(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 142 713 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Claims EN 32

(48) Corrigendum issued on:
21.07.2010 Bulletin 2010/29

(45) Date of publication and mention of the grant of the patent:
17.03.2010 Bulletin 2010/11

(21) Application number: **00971797.6**

(22) Date of filing: **06.11.2000**

(51) Int Cl.:
B41J 1/00 *(2006.01)*

(86) International application number:
PCT/JP2000/007783

(87) International publication number:
WO 2001/032424 (10.05.2001 Gazette 2001/19)

(54) **INKJET TYPE RECORDING DEVICE AND METHOD OF SUPPLYING INK TO SUB-TANK BY THE SAME DEVICE, AND METHOD OF CHECKING AMOUNT OF INK SUPPLIED TO SUB-TANK BY THE SAME DEVICE**

AUFZEICHNUNGSGERÄT DES TINTENSTRAHLTYPS UND VERFAHREN ZUR TINTENVERSORGUNG FÜR DEN UNTERTANK MITTELS DESSELBEN GERTES UND VERFAHREN ZUR KONTROLLE DER DEM UNTERTANK ZUGEFÜHRTEN TINTENMENGE MITTELS DESSELBEN GERÄTES

DISPOSITIF D'IMPRESSION DE TYPE JET D'ENCRE, PROCEDE D'ALIMENTATION EN ENCRE DE RESERVOIR SECONDAIRE ET PROCEDE D'EVALUATION DE QUANTITE D'ENCRE FOURNIE A CE RESERVOIR PAR LE MEME DISPOSITIF

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority:
05.11.1999 JP 31507199
06.12.1999 JP 34635499
20.01.2000 JP 2000011109
21.01.2000 JP 2000012461
21.01.2000 JP 2000012462
01.02.2000 JP 2000024420
01.02.2000 JP 2000024422
18.02.2000 JP 2000041722
11.07.2000 JP 2000209885
02.11.2000 JP 2000335736

(43) Date of publication of application:
10.10.2001 Bulletin 2001/41

(73) Proprietor: **Seiko Epson Corporation**
Shinjuku-ku
Tokyo 163-0811 (JP)

(72) Inventors:
- **KIMURA, Hitotoshi**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **KOBAYASHI, Atsushi**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **TAMURA, Noboru**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **TOJO, Hiroaki**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **ARUGA, Yoshiharu**
  Suwa-shi,
  Nagano 392-8502 (JP)

Printed by Jouve, 75001 PARIS (FR)

(Cont. next page)

- **USUI, Minoru**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **SUZUKI, Kazunaga**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **MANO, Takashi**
  Suwa-shi,
  Nagano 392-8502 (JP)
- **KUMAGAI, Toshio**
  Suwa-shi,
  Nagano 392-8502 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(56) References cited:

EP-A- 0 585 560	**EP-A- 0 841 173**
EP-A1- 1 055 520	**WO-A-97/30850**
WO-A-99/41083	**WO-A1-99/41083**
JP-A- 10 138 506	**JP-A- 11 192 732**
JP-A- 11 300 986	**US-A- 4 737 801**
US-A- 5 136 309	

- **PATENT ABSTRACTS OF JAPAN vol. 012, no. 142 (M-692), 30 April 1988 (1988-04-30) & JP 62 263059 A (CANON INC), 16 November 1987 (1987-11-16)**
- **PATENT ABSTRACTS OF JAPAN vol. 006, no. 027 (P-102), 17 February 1982 (1982-02-17) & JP 56 147017 A (RICOH CO LTD), 14 November 1981 (1981-11-14)**

Description

TECHNICAL FIELD

[0001] This invention relates to an ink jet recording apparatus wherein a subtank for supplying ink to a recording head is mounted on a carriage on which the recording head is mounted, and the subtank is replenished with ink in succession from a main tank via an ink replenishing tube, and a method of replenishing ink to the subtank.

BACKGROUND ART

[0002] An ink jet recording apparatus can form small dots at a high density with relatively small noise at the print time, and thus nowadays is used for various types of print including color print. Such an ink jet recording apparatus generally comprises an ink jet recording head mounted on a carriage and moving in a width direction of recording paper, and a paper feeder for relatively moving the recording paper in a direction orthogonal to a move direction of the recording head so that ink drops are ejected from the recording head based on print data, to perform recording on the recording paper.

[0003] The recording head capable of ejecting black ink, yellow ink, cyan ink, and magenta ink, for example, is mounted on the carriage and not only text print in black ink, but also full color print is enabled by varying a ratio of the respective inks ejected.

[0004] On the other hand, in this kind of recording apparatus provided for offices or business, for example, it becomes necessary to dispose a large-capacity ink cartridge to deal with a relatively large amount of print, and thus a recording apparatus of the type wherein a main tank as an ink cartridge is placed in a placement unit (cartridge holder) placed on a side of the recording apparatus main unit, for example, is provided.

[0005] Subtanks are placed on the carriage on which the recording head is mounted and each subtank is replenished with ink from the main tank via an ink replenishing tube, and further ink is supplied from each subtank to the recording head.

[0006] By the way, nowadays a large-sized recording apparatus with a long scanning distance of a carriage capable of printing on a large paper face is demanded. In such a recording apparatus, to improve throughput, a recording head is provided with a larger number of nozzles more and more. Further, to improve throughput, a recording apparatus wherein while print is executed, each subtank mounted on a carriage can be replenished with ink in succession from a main tank and ink is supplied stably from each subtank to the main tank is demanded.

[0007] In such a recording apparatus, an ink replenishing tube needs to be connected from the main tank to each subtank corresponding to each ink and the scan distance of the carriage is large and thus the tube run length grows inevitably. Moreover, a recording head is provided with a larger number of nozzles as mentioned above and thus a technical problem is involved wherein the consumed ink amount is large, the dynamic pressure of ink is thus raised in each ink replenishing tube connected from the main tank to each subtank, and the replenished amount of each subtank with ink is thereby insufficient.

[0008] As one means for solving such a problem, for example, a configuration for applying an air pressure to the main ink side and generating a forcible ink flow by the air pressure from the main tank to each subtank for replenishing the subtank with necessary and sufficient ink can be adopted.

[0009] To attempt to adopt such a configuration, it is necessary to manage so that the ink amount in each subtank always becomes a predetermined range, and the necessity of adopting a function capable of adjusting the acceptance amount of ink from the main tank in each subtank occurs.

[0010] WO 99/41083 discloses an ink jet recorder wherein ink is supplied to an ink storage chamber owing to a vacuum occurring due to the suction of the air from an air discharge port. For this purpose, a subtank comprising the ink storage chamber is coupled to an ink supply unit via an ink injection needle and a rubber member into which the ink injection needle is penetrated.

DISCLOSURE OF THE INVENTION

[0011] It is therefore an object of the invention to provide an ink jet recording apparatus capable of properly managing the amount of ink with which a subtank is replenished from a main tank, and a method of replenishing ink to a subtank in the recording apparatus.

[0012] In order to achieve the above object, according to the invention, there is provided an ink jet recording apparatus according to claim 1.

[0013] According to the invention, there is also provided a method of replenishing ink stored in a main tank to a subtank according to claim 41. Preferred embodiments of the invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a plan view to show the general configuration of an ink jet recording apparatus incorporating the invention.

Fig. 2 is a schematic drawing to show an ink supply system from a main tank to a recording head.

Fig. 3 is a schematic drawing to show a mode in which subtanks are arranged in parallel and magnetoelectric devices are disposed.

Fig. 4 is a schematic drawing to show another mode in which a magnetoelectric device is disposed on each subtank.

Fig. 5 is a characteristic drawing to show the relationship between a permanent magnet attached to

a float member and the magnetic flux detection sensitivity of the magnetoelectric device.

Fig. 6 is a schematic drawing to examine the relationship between the placement position of the permanent magnet attached to the float member and the placement position of the magnetoelectric device on the subtank side.

Fig. 7 is a schematic drawing to examine another configuration of the placement position of the permanent magnet attached to the float member and the placement position of the magnetoelectric device on the subtank side.

Fig. 8 is a schematic drawing to examine the relationship of the ink amount detection accuracy in the subtank with the distance between a pivotal center of the float member and the permanent magnet.

Fig. 9 is a schematic drawing to examine the relationship of the ink amount detection accuracy in the subtank if the distance between the pivotal center of the float member and the permanent magnet is shortened.

Fig. 10 is a schematic drawing to show preferred ink amount detection levels when an ink-low state condition is detected by an ink amount detector placed in the subtank.

Fig. 11 is a sectional view to show a part of the main tank and a cartridge holder in a state in which an ink replenishing valve is closed.

Fig. 12 is a sectional view to show a part of the main tank and the cartridge holder in a state in which the ink replenishing valve is opened.

Fig. 13 is a flowchart to show an ink replenishing control routine of the subtank from the main tank, executed in the recording apparatus;

Fig. 14 is a schematic drawing to show an ink supply system from the main tank to the recording head.

Fig. 15 is a sectional view to show the configuration of an ink cartridge shown in Fig. 14.

Fig. 16 is a block diagram to show the configuration of a control circuit installed in the ink jet recording apparatus shown in Fig. 1.

Fig. 17 is a flowchart to show an operation routine for detecting an ink end condition of the cartridge performed by the control circuit shown in Fig. 16.

Fig. 18 is a schematic drawing to show a first example of an ink end detector that can be used in the operation routine for detecting the ink end condition shown in Fig. 17.

Fig. 19 is a schematic drawing to show a second example of the ink end detector.

Fig. 20 is a schematic drawing to show a third example of the ink end detector.

Fig. 21 is a flowchart to show the basic concept of a method of checking the replenished amount of ink to the subtank.

Fig. 22 is a flowchart to show the basic concept of a different checking method.

Fig. 23 is a flowchart to show a control routine to use the checking method shown in Fig. 21.

Fig. 24 is a flowchart to show a control routine to use different checking method for the ink replenishing system.

Fig. 25 is a schematic drawing to show another configuration of an ink supply system from a main tank to a recording head in ink jet recording apparatus incorporating the invention.

Fig. 26 is a block diagram to show another embodiment of the invention.

Fig. 27 is a block diagram to show a modified example of the embodiment in Fig. 26.

Fig. 28 is a block diagram to show ink amount detector used with the embodiment shown in Figs. 26 and 27.

Fig. 29 is a schematic drawing to show another embodiment according to the invention.

Fig. 30 is a chart to show the relationship between the time to re-fill (re-replenish) and the residual ink amount.

Fig. 31 is a chart to show the relationship between the residual ink amount and the discharged ink amount.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] Embodiments of ink jet recording apparatuses according to the invention will be discussed with reference to the accompanying drawings.

[0016] Fig. 1 shows an example of an ink jet recording apparatus incorporating the invention as a top view.

[0017] In Fig. 1, a carriage 1 is guided by a scanning guide member 4 via a timing belt 3 driven by a carriage motor 2 and is reciprocated in a main scanning direction of the longitudinal direction of a paper feeder 5, namely, the width direction of recording paper. Although not shown in Fig. 1, an ink jet recording head 6 described later is mounted on a face of the carriage 1 opposed to the paper feeder 5.

[0018] Subtanks 7a to 7d for supplying ink to the recording head 6 are also mounted on the carriage 1. In the embodiment, to temporarily store inks in the subtanks, four subtanks 7a to 7d are provided in a one-to-one-correspondence with the inks.

[0019] Black ink, yellow ink, magenta ink, and cyan ink are supplied to the subtanks 7a to 7d via flexible ink replenishing tubes 10 forming ink supply passages from main tanks 9a to 9d as ink cartridges placed in a cartridge holder 8 placed at an end part of the recording apparatus.

[0020] On the other hand, a capping unit 11 capable of sealing a nozzle formation face of the recording head is placed in a non-print area (home position) on the move passage of the carriage 1 and further a cap member 11 a formed of a flexible material of rubber, etc., capable of sealing the nozzle formation face of the recording head is placed on the top of the capping unit 11. When the carriage 1 moves to the home position, the nozzle formation face of the recording head is sealed by the cap

member 11a.

[0021] The cap member 11 a serves as a lid for sealing the nozzle formation face of the recording head 6 for preventing nozzle openings from drying, during the non-operating period of the recording apparatus. One end of a tube in a suction pump (tube pump) is connected to the cap member 11 a although not shown in the figure, and the cleaning operation of causing a negative pressure produced by the suction pump to act on the recording head for sucking and discharging ink from the recording head 6 is executed.

[0022] A wiper 12 made of an elastic material of rubber, etc., is placed on the print area side of the capping unit 11 to wipe and clean the nozzle formation face of the recording head as required.

[0023] Next, Fig. 2 schematically shows the configuration of an ink supply system installed in the recording apparatus shown in Fig. 1. The ink supply system will be discussed together with Fig. 1 with the same numerals shown. In Figs. 1 and 2, air compressed by an air compressing pump 21, which forms a part of a compressor unit, is supplied to a pressure regulating valve 22 also serving as an atmospheric release valve, and further is supplied via a pressure detector 23 to the main tanks 9a to 9d (denoted representatively by numeral 9 in Fig. 2 and in the description to follow, the main tanks may be representatively denoted simply by numeral 9).

[0024] The pressure regulating valve 22 also serving as an atmospheric release valve has a function of releasing pressure for maintaining the air pressure applied to each of the main tanks 9a to 9d in a predetermined range when the air pressure compressed by the air compressing pump 21 reaches a predetermined pressure or more. The pressure release valve also has a function capable of releasing the compressed state produced by the air compressing pump 21 in response to an instruction.

[0025] Further, the pressure detector 23 senses the air pressure compressed by the air compressing pump 21 and controls driving the air compressing pump 21. That is, if the pressure detector 23 detects the air pressure compressed by the air compressing pump 21 reaching the predetermined pressure, it stops driving the air compressing pump 21 and if the pressure detector 23 detects the air pressure compressed by the air compressing pump 21 becoming less than determined pressure, it drives the air compressing pump 21, and this control sequence is repeated, thereby maintaining the air pressure applied to each of the main tanks 9a to 9d in the predetermined range. As the schematic structure of the main tank 9 is shown in Fig. 2, the outer hull of the main tank is hermetically formed and an ink pack 24 formed of a flexible material in which ink is sealed is stored in the main tank. The space formed by the main tank 9 and the ink pack 24 forms an air chamber (pressure chamber) 25 and compressed air via the pressure detector 23 is supplied to the inside of the air chamber 25.

[0026] According to the configuration, each ink pack 24 stored in each of the main tanks 9a to 9d undergoes pressurization of the compressed air and an ink flow under a predetermined pressure is produced from each of the main tanks 9a to 9d to each of the subtanks 7a to 7d.

[0027] Ink compressed in each of the main tanks 9a to 9d is supplied to each of the subtanks 7a to 7d mounted on the carriage 1 (the subtanks are denoted representatively by numeral 7 in Fig. 2 and in the description to follow, the subtanks may be representatively denoted simply by numeral 7) via each of ink replenishing valves 26 and each of the ink replenishing tubes 10 forming an ink replenishing controller.

[0028] Although the configuration of the subtank 7 shown in Fig. 2 will be described later in detail, in the basic configuration of the subtank 7, a float member 31 is placed in the subtank and a permanent magnet 32 is attached to a part of the float member 31. Magnetoelectric devices 33a and 33b (in the description to follow, the magnetoelectric devices may be representatively denoted simply by numeral 33) represented by hall devices are placed on a board 34 and are attached to a side wall of the subtank 7.

[0029] According to the configuration, the permanent magnet 32 placed on the float member 31 and the hall devices 33a and 33b for producing electric output in response to the magnetic flux density of the permanent magnet 32 following the float position of the float member 31 make up an ink amount detector.

[0030] Therefore, for example, if the ink amount in the subtank 7 becomes low, the position of the float member 31 housed in the subtank moves in a gravity direction and the position of the permanent magnet 32 also moves in the gravity direction accordingly. Therefore, the electric output of the hall devices 33a and 33b as the permanent magnet moves can be sensed as the ink amount in the subtank 7, and the ink replenishing valve 26 is opened based on the electric output provided by the hall devices 33a and 33b.

[0031] Thus, the ink compressed in the main tank 9 is supplied separately to the associated subtank 7 in which the ink amount lowers. If the ink amount in the subtank 7 reaches a predetermined volume, the ink replenishing valve 26 is closed based on the electric output provided by the hall devices 33a and 33b. Such a sequence is repeated, whereby the subtank is replenished intermittently with ink from the main tank and an almost constant amount of ink is always stored in each subtank.

[0032] Since each subtank 7 is thus replenished with the corresponding ink compressed by the air pressure in the main tank 9 based on the electric output based on the position of the float member 31 placed in the subtank 7, the ink replenishing response can be enhanced and the ink storage amount in the subtank 7 is managed appropriately.

[0033] Ink is supplied from each subtank 7 to the recording head 6 via a valve 35 and a tube 36 connected thereto and ink drops are ejected through nozzle openings 6a formed in the nozzle formation face of the recording head 6 based on print data supplied to the recording

head 6. In Fig. 2, a tube connected to the capping unit 11 is connected to the suction pump (tube pump) not shown. Numeral 7e denotes an atmospheric release port made in the subtank 7.

[0034] Next, disposition examples of the permanent magnet and the magnetoelectric device provided for the subtank will be discussed with reference to Figs. 3 to 9. Figs. 3A and 3B show a state in which the subtanks having the described configuration are arranged in parallel for making up a subtank unit and shows a mode in which the hall device 33 as the magnetoelectric device is disposed on the side wall of each subtank as a schematic drawing. Fig. 3A is a sectional view taken along a line E-E in Fig. 3B viewed in the arrow direction. Fig. 3B is a sectional view of a state in which one of the subtanks making up the subtank unit is cut in a plane direction. The subtank unit supported in a parallel state is housed in a holder 81. It comprises a board holder 82 having engagement members 82a for engaging with fitting holes 81a made in the holder 81, and the hall device 33 is placed on the side wall part of each subtank 7 in an urged state by a plurality of springs 83 placed between the board holder 82 and the board 34 on which the hall devices 33 are arranged. In the disposition example, the case where one hall device 33 is provided for each subtank is taken as an example, but two hall devices may be provided for each subtank, as described above.

[0035] In this case, as shown in the figure, the subtank 7 is formed in the side wall with a recess part 41c for positioning the hall device 33 and the recess part 41c for positioning is formed, whereby the side wall part of the subtank 7 is made thinner and the distance between the moving path of the permanent magnet 32 attached to the float member 31 and the hall device 33 can be made shorter.

[0036] Figs. 4A and 4B show a modified example wherein the hall device 33 as the magnetoelectric device is disposed on the side wall of the subtank 7 as a schematic drawing. In the modified example, the board 34 on which the hall devices 33 are disposed is attached to the subtanks 7 by thermal caulking. Fig. 4A shows a state just before thermal caulking is executed as a sectional view and Fig. 4B shows a state after thermal caulking is executed as a sectional view.

[0037] In this case, the subtank 7 is formed of a thermoplastic resin and is previously formed on the side wall part with a pair of projections 41 d as shown in Fig. 4A. On the other hand, the board 34 on which the hall device 33 is mounted is formed with a pair of through holes 34a at the positions corresponding to the pair of projections 41 d.

[0038] As shown in Fig. 4A, the through holes 34a made in the board 34 are inserted into the projections 41 d and in this state a heated jig (not shown) is pressed against the projections 41d as indicated by arrows F, whereby the projections 41d are melted and become deformed like flat plates because of the thermoplastic property for holding the board 34 on the side wall part of the subtank 7 as shown in Fig. 4B.

[0039] Also in the example shown in the figures, the recess part 41c for positioning the hall device 33 is formed, whereby the side wall part of the subtank 7 is made thinner and the distance between the moving path of the permanent magnet 32 attached to the float member 31 and the hall device 33 can be made shorter.

[0040] The distance between the moving path of the permanent magnet and the hall device will be discussed. Fig. 5 examines the distance between the moving path of the permanent magnet 32 attached to the float member 31 and the hall device 33 as the magnetoelectric device and shows the relationship between the distance therebetween and the magnetic flux detection sensitivity of the hall device 33.

[0041] That is, a curve G indicates setting such that the distance between the moving path of the permanent magnet 32 and the hall device 33 becomes relatively short, and a curve H indicates a case where the distance between the moving path of the permanent magnet 32 and the hall device 33 is relatively long. The longitudinal solid line represents the magnetic flux density received by the hall device 33 and the lateral solid line indicates the moving path of the permanent magnet 32, namely, the displacement of the permanent magnet 32 from the center longitudinal solid line where the permanent magnet 32 is brought closest to the hall device 33.

[0042] Here, it is assumed that the electric output produced by the hall device 33 is used in a line area almost proportional to the magnetic flux density received at each (the electric output is used in the area proportional to the magnetic flux density). Therefore, if a threshold voltage (threshold level) for opening/closing the valve 26 upon reception of the electric output produced by the hall device 33 is SL in Fig. 5, the width of the area crossing SL in the characteristic G becomes narrow as indicated by I and the width of the area crossing SL in the characteristic H becomes wide as indicated by J.

[0043] In other words, as the distance between the moving path of the permanent magnet 32 and the hall device 33 is narrower, the detection sensitivity relative to of the displacement of the permanent magnet 32 can be enhanced and the detection accuracy of the remaining flow amount of ink in the subtank can be more improved. Therefore, the subtank 7 is formed in the side wall with the recess part 41 c for positioning the hall device 33 and the side wall part of the subtank 7 is made thin in the presence of the recess part 41 c for positioning, so that the detection accuracy of the remaining flow amount of ink in the subtank can be more improved.

[0044] Figs. 6 and 7 examine the relationship between the placement position of the permanent magnet attached to the float member and the placement position of the hall device as the magnetoelectric device on the subtank side. That is, in the configuration shown in Fig. 6, the hall device 33 mounted on the board 34 is placed on the side wall part of the subtank 7 and on the other hand, the permanent magnet 32 is placed on the float

member 31 on an extension of a support arm 45 and the hall device 33 senses the magnetic flux density as the permanent magnet 32 placed on the float member moves in the gravity direction. That is, the configuration shown in Fig. 6 is a similar configuration to that of the embodiment shown in Figs. 2 to 4.

[0045] On the other hand, in the configuration shown in Fig. 7, the hall device 33 mounted on the board 34 is placed on the upper wall of the subtank 7 and the permanent magnet 32 is placed on the upper wall of the float member 31. The magnetic flux density change on the hall device 33 as the permanent magnet 32 placed on the float member 31 moves in the gravity direction is sensed. Therefore, in the configuration shown in Fig. 7, electric output responsive to the remaining flow amount of ink in the subtank 7 can also be produced and the mode can also be adopted effectively.

[0046] However, in the configuration of placing a plurality of hall devices for generating output signals different in phase as the permanent magnet placed on the float member moves, the mode shown in Fig. 6 is effective. This configuration is shown schematically in Fig. 8. That is, on the side wall of the subtank 7, two hall devices 33a and 33b are placed along the moving path of the permanent magnet placed on the float member. According to the mode, taking a state in which the subtank is replenished with ink as an example, as the float member moves (rises) in the anti-gravity direction following replenishing with ink, first a large magnetic force acts on the second hall device 33b and if replenishing with ink is further continued, large magnetic force acts on the first hall device 33a.

[0047] Therefore, outputs of the hall devices 33a and 33b are converted into binary signals based on a predetermined threshold voltage, combinations of (00), (01), (11), and (10) can be provided and it is made possible to recognize the ink amount in the subtank with good accuracy. For example, if the ink amount in the subtank is gradually decreased by the print operation, it can also be recognized with good accuracy.

[0048] Fig. 9 examines the relationship of the ink amount detection accuracy in the subtank with the distance between the pivotal center of the float member 31 and the permanent magnet in the above-described configuration shown in Fig. 8. That is, in Fig. 8, the distance between pivotal center 44 of the float member and the permanent magnet 32 is shown as L1 and in Fig. 9, the distance is shown as L2.

