraph [0047]; figure 2 *	2,7	
A	----- US 2004/066432 A1 (HATADA SHIGEO [JP] ET AL) 8 April 2004 (2004-04-08) * abstract *	2,7	
A	----- US 2002/097307 A1 (TSUKUDA KEIICHIRO [JP]) 25 July 2002 (2002-07-25) * paragraphs [0040], [0053]; figures 1,6 *	2,7	
A	----- US 2006/152562 A1 (OHISHI CHIKASHI [JP]) 13 July 2006 (2006-07-13) * paragraphs [0069], [0073]; figures 1,2 *	2,7	
			TECHNICAL FIELDS SEARCHED (IPC)
			B41J
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 November 2012	Examiner De Groot, Ronald
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 18 4596

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-11-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008239027 A1	02-10-2008	NONE	

US 2004066432 A1	08-04-2004	JP 4191972 B2	03-12-2008
		JP 2004122663 A	22-04-2004
		US 2004066432 A1	08-04-2004

US 2002097307 A1	25-07-2002	JP 4652556 B2	16-03-2011
		JP 2002144550 A	21-05-2002
		US 2002097307 A1	25-07-2002

US 2006152562 A1	13-07-2006	JP 2006192638 A	27-07-2006
		US 2006152562 A1	13-07-2006

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2011079295 A [0004] [0005]