[0049] In the modes shown in Figs. 8 and 9, the distance between the center parts of the hall devices 33a and 33b is shown as L3. In both the configurations, for example, if L1 is 50 mm and L2 is 25 mm and L3 is 5 mm, comparison of the detection accuracy between the first and second hall devices 33a and 33b is as follows:

[0050] In the configuration shown in Fig. 8, the difference between the distance between the permanent magnet 32 and the first hall device 33a when the permanent magnet 32 faces the first hall device 33a and the distance between the permanent magnet 32 and the second hall device 33b when the permanent magnet 32 faces the second hall device 33b, namely, W1 shown in Fig. 8 becomes 0.25 mm.

[0051] On the other hand, in the configuration shown in Fig. 9, the difference between the distance between the permanent magnet 32 and the first hall device 33a when the permanent magnet 32 faces the first hall device 33a and the distance between the permanent magnet 32 and the second hall device 33b when the permanent magnet 32 faces the second hall device 33b, namely, W2 shown in Fig. 9 becomes 0.51 mm.

[0052] As the widths of the W1 and W2 are larger, variations occur in detection in the first and second hall devices 33a and 33b and particularly, to detect the ink amount in the subtank in the four-combination state resulting from converting the outputs of the hall devices 33a and 33b into binary signals based on the predetermined threshold voltage as described above, it is ideal that the W1 and W2 are nearer to zero.

[0053] According to the examinations, it is desirable to set so that the distance between the pivotal center of the float member 31 and the permanent magnet 32 becomes longer as shown in Fig. 8, and therefore preferably the placement position of support shaft 44 for supporting the float member 31 for rotation is formed in the proximity of an end part in a horizontal direction in the subtank 7.

[0054] As seen from the description made the above, the recording apparatus comprises the float member 31 housed in the subtank 7 and floating up in accordance with ink stored in the subtank 7, the magnetoelectric device 33 (33a, 33b) as an output generator for generating electric output following the float position of the float member 31 responsive to the ink amount in the subtank 7, and the ink replenishing valve 26 as supply controller for controlling the amount of ink supplied to the subtank in accordance with the electric output provided by the output generator, and thus the subtank 7 is replenished with ink in succession from the main tank 9 in response to the ink storage amount in the subtank 7. Therefore, a proper amount of ink is stored in the subtank while print is continued, so that it is made possible for even a recording apparatus with a long scanning distance capable of printing on a large-scaled paper face, for example, to stably execute print without degrading throughput.

[0055] In the ink amount detector realized by the float member 31 in the subtank, it is desired that the detection level of an ink-low state should be set so that ink remains in the subtank as ink is consumed by executing one cleaning operation. The detection level of the ink-low state is thus set, whereby if the cleaning operation is executed, for example, just before the ink amount detector detects the ink-low state, the subtank can be prevented from becoming empty of ink.

[0056] A concept as shown in Figs. 10A and 10B can be adopted as a method of setting the ink-low state detection level. Figs. 10A and 10B schematically show the state of the subtank in an ink-low state condition. First,

Fig. 10A shows a state in which the ink volume in the subtank corresponding to a predetermined value (ink-low state) detected by the ink amount detector is set to the amount or more of ink consumed by one cleaning operation. In this case, the remaining ink amount in the subtank at the ink-low state detection level is shown as (A). Letting the amount of ink consumed by one cleaning operation be (B), if the ink-low state level is set so that the relation of $A \geq B$ is set, the subtank can be prevented from becoming empty of ink if the cleaning operation is executed just before the ink amount detector detects the ink-low state.

[0057] Next, Fig. 10B shows a state in which the ink volume in the subtank corresponding to a predetermined value (ink-low state) detected by the ink amount detector is set to the amount or more resulting from subtracting the amount of ink with which the subtank is replenished during the cleaning operation from the amount of ink consumed by one cleaning operation, in this case, the remaining ink amount in the subtank at the ink-low state detection level is shown as (A'). The amount of ink consumed by one cleaning operation is (B). However, if the cleaning operation is executed and the ink amount detector detects the ink-low state, the ink replenishing valve 26 is opened and thus the subtank is replenished with the ink amount shown as (C) during the cleaning operation.

[0058] Therefore, if the ink-low state level is set so that the relation of $(A' + C \geq B$ is satisfied, the subtank can be prevented from becoming empty of ink if the cleaning operation is executed just before the ink amount detector detects the ink-low state. In other words, the relation of $A' \geq (B - C)$ as mentioned above is satisfied. Thus, the ink-low state level detected by the ink amount detector can be set to a lower level than that shown in Fig. 10A, and it is also made possible to design the capacity of each subtank mounted on the carriage as a small size.

[0059] Next, the placement state of the main tanks in the cartridge 8 and the ink replenishing value will be discussed in detail with reference to Figs. 11 and 12. Figs. 11 and 12 are sectional views to show a part of the main tank 9 and a part of the cartridge holder 8 on an enlarged scale in the state in which the main tank 9 as an ink cartridge mentioned above in the cartridge holder 8. Fig. 11 shows a state in which the ink replenishing value 26 placed in the cartridge holder 8 is closed, and Fig. 12 shows a state in which the ink replenishing value 26 is opened; parts corresponding to the parts previously described are denoted by the same numerals.

[0060] An ink tap 71 is formed integrally with the ink pack 24 stored in the main tank 9 and is attached so as to project from one end part of the main tank 9 to the outside. A packing member 71 a formed like a ring is placed at the tip part of the ink tap 71 and a valve member 71b placed slidably in an axial direction in the ink tap 71 is urged to the side of the packing member 71 a by a spring 71 c.

[0061] According to the configuration, if the main tank 9 is not placed in the cartridge holder 8, the valve member 71b abuts the packing member 71a so that leaking out ink from the ink pack 24 can be blocked. In the state shown in the figure, the valve member 71 b is pushed in by a hollow needle described later and ink can be derived from the ink pack 24.

[0062] On the other hand, a connection plug 73 is formed to project at the center of the cartridge holder 8. A hollow needle 73b formed with an ink inlet hole 73a in the vicinity of the tip part is placed in the connection plug 73 and further a slider 73c placed slidably in the axial direction is provided so as to surround the outer periphery of the hollow needle 73b. The slider 73c is urged so as to forward project by a spring 73d.

[0063] According to the configuration, if the main tank 9 is not placed in the cartridge holder 8, the slider 73c closes the ink inlet hole 73a made in the hollow needle 73b to close the valve. In the state shown in the figure, the slider 73c is pushed in by the connection plug 73 in the cartridge holder 8, the ink inlet hole 73a in the hollow needle 73b is exposed, and ink can be introduced into the hollow needle 73b from the main tank 9.

[0064] The outer hull member of the main tank 9 is formed with an inlet port 75 formed of a tubular body communicating with the air chamber (pressure chamber) 25. On the other hand, a compressed air supply plug 77 is disposed in the cartridge holder tank 8 and an annular packing member 77a is placed in the compressed air supply plug 77. Therefore, in the state shown in the figure in which the main tank 9 is placed in the cartridge holder 8, the annular packing member 77a placed in the cartridge holder 8 is brought into intimate contact with and is coupled with the outer peripheral surface of the inlet port 75 formed of a tubular body. Accordingly, the compressed air can be introduced into the air chamber (pressure chamber) 25 of the main tank 9.

[0065] The ink replenishing value 26 is disposed at a base end part of the hollow needle 73b disposed in the cartridge holder 8 and the ink replenishing tube 10 is connected via the valve 26, so that the subtank 7 mounted on the carriage 1 can be replenished with ink as described above.

[0066] The ink replenishing value 26 comprises a diaphragm valve 26a and its peripheral margin part is sandwiched between a first case 26b and a second case 26c and the diaphragm valve 26a is housed in both the cases. A slide shaft 26d attached to almost the center of the diaphragm valve 26a is attached slidably in the axial direction to the second case 26c. The slide shaft 26d receives a driving force produced by an electromagnetic plunger 79 as an actuator and is driven in a horizontal direction as shown in the figure. Therefore, upon reception of the axial driving force of the slide shaft 26d, almost the center of the diaphragm valve 26a is moved in the horizontal direction.

[0067] In the embodiment, the driving force produced by the electromagnetic plunger 79 is transmitted to one end part of a driving lever 78 pivoted via a support shaft

78a and is transmitted to the slide shaft 26d capable of driving the diaphragm valve 26a at an opposite end part of the drive lever.

[0068] Further, a spring 26e is placed between the slide shaft 26d and the second case 26c and when the electromagnetic plunger 79 is in a non-activated state, as shown in Fig. 11, the center of the diaphragm valve 26a closes an opening part 26f made in the first case 26b connected to the base end part of the hollow needle 73b to close the valve by the urging force of the spring 26e. When the electromagnetic plunger 79 is activated, as shown in Fig. 12, a driving rod 79a of the electromagnetic plunger 79 is pulled in, whereby the slide shaft 26d is pulled out via the driving lever 78. Therefore, the center of the diaphragm valve 26a leaves the opening part 26f made in the first case 26b and is opened.

[0069] Therefore, in the open state of the diaphragm valve 26a as the electromagnetic plunger 79 is activated, ink is introduced from the ink pack 24 into the first case 26b in which the diaphragm valve is placed via an ink flow passage provided by the hollow needle 73b as indicated by the arrow in Fig. 12, and the subtank 7 can be replenished with ink via the ink replenishing tube 10 connected to the first case 26b. When the amount of ink in the subtank 7 reaches the predetermined volume, the electromagnetic plunger 79 is not activated and replenishing with ink is stopped according to output of the hall devices 33a and 33b for detecting the magnetic flux density change of the permanent magnet 32 following the float position of the float member 31 placed in the subtank 7.

[0070] If the operation power of the recording apparatus is turned off, the electromagnetic plunger 79 is also placed in a non-activated state, whereby the center of the diaphragm valve 26a closes the opening part 26f made in the first case 26b connected to the base end part of the hollow needle 73b to close the valve by the urging force of the spring 26e, as shown in Fig. 11. Therefore, if a water head difference exists between the main tank 9 and the subtank 7, ink flowing in either direction via the ink replenishing tube 10 can be blocked.

[0071] As understood from the configuration shown in Figs. 11 and 12, the ink flow passage to the opening part 26f of the first case 26b in which the diaphragm valve 26a is placed, namely, the ink flow passage formed in the hollow needle 73b and the ink flow passage from the inside of the case 26b to the ink replenishing tube 10 are made almost orthogonal to each other and the derivation part of the ink replenishing tube 10 connected to the case 26b is placed so as to head for almost in a vertical direction.

[0072] According to the configuration, air bubbles entered when the main tank 9 as an ink cartridge is placed in the cartridge holder 8 can be floated toward the ink replenishing tube 10 side without building up in the vicinity of the diaphragm valve 26a. The air bubbles floated toward the ink replenishing tube 10 side are introduced into the subtank 7 and are floated, so that a problem of the air bubbles entering the recording head 6 and causing a print failure to occur can be circumvented.

[0073] In the embodiment shown in Figs. 11 and 12, the ink replenishing valve comprising the diaphragm valve 26a is placed in the cartridge holder 8 in which the main tank is placed. That is, the ink replenishing valve is placed in the close vicinity of the main tank side in the ink replenishing passage from the main tank to the subtank. For example, if the main tank 9 is drawn out from the cartridge holder 8, leaking out ink existing in the ink replenishing tube 10 to the cartridge holder 8 side can be effectively blocked because the ink replenishing valve is placed in the close vicinity of the cartridge holder 8.

[0074] In this case, although the cartridge holder 8 comprises the slider 73c for covering the ink inlet hole 73a of the hollow needle 73b to close the valve, placing the ink replenishing valve in the close vicinity of the main tank side as can contribute to more effective blocking of leaking out ink from the connection plug 73 in the cartridge holder upon reception of a backward flow caused by the water head difference, because the valve closing function of the ink inlet hole 73a by the slider 73c and the valve closing function by the ink replenishing value 26 work as a synergistic effect.

[0075] Since the recording apparatus is configured as described above, ink is always pushed out by compressed air from the main tank to the subtank during the operation of the recording apparatus. The amount of ink in the subtank is detected by the ink amount detector and opening and closing the ink replenishing valve placed in the ink replenishing passage from the main tank to the subtank are controlled by control signals provided by the ink amount detector, whereby necessary and sufficient ink can always be stored in the subtank.

[0076] That is, the recording apparatus comprises the ink amount detector for detecting the amount of ink stored in the subtank and the ink replenishing controller being placed in the ink replenishing passage between the main tank and the subtank for controlling replenishing the subtank with ink from the main tank in response to the ink amount detection state of the ink amount detector and thus the subtank is always replenished with ink, for example, even during printing and a proper amount of ink can be held in the subtank. Therefore, for example, if the recording apparatus is adopted as a large-sized recording apparatus using a recording head with a large number of nozzles and having a carriage with a long scanning distance, stable print operation can be executed without degrading throughput. According to the ink jet recording apparatus adopting the ink replenishing method, air pressure is applied to the main tank by the compressor unit so as to control the opening/closing of the ink replenishing valve placed in the ink replenishing passage between the main tank and the subtank, in response to the detection state of the amount of ink stored in the subtank. Thus, in addition to the above-described technical advantage, the replenishing operation of each subtank with ink can be performed promptly and the amount of ink in each

subtank can always be managed in a proper state.

[0077] The ink supply valve closed when the operation power of the recording apparatus is off is placed in the ink supply passage from the main tank as an ink cartridge to the subtank mounted on the carriage. Thus, during the non-operating period of the recording apparatus or at the time of an unexpected power outage, ink flowing in either direction because of the water head difference between the main tank and the subtank can be blocked and the recording apparatus not polluting the machine with leaked ink can be provided.

[0078] For example, if the ink amount detector containing the float member malfunctions or some failure occurs in the control signal transmission system from the ink amount detector to the ink replenishing valve in the ink jet recording apparatus configured as described above, an accident occurs in which the ink replenishing valve is not closed although the subtank is replenished with a predetermined amount of ink. If such an accident occurs, the following problem can occur: The subtank is continuously replenished with ink from the main tank by the compressed air and ink leaks via the atmospheric release port 7e formed in the subtank or the like, polluting the surroundings.

[0079] Then, a control routine of replenishing the subtank with ink intended so as to prevent such a problem of leaking ink from the subtank, for example, assuming the accident as described above will be discussed with reference to Fig. 13. The replenishing operation of the subtank with ink will be discussed according to the control routine shown in Fig. 13.

[0080] First, at step S11, ink level detection in the subtank is executed. It is determined by output of the hall devices 33a and 33b for detecting the magnetic flux density of the permanent magnet attached to the float member as described above.

[0081] Here, if the ink amount detector determines that the amount of ink in the subtank is less than a predetermined value, the case is called "LOW" and if the ink amount detector determines that the amount of ink in the subtank reaches a sufficient amount, the case is called "FULL." If the ink amount is determined "FULL" at step S11, a return mode is entered and subsequently the ink amount is monitored at step S11. If the ink amount is determined "LOW" as the recording head consumes ink, control goes to step S12 and the ink replenishing valve 26 is opened.

[0082] Therefore, replenishing the subtank with ink from the main tank is started (ink replenishing step). Subsequently, the ink amount detector monitors the ink amount in the subtank as shown at step S13. Just after the replenishing valve 26 is opened at the step S12, normally the "LOW" state is detected at step S13 and determination shown at step S14 is made.

[0083] That is, at step S14, the elapsed time since the ink replenishing valve opening operation executed at step S12 is determined and if the elapsed time is less than a predetermined time period, control returns to step S13 and ink level detection in the subtank is executed, namely, the ink amount detector monitors the control output. The loop returning to step S13 from step S14 mentioned above is repeated.

[0084] In the state in which the elapsed time is less than the predetermined time period, the subtank is replenished with ink and if the ink amount is determined "FULL" at step S13, control goes to step S15 at which the ink replenishing valve 26 is closed and a return mode is entered (ink replenishment stopping step). Therefore, the operation shown at steps S11 to S15 is repeated and the subtank is intermittently replenished with ink from the main tank. The operation shown at steps S11 to S15 is repeated when the ink replenishing operation is performed normally.

[0085] Here, for example, if the float member 31 forming a part of the ink amount detector undergoes some failure and does not float up, for example, although the subtank is replenished with a sufficient amount of ink, the subtank is continuously replenished with an excessive amount of ink. A similar accident also occurs if an unexpected failure occurs in the control signal transmission system from the ink amount detector to the ink replenishing valve. Consequently, a problem of ink overflowing the subtank occurs.

[0086] The routine shown at the step S14 and step S16 following the step controls so as to prevent the subtank from being replenished with an excessive amount of ink assuming occurrence of such a failure. That is, at step S14, the elapsed time period since the ink replenishing valve opening executed at step S12 is monitored as described above, and if it is determined in the loop operation of steps S13 and S14 that "FULL" is not detected, namely, the "LOW" state remains although the predetermined time period has elapsed, control goes to step S16 and the ink replenishing valve 26 is forcibly closed (ink replenishment forcibly stopping step).

[0087] In such a state, it can be assumed that some failure occurs in the ink replenishing system as described above and therefore the valve is forcibly closed automatically because of the expiration of the predetermined time period managed at step S14, whereby replenishing the subtank with excessive ink can be stopped. If control goes to step S14, it is desired that error display indicating the ink supply failure state should be produced for informing the user that trouble in the ink replenishing system occurs.

[0088] According to the described configuration, for example, when a failure such that a predetermined air pressure is not applied to the air chamber (pressure chamber) 25 of the main tank or such that ink is hard to flow in the tube 10 forming the ink replenishing passage from the main tank to the subtank occurs, error display can also be produced, in which case a print failure can occur and anyway the user can be informed of the necessity for maintenance.

[0089] As seen from the description made above, the ink jet recording apparatus adopting the ink replenishing

control method comprises the controller for forcibly closing the ink replenishing valve placed in the ink replenishing passage from the main tank as an ink cartridge to the subtank if the predetermined time period has elapsed after the ink replenishing valve was opened, so that the problem of polluting the machine with leaked ink, etc., in the recording apparatus using this kind of ink supply system for pressurizing the main tank can be solved.

[0090] Next, a second embodiment comprising ink end detector for checking whether or not an ink cartridge of a main tank is in an ink end condition will be discussed with reference to Figs. 14 to 20. Members corresponding to those previously described with reference to Figs. 1 to 13 are denoted by the same reference numerals in Figs. 14 to 20 and will not be discussed again in detail.

[0091] In the main tank 9 as an ink cartridge, a memory 27 capable of recording information concerning the main tank 9 is placed in a part of a case of the main tank as also shown in Fig. 15, and data concerning the residual ink amount in the main tank is written into the memory 27 as described later. As shown in Fig. 14, a terminal 28 for writing or reading information into or from the memory 27 is placed on a part of the main tank 9, and when the main tank 9 is placed in a recording apparatus, the terminal is electrically connected to the recording apparatus and information concerning the residual ink amount in the main tank is transferred.

[0092] A detection switch 29 forming an ink end detector for detecting the amount of ink stored in the main tank becoming a predetermined value or less may be provided in the main tank 9 as also shown in Fig. 15. One face of the ink pack 24 is put on the inner face of the case forming the main tank 9, for example, with a double-faced adhesive sheet and an actuation plate 24b is put on another face of the ink pack 24 in a similar manner. According to the configuration, if the amount of ink sealed in the ink pack 24 becomes low, a part of the actuation plate 24b functions so as to turn on the detection switch 29, for example, as the ink pack 24 contracts.

[0093] As show in Fig. 14, a terminal 30 where on/off information of the switch 29 is derived is placed on a part of the main tank 9 and when the main tank 9 is placed in the recording apparatus, the terminal can be electrically connected to the recording apparatus.

[0094] On the other hand, in the embodiment, a consumed ink amount calculator for calculating the consumed ink amount in a subtank as described later is provided, and if the calculator determines that ink consumption in the subtank exceeds a predetermined amount, the ink replenishing valve 26 is opened. Thus, ink compressed in the main tank 9 is separately sent to the subtank 7 where ink consumption exceeds the predetermined amount.

[0095] If the residual ink amount in the subtank 7 reaches a predetermined volume, the ink replenishing valve 26 is closed based on output of ink amount detector containing the float member as described above. Such a sequence is repeated, whereby the subtank is intermittently replenished with ink from the main tank and ink in a constant range is always stored in each subtank.

[0096] Fig. 16 shows an example of a control circuit forming an ink end detector of a cartridge, installed in the recording apparatus according to the second embodiment. Parts corresponding to those previously described are denoted by the same reference numerals in Fig. 16, and therefore will not be discussed again. As shown in Fig. 16, the suction pump 15 is connected to capping unit 11 and the discharge side of the suction pump 15 is connected to a waste ink tank 16.

[0097] In Fig. 16, a print controller 100 has a function of generating bit map data based on print data from a host computer, and causing a head driver 101 to generate a drive signal based on the data for ejecting ink through the recording head 6 mounted on the carriage 1. Upon reception of a flushing command signal from a flushing controller 102, the head driver 101 also outputs a drive signal for the flushing operation to the recording head 6 in addition to the drive signal based on the print data.

[0098] A cleaning controller 103 has a function of controlling a pump driver 105 for driving the suction pump 15 upon reception of a control signal from a cleaning command detector 104. A cleaning command switch 106 placed on an operation panel, etc., of the recording apparatus is operated, whereby the cleaning command detector 104 operates and manual cleaning operation is executed.

[0099] The cleaning controller 103 also receives a control signal from the print controller 100 and comprises a cleaning operation function of controlling the pump driver 105 for driving the suction pump 15 according to the received control signal.

[0100] On the other hand, each of the print controller 100, the flushing controller 102, and the cleaning controller 103 supplies a control signal to a consumed ink amount calculator 107. The consumed ink amount calculator 107 has a function of calculating the consumption amount of ink stored in each subtank 7. The number of ink drops ejected through the recording head by the print controller 100 based on the print data and the number of ink drops ejected through the recording head by the flushing operation of the flushing controller 102, and data whenever the cleaning operation of sucking and discharging ink from the recording head by the cleaning controller 103 is executed are supplied to the consumed ink amount calculator 107.

[0101] The consumed ink amount calculator 107, which receives the data, accesses a coefficient provider 108 based on the number of ink drops ejected through the recording head by execution of print, the number of ink drops ejected through the recording head by the flushing operation, and ink discharge processing each time the cleaning operation is executed and multiplies the data by a coefficient corresponding to each, thereby calculating the consumption amount of ink in the subtank 7.

[0102] The consumption amount of ink in the subtank 7 thus calculated is sent to a subtank consumed ink coun-

ter 109 and is counted up (added). If the count reaches a predetermined numeric value, it means a state in which the ink amount in the subtank 7 is decreased, and therefore the ink replenishing valve 26 is opened so as to replenish the subtank with ink from the main tank.

[0103] If the ink volume in the subtank 7 becoming a predetermined value (almost fill-up state) as the subtank is replenished with ink is detected based on electric output of the hall devices 33a and 33b, the ink replenishing valve 26 is closed as mentioned above, and at the same time, the count of the subtank consumed ink counter 109 is reset.

[0104] On the other hand, information of the consumed ink amount in the subtank is transferred from the subtank consumed ink counter 109 to a main tank residual ink counter 110. The data concerning the residual ink amount in the main tank stored in the memory 27 installed in the placed main tank is preset in the main tank residual ink counter 110 through write and read unit 111.

[0105] The count of the subtank consumed ink counter 109 just before it is reset is sent to the main tank residual ink counter 110 and the count of the subtank consumed ink counter 109 is subtracted from the count indicating the residual ink amount in the main tank. Accordingly, the main tank residual ink counter 110 is decremented as ink is consumed, and the numeric data is written into the memory 27 through a reader/writer 111. The consumed ink amount calculator 107, the coefficient provider 108, the subtank consumed ink counter 109, and the main tank residual ink counter 110 generally are placed in the recording apparatus, but may be placed in the host computer as required.

[0106] A control signal sent to open the ink replenishing valve 26 from the subtank consumed ink counter 109 is supplied to a timer 112. The timer 112 starts to count the time period at the same time as the ink replenishing valve 26 is opened. It receives output of the hall devices 33a and 33b occurring when the subtank 7 is placed almost in a fill-up state.

[0107] Upon reception of the control signal sent to open the ink replenishing valve 26, the timer 112 starts to count the time period, and if the output of the hall devices 33a and 33b occurring when the subtank 7 is placed almost in a fill-up state does not come although a predetermined time period has elapsed, the timer 112 causes a display 113 to display a message, etc., indicating that the main tank is in an ink end condition.

[0108] That is, in the recording apparatus, compressed air is supplied to the inside of the air chamber (pressure chamber) of the main tank and each subtank is replenished with ink from each main tank by the compressed air. Therefore, the time interval between the instant at which replenishing each subtank with ink is started and the instant at which the subtank 7 is placed almost in a fill-up state is found on the design. Thus, if replenishing each subtank with ink is insufficient although the time interval is exceeded largely, it can be estimated that the main tank is in an ink end condition.

[0109] If the main tank being in an ink end condition is thus detected, the display 83 is caused to display a message, etc., indicating that the main tank is in an ink end condition, and the print operation of the recording apparatus is stopped. Accordingly, a problem of making also the subtank empty of ink can be circumvented and air bubbles entering the ink supply passage of the recording head can be blocked effectively. Although the display 83 may be placed in the recording apparatus, display of the host computer may be used as required.

[0110] At this time, ink in the main tank can be spent all until the main tank becomes almost empty of ink, and the running cost and the load of treating the remaining ink in the scrapped ink cartridge, etc., can be decreased.

[0111] By the way, according to the main tank ink end detector having the described configuration, for example, if some failure occurs in the ink replenishing passage from the main tank to the subtank or the supply passage of the compressed air, there is a probability that it may be recognized by mistake that the main tank is in an ink end condition. A control routine shown in Fig. 17 is designed so that it can circumvent such a problem. The function of the control routine will be discussed together with the control circuit shown in Fig. 16 with reference to a flowchart indicating the control routine.

[0112] To detect an ink end condition of the main tank, first the amount of ink consumed for print, etc., is added to the subtank consumed ink counter as shown at step S11. To do this operation, the consumption amount of ink in the subtank calculated by the consumed ink amount calculator 107 shown in Fig. 16 is sent to the subtank consumed ink counter 109 for adding the consumed ink amount. At step S12, whether or not the subtank consumed ink counter is greater than a predetermined value (A) is checked.

[0113] This is to check whether or not the count of the subtank consumed ink counter 109 shown in Fig. 16 exceeds the predetermined value (A). If it is determined that the count does not exceed the predetermined value (A) (No), the ink volume in the subtank has a margin. Therefore, control returns until the count exceeds the predetermined value (A), and the routine at the steps S11 and S12 is repeated. If it is determined at the step S12 that the numeric value of the subtank consumed ink counter 109 exceeds the predetermined value (A), control goes to step S13 and the operation of replenishing the subtank with ink is started. This is performed by opening the ink replenishing valve 26. Subsequently, at step S14, whether or not replenishing the subtank with ink is complete is checked. To do this, output of the hall devices 22a and 33b is used as described above.

[0114] Concurrently with the checking at step S14, checking whether or not the predetermined time period has elapsed since the operation of replenishing the subtank with ink was started is also started at step S18. This is performed by the timer 112 shown in Fig. 16. It is determined that replenishing the subtank with ink is complete before the expiration of the predetermined time pe-

riod (Yes), the ink replenishing operation is stopped at step S15. This is performed by closing the ink replenishing valve 26 as described above.

[0115] At step S16, the subtank consumed ink counter 109 is reset and at step S17 following the step, the value (A) is subtracted from the main tank residual ink counter 110.

[0116] Accordingly, the ink amount as much as one replenishing the subtank with ink is subtracted and the subtraction result (in other words, the residual ink amount in the ink cartridge) is set in the main tank residual ink counter 110.

[0117] On the other hand, it is determined at the step S14 that replenishing the subtank with ink is not complete (No), and moreover it is determined at step S18 that the predetermined time period has elapsed, it is estimated that the ink cartridge becomes empty of ink. Then, at step S19, the operation of replenishing the subtank with ink is stopped.

[0118] Subsequently, at step S20, whether or not the cartridge residual ink amount counter 110 is equal to or less than a predetermined value is determined. If replenishing the subtank with ink is not complete within the predetermined time period although the main tank residual ink counter 110 does not reach the predetermined value or less (No), in other words although a considerable amount of ink is left in the cartridge, it can be assumed that some trouble occurs, for example, in the ink replenishing passage, the supply passage of the compressed air, or the like. In this case, error display is produced on the display 113.

[0119] If it is determined at the step S20 that the main tank residual ink amount counter 110 reaches the predetermined value or less (Yes), it is determined that the ink cartridge enters an end condition certainly. In this case, display indicating the ink end is produced on the display 113. That is, the determination at the step S20 is provided, whereby the ink end condition of the main tank can be recognized correctly.

[0120] In the embodiment described above, the information of the residual ink amount in the ink cartridge is read from the memory 27 placed in a part of the case forming the main tank as the ink cartridge, and the consumed ink amount in the subtank is subtracted from the information for use as the residual ink amount information of the ink cartridge.

[0121] However, the detection switch 29 placed in the ink cartridge, for example, as shown in Figs. 14 and 15 can be used as means for recognizing the residual amount information of ink in the ink cartridge.

[0122] In this case, the residual amount information of ink in the cartridge based on the detection switch 29 is used at step S20 shown in Fig. 17 as information for determining whether the condition is an error or ink end condition.

[0123] Pressurized air is introduced into the air chamber (pressure chamber) of the ink cartridge and the subtank is replenished with ink, but the invention can also be used for recording apparatuses other than such a type of recording apparatus. For example, in a recording apparatus for sucking so as to place the inside of a subtank in negative pressure and replenishing the subtank with ink or a recording apparatus for providing a water head difference between an ink cartridge and a subtank for producing an ink flow from the ink cartridge into the subtank, physical detectors as shown in Figs. 18 to 20 can be used as the residual amount detector of ink in the cartridge.

[0124] First, Figs. 19A and 19B show a configuration wherein a case of an ink cartridge 9 is molded of a transparent resin and a light source 86 an a photosensor 87 are placed so as to sandwich the vicinity of the lower portion of the case. As shown in Fig. 19A, if a large amount of ink is stored in the ink cartridge 9, projection light from the light source 86 is blocked and thus the sensor 87 cannot sense the projection light. As shown in Fig. 19B, the ink in the cartridge 9 is decreased to less than a predetermined value, the sensor 87 can sense the projection light from the light source 86 through the case molded of a transparent resin and the residual ink amount is determined less than the predetermined value.

[0125] Figs 18A and 18B show a configuration wherein a case of an ink cartridge 9 is molded of a transparent resin and a prism part 85 is formed at a corner between the lower bottom portion and the side wall portion of the case. That is, the incidence angle on the print part 85 from the light source 86 and the outgoing angle from the prism part 85 to the sensor 87 are set to each an angle of θ (= 45 degrees). The residual amount of ink in the ink cartridge is detected based on the difference between the critical angle of total reflection determined by the flexion ratio between the ink in the cartridge 9 and the resin forming the case and the critical angle of total reflection determined by the flexion ratio between air and the resin forming the case.

[0126] Further, Fig. 20 shows a configuration wherein a pair of electrode terminals 90a and 90b is buried toward the storage space of ink in the proximity of the lower bottom face of a case of an ink cartridge 9 and a predetermined voltage is applied to one electrode terminal 90a from a constant-voltage source 91. A resistor 92 is connected to the other electrode terminal 90b between the electrode terminal and reference potential (ground) and a voltage detector 93 for detecting a potential occurring at the resistor 92 is connected to the other electrode terminal 90b mentioned above.

[0127] According to the configuration, if ink of a capacity to such an extent that the pair of electrode terminals is brought into conduction or more is left in the ink cartridge, the voltage detector 93 detects a predetermined voltage value or more. If the residual amount of ink in the ink cartridge is near an end condition, the voltage value detected by the voltage detector 93 lowers by far. Therefore, the configuration makes it possible to detect the residual amount of ink in the ink cartridge.

[0128] The ink end detector in the ink cartridge shown

in Figs. 18 to 20 described above can also be used replacing the numeric value of the residual amount counter of the cartridge at step S20 in Fig. 17 described above.

[0129] According to an ink jet recording apparatus adopting such a cartridge ink end determination method, if the amount of ink with which a subtank is replenished is insufficient although the ink replenishing time of the subtank from an ink cartridge exceeds a predetermined time period, the ink cartridge is determined to be in an ink end condition, so that the ink end condition of the ink cartridge can be recognized precisely. An ink end condition of an ink cartridge is detected by such a detection method, whereby uneconomical management of replacing the ink cartridge with a large amount of ink left or the like can be circumvented.

[0130] Next, there will be described a method of checking whether the overflow condition is erroneous detection of the ink level caused accidentally by a factor as mentioned above or an overflow condition caused by a true failure, in a case where the ink amount detector comprising the two hall devices 33a and 33b described above detects an overflow condition of ink. A control circuit is basically the same as that shown in Fig. 16 and therefore flowcharts are used for the description to follow.

[0131] Fig. 21 is a flowchart to show the basic concept of a first checking method. That is, first as shown at step S11, whether or not subtank is in an overflow condition is checked based on the output combination of the two hall devices 33a and 33b making up the ink amount detector. If it is determined that the subtank is not in an overflow condition (No), control is returned and a similar determination is repeated from the start.

[0132] If it is determined at the step S11 that the subtank is in an overflow condition, overflow time cleaning operation is executed as shown at step S12. In the cleaning operation at this time (hereinafter, called as an overflow cleaning), the nozzle formation face of the recording head 6 is sealed with the capping unit 11 and negative pressure produced by the suction pump 15 is applied, whereby ink is sucked and discharged from the recording head. In the overflow cleaning, a larger amount of ink than that in the manual cleaning operation or timer cleaning operation is sucked and discharged.

[0133] At step S13 after execution of such overflow cleaning, again whether or not the subtank is in an overflow condition is checked by the ink amount detector. Here, if it is determined that the subtank is not in an overflow condition (No), the control is returned. Erroneous detection of the ink level accidentally caused by vibration, etc., is possible at the determination time at the step S11, in which case it is determined that the subtank is not in an overflow condition, of course. Although the subtank actually enters an overflow condition, the overflow condition may be canceled by executing the overflow cleaning at step S12. In any way, it is determined that the subtank is not in an overflow condition in the result of the rechecking, the printable state of the recording apparatus is continued.

[0134] On the other hand, if it is determined that the subtank is still in an overflow condition (Yes) in the result of the rechecking, it is estimated that the subtank enters an overflow condition because of some failure, in which case it is desirable that error display indicating the necessity for maintenance should be produced on the display 113.

[0135] Next, Fig. 22 is a flowchart to show the basic concept of a second checking method when the ink amount detector detects an ink overflow condition. In the second checking method, the operation of sucking and discharging ink from the recording head is executed two or more times and whether or not the subtank is in an ink overflow condition is checked each time the operation of sucking and discharging ink is executed. That is, as shown at step S21, whether or not the subtank is in an overflow condition is checked based on the output combination of the two hall devices 33a and 33b making up the ink amount detector as at the step S11. If it is determined that the subtank is not in an overflow condition (No), control is returned and a similar determination is repeated from the start.

[0136] If it is determined at the step S21 that the subtank is in an overflow condition, the number of times the subtank has been determined to be in an overflow condition, n, is incremented by one as shown at step S22. The incremented number of times an overflow condition has been detected, n, is compared with a predetermined value N at step S23. Here, if it is determined that the number of times an overflow condition has been detected, n, is less than the predetermined value N (No), a predetermined amount of ink is sucked and discharged from the recording head. Also in this case, the nozzle formation face of the recording head 6 is sealed with the capping unit 11 and negative pressure produced by the suction pump 15 is applied, whereby ink is sucked and discharged from the recording head. The amount of sucking and discharging ink at the step S24 is controlled so as to become an amount less by far than that the amount of sucking and discharging ink in the overflow cleaning. Again, control returns to step S21 and whether or not the subtank is in an overflow condition is checked by the ink amount detector. If it is determined that the subtank is not in an overflow condition (No), control is returned. It can also be estimated that erroneous detection was accidentally caused by vibration, etc., at the previous ink level detection time, and the printable state of the recording apparatus is continued.

[0137] If it is determined that the subtank is in an overflow condition although again the check is made at step S21, the routine of incrementing the number of times the subtank has been determined to be in an overflow condition, n, by one as mentioned above is repeated. If it is determined at step S23 that the number of times the subtank has been determined to be in an overflow condition, n, reaches the predetermined value N (Yes), it is estimated that the subtank enters an overflow condition because of some failure. Also in this case, it is desirable

that error display indicating the necessity for maintenance should be produced on the display 113.

[0138] According to the control routine shown in Fig. 22, the amount of ink discharged at a time from the recording head is lessened and whether or not the subtank is in an overflow condition is determined over several times. If it is determined that the overflow condition is canceled in a state in which the number of times the subtank has been determined to be in an overflow condition, n, does not reach the predetermined value N, the printable state of the recording apparatus is continued. Therefore, the control routine can contribute to a decrease in the total discharge amount of ink.

[0139] Fig. 23 shows a specific control routine to use the checking method shown in Fig. 21 for the ink replenishing system of the recording apparatus described above. The routine is executed separately for each of the main tanks as ink cartridges and each of the subtanks corresponding thereto. The control routine is started when the operation power of the recording apparatus is turned on and every five seconds, for example, during printing, and whether or not replenishing the subtank with ink from the main tank is enabled is determined.

[0140] First, when the operation power of the recording apparatus is turned on, a replenishing stop flag is reset as shown at step S31. That is, the replenishing stop flag is reset, whereby it is made possible to replenish the subtank 7 with ink. The amount of ink in the subtank 7 is determined from determination of ink level detection shown at step S33, namely, the output combination of the two hall devices 33a and 33b making up the ink amount detector.

[0141] On the other hand, during the print operation, the determination shown at step S32 is entered every five seconds as mentioned above, and whether the replenishing stop flag is set or reset is determined. If the replenishing stop flag is set, the subtank is not replenished with ink and the replenishing valve 26 is closed as shown at step S34, then control is returned. If it is determined at step S32 that the replenishing stop flag is reset, control goes to the step S33 and ink level detection in the subtank 7 is determined.

[0142] At step S33, which condition of ink overflow, full, and low is determined as mentioned above. If the condition is determined an overflow condition, control goes to step S35 and the replenishing stop flag is set. The replenishing valve 26 is closed as shown at step S36. Subsequently, the pressure regulating valve (relief valve) 22 is opened as shown at step S37, whereby compressed air by the air compressing pump 21 is released to the atmosphere. Here, the overflow cleaning is executed as shown at step S38. That is, the cleaning operation at this time is operation similar to that at step S12 previously described with reference to Fig. 21, whereby a large amount of ink is sucked from the recording head 6. At step S39 following the step, whether or not the amount of ink in the subtank 7 is an overflow condition is determined. That is, the step S39 is similar to step S13 previously described with reference to Fig. 21. If it is determined at the step S39 that the subtank is still in an overflow condition (Yes), it is estimated that the subtank 7 enters an overflow condition because of some failure, in which case error display indicating the necessity for maintenance is produced on the display 113.

[0143] On the other hand, if it is determined at the above-described step S39 that the subtank is not in an overflow condition (No), it can be estimated that the determination result of overflow at the step S33 is erroneous detection of the ink level caused accidentally. Therefore, in this case, the pressure regulating valve (relief valve) 22 is closed as shown at step S40 and the air compressing pump 21 is driven for pressuring the ink cartridge as shown at step S41. That is, the recording apparatus is restored to the printable state and control is returned.

[0144] If it is determined at the above-described step S39 that the subtank is not in an overflow condition (No), it can be estimated that in the previous ink level detection operation, vibration, etc., is received and erroneous detection results, as described above. Thus, in this case, a warning containing a message of "do not give vibration," or the like may be displayed on the display 113.

[0145] Control returns to the step S33 and if it is determined at the step S33 that ink is a full condition, the subtank 7 need not be replenished with ink, and control is returned. If it is determined at step S33 that ink is a low condition, control goes to step S42 and the count-up value of the subtank consumed ink counter 109 is referenced. Whether or not the consumed ink amount in the subtank is equal to or greater than "Ch*" is checked.

[0146] This "Ch*" is a predetermined value set as a parameter and if it is determined that the count-up value of the consumed ink counter 109 does not reach the predetermined value (No), control is returned. If it is determined that the count-up value of the consumed ink counter 109 reaches the predetermined value (Yes), control goes to the routine of replenishing the subtank 7 with ink.

[0147] In the embodiment, if the ink level detection result at step S33 is a low condition and the count-up value of the consumed ink counter 109 reaches the predetermined value or more, replenishing the subtank 7 with ink is started, as described above. Such a logical multiplication is applied, whereby the interval of replenishing the subtank 7 with ink can be prolonged, and the management accuracy of the storage amount of ink in the subtank 7 can also be enhanced.

[0148] That is, for example, if replenishing the subtank 7 with ink is started based only on the ink level detection result at step S33, replenishing with ink is started in the ink-low state condition and when the replenishing with ink is started, an ink full condition is detected and the replenishing with ink is stopped after the expiration of a short time. Further, the subtank enters an ink-low state condition after the expiration of a short time period and thus the ink replenishing operation is frequently repeated all the time. Therefore, replenishing with ink is not started until it is checked that the subtank enters an ink-low state

condition and that the consumption amount of ink in the subtank 7 exceeds the predetermined value as described above, so that the ink replenishing operation is repeated at sufficient time intervals.

[0149] On the other hand, for example, if replenishing the subtank 7 with ink is started using only the count-up value of the consumed ink counter 109 shown at step S42, it is inevitable that a slight error will occur in the computation processing of the consumed ink amount calculator 107 shown in Fig. 16 and therefore the consumed ink counter 109 is reset and counted up repeatedly, whereby errors are accumulated and the amount of ink in the subtank 7 gradually grows and enters an overflow condition; in the worst case, the result of leaking ink from the subtank 7 is incurred. Alternatively, the level of ink in the subtank gradually decreases and the subtank becomes empty of ink and an accident in which air enters the ink flow passage leading to the recording head may be caused.

[0150] If the determination at step is "Yes," control goes to the routine of replenishing the subtank 7 with ink, as described above. At step S43 following step S42, ink level detection operation to monitor the ink level of the subtank based on replenishing with ink is performed. At this point in time, the ink level detection result is almost always low and at step S44, the replenishing valve 26 is opened and replenishing the subtank 7 with ink from the main tank 9 is started.

[0151] At step S45, whether or not a time period in which the ink low condition has been continued reaches a predetermined value is checked. In other words, here the elapsed time period after the replenishing valve 26 was opened at step S44 is measured by the timer 112 shown in Fig. 16. At this point in time, the ink level low duration does not reach the predetermined time period and the determination is "No". Therefore, control again returns to step S43 via a loop of (A) shown in Fig. 23 and the state of replenishing the subtank 7 with ink is monitored. That is, the ink replenishing routine from step S43 to S45 is repeated. If it is determined at step S43 that the ink level of the subtank becomes a full condition, control goes to step S46.

[0152] At step S46, the replenishing valve 26 is closed. The consumed ink counter 109 of the subtank 7 is reset to zero as shown at step S47. At step S48, the count of the consumed ink counter (most recent) is subtracted from the count of the cartridge residual amount counter and control is returned. As this subtraction operation, as described above, the count of the consumed ink counter 109 of the subtank just before reset (most recent) is sent to the residual amount counter 110 of the main tank 9 and is subtracted from the count indicating the residual amount of ink in the main tank. Accordingly, the residual amount of ink in the main tank 9 can be managed.

[0153] On the other hand, if an overflow condition is detected in a state in which replenishing the subtank 7 with ink is monitored via the loop (A) as described above, the routine of step S35 and later previously described is entered and the overflow condition is again checked.

[0154] If it is determined at the step S45 that the time period in which the ink low condition has been continued exceeds the predetermined time period (Yes), it means that the subtank 7 is not sufficiently replenished with ink although the ink replenishing time of the subtank 7 reaches a predetermined time period. Therefore, control goes to step S49 and the residual amount of ink in the ink cartridge is referenced. In this case, the value of the residual amount counter 110 of the main tank 9 is referenced and if the determination is ink-low state (Yes), ink in the ink cartridge is insufficient and the replenishing valve 26 is closed as shown at step S50. The replenishing stop flag is set as shown at step S51. In this case, it is desirable that error display indicating that the ink cartridge is in an ink out (ink end) condition should be produced on the display 113.

[0155] If it is determined at the step S49 that the value of the residual amount counter 110 of the main tank 9 is not ink-low state (No), it can be assumed that the ink supply system undergoes some failure and the subtank is not replenished with ink. In this case, it is desirable that error display indicating an ink supply failure should be produced on the display 113.

[0156] Fig. 24 shows a control routine for again checking whether or not the subtank is in an overflow condition after ink is consumed through the recording head when the ink amount detector of the subtank detects an overflow condition of a larger amount of ink than the predetermined value. The routine is executed separately for each of the main tanks as ink cartridges and each of the subtanks corresponding thereto. The control routine is started every five seconds, for example, during printing of the recording apparatus, and whether or not replenishing the subtank with ink from the main tank is enabled is determined.

[0157] The control routine shown in Fig. 24 has a control mode roughly similar to that of the control routine previously described with reference to Fig. 23. Therefore, the corresponding steps are denoted by the same step numbers and will not be discussed again in detail. In the control routine shown in Fig. 24, if the condition is determined an overflow at the determination of ink level in the subtank at step S33, control goes to step S52. As shown at step S52, print is executed to the end of a predetermined number of page, thereby consuming ink through the recording head.

[0158] In this case, it is practical to control so as to continue the print execution of the predetermined amount to the end of the corresponding one page; for example, however, print execution may be continued to the end of all pages corresponding to the print command received from the host computer. Control goes to step S43 in the state in which ink is consumed by executing the step S52, and again the ink level condition in the subtank is checked. If the condition is still determined an overflow as a result of the rechecking, the routine at step S35 and later is entered.

[0159] In the control routine shown in Fig. 24, the rechecking at steps S38 to S41 shown in Fig. 23 is not executed. The reason why the rechecking is not executed is that whether or not the condition is still an overflow is already rechecked at step S43 after ink is consumed at step S53.

[0160] As seen from the description made above, according to the ink jet recording apparatus adopting the check method of the ink replenished amount of the subtank, the ink amount detector of the subtank detects an overflow condition of a larger amount of ink than the predetermined value, whether or not the condition is an ink overflow condition is rechecked after execution of the recovery measure. If the overflow condition is released as a result of the rechecking, the printable state is continued, so that stopping the operation of the recording apparatus caused by an erroneous determination made accidentally can be avoided.

[0161] In each of the embodiments previously described with reference to Figs. 2 to 24, air pressure produced by the air compressing pump is applied to each subtank and the corresponding ink replenishing valve is opened or closed in response to the detection condition of the amount of ink stored in each subtank; each embodiment is shown as one preferred embodiment in the ink supply system of the recording apparatus.

[0162] However, the invention is not limited to the embodiments; for example, a mode as shown in Fig. 25 can also be adopted preferably. That is, in the mode shown in Fig. 25, an ink supply system is shown schematically and can be described in comparison with the ink supply system previously described with reference to Fig. 2. Parts corresponding to those previously described with reference to Fig. 2 are denoted by the same reference numerals in Fig. 25 and therefore will not be discussed again in detail.

[0163] In the ink supply system shown in Fig. 25, an ink pack 24 formed of a flexible material in which ink is sealed is stored in a main tank 9 and the ink sealed in the ink pack 24 is sent out by driving an ink supplying pump 38 as an ink replenishing controller so that a subtank 7 is replenished with the ink via a flexible tube 10 as an ink replenishing passage.

[0164] The ink supplying pump 38 is driven appropriately in response to the detection state of ink amount detector made up of a combination of a permanent magnet 32 on a float member 31 placed in the subtank 7 and hall devices 33a and 33b.

[0165] According to the configuration, if it is recognized that the amount of ink in the subtank 7 lowers based on the electric output provided by the hall devices 33a and 33b, the ink supplying pump 38 corresponding to the subtank is driven, whereby the subtank is replenished with ink separately from the main tank. If the amount of ink in the subtank 7 reaches a predetermined volume, driving the ink supplying pump 38 is stopped based on the electric output of the hall devices 33a and 33b mentioned above. Such a sequence is repeated, whereby the subtank is replenished intermittently with ink from the main tank and an almost constant amount of ink is always stored in each subtank.

[0166] According to the configuration, the configuration of applying the air pressure produced by the air compressing pump forming a part of the compressor unit to each main tank as in the embodiments shown in Figs. 2 to 24 becomes unnecessary, so that the configuration of the ink supply system can be simplified to some extent.

[0167] In the ink supply system shown in Fig. 25, if the operation power of the recording apparatus is turned off, driving the ink supplying pump 38 is also stopped, of course, and ink flow is blocked. Accordingly, a problem of backward flowing of ink from each subtank 7 to each main tank 9 can be circumvented. In the ink supply system shown in Fig. 25, the consumed ink amount calculator in each subtank, which is provided as a software, can also be used together.

[0168] Next, a third embodiment will be discussed with reference to Figs. 26 and 27. Parts identical with or corresponding to those previously described with reference to Figs. 2 to 25 are denoted by the same reference numerals in Figs. 26 and 27 and will not be discussed again. In the embodiment, a subtank unit is replenished with an amount of ink matching the amount of ink consumed in a recording head by pump controller, so that the ink level in the subtank unit can be maintained with high accuracy in an optimum state for print without incurring complicity of a structure of ink level detector, etc.

[0169] Fig. 26 is a block diagram to show the third embodiment. A subtank unit 7 is implemented as a vessel comprising an atmospheric release port 7e and an ink supply port 10a in the top and a float member 31 for detecting an ink level is placed in the vessel. A magnetic substance 32 is placed on the float member 31 and magnetoelectric devices 33a and 33b each as a sensor for detecting the magnetic substance 32 are placed at positions facing the upper and lower limits of the ink level.

[0170] An ink cartridge 9 in the embodiment comprises an ink pack 24 stored in a hard case that can be sealed and an air pump 120 is connected to the space between the hard case and the ink pack 24 so that the ink pack 24 is compressed by air for discharging ink.

[0171] Pump controller 121 controls a flow amount so that the ink level in the subtank unit becomes at least above the lower limit value and below the upper limit value based on signals from the magnetoelectric devices 33a and 33b as sensors, and drives an air pump 120 in response to ejection by head driver 101.

[0172] In the embodiment, when the subtank unit 7 is not replenished with ink, the pump controller 121 drives the air pump 120 based on the signals from the magnetoelectric devices 33a and 33b as replenishing sensors for the subtank 7 with ink in an ink cartridge 9 to a stipulated level.

[0173] When a print signal is input from a host not shown, print controller 100 controls the head driver 101 to execute print through a recording head 6. The pump

controller 121 adjusts the displacement of the air pump 120 while detecting the amount of ink consumed through the recording head 6 based on a signal from the head driver 21, and discharges ink so that the ink outflow amount from the ink cartridge 9 matches the consumed ink amount in the print.

[0174] Accordingly, at the text print time less consuming ink, ink in the ink cartridge 9 flows into the subtank 7 in a small flow amount and in graphics print, etc., much consuming ink, ink in the ink cartridge 9 flows into the subtank 7 in a large flow amount, so that the ink level in the subtank is always maintained in an optimum state.

[0175] Since the subtank unit 7 is thus replenished with an amount of ink matching the consumed ink amount in the recording head 6 from the ink cartridge, the ink level in the subtank unit can always be maintained in an optimum state without receiving the effect of hysteresis or a dead band of the ink level detector of the float, etc.

[0176] In the above-described embodiment, the ink pack 24 is compressed by air for replenishing the subtank 7 with ink, but if an ink supplying pump 122 is connected to a midpoint of an ink supply tube 10 as shown in Fig. 27 and the flow amount of the pump 122 is controlled, a similar advantage can also be provided.

[0177] An ink replenishing method capable of properly maintaining the ink level in the subtank 7 using the magnetoelectric devices 33a and 33b as sensors and judgement circuit in the third embodiment described above will be discussed with reference to Fig. 28.

[0178] As shown in Fig. 28, the magnetoelectric devices 33a and 33b as sensors are placed with a spacing of $\Delta H1 + \Delta H2$ so that ink in the subtank 7 can be detected above and below stipulated level L0 and a magnetic field of the permanent magnet 32 as an indicator can be detected in a predetermined range, namely, a range A ($=\Delta A1+\Delta A2$) in which the ink level should be maintained at the same time.

[0179] Accordingly, if the float member 31 moves down more than $\Delta A1$ below the position corresponding to the stipulated level L0, the magnetic field of the indicator 32 does not act on the upper magnetic sensor 33a and the fact that the ink level decreases to the liquid amount requiring pouring can be detected, and if the float member 31 moves up more than $\Delta A2$ above the position corresponding to the stipulated level L0, the magnetic field of the indicator 32 does not act on the lower magnetic sensor 33b and the fact that the ink level reaches the liquid amount to stop pouring can be detected.

[0180] That is, in the range of $\Delta A1 + \Delta A2$ in which the ink level should be maintained properly, the magnetic flux distribution of the indicator 32, the sensitivities of the magnetic sensors 33a and 33b, and the placement spacing $\Delta H1 + \Delta H2$ therebetween are adjusted so that the magnetic field of the indicator 32 acts on the two magnetic sensors 33a and 33b at the same time.

[0181] The range of $\Delta A1 + \Delta A2$ in which the ink level should be maintained becomes narrow if the spacing between the magnetic sensors 33a and 33b is widened, and the range becomes wide if the spacing is lessened. If an indicator having a large magnetic flux distribution in an up and down direction is used as the indicator 32, the range in which the ink level should be maintained can be enlarged.

[0182] The float member is formed on the top with a projection 31a (see Figs. 26 and 27) for defining the upper limit position of the float member 31 regardless of a rise in the ink level, and the projection 31 a abuts the upper face of the subtank 7 for limiting the rise position of the float member 31 and preventing the float member 31 from moving outside the detection range of the magnetic sensor 33a.

[0183] In the embodiment, the float member is formed with the projection 31 a for regulating the upper limit, but if the subtank is formed with a projection, a similar advantage can also be provided.

[0184] A judgement circuit 123 for receiving signals from the magnetic sensors 33a and 33b assumes that ink is of a too small amount, and outputs a first error signal if the first and second magnetic sensors 33a and 33b output both low signals (in the embodiment, the low signal means a state in which a magnetic flux is not detected and a high signal means a state in which a magnetic flux is detected).

[0185] If a high signal is output only from the first magnetic sensor 33b at the lower position, a pouring start signal is output.

[0186] Further, high signals are output from both the first and second magnetic sensors 33a and 33b, the liquid amount is maintained properly and therefore a pouring stop signal is output.

[0187] Further, if a high signal is output only from the second magnetic sensor 33a at the upper position, it is assumed that ink is oversupplied, and a second error signal is output.

[0188] The first error signal from the judgement circuit 123 is output to an alarm 124, the pouring start signal and the pouring stop signal are output to pump driver 121, and the second error signal is output to a forcible stopper 125, in the embodiment, a switch for outputting drive power to the pump 120 (122).

[0189] Such control is performed, whereby the ink level in ink supply unit 3 is maintained in the range of $-\Delta A1$ to $+\Delta A2$ sandwiching the stipulated level L0 therebetween and ink can be supplied to the recording head 4 at the water head difference appropriate for print.

[0190] By the way, if the pump 120 (122) continues to operate because of trouble of the pump driver 121 although the judgement circuit 123 outputs a pouring stop signal at replenishing with ink, the float member 31 moves up to a top dead center defined by the projection 31a. In this state, a low signal is output from the first magnetic sensor 33b and a high signal is output from the second magnetic sensor 33a and thus the judgement circuit 123 outputs a second error signal to the forcible stopper 125 for shutting down the operation power supplied to the pump 120 (122) and forcibly stopping pouring of ink,

thereby preventing an overflow.

[0191] If a larger amount of ink than the stipulated amount is thus poured, the float member 31 is stayed at the given upper limit position by the projection 31 a, so that the magnetic field of the indicator 32 acts on the second magnetic sensor 33a and the state can be distinguished from the state in which ink becomes too small. That is, if the upper limit position of the float member 31 is not regulated, the indicator 32 moves to a position at which the magnetic field of the indicator 32 does not act on the second magnetic sensor 33a, and the state cannot be distinguished from the state in which ink becomes too small.

[0192] As described above, the indicator of a magnetic substance is placed in the subtank, the float member whose upper limit position is regulated is housed, at least two magnetic sensors are placed so as to sandwich the stipulated ink level therebetween in the up and down direction in areas being outside the ink supplier, where the magnetic flux of the indicator can be received at the same time, and at least three types of ink levels are detected based on the signals of the magnetic sensors, so that not only the predetermined width, but also the limit amount of the amount of ink in the ink supply unit is detected by a number of sensors as small as possible, and the subtank can be replenished with ink with high accuracy.

[0193] In the ink jet recording apparatus, if the time elapses with the subtank filled with ink, the dissolved air amount of ink in the subtank increases and the ink becomes saturated. If print is started in a state in which ink in the subtank is thus saturated, a sufficient negative pressure is not applied in the recording head and the eject state becomes unstable and at the cleaning time, bubbles occur and the cleaning easily becomes insufficient; this is a problem.

[0194] Next, an embodiment for solving such a problem will be discussed. An ink jet recording apparatus comprises: a print controller 100 for creating bit map data based on a print signal from a host; a carriage controller 130 for controlling a motor 131 for controlling a movement of a carriage 1 in a main scanning direction; and a head driver 101 for driving piezoelectric vibrators based on a signal from the print controller 100 for ejecting ink drops through a recording head 6.

[0195] The recording apparatus also comprises a timer 133 being started when the power of the recording apparatus is turned off, etc., for measuring the non-operating period of the recording apparatus until the power is then turned on, and a refilling (re-replenishing) controller 132 for discharging ink in a subtank 7 and filling again the subtank with fresh ink in a main tank 9 if the non-operating time measured by the timer 133 reaches at a predetermined time period or more.

[0196] A discharging passage 134 provided with a discharging valve 135 opened and closed as instructed by the refilling controller 132 communicates with the subtank 7. On the other hand, the main tank 9 is provided with a pack compressor 136 consisting of an air compressing pump 21, a pressure regulating valve 22, and a pressure detector 23 for pressurizing the inside of the main tank 9 to compress an ink pack 24 for filling (replenishing) the subtank 7 with ink in the ink pack 244 as instructed by the refilling controller 132.

[0197] Here, the dissolved air amount of ink in the subtank 7 increases and soon the ink becomes saturated as the non-operating time of the recording apparatus since the recording apparatus was turned off is prolonged. If print is executed in such ink with the dissolved ink saturated, cleaning and ejecting become easily unstable as described above.

[0198] Therefore, the predetermined time period for determining whether or not the subtank is to be re-filled (re-replenished) with ink is set to the time at which the saturation degree of ink in the subtank 7 arrives at a given value or more and when the recording apparatus in a non-operating state is turned on, if the non-operating time exceeds the time, the saturation degree of ink in the subtank 7 is high and thus the ink in the subtank is discharged and is replaced with fresh ink before print is executed. On the other hand, if the non-operating time does not reach the time, since the ink ejection is stable to some extent, print is executed without performing the cleaning or the refilling (re-replenishing).

[0199] The recording apparatus having the configuration described above can be used, for example, as follows: First, when the power of the recording apparatus in a non-operating state is turned on, the timer 133 measures the non-operating time until the power is now turned on since the power was previously turned off. Next, if the non-operating time measured by the timer 133 reaches a predetermined time period, as instructed by the refilling controller 132, the discharging valve 135 is opened for discharging ink remaining in the subtank 7, and then the pack compressor 136 pressurizes the inside of the main tank 9 to compress the ink pack 24 for filling the subtank 7 with ink in the ink pack 24. The subtank 7 is filled with fresh ink before print is executed. On the other hand, if the non-operating time period measured by the timer 133 does not exceed the predetermined time period, print is started.

[0200] Thus, if the ink in the subtank 7 becomes saturated while the recording apparatus is non-operating, when operation of the recording apparatus is restarted, the saturated ink is discharged and is replaced with fresh ink, so that instabilization of cleaning and ejecting caused by ink degradation in the subtank 7 is prevented. Ink not so much degraded in a short non-operating time need not be discharged, so that fruitless consumption of ink can be decreased.

[0201] In the above-described embodiment, the subtank 7 may be filled with ink before the recording apparatus enters a non-operating state. In doing so, the time until the dissolved air of ink in the subtank 7 reaches saturation can be prolonged to the maximum, so that the predetermined time period can be set long accordingly

and while the non-operating time is not so much long, operation of the recording apparatus can be restarted without replacing ink in the subtank 7 and fruitless consumption of ink can be decreased.

[0202] More preferably, a residual amount sensor 137 consisting of a permanent magnet 32 and a hall device 33 for sensing the residual amount of ink in a subtank 7 is provided as shown in Fig. 29, and a timer 133 is set so that a time period X until the refilling is performed becomes shorter as the residual amount of ink in the subtank 7 is less, as shown in Fig. 30. In the example, when the residual amount of ink is to one third, the time period X is set to one week, when the residual amount of ink is in the range of a third to two thirds, the time period X is set to two week, and when the residual amount of ink is in the range of two thirds to a fill-up, the time period X is set to three weeks.

[0203] In the recording apparatus, saturated ink is discharged reliably and ink not so much degraded need not be discharged, so that the ink use efficiency can be enhanced. When the recording apparatus shown in Fig. 29 is used and operation of the recording apparatus in a non-operating state is restarted, ink in the subtank 7 may be discharged with some of the ink left and the subtank 7 may be filled with fresh ink, as shown in Fig. 31. In the example, ink in the subtank 7 is discharged to one third the capacity of the subtank 7 and the subtank is filled with fresh ink with the ink left in the subtank in one third the capacity.

[0204] In the recording apparatus, if saturated ink remains in the subtank 7 to some extent, the ink is mixed with fresh ink, whereby the saturation degree can be lowered until given stability can be provided as a whole, so that ink consumption can be decreased accordingly.

Claims

1. An ink jet recording apparatus comprising:

a recording head (6)mounted on a carriage (1) to be reciprocately moved in a widthwise direction of recording paper; and
a subtank (7a to 7d) mounted on the carriage (1) for supplying ink, which is replenished from a main tank (9a to 9d) via a replenishment passage (10), to the recording head (6),
an ink amount detector (31, 32, 33a, 33b), which detects an amount of ink stored in the subtank (7a to 7d);
a replenishment controller, and
a pump (21) configured to be operated in accordance with the ink amount detected by the ink amount detector (31, 32, 33a, 33b) to replenish ink stored in the main tank (9a to 9d) to the subtank (7a to 7d),

characterized in that

the replenishment controller comprises:

an ink replenishment valve (26) that is provided in the replenishment passage (10) and is opened or closed in accordance with the ink amount detected by the ink amount detector.

2. The recording apparatus as set forth in claim 1, wherein the ink amount detector includes a float member (31) floating on ink stored in the subtank (7a to 7d), and to an output generator (32', 33a, 33b) which generates an electrical output in accordance with a floating position of the float member (31), which changes according to the stored ink amount.

3. The recording apparatus as set forth in any one of claims 1 to 2, wherein the ink amount detector detects the ink amount stored in the subtank (7a to 7d) by calculating an amount of ink ejected or sucked from the recording head.

4. The recording apparatus as set forth in claim 2, wherein the output generator includes a permanent magnet (32) disposed on the float member, and a magnetoelectric element (33a, 33b) which generates the electrical output in accordance with a magnetic flux density changing its value according to the position of the float member (31).

5. The recording apparatus as set forth in claim 4, wherein the magnetoelectric element (33a, 33b) is a hall element.

6. The recording apparatus as set forth in claim 5, wherein a plurality of magnetoelectric elements (33a, 33b) are arranged so as to generate output signals having different phases in accordance with a movement of the permanent magnet (32) provided with the float member (31).

7. The recording apparatus as set forth in claim 6, wherein at least two magnetoelectric elements (33a, 33b) are arranged above and below a predetermined level of ink such that both elements are able to detect the magnetic flux generated from the permanent magnet (32) so that at least three ink levels are recognized.

8. The recording apparatus as set forth in claim 7, wherein the following states are recognized by the output signals from the magnetoelectric elements (33a, 33b):

a state in which ink stored is too few;
a state in which the ink replenishment needs starting;
a state in which the ink replenishment needs terminating; and

a state in which ink stored is too much.

9. The recording apparatus as set forth in claim 1, wherein the replenishment controller blocks ink communication when an operation power of the apparatus is turned off.

10. The recording apparatus as set forth in claim 1, wherein the ink replenishing valve (26) includes a diaphragm valve (26a), a slide shaft (26d) provided in a substantially center portion of the diaphragm valve (26a), and an actuator (79) which moves the slide shaft (26d) in an axial direction thereof to open or close the diaphragm valve (26a).

11. The recording apparatus as set forth in claim 10, wherein the replenishing valve (26) includes a case (26b, 26c) which accommodates the diaphragm valve (26a) therein, so that an aperture (26f) formed on the case is opened or closed by the diaphragm valve.

12. The recording apparatus as set forth in claim 10 or 11, wherein the center portion of the diaphragm valve (26a) is horizontally movable.

13. The recording apparatus as set forth in claim 11, wherein an ink replenishing tube (10) is vertically connected to the case; and
wherein an ink supply passage extending to the aperture of the case and an ink supply passage extending from the case to the ink replenishing tube are perpendicular to each other.

14. The recording apparatus as set forth in claim 10, wherein the actuator (79) is an electromagnetic plunger.

15. The recording apparatus as set forth in claim 14, wherein a driving force of the electromagnetic plunger (79) is acted on one end of a pivotal driving lever so that the driving force is transmitted to the slide shaft (26d) via the other end of the driving lever.

16. The recording apparatus as set forth in claim 14 or 15, wherein the diaphragm valve (26a) is opened when the electromagnetic plunger (79) is activated, and is closed when the electromagnetic plunger (79) is not activated.

17. The recording apparatus as set forth in claim 1, further comprising an ink end detector which determines that the ink cartridge is in an ink end state when an ink amount replenished to the subtank is insufficient even if a time period spent for the ink replenishment is a predetermined time period or more.

18. The recording apparatus as set forth in claim 17, further comprising:

a consumed ink amount calculator (107), which calculates an ink amount consumed in the subtank;
the ink replenishing valve (26), which is opened to replenish ink stored in the ink cartridge to the subtank, when the consumed ink amount calculated by the consumed ink amount calculator reaches a predetermined value;
an ink amount detector (31, 32, 33a, 33b), which closes the ink replenishing valve (26) in accordance with a detection output which is provided when it is detected that ink stored in the subtank (7a to 7d) reaches a predetermined volume by the replenishment;
a timer (112), which starts counting a time period when the ink replenishing valve is opened; and
an ink end detector which determines that the ink cartridge is in an ink end state when the detection output from the ink amount detector is absent even if the timer counts a predetermined time period.

19. The recording apparatus as set forth in claim 17, further comprising a residual ink amount detector, which detects that an ink amount remaining in the ink cartridge is a predetermined amount or less,
wherein the determination of the ink end detector is made effective when the residual ink amount detector detects that the residual ink amount is the predetermined amount or less.

20. The recording apparatus as set forth in claim 18 or 19 wherein the consumed ink amount calculator and the residual ink amount detector respectively calculate the consumed ink amount and the residual ink amount by multiplying coefficients which are respectively provided in association with ink ejection for printing, ink ejection for flushing, and ink suction for cleaning.

21. The recording apparatus as set forth in claim 18, wherein the ink amount detector includes a float member (31) floating on ink stored in the subtank (7a to 7d), an output generator (32, 33a, 33b) which generates an electrical output in accordance with a floating position of the float member (31), which changes according to the stored ink amount.

22. The recording apparatus as set forth in claim 1, further comprising:

the ink replenishing valve (26) which is opened or closed by a control signal generated by the ink amount detector (31, 32, 33a, 33b); and
a controller, which forcibly closes the ink replen-

ishment valve (26) when a predetermined time period is elapsed after the ink replenishment valve is opened.

23. The recording apparatus as set forth in claim 22, wherein a recovery operation is performed when the ink amount detector (31, 32, 33a, 33b) detects an ink overflow state in which the ink amount stored in the subtank (7a to 7d) exceeds a predetermined value.

24. The recording apparatus as set forth in claim 22, wherein the ink overflow state is rechecked after the recovery operation is completed.

25. The recording apparatus as set forth in claim 24, wherein a printable condition is continued when the ink overflow state is not detected by the rechecking.

26. The recording apparatus as set forth in claim 24, wherein an error condition is recognized when the ink overflow state is detected by the rechecking.

27. The recording apparatus as set forth in claim 23, wherein the recovery operation is either one of an operation for discharging ink from the recording head (6) or an operation for consuming ink.

28. The recording apparatus as set forth in claim 27, wherein the discharging operation is performed by sealing a nozzle formation face of the recording head (6) with a capping member and applying negative pressure generated by a suction pump therein.

29. The recording apparatus as set forth in claim 28, wherein the discharging operation is repeatedly performed; and
wherein the ink overflow state is checked every time when the discharging operation is performed.

30. The recording apparatus as set forth in claim 29, wherein an error condition is recognized when the ink overflow state is detected even after the discharging operation is repeated at a predetermined number of times.

31. The recording apparatus as set forth in claim 27, wherein the consuming operation is performed by executing a predetermined amount of printing.

32. The recording apparatus as set forth in claim 31, wherein the printing is continued until printing for a subject page is finished.

33. The recording apparatus as set forth in claim 24, wherein an error massage is displayed on a display (113) when the ink overflow state is detected by the rechecking.

34. The recording apparatus as set forth in claim 24, wherein an alarm massage is displayed on a display (113) when the ink overflow state is not detected by the rechecking.

35. The recording apparatus as set forth in claim 1, wherein the ink stored in the ink cartridge is replenished to the subtank (7a to 7d) when the ink amount detector (31, 32, 33a, 33b) detects that the ink amount stored in the subtank is a predetermined amount or less; and
wherein the ink amount detector detects an ink low level which is determined as an ink amount capable of remaining in the subtank even after ink consumption by a single cleaning operation.

36. The recording apparatus as set forth in claim 35, wherein the predetermined amount detected by the ink amount detector (31, 32, 33a, 33b) is an ink amount consumed by a single cleaning operation or more.

37. The recording apparatus as set forth in claim 35, wherein the predetermined amount detected by the ink amount detector (31, 32, 33a, 33b) is an ink amount, which is defined by subtracting an ink amount replenished during the cleaning operation from an ink amount consumed by a single cleaning operation, or more.

38. The recording apparatus as set forth in claim 1, further comprising:

a timer, which counts a time period in which the apparatus is not operated;
a discharger, which discharges ink stored in the subtank; and
a refilling controller, which controls the discharger and the replenishment controller such that ink stored in the subtank is discharged while replenishing ink stored in the main tank to the subtank, when the apparatus is recovered from the non-operating state and a time period counted by the timer reaches a predetermined time period.

39. The recording apparatus as set forth in claim 38, further comprising a residual ink sensor, which detects an ink amount remaining in the subtank which is in the non-operating state,
wherein the predetermined time period is made shorter as less amount of ink is detected by the residual ink sensor.

40. The recording apparatus as set forth in claim 38 or 39, wherein a part of ink left in the subtank is discharged when the apparatus is recovered from the non-operating state.

41. A method of replenishing ink stored in a main tank (9a to 9d) to a subtank (7a to 7d) mounted on a carriage (1) reciprocately moving in a widthwise direction of recording paper, together with a recording head (6), which are incorporated in an ink jet recording apparatus, the method comprising the steps of:

operating a pump (21) to replenish ink stored in the main tank (9a to 9d) to the subtank (7a to 7d); and
operating an ink replenishing valve (26) provided in a replenishment passage (10) which connects the main tank (9a to 9d) and the subtank (7a to 7d), in accordance with an amount of ink stored in the subtank, so as to be opened and closed repeatedly in a single replenishing operation;

wherein the ink replenishing valve (26) is opened and closed irrespective of the reciprocate movement of the carriage (1).

42. The replenishing method as set forth in claim 41, further comprising the steps of:

replenishing ink by opening the ink replenishing valve (26), when an ink amount detector (31, 32, 33a, 33b) detects that the ink amount stored in the subtank (7a to 7d) is less than a predetermined value;
stopping the replenishment of ink by closing the ink replenishing valve (26), when the ink amount detector detects that a replenished ink amount in the subtank (7a to 7d) reaches a sufficient volume; and
closing forcibly the ink replenishing valve (26), when a predetermined time period is elapsed after the replenishing step is started.

43. The replenishing method as set forth in claim 42, further comprising the step of displaying an error message, when the forcible closing step is executed.

44. The replenishing method as set forth in claim 41, further comprising the steps of:

detecting an ink amount replenished to the subtank (7a to 7d) by an ink amount detector (31, 32, 33a, 33b);
discharging ink from the recording head (6) when it is detected an ink overflow state in which the replenished ink amount detected by the detecting step exceeds a predetermined value;
checking whether the subtank (7a to 7d) is in the ink overflow state by detecting again an ink amount replenished to the subtank by the ink amount detector, after the discharging step;
continuing a printable condition of the apparatus when the ink overflow state is not detected by the checking step; and
determining an error condition of the apparatus when the ink overflow state is detected by the checking step.

45. The replenishing method as set forth in claim 41, further comprising the steps of:

detecting an ink amount replenished to the subtank (7a to 7d) by the ink amount detector (31, 32, 33a, 33b);
discharging ink from the recording head (6) when it is detected an ink overflow state in which the replenished ink amount detected by the detecting step exceeds a predetermined value, while incrementing a number of which the ink overflow state is detected;
repeating the discharging step and the incrementing step while comparing the detected number with a predetermined number; and
detecting an error condition of the apparatus when the detected number reaches the predetermined number.

46. The replenishing method as set forth in claim 44 or 45, wherein the discharging step includes the steps of:

sealing a nozzle formation face of the recording head (6) with a capping member; and
applying negative pressure therein, which is generated by a suction pump.

Patentansprüche

1. Tintenstrahlaufzeichnungsvorrichtung umfassend:

einen Aufzeichnungskopf (6), der an einem Schlitten (1) angebracht ist, der in einer Breitenrichtung von Aufzeichnungspapier hin und her bewegt wird; und
einen an dem Schlitten (1) angebrachten Subtank (7a bis 7d) zum Zuführen von Tinte, die von einem Haupttank (9a bis 9d) über einen Nachfülldurchlass (10) nachgefüllt wird, zu dem Aufzeichnungskopf (6);
einen Tintenmengendetektor (31, 32, 33a, 33b), der eine in dem Subtank (7a bis 7d) gespeicherte Tintenmenge erfasst;
eine Nachfüllsteuereinrichtung; und
eine Pumpe (21), die dafür ausgelegt ist, gemäß der durch den Tintenmengendetektor (31, 32, 33a, 33b) erfassten Tintenmenge betrieben zu werden, um in dem Haupttank (9a bis 9d) gespeicherte Tinte in den Subtank (7a bis 7d) nachzufüllen,

dadurch gekennzeichnet, dass
die Nachfüllsteuereinrichtung umfasst:

ein Tintennachfüllventil (26), das in dem Nachfülldurchlass (10) vorgesehen ist und gemäß der durch den Tintenmengendetektor erfassten Tintenmenge geöffnet oder geschlossen wird.

2. Aufzeichnungsvorrichtung nach Anspruch 1, bei welcher der Tintenmengendetektor ein Schwimmerelement (31), das in in dem Subtank (7a bis 7d) gespeicherter Tinte schwimmt, und einen Ausgabeerzeuger (32', 33a, 33b) beinhaltet, der eine elektrische Ausgabe gemäß einer Schwimmposition des Schwimmerelements (31) erzeugt, die sich gemäß der gespeicherten Tintenmenge ändert.

3. Auf zeichnungsvorrichtung nach einem der Ansprüche 1 bis 2, bei welcher der Tintenmengendetektor die in dem Subtank (7a bis 7d) gespeicherte Tintenmenge durch Berechnen einer Menge von aus dem Aufzeichnungskopf ausgestoßener oder gesaugter Tinte erfasst.

4. Aufzeichnungsvorrichtung nach.Anspruch 2, bei welcher der Ausgabeerzeuger einen Permanentmagneten (32), der an dem Schwimmerelement angeordnet ist, und ein magnetoelektrisches Element (33a, 33b) beinhaltet, das die elektrische Ausgabe gemäß einer magnetischen Flussdichte erzeugt, die ihren Wert gemäß der Position des Schwimmerelements (31) ändert.

5. Aufzeichnungsvorrichtung nach Anspruch 4, bei der das magnetoelektrische Element (33a, 33b) ein Hall-Element ist.

6. Aufzeichnungsvorrichtung nach Anspruch 5, bei der mehrere magnetoelektrische Elemente (33a, 33b) so angeordnet sind, dass sie Ausgabesignale mit unterschiedlichen Phasen gemäß einer Bewegung des an dem Schwimmerelement (31) vorgesehenen Permanentmagneten (32) erzeugen.

7. Aufzeichnungsvorrichtung nach Anspruch 6, bei der wenigstens zwei magnetoelektrische Elemente (33a, 33b) oberhalb und unterhalb eines vorgegebenen Tintenpegels so angeordnet sind, dass beide Elemente den durch den Permanentmagneten (32) erzeugten magnetischen Fluss erfassen können, so dass wenigstens drei Tintenpegel erkannt werden.

8. Aufzeichnungsvorrichtung nach Anspruch 7, bei der die folgenden Zustände durch die Ausgabesignale von den magnetoelektrischen Elementen (33a, 33b) erkannt werden:

ein Zustand, in dem zuwenig Tinte gespeichert ist;
ein Zustand, in dem das Tintennachfüllen begonnen werden muss;
ein Zustand, in dem das Tintennachfüllen beendet werden muss; und
ein Zustand, in dem zuviel Tinte gespeichert ist.

9. Aufzeichnungsvorrichtung nach Anspruch 1, bei der die Nachfüllsteuereinrichtung die Tintenkommunikation blockiert, wenn eine Betriebsleistung der Vorrichtung abgeschaltet wird.

10. Aufzeichnungsvorrichtung nach Anspruch 1, bei der das Tintennachfüllventil (26) ein Membranventil (26a), einen Gleitschaft (26d), der in einem im Wesentlichen mittigen Abschnitt des Membranventils (26a) vorgesehen ist, und einen Aktuator (79) beinhaltet, der den Gleitschaft (26d) in einer axialen Richtung desselben bewegt, um das Membranventil (26a) zu öffnen oder zu schließen.

11. Aufzeichnungsvorrichtung nach Anspruch 10, bei der das Nachfüllventil (26) ein Gehäuse (26b, 26c) beinhaltet, welches das Membranventil (26a) so darin aufnimmt, dass eine an dem Gehäuse ausgebildete Öffnung (26f) durch das Membranventil geöffnet oder geschlossen wird.

12. Aufzeichnungsvorrichtung nach Anspruch 10 oder 11, bei welcher der mittige Abschnitt des Membranventils (26a) horizontal bewegbar ist.

13. Aufzeichnungsvorrichtung nach Anspruch 11, bei der eine Tintennachfüllröhre (10) vertikal mit dem Gehäuse verbunden ist; und
bei der ein Tintenzuführdurchlass, der sich zu der Öffnung des Gehäuses erstreckt, und ein Tintenzuführdurchlass, der sich von dem Gehäuse zu der Tintennachfüllröhre erstreckt, senkrecht zueinander sind.

14. Aufzeichnungsvorrichtung nach Anspruch 10, bei welcher der Aktuator (79) ein elektromagnetischer Kolben ist.

15. Aufzeichnungsvorrichtung nach Anspruch 14, bei der eine Antriebskraft des elektromagnetischen Kolbens (79) auf ein Ende eines schwenkbaren Antriebshebels wirkt, so dass die Antriebskraft über das andere Ende des Antriebshebels auf der Gleitschaft (26d) übertragen wird.

16. Aufzeichnungsvorrichtung nach Anspruch 14 oder 15, bei der das Membranventil (26a) geöffnet ist, wenn der elektromagnetische Kolben (79) in Betrieb gesetzt ist, und geschlossen ist, wenn der elektromagnetische Kolben (79) nicht in Betrieb gesetzt ist.

17. Aufzeichnungsvorrichtung nach Anspruch 1, die ferner einen Tintenenddetektor umfasst, der bestimmt, dass die Tintenpatrone sich in einem Tintenendzustand befindet, wenn eine in den Subtank nachgefüllte Tintenmenge unzureichend ist, sogar wenn eine für das Tintennachfüllen aufgewandte Zeitdauer eine vorgegebene Zeitdauer oder mehr ist.

18. Aufzeichnungsvorrichtung nach Anspruch 17, ferner umfassend:

einen Rechner (107) für eine verbrauchte Tintenmenge, der eine in dem Subtank verbrauchte Tintenmenge berechnet;
das Tintennachfüllventil (26), das geöffnet wird, um in der Tintenpatrone gespeicherte Tinte in den Subtank nachzufüllen, wenn die durch den Rechner für eine verbrauchte Tintenmenge berechnete verbrauchte Tintenmenge einen vorgegebenen Wert erreicht;
einen Tintenmengendetektor (31, 32, 33a, 33b), der das Tintennachfüllventil (26) gemäß einer Erfassungsausgabe schließt, die bereitgestellt wird, wenn erfasst wird, dass in dem Subtank (7a bis 7d) gespeicherte Tinte durch das Nachfüllen ein vorgegebenes Volumen erreicht;
einen Zeitgeber (112), der beginnt, eine Zeitdauer zu messen, wenn das Tintennachfüllventil geöffnet wird; und
einen Tintenenddetektor, der bestimmt, dass die Tintenpatrone sich in einem Tintenendzustand befindet, wenn die Erfassungsausgabe des Tintenmengendetektors fehlt, sogar wenn der Zeitgeber eine vorgegebene Zeitdauer misst.

19. Aufzeichnungsvorrichtung nach Anspruch 17, die ferner einen Resttintenmengendetektor umfasst, der erfasst, dass eine in der Tintenpatrone verbliebene Tintenmenge eine vorgegebene Menge oder weniger ist,
wobei die Bestimmung des Tintenenddetektors wirksam gemacht wird, wenn der Resttintenmengendetektor erfasst, dass die Resttintenmenge die vorgegebene Menge oder weniger ist.

20. Aufzeichnungsvorrichtung nach Anspruch 18 oder 19, bei welcher der Rechner für eine verbrauchte Tintenmenge und der Resttintenmengendetektor jeweils die verbrauchte Tintenmenge und den Resttintenbetrag durch Multiplizieren von Koeffizienten berechnen, die jeweils in Verbindung mit einem Tintenausstoß zum Drukken, einem Tintenausstoß zum Spülen und einem Tintenansaugen zum Reinigen bereitgestellt werden.

21. Aufzeichnungsvorrichtung nach Anspruch 18, bei welcher der Tintenmengendetektor ein Schwimmerelement (31), das in in dem Subtank (7a bis 7d) gespeicherter Tinte schwimmt, und einen Ausgabeerzeuger (32, 33a, 33b) beinhaltet, der eine elektrische Ausgabe gemäß einer Schwimmposition des Schwimmerelements (31) erzeugt, die sich gemäß der gespeicherten Tintenmenge ändert.

22. Aufzeichnungsvorrichtung nach Anspruch 1, ferner umfassend:

das Tintennachfüllventil (26), das durch ein Steuersignal geöffnet oder geschlossen wird, das durch den Tintenmengendetektor (31, 32, 33a, 33b) erzeugt wird; und
eine Steuereinrichtung, die das Tintennachfüllventil (26) zwangsweise schließt, wenn eine vorgegebene Zeitdauer vergangen ist, nachdem das Tintennachfüllventil geöffnet wurde.

23. Aufzeichnungsvorrichtung nach Anspruch 22, bei der ein Wiederherstellungsvorgang durchgeführt wird, wenn der Tintenmengendetektor (31, 32, 33a, 33b) einen Tintenüberlaufzustand erfasst, in dem die in dem Subtank (7a bis 7d) gespeicherte Tintenmenge einen vorgegebenen Wert übersteigt.

24. Aufzeichnungsvorrichtung nach Anspruch 22, bei welcher der Tintenüberlaufzustand nochmals überprüft wird, nachdem der Wiederherstellungsvorgang vollendet ist.

25. Aufzeichnungsvorrichtung nach Anspruch 24, bei der ein druckfähiger Zustand fortgeführt wird, wenn der Tintenüberlaufzustand durch das nochmalige Überprüfen nicht erfasst wird.

26. Aufzeichnungsvorrichtung nach Anspruch 24, bei der ein Fehlerzustand erkannt wird, wenn der Tintenüberlaufzustand durch das nochmalige Überprüfen erfasst wird.

27. Aufzeichnungsvorrichtung nach Anspruch 23, bei welcher der Wiederherstellungsvorgang entweder ein Vorgang zum Abführen von Tinte aus dem Aufzeichnungskopf (6) oder ein Vorgang zum Verbrauchen von Tinte ist.

28. Aufzeichnungsvorrichtung nach Anspruch 27, bei welcher der Abführvorgang durch Abdichten einer Düsenausbildungsfläche des Aufzeichnungskopfs (6) mit einem Abdeckelement und Aufbringen eines durch eine Ansaugpumpe erzeugten Unterdrucks darin durchgeführt wird.

29. Aufzeichnungsvorrichtung nach Anspruch 28, bei welcher der Abführvorgang wiederholt durchgeführt wird; und
bei welcher der Tintenüberlaufzustand jedes Mal

überprüft wird, wenn der Abführvorgang durchgeführt wird.

30. Aufzeichnungsvorrichtung nach Anspruch 29, bei der ein Fehlerzustand erkannt wird, wenn der Tintenüberlaufzustand erfasst wird, sogar nachdem der Abführvorgang eine vorgegebene Anzahl von Malen wiederholt wurde.

31. Aufzeichnungsvorrichtung nach Anspruch 27, bei welcher der Verbrauchsvorgang durch Ausführen einer vorgegebenen Menge eines Druckens durchgeführt wird.

32. Aufzeichnungsvorrichtung nach Anspruch 31, bei der das Drucken fortgesetzt wird, bis das Drucken für eine Gegenstandsseite beendet ist.

33. Aufzeichnungsvorrichtung nach Anspruch 24, bei der eine Fehlermeldung auf einer Anzeige (113) angezeigt wird, wenn der Tintenüberlaufzustand durch das nochmalige Überprüfen erfasst wird.

34. Aufzeichnungsvorrichtung nach Anspruch 24, bei der eine Alarmmeldung auf einer Anzeige (113) angezeigt wird, wenn der Tintenüberlaufzustand durch das nochmalige Überprüfen nicht erfasst wird.

35. Aufzeichnungsvorrichtung nach Anspruch 1, bei der die in der Tintenpatrone gespeicherte Tinte in den Subtank (7a bis 7d) nachgefüllt wird, wenn der Tintenmengendetektor (31, 32, 33a, 33b) erfasst, dass die in dem Subtank gespeicherte Tintenmenge eine vorgegebene Menge oder weniger ist; und bei welcher der Tintenmengendetektor einen Tintentiefstand erfasst, der als eine Tintenmenge bestimmt ist, die sogar nach dem Tintenverbrauch durch einen einzelnen Reinigungsvorgang in dem Subtank verbleiben kann.

36. Aufzeichnungsvorrichtung nach Anspruch 35, bei der die durch den Tintenmengendetektor (31, 32, 33a, 33b) erfasste vorgegebene Menge eine durch einen einzelnen Reinigungsvorgang verbrauchte Tintenmenge oder mehr ist.

37. Aufzeichnungsvorrichtung nach Anspruch 35, bei der die durch den Tintenmengendetektor (31, 32, 33a, 33b) erfasste vorgegebene Menge eine Tintenmenge, die durch Subtrahieren einer während des Reinigungsvorgangs nachgefüllten Tintenmenge von einer durch einen einzelnen Reinigungsvorgang verbrauchten Tintenmenge definiert ist, oder mehr ist.

38. Aufzeichnungsvorrichtung nach Anspruch 1, ferner umfassend:

einen Zeitgeber, der eine Zeitdauer misst, in der die Vorrichtung nicht betrieben wird;
eine Abführeinrichtung, die in dem Subtank gespeicherte Tinte abführt; und
eine Wiederauffüllsteuereinrichtung, welche die Abführeinrichtung und die Nachfüllsteuereinrichtung so steuert, dass in dem Subtank gespeicherte Tinte abgeführt wird, während in dem Haupttank gespeicherte Tinte in den Subtank nachgefüllt wird, wenn die Vorrichtung aus dem betriebsfreien Zustand zurückgeholt wird und eine durch den Zeitgeber gemessene Zeitdauer eine vorgegebene Zeitdauer erreicht.

39. Aufzeichnungsvorrichtung nach Anspruch 38, die ferner einen Resttintensensor umfasst, der eine in dem Subtank, der in dem betriebsfreien Zustand ist, verbliebene Tintenmenge erfasst,
wobei die vorgegebene Zeitdauer verkürzt wird, wenn eine geringere Tintenmenge durch den Resttintensensor erfasst wird.

40. Aufzeichnungsvorrichtung nach Anspruch 38 oder 39, bei der ein Teil von in dem Subtank belassener Tinte abgeführt wird, wenn die Vorrichtung aus dem betriebsfreien Zustand zurückgeholt wird.

41. Verfahren zum Nachfüllen von in einem Haupttank (9a bis 9d) gespeicherter Tinte in einen Subtank (7a bis 7d), der an einem Schlitten (1) angebracht ist, der sich in einer Breitenrichtung von Aufzeichnungspapier zusammen mit einem Aufzeichnungskopf (6) hin und her bewegt, wobei diese in einer Tintenstrahlaufzeichnungsvorrichtung aufgenommen sind und das Verfahren die folgenden Schritte umfasst:

Betreiben einer Pumpe (21), um in dem Haupttank (9a bis 9d) gespeicherte Tinte in den Subtank (7a bis 7d) nachzufüllen; und
Betätigen eines Tintennachfüllventils (26), das in einem Nachfülldurchlass (10) vorgesehen ist, der den Haupttank (9a bis 9d) und den Subtank (7a bis 7d) verbindet, gemäß einer in dem Subtank gespeicherten Tintenmenge, so dass dieses in einem einzelnen Nachfüllvorgang wiederholt geöffnet und geschlossen wird;

wobei das Tintennachfüllventil (26) ungeachtet der Hinundherbewegung des Schlittens (1) geöffnet und geschlossen wird.

42. Nachfüllverfahren nach Anspruch 41, das ferner die folgenden Schritte umfasst:

Nachfüllen von Tinte durch Öffnen des Tintennachfüllventils (26), wenn ein Tintenmengendetektor (31, 32, 33a, 33b) erfasst, dass die in dem Subtank (7a bis 7d) gespeicherte Tintenmenge

geringer als ein vorgegebener Wert ist;
Beenden des Nachfüllens von Tinte durch Schließen des Tintennachfüllventils (26), wenn der Tintenmengendetektor erfasst, dass eine nachgefüllte Tintenmenge in dem Subtank (7a bis 7d) ein ausreichendes Volumen erreicht; und zwangsweises Schließen des Tintennachfüllventils (26), wenn eine vorgegebene Zeitdauer vergangen ist, nachdem der Nachfüllschritt begonnen wurde.

43. Nachfüllverfahren nach Anspruch 42, das ferner den Schritt des Anzeigens einer Fehlermeldung, wenn der zwangsweise Schließungsschritt ausgeführt wird, umfasst.

44. Nachfüllverfahren nach Anspruch 41, das ferner die folgenden Schritte umfasst:

Erfassen einer in den Subtank (7a bis 7d) nachgefüllten Tintenmenge durch einen Tintenmengendetektor (31, 32, 33a, 33b);
Abführen von Tinte aus dem Aufzeichnungskopf (6), wenn ein Tintenüberlaufzustand erfasst wird, in dem die durch den Erfassungsschritt erfasste nachgefüllte Tintenmenge einen vorgegebenen Wert übersteigt;
Überprüfen, ob der Subtank (7a bis 7d) in dem Tintenüberlaufzustand ist, indem nach dem Abführschritt nochmals eine in den Subtank nachgefüllte Tintenmenge durch den Tintenmengendetektor erfasst wird;
Fortführen eines druckfähigen Zustands der Vorrichtung, wenn der Tintenüberlaufzustand durch den Überprüfungsschritt nicht erfasst wird; und
Bestimmen eines Fehlerzustands der Vorrichtung, wenn der Tintenüberlaufzustand durch den Überprüfungsschritt erfasst wird.

45. Nachfüllverfahren nach Anspruch 41, das ferner die folgenden Schritte umfasst:

Erfassen einer in den Subtank (7a bis 7d) nachgefüllten Tintenmenge durch den Tintenmengendetektor (31, 32, 33a, 33b);
Abführen von Tinte aus dem Aufzeichnungskopf (6), wenn ein Tintenüberlaufzustand erfasst wird, in dem die durch den Erfassungsschritt erfasste nachgefüllte Tintenmenge einen vorgegebenen Wert übersteigt, während eine Anzahl von Erfassungen des Tintenüberlaufzustands erhöht wird;
Wiederholen des Abführschritts und des Erhöhungsschritts, während die erfasste Anzahl mit einer vorgegebenen Anzahl verglichen wird; und
Erfassen eines Fehlerzustands der Vorrichtung, wenn die erfasste Anzahl die vorgegebene Anzahl erreicht.

46. Nachfüllverfahren nach Anspruch 44 oder 45, bei dem der Abführschritt die folgenden Schritte umfasst:

Abdichten einer Düsenausbildungsfläche des Aufzeichnungskopfs (6) mit einem Abdeckelement; und
Aufbringen eines Unterdrucks darin, der durch eine Ansaugpumpe erzeugt wird.

Revendications

1. Appareil d'enregistrement à jet d'encre comprenant :

une tête d'enregistrement (6) montée sur un chariot (1) pour être déplacée dans un mouvement de va-et-vient dans une direction en largeur de papier d'enregistrement ; et
un réservoir secondaire (7a à 7d) monté sur le chariot (1) pour fournir de l'encre, qui est réapprovisionné à partir d'un réservoir principal (9a à 9d) par l'intermédiaire d'un passage de réapprovisionnement (10), à la tête d'enregistrement (6),
un détecteur de quantité d'encre (31, 32, 33a, 33b), qui détecte une quantité d'encre stockée dans le réservoir secondaire (7a à 7d) ;
une unité de commande de réapprovisionnement, et
une pompe (21) configurée pour être mise en oeuvre selon la quantité d'encre détectée par le détecteur de quantité d'encre (31, 32, 33a, 33b) pour réapprovisionner le réservoir secondaire (7a à 7d) en encre stockée dans le réservoir principal (9a à 9d),

caractérisé en ce que
l'unité de commande de réapprovisionnement comprend :

une soupape de réapprovisionnement en encre (26) qui est disposée dans le passage de réapprovisionnement (10) et qui est ouverte ou fermée selon la quantité d'encre détectée par le détecteur de quantité d'encre.

2. Appareil d'enregistrement selon la revendication 1, dans lequel le détecteur de quantité d'encre inclut un élément flottant (31) flottant sur l'encre stockée dans le réservoir secondaire (7a à 7d), et vers un générateur de sortie (32', 33a, 33b) qui génère une sortie électrique selon une position de flottement de l'élément flottant (31), qui change selon la quantité d'encre stockée.

3. Appareil d'enregistrement selon l'une quelconque des revendications 1 à 2, dans lequel le détecteur de quantité d'encre détecte la quantité d'encre stockée dans le réservoir secondaire (7a à 7d) en calculant une quantité d'encre éjectée ou aspirée à partir de la tête d'enregistrement.

4. Appareil d'enregistrement selon la revendication 2, dans lequel le générateur de sortie inclut un aimant permanent (32) disposé sur l'élément flottant, et un élément magnétoélectrique (33a, 33b) qui génère la sortie électrique selon une densité de flux magnétique changeant sa valeur selon la position de l'élément flottant (31).

5. Appareil d'enregistrement selon la revendication 4, dans lequel l'élément magnétoélectrique (33a, 33b) est un élément à effet Hall.

6. Appareil d'enregistrement selon la revendication 5, dans lequel une pluralité d'éléments magnétoélectriques (33a, 33b) sont agencés de façon à générer des signaux de sortie ayant différentes phases selon un mouvement de l'aimant permanent (32) muni de l'élément flottant (31).

7. Appareil d'enregistrement selon la revendication 6, dans lequel au moins deux éléments magnétoélectriques (33a, 33b) sont agencés au-dessus et au-dessous d'un niveau d'encre prédéterminé de sorte que les deux éléments sont susceptibles de détecter le flux magnétique généré à partir de l'aimant permanent (32) de sorte qu'au moins trois niveaux d'encre sont reconnus.

8. Appareil d'enregistrement selon la revendication 7, dans lequel les états suivants sont reconnus par les signaux de sortie en provenance des éléments magnétoélectriques (33a, 33b) :

   un état dans lequel l'encre stockée est en trop faible quantité ;
   un état dans lequel le réapprovisionnement en encre a besoin de débuter ;
   un état dans lequel le réapprovisionnement en encre a besoin de se terminer ; et
   un état dans lequel l'encre stockée est en trop grande quantité.

9. Appareil d'enregistrement selon la revendication 1, dans lequel l'unité de commande de réapprovisionnement bloque la communication d'encre quand une alimentation en énergie de l'appareil est coupée.

10. Appareil d'enregistrement selon la revendication 1, dans lequel la soupape de réapprovisionnement en encre (26) inclut un clapet à membrane (26a), un arbre coulissant (26d) disposé dans une partie sensiblement centrale du clapet à membrane (26a), et un dispositif de mise en oeuvre (79) qui déplace l'arbre coulissant (26d) dans une direction axiale de ce dernier pour ouvrir ou fermer le clapet à membrane (26a).

11. Appareil d'enregistrement selon la revendication 10, dans lequel la soupape de réapprovisionnement (26) inclut un boîtier (26b, 26c) qui loge le clapet à membrane (26a) en son sein, de sorte qu'une ouverture (26f) formée sur le boîtier est ouverte ou fermée par le clapet à membrane.

12. Appareil d'enregistrement selon la revendication 10 ou 11, dans lequel la partie centrale du clapet à membrane (26a) peut être déplacé horizontalement.

13. Appareil d'enregistrement selon la revendication 11, dans lequel un tube de réapprovisionnement en encre (10) est verticalement relié au boîtier ; et
dans lequel un passage d'alimentation en encre s'étendant jusqu'à l'ouverture du boîtier et un passage d'alimentation en encre s'étendant à partir du boîtier jusqu'au tube de réapprovisionnement en encre sont perpendiculaires l'un par rapport à l'autre.

14. Appareil d'enregistrement selon la revendication 10, dans lequel le dispositif de mise en oeuvre (79) est un plongeur électromagnétique.

15. Appareil d'enregistrement selon la revendication 14, dans lequel une force d'entraînement du plongeur électromagnétique (79) agit sur une extrémité d'un levier d'entraînement pivotant de sorte que la force d'entraînement est transmise à l'arbre coulissant (26d) par l'intermédiaire de l'autre extrémité du levier d'entraînement.

16. Appareil d'enregistrement selon la revendication 14 ou 15, dans lequel le clapet à membrane (26a) est ouvert lorsque le plongeur électromagnétique (79) est activé, et est fermé lorsque le plongeur électromagnétique (79) n'est pas activé.

17. Appareil d'enregistrement selon la revendication 1, comprenant en outre un détecteur de fin d'encre qui détermine que la cartouche d'encre est dans un état de fin d'encre quand une quantité d'encre ayant réapprovisionné le réservoir secondaire est insuffisante même si une période de temps passée pour le réapprovisionnement en encre est une période de temps prédéterminée ou plus.

18. Appareil d'enregistrement selon la revendication 17, comprenant en outre :

   un calculateur de quantité d'encre consommée (107), qui calcule une quantité d'encre consom-

mée dans le réservoir secondaire ;
la soupape de réapprovisionnement en encre (26), qui est ouverte pour réapprovisionner le réservoir secondaire en encre stockée dans la cartouche d'encre, lorsque la quantité d'encre consommée calculée par le calculateur de quantité d'encre consommée atteint une valeur prédéterminée ;
un détecteur de quantité d'encre (31, 32, 33a, 33b), qui ferme la soupape de réapprovisionnement en encre (26) selon une sortie de détection qui est fournie quand on détecte que l'encre stockée dans le réservoir secondaire (7a à 7d) atteint un volume prédéterminé par le réapprovisionnement ;
une minuterie (112), qui commence à compter une période de temps quand la soupape de réapprovisionnement en encre est ouverte ; et
un détecteur de fin d'encre, qui détermine que la cartouche d'encre est dans un état de fin d'encre quand la sortie de détection en provenance du détecteur de quantité d'encre est absente même si la minuterie compte une période de temps prédéterminée.

19. Appareil d'enregistrement selon la revendication 17, comprenant en outre un détecteur de quantité d'encre résiduelle, qui détecte qu'une quantité d'encre restant dans la cartouche d'encre est une quantité prédéterminée ou moins,
dans lequel la détermination du détecteur de fin d'encre est rendue effective lorsque le détecteur de quantité d'encre résiduelle détecte que la quantité d'encre résiduelle est la quantité prédéterminée ou moins.

20. Appareil d'enregistrement selon la revendication 18 ou 19, dans lequel le calculateur de quantité d'encre consommée et le détecteur de quantité d'encre résiduelle calculent respectivement la quantité d'encre consommée et la quantité d'encre résiduelle en multipliant des coefficients qui sont fournis respectivement en collaboration avec de l'éjection d'encre pour l'impression, de l'éjection d'encre pour le rinçage, et de l'aspiration d'encre pour le nettoyage.

21. Appareil d'enregistrement selon la revendication 18, dans lequel le détecteur de quantité d'encre inclut un élément flottant (31) flottant sur de l'encre stockée dans le réservoir secondaire (7a à 7d), un générateur de sortie (32, 33a, 33b) qui génère une sortie électrique selon une position de flottement de l'élément flottant (31), qui change selon la quantité d'encre stockée.

22. Appareil d'enregistrement selon la revendication 1, comprenant en outre :
la soupape de réapprovisionnement en encre (26) qui est ouverte ou fermée par un signal de commande généré par le détecteur de quantité d'encre (31, 32, 33a, 33b) ; et
une unité de commande, qui ferme de force la soupape de réapprovisionnement en encre (26) quand une période de temps prédéterminée est écoulée après que la soupape de réapprovisionnement en encre est ouverte.

23. Appareil d'enregistrement selon la revendication 22, dans lequel une opération de récupération est effectuée quand le détecteur de quantité d'encre (31, 32, 33a, 33b) détecte un état de débordement d'encre dans lequel la quantité d'encre stockée dans le réservoir secondaire (7a à 7d) dépasse une valeur prédéterminée.

24. Appareil d'enregistrement selon la revendication 22, dans lequel l'état de débordement d'encre est revérifié après que l'opération de récupération est achevée.

25. Appareil d'enregistrement selon la revendication 24, dans lequel une condition imprimable est continuée quand l'état de débordement d'encre n'est pas détecté par la revérification.

26. Appareil d'enregistrement selon la revendication 24, dans lequel une condition d'erreur est reconnue quand l'état de débordement d'encre est détecté par la revérification.

27. Appareil d'enregistrement selon la revendication 23, dans lequel l'opération de récupération est l'une ou l'autre d'une opération pour décharger de l'encre à partir de la tête d'enregistrement (6) ou d'une opération pour consommer de l'encre.

28. Appareil d'enregistrement selon la revendication 27, dans lequel l'opération de décharge est effectuée en scellant une face de formation de buse de la tête d'enregistrement (6) par un élément de recouvrement et en appliquant une pression négative générée par une pompe d'aspiration en son sein.

29. Appareil d'enregistrement selon la revendication 28, dans lequel l'opération de décharge est effectuée répétitivement; et
dans lequel l'état de débordement d'encre est vérifié chaque fois quand l'opération de décharge est effectuée.

30. Appareil d'enregistrement selon la revendication 29, dans lequel une condition d'erreur est reconnue quand l'état de débordement d'encre est détecté même après que l'opération de décharge est répétée un nombre prédéterminé de fois.

31. Appareil d'enregistrement selon la revendication 27, dans lequel l'opération de consommation est effectuée en exécutant une quantité prédéterminée d'impression.

32. Appareil d'enregistrement selon la revendication 31, dans lequel l'impression est continuée jusqu'à ce que l'impression d'une page soumise soit finie.

33. Appareil d'enregistrement selon la revendication 24, dans lequel un message d'erreur est affiché sur un afficheur (113) quand l'état de débordement d'encre est détecté par la revérification.

34. Appareil d'enregistrement selon la revendication 24, dans lequel un message d'alarme est affiché sur un afficheur (113) quand l'état de débordement d'encre n'est pas détecté par la revérification.

35. Appareil d'enregistrement selon la revendication 1, dans lequel le réservoir secondaire (7a à 7d) est réapprovisionné en encre stockée dans la cartouche d'encre lorsque le détecteur de quantité d'encre (31, 32, 33a, 33b) détecte que la quantité d'encre stockée dans le réservoir secondaire est une quantité prédéterminée ou moins ; et
dans lequel le détecteur de quantité d'encre détecte un niveau d'encre bas qui est déterminé en tant que quantité d'encre susceptible de rester dans le réservoir secondaire même après une consommation d'encre par une seule opération de nettoyage.

36. Appareil d'enregistrement selon la revendication 35, dans lequel la quantité prédéterminée détectée par le détecteur de quantité d'encre (31, 32, 33a, 33b) est une quantité d'encre consommée par une seule opération de nettoyage ou plus.

37. Appareil d'enregistrement selon la revendication 35, dans lequel la quantité prédéterminée détectée par le détecteur de quantité d'encre (31, 32, 33a, 33b) est une quantité d'encre qui est définie en soustrayant une quantité d'encre réapprovisionnée pendant l'opération de nettoyage d'une quantité d'encre consommée par une seule opération de nettoyage, ou plus.

38. Appareil d'enregistrement selon la revendication 1, comprenant en outre :

une minuterie, qui compte une période de temps pendant laquelle l'appareil n'est pas mis en oeuvre ; un dispositif de décharge, qui décharge de l'encre stockée dans le réservoir secondaire ; et
une unité de commande de remplissage, qui commande le dispositif de décharge et l'unité de commande de réapprovisionnement de sorte que de l'encre stockée dans le réservoir secondaire est déchargée tout en réapprovisionnant le réservoir secondaire en encre stockée dans le réservoir principal, lorsque l'appareil est récupéré de l'état non opérationnel et qu'une période de temps comptée par la minuterie atteint une période de temps prédéterminée.

39. Appareil d'enregistrement selon la revendication 38, comprenant en outre un capteur d'encre résiduelle, qui détecte une quantité d'encre restant dans le réservoir secondaire qui est dans l'état non opérationnel,
dans lequel la période de temps prédéterminée est rendue plus courte comme une quantité moindre d'encre est détectée par le capteur d'encre résiduelle.

40. Appareil d'enregistrement selon la revendication 38 ou 39, dans lequel une partie d'encre laissée dans le réservoir secondaire est déchargée quand l'appareil est récupéré de l'état non opérationnel.

41. Procédé de réapprovisionnement en encre stockée dans un réservoir principal (9a à 9d) d'un réservoir secondaire (7a à 7d) monté sur un chariot (1) se déplaçant dans un mouvement de va-et-vient dans une direction en largeur de papier d'enregistrement, en même temps qu'une tête d'enregistrement (6), qui sont incorporés dans un appareil d'enregistrement à jet d'encre, le procédé comprenant les étapes consistant à :

mettre en oeuvre une pompe (21) pour réapprovisionner le réservoir secondaire (7a à 7d) en encre stockée dans le réservoir principal (9a à 9d) ; et
mettre en oeuvre une soupape de réapprovisionnement en encre (26) disposée dans un passage de réapprovisionnement (10) qui relie le réservoir principal (9a à 9d) et le réservoir secondaire (7a à 7d), selon une quantité d'encre stockée dans le réservoir secondaire, de façon à être ouverte et fermée répétitivement dans une seule opération de réapprovisionnement ;

dans lequel la soupape de réapprovisionnement en encre (26) est ouverte et fermée sans tenir compte du mouvement de va-et-vient du chariot (1).

42. Procédé de réapprovisionnement selon la revendication 41, comprenant en outre les étapes consistant à :

réapprovisionner en encre en ouvrant la soupape de réapprovisionnement en encre (26), quand un détecteur de quantité d'encre (31, 32, 33a, 33b) détecte que la quantité d'encre stoc-

kée dans le réservoir secondaire (7a à 7d) est inférieure à une valeur prédéterminée ;
arrêter le réapprovisionnement en encre en fermant la soupape de réapprovisionnement en encre (26), quand le détecteur de quantité d'encre détecte qu'une quantité d'encre ayant réapprovisionné le réservoir secondaire (7a à 7d) atteint un volume suffisant ; et
fermer de force la soupape de réapprovisionnement en encre (26), quand une période de temps prédéterminée est écoulée après que l'étape de réapprovisionnement est commencée.

43. Procédé de réapprovisionnement selon la revendication 42, comprenant en outre l'étape consistant à afficher un message d'erreur quand l'étape de fermeture de façon forcée est exécutée.

44. Procédé de réapprovisionnement selon la revendication 41, comprenant en outre les étapes consistant à :

détecter une quantité d'encre ayant réapprovisionné le réservoir secondaire (7a à 7d) par un détecteur de quantité d'encre (31, 32, 33a, 33b) ;
décharger de l'encre à partir de la tête d'enregistrement (6) quand on détecte un état de débordement d'encre dans lequel la quantité d'encre réapprovisionnée détectée par l'étape de détection dépasse une valeur prédéterminée ;
vérifier si le réservoir secondaire (7a à 7d) est dans l'état de débordement d'encre en détectant de nouveau une quantité d'encre ayant réapprovisionné le réservoir secondaire par le détecteur de quantité d'encre, après l'étape de décharge ;
continuer une condition imprimable de l'appareil quand l'état de débordement d'encre n'est pas détecté par l'étape de vérification ; et
déterminer une condition d'erreur de l'appareil quand l'état de débordement d'encre est détecté par l'étape de vérification.

45. Procédé de réapprovisionnement selon la revendication 41, comprenant en outre les étapes consistant à :

détecter une quantité d'encre ayant réapprovisionné le réservoir secondaire (7a à 7d) par le détecteur de quantité d'encre (31, 32, 33a, 33b) ;
décharger de l'encre à partir de la tête d'enregistrement (6) quand on détecte un état de débordement d'encre dans lequel la quantité d'encre réapprovisionnée détectée par l'étape de détection dépasse une valeur prédéterminée, tout en incrémentant un nombre dont l'état de débordement d'encre est détecté ;
répéter l'étape de décharge et l'étape d'incrémentation tout en comparant le nombre détecté à un nombre prédéterminé ; et
détecter une condition d'erreur de l'appareil lorsque le nombre détecté atteint le nombre prédéterminé.

46. Procédé de réapprovisionnement selon la revendication 44 ou 45, dans lequel l'étape de décharge inclut les étapes consistant à :

sceller une face de formation de buse de la tête d'enregistrement (6) par un élément de recouvrement ; et
appliquer une pression négative en son sein, qui est générée par une pompe d'aspiration.

FIG. 1

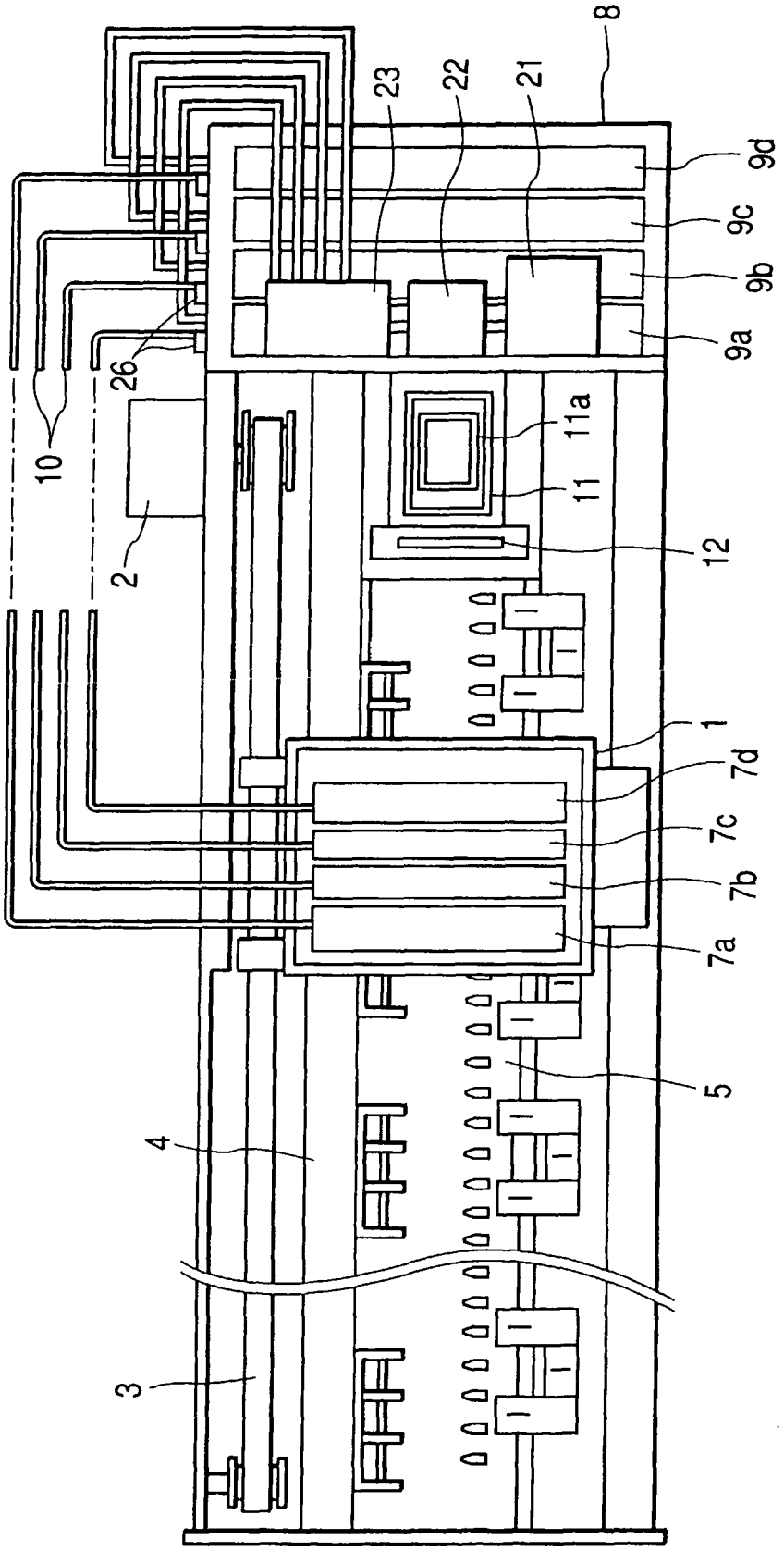


FIG. 2

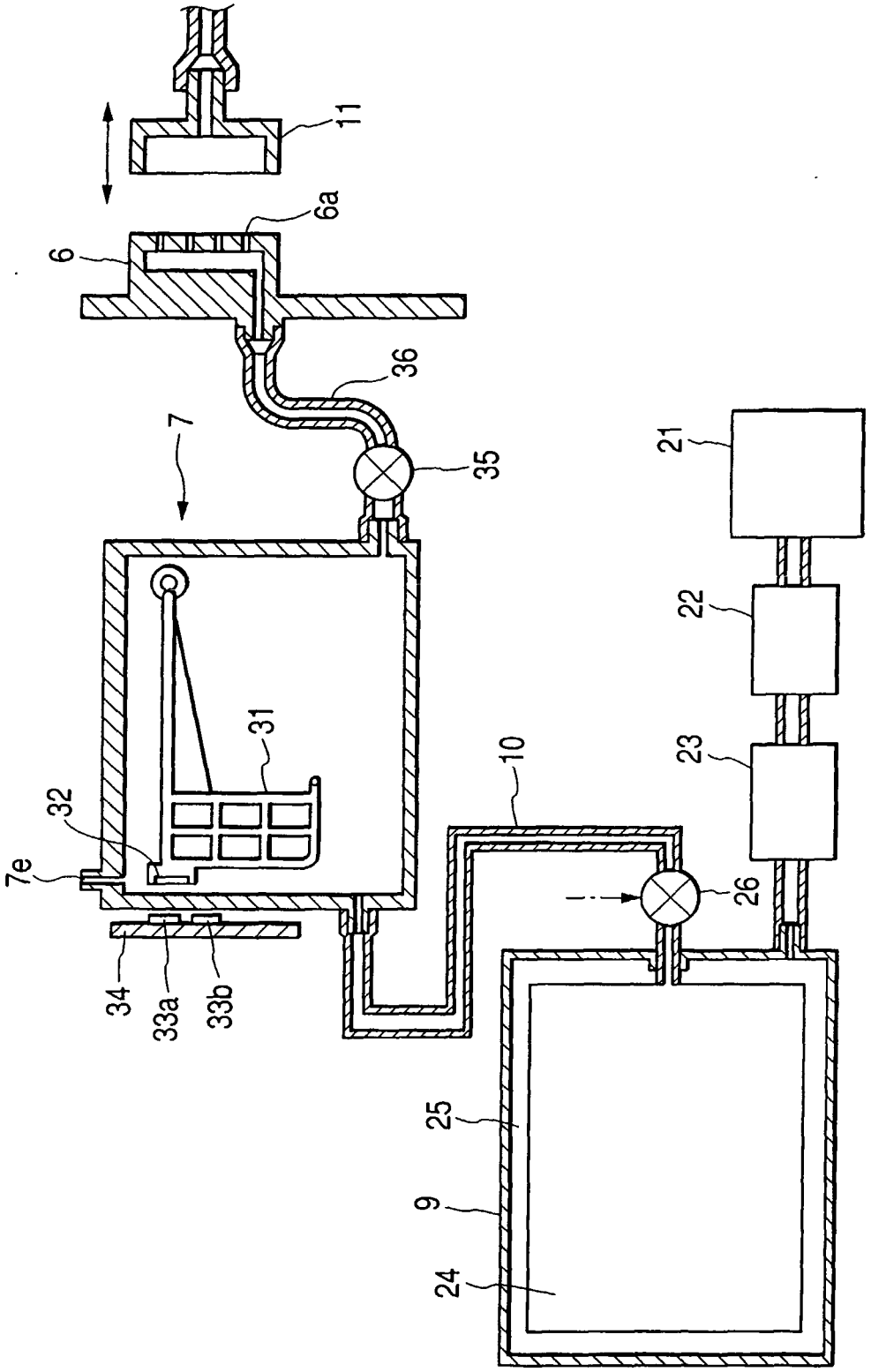


FIG. 3A

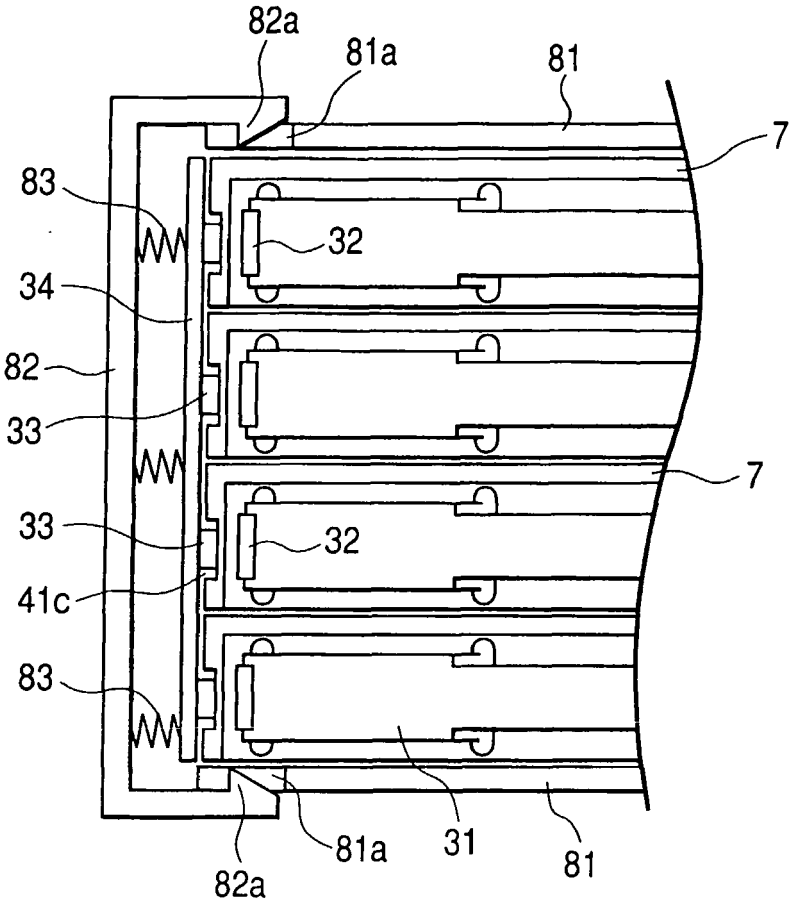

82a
81a
81
7
83
32
34
82
33
7
33
32
41c
83
81a
31
81
82a

FIG. 3B

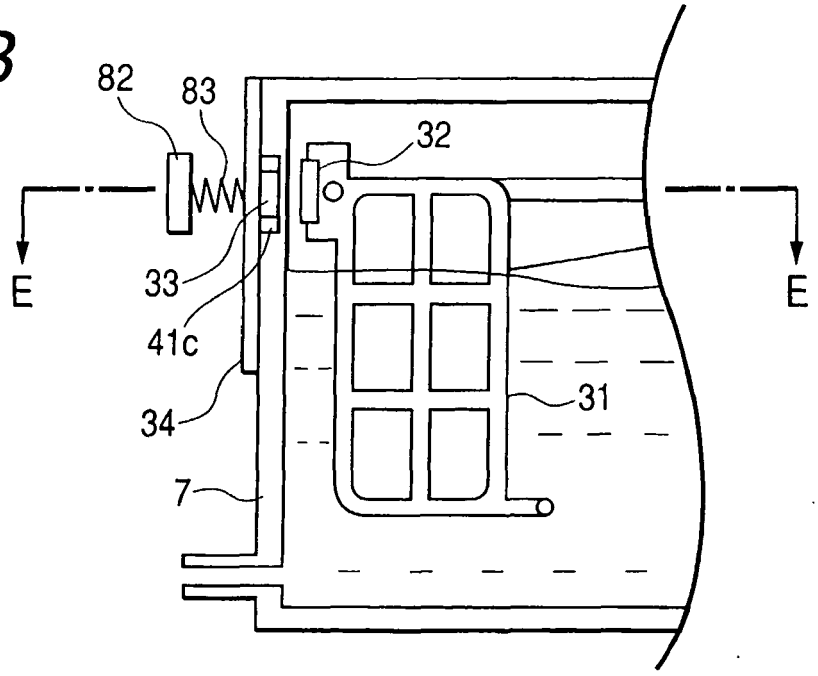

82
83
32
E
33
E
41c
31
34
7

FIG. 4A

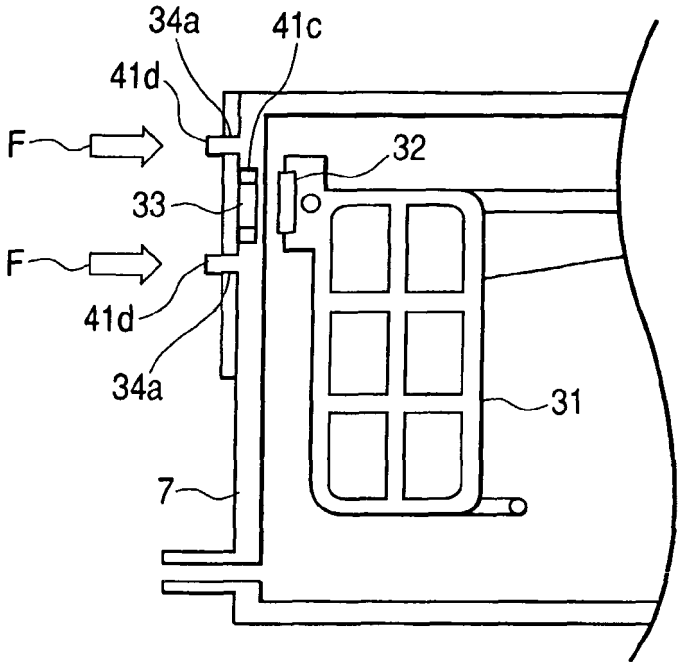


FIG. 4B

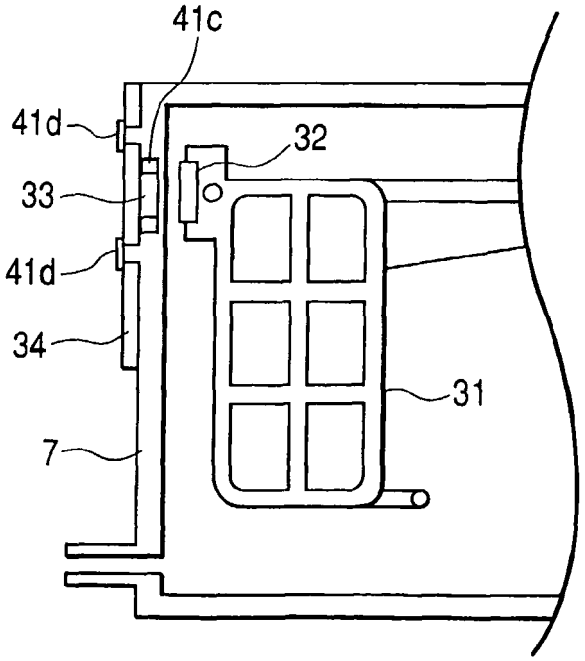


FIG. 5

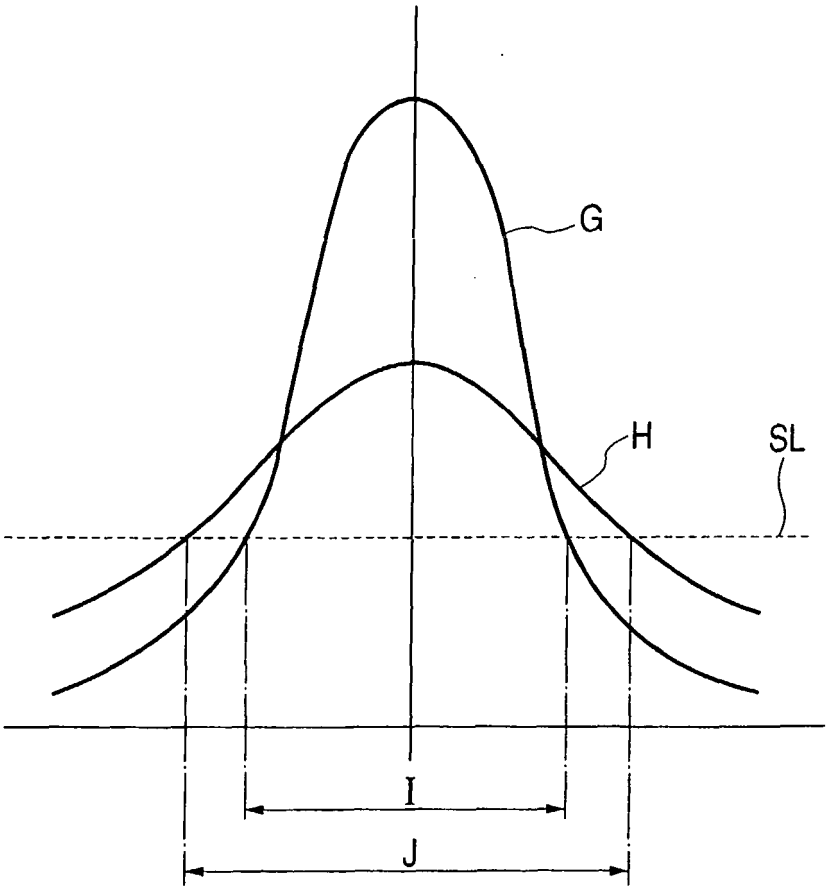


FIG. 6

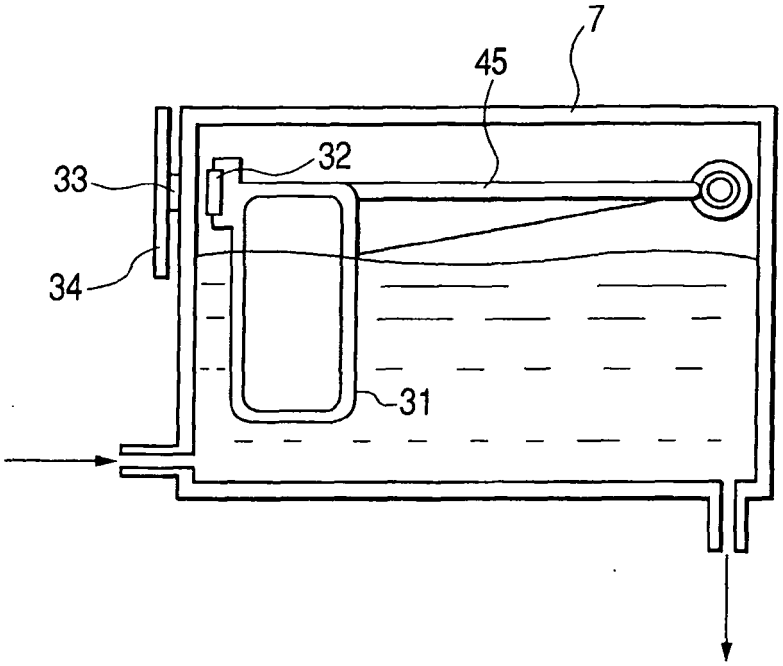


FIG. 7

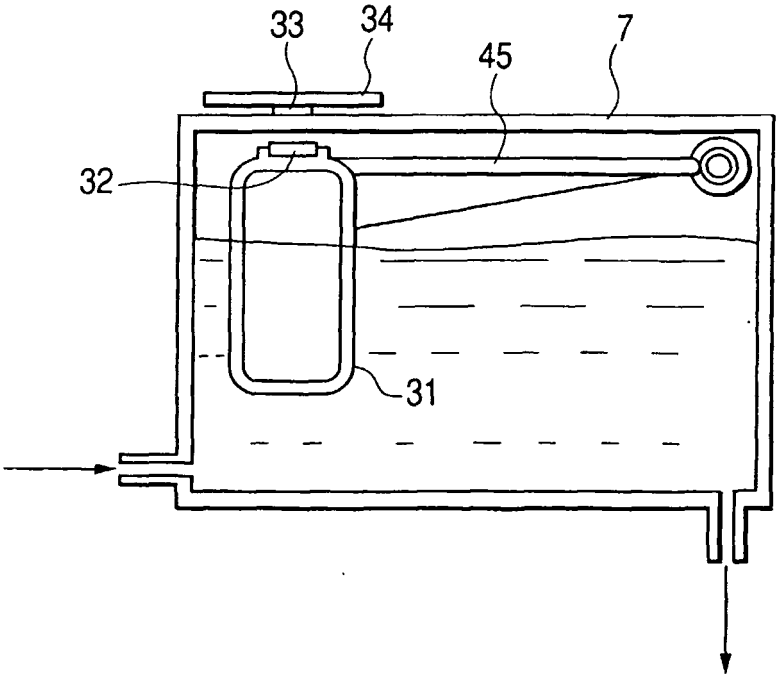


FIG. 8

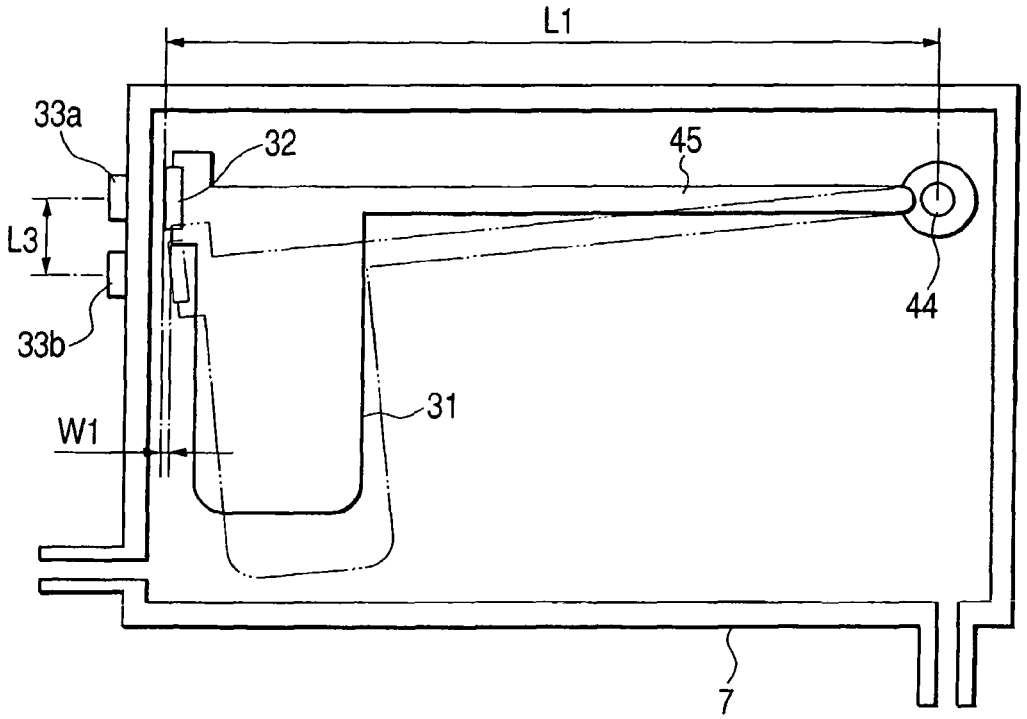


FIG. 9

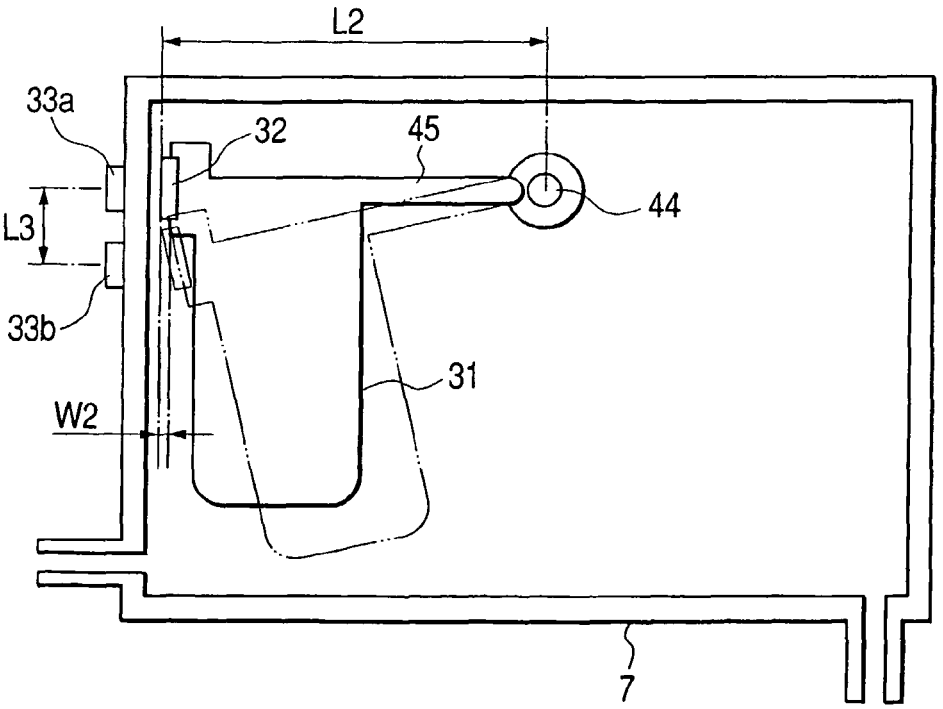


FIG. 10B

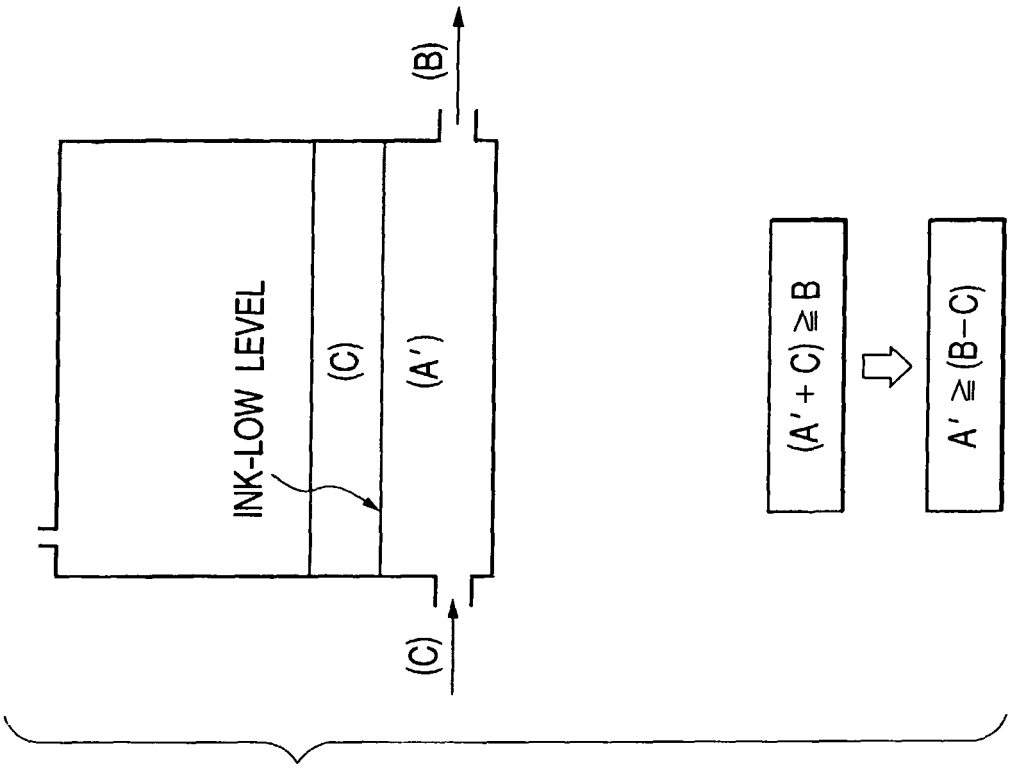


FIG. 10A

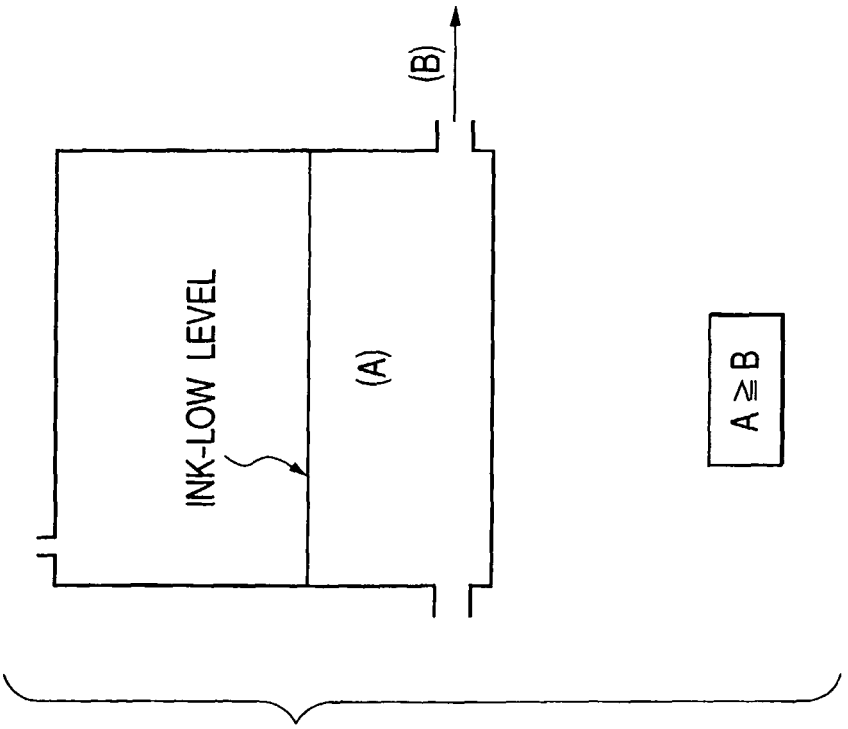


FIG. 11

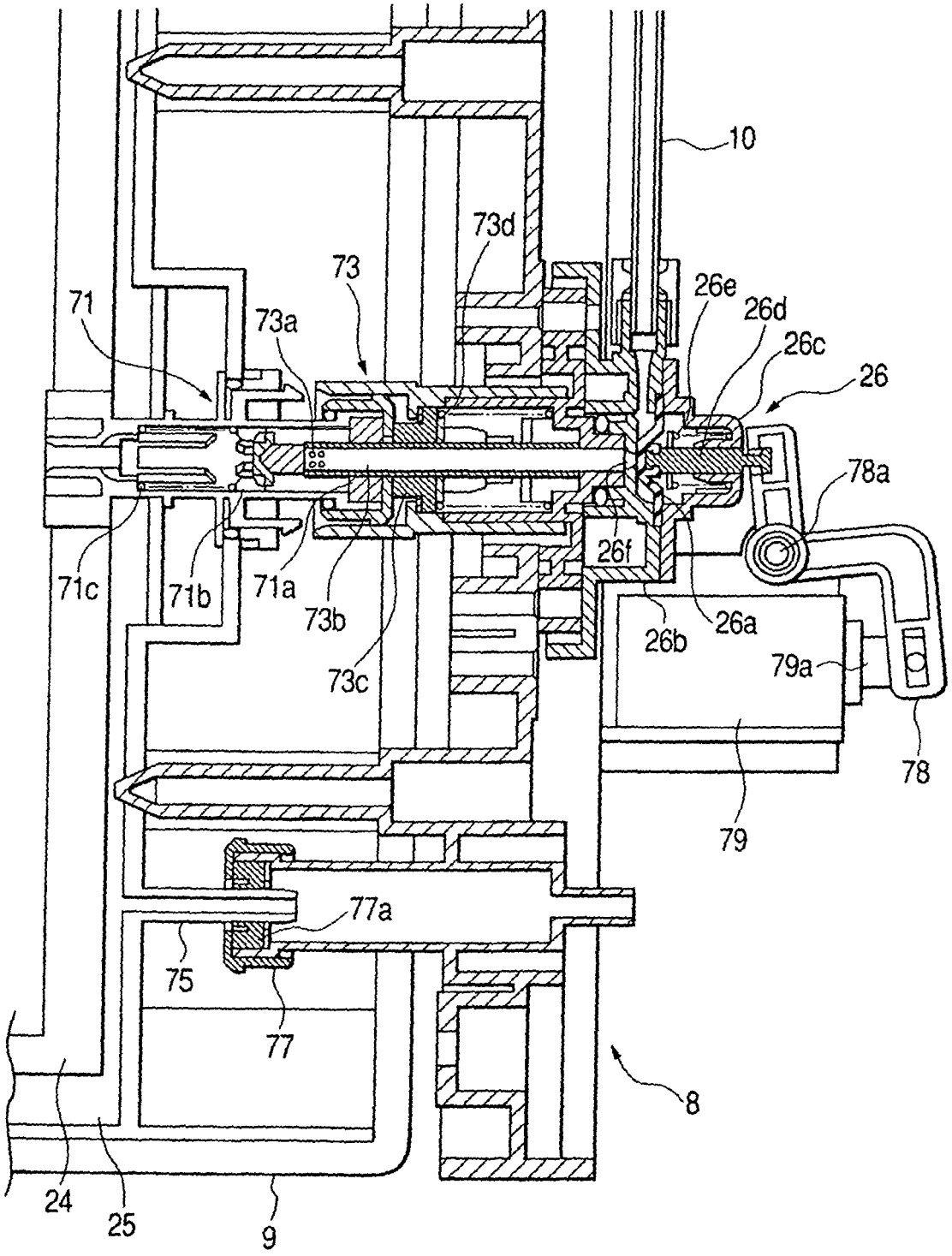

10
73d
73
71
73a
26e
26d
26c
26
78a
26f
71c
71b
71a
73b
73c
26b
26a
79a
78
79
77a
75
77
8
24
25
9

FIG. 12

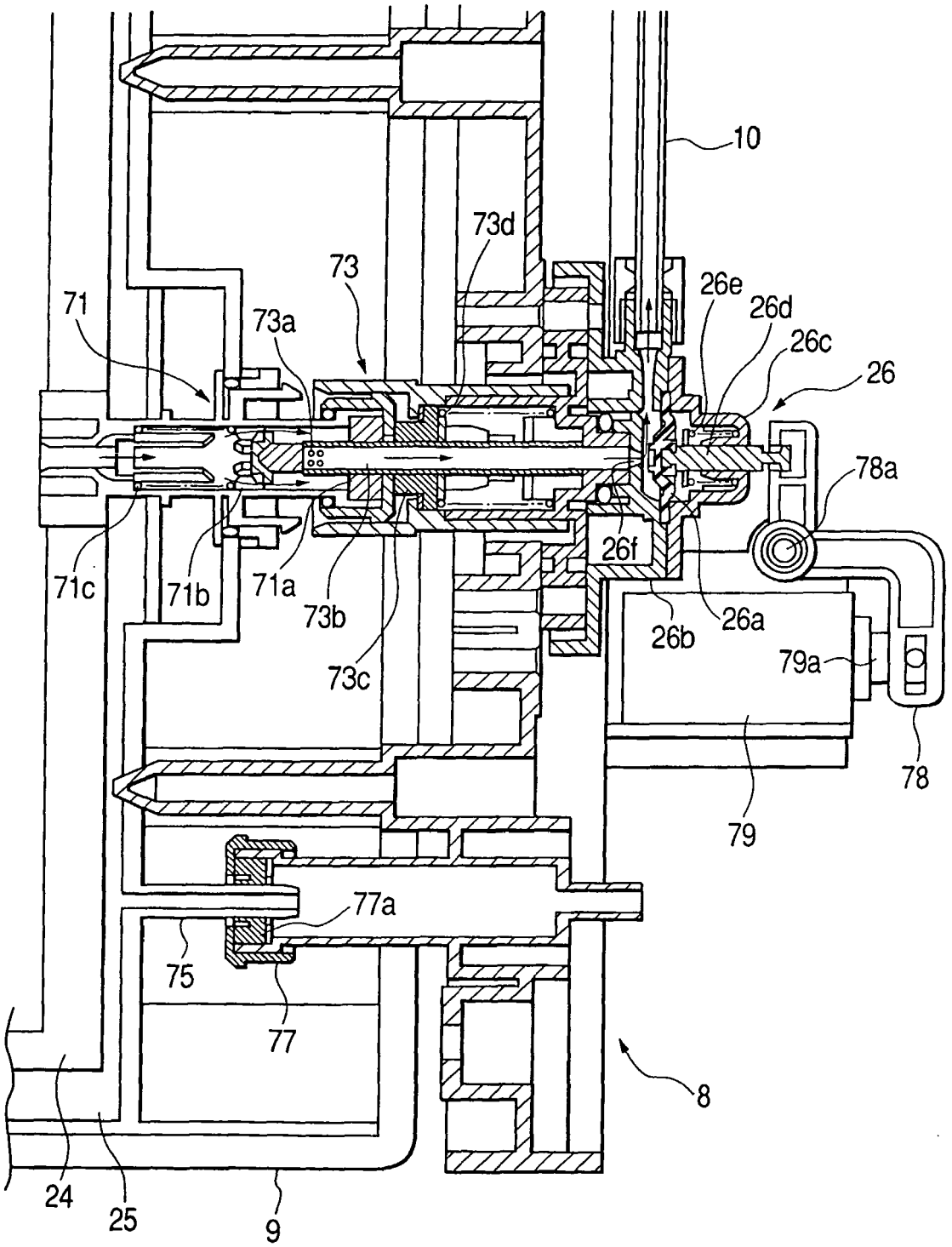

10
73d
73
71
73a
26e
26d
26c
26
78a
26f
71c
71b
71a
73b
73c
26b
26a
79a
78
79
77a
75
77
8
24
25
9

FIG. 13

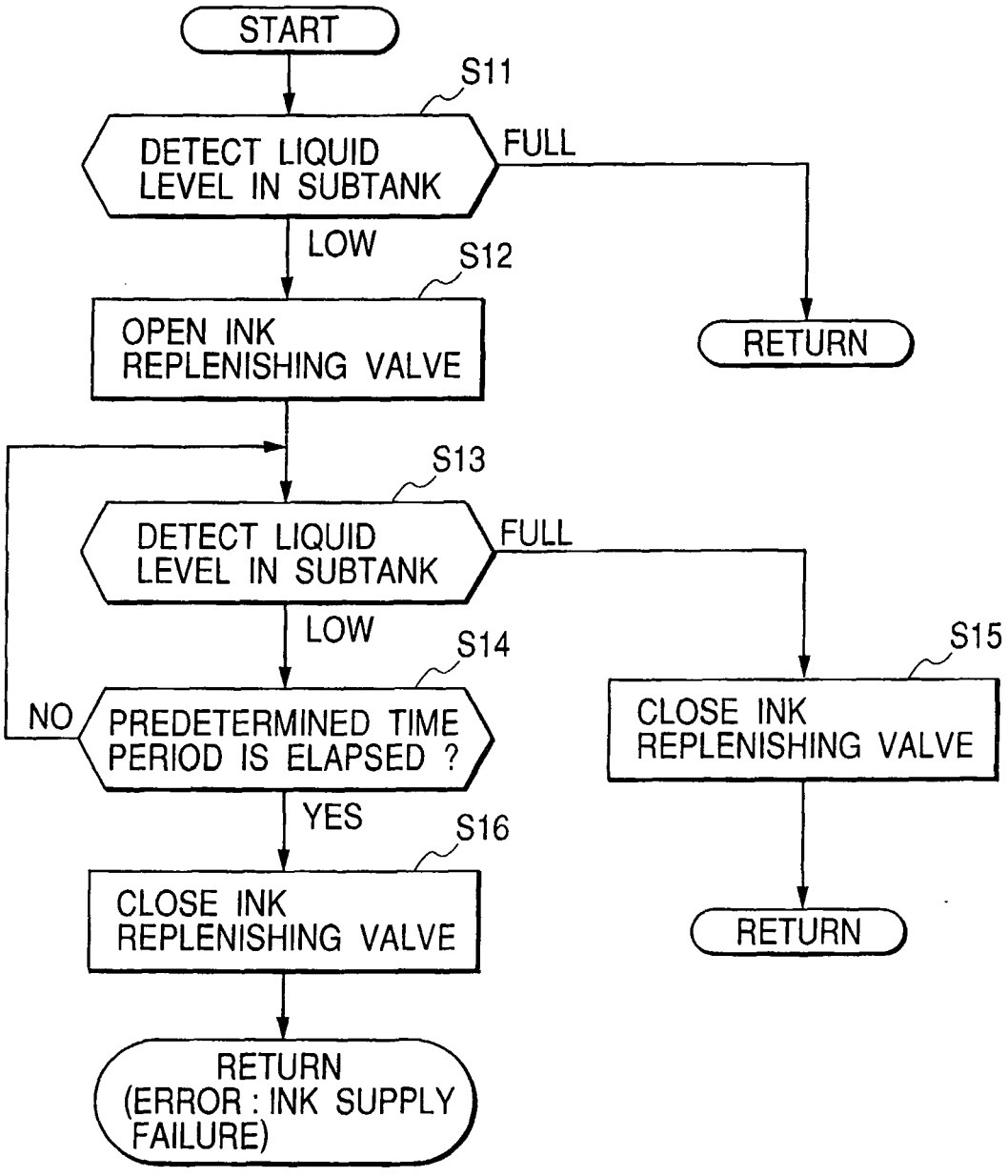

START
S11
DETECT LIQUID LEVEL IN SUBTANK
FULL
LOW
S12
OPEN INK REPLENISHING VALVE
RETURN
S13
DETECT LIQUID LEVEL IN SUBTANK
FULL
LOW
S14
NO
PREDETERMINED TIME PERIOD IS ELAPSED ?
S15
CLOSE INK REPLENISHING VALVE
YES
S16
CLOSE INK REPLENISHING VALVE
RETURN
RETURN (ERROR : INK SUPPLY FAILURE)

FIG. 14

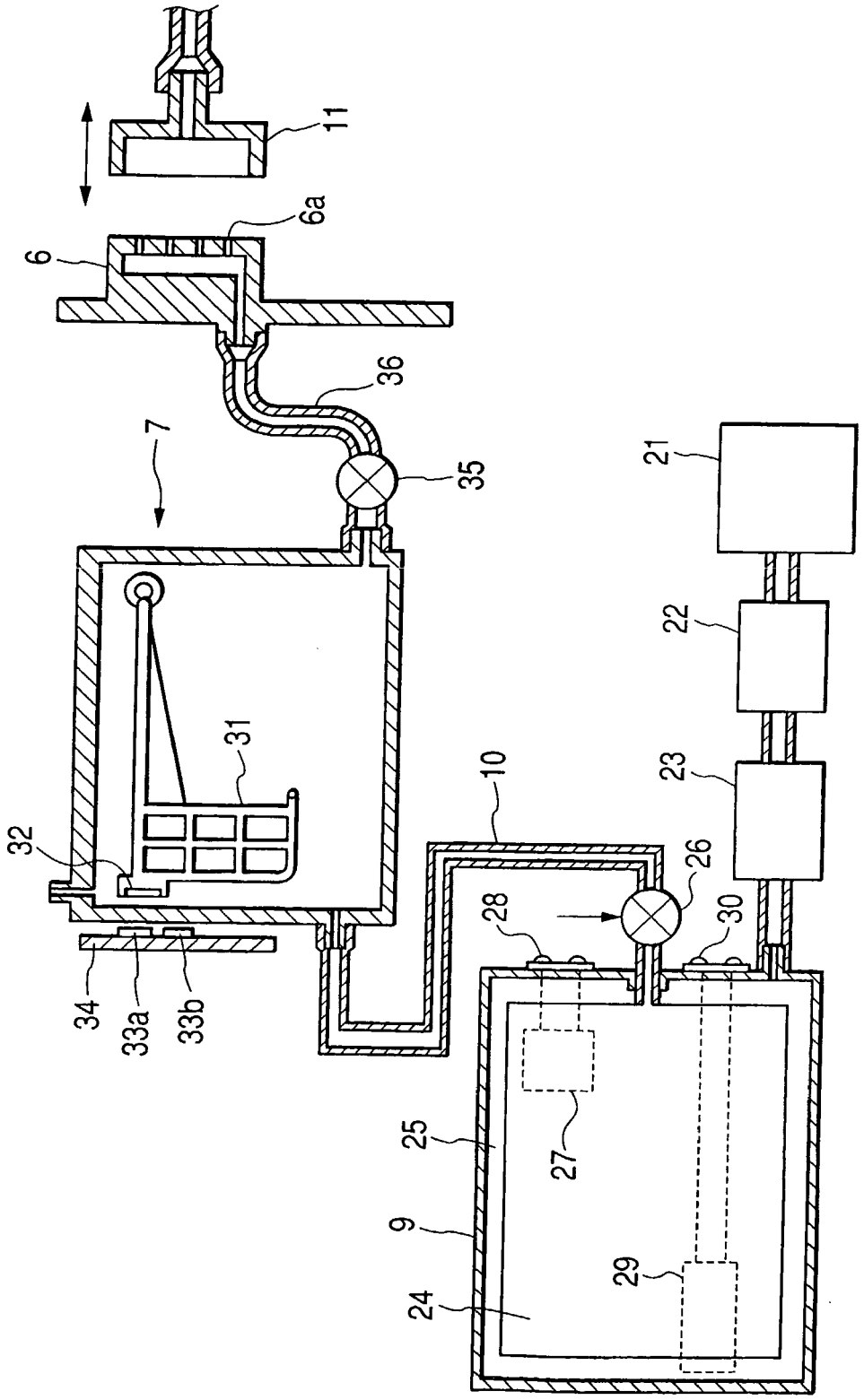


FIG. 15

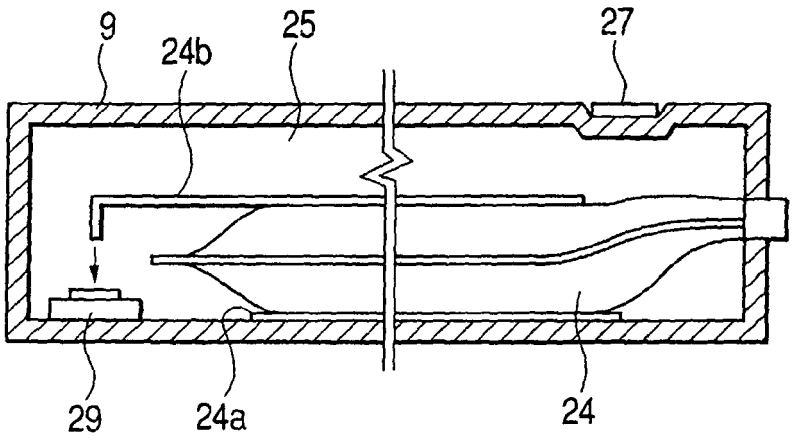


FIG. 16

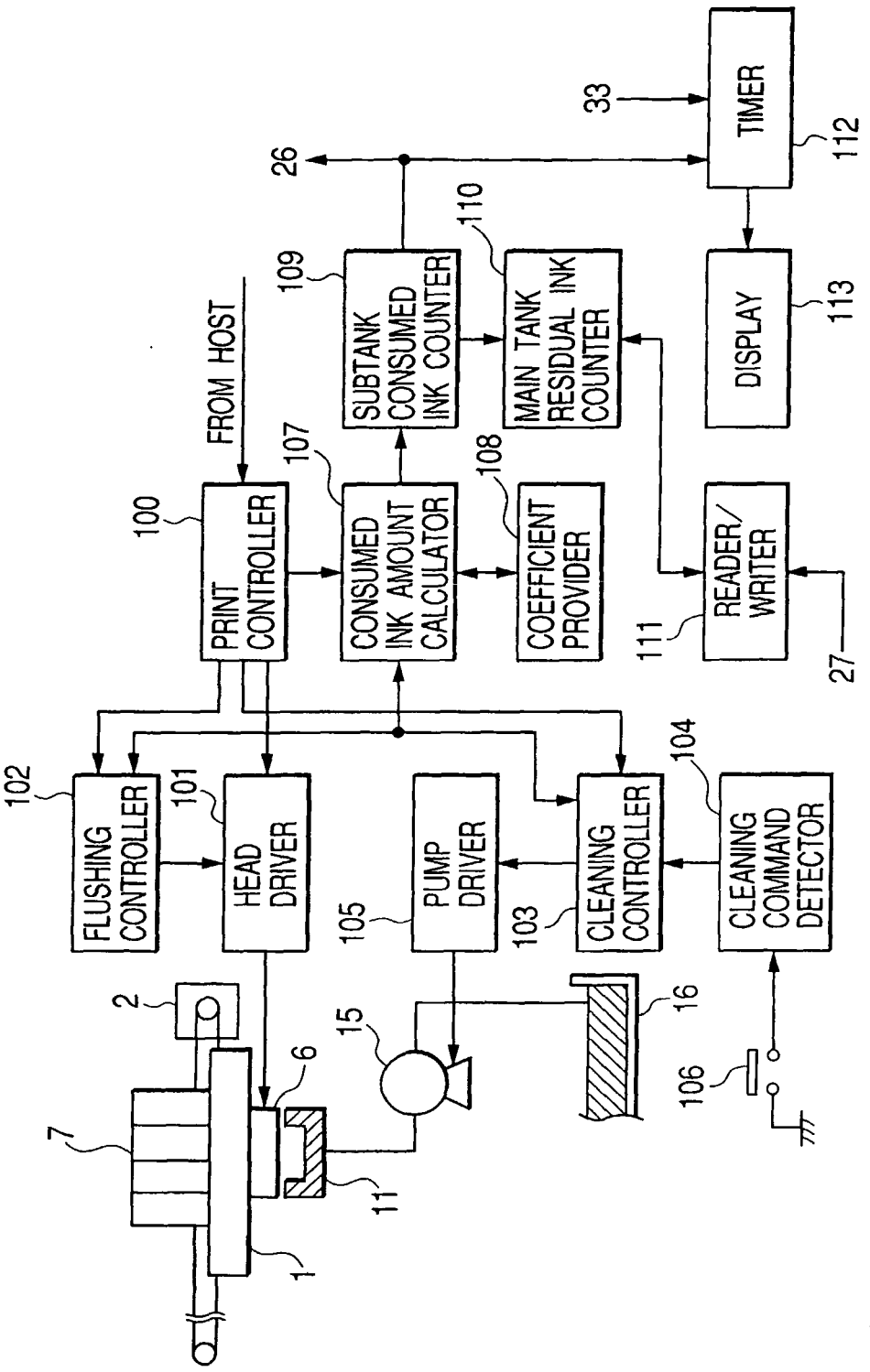

TIMER
112
33
26
SUBTANK CONSUMED INK COUNTER
110
109
MAIN TANK RESIDUAL INK COUNTER
DISPLAY
113
FROM HOST
107
108
100
PRINT CONTROLLER
CONSUMED INK AMOUNT CALCULATOR
COEFFICIENT PROVIDER
READER/ WRITER
111
27
102
101
FLUSHING CONTROLLER
HEAD DRIVER
PUMP DRIVER
CLEANING CONTROLLER
104
CLEANING COMMAND DETECTOR
105
103
2
15
16
6
7
106
11
1

FIG. 17

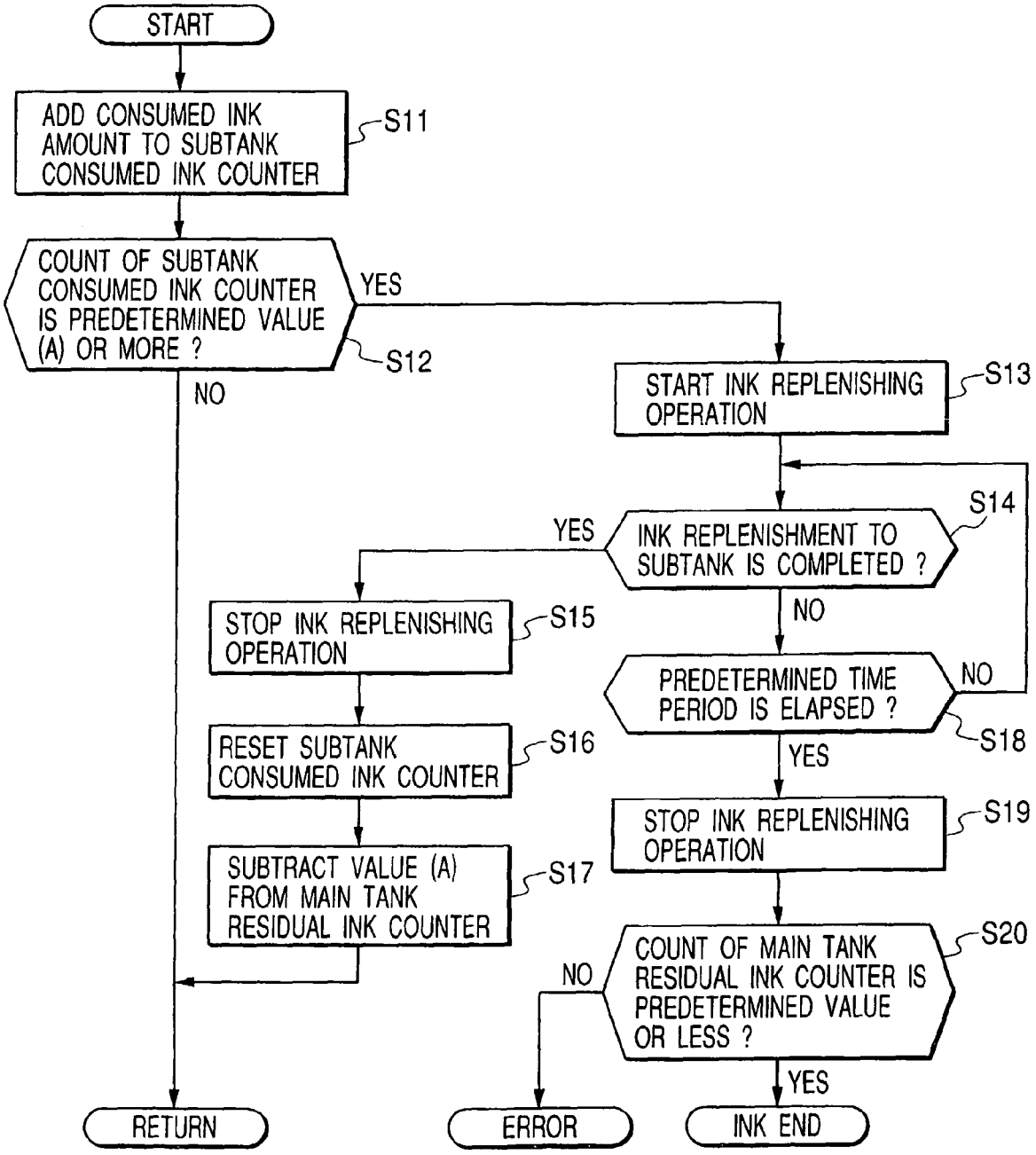

START
ADD CONSUMED INK AMOUNT TO SUBTANK CONSUMED INK COUNTER
S11
COUNT OF SUBTANK CONSUMED INK COUNTER IS PREDETERMINED VALUE (A) OR MORE ?
S12
YES
NO
START INK REPLENISHING OPERATION
S13
INK REPLENISHMENT TO SUBTANK IS COMPLETED ?
S14
YES
NO
STOP INK REPLENISHING OPERATION
S15
PREDETERMINED TIME PERIOD IS ELAPSED ?
NO
S18
YES
RESET SUBTANK CONSUMED INK COUNTER
S16
STOP INK REPLENISHING OPERATION
S19
SUBTRACT VALUE (A) FROM MAIN TANK RESIDUAL INK COUNTER
S17
COUNT OF MAIN TANK RESIDUAL INK COUNTER IS PREDETERMINED VALUE OR LESS ?
S20
NO
YES
RETURN
ERROR
INK END

FIG. 18B

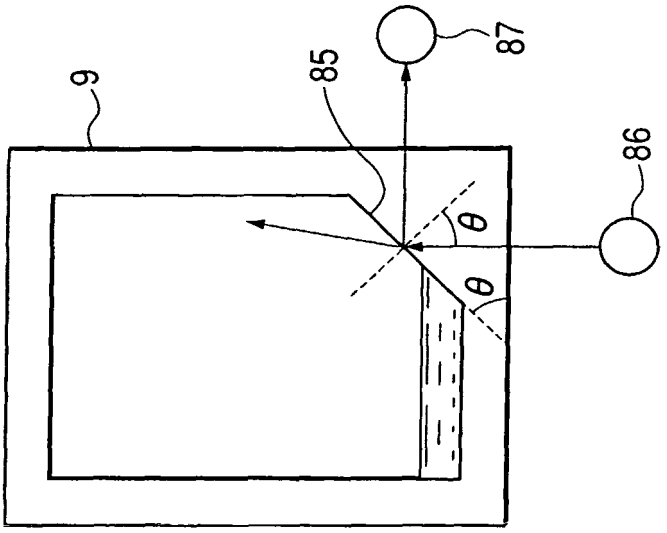


FIG. 18A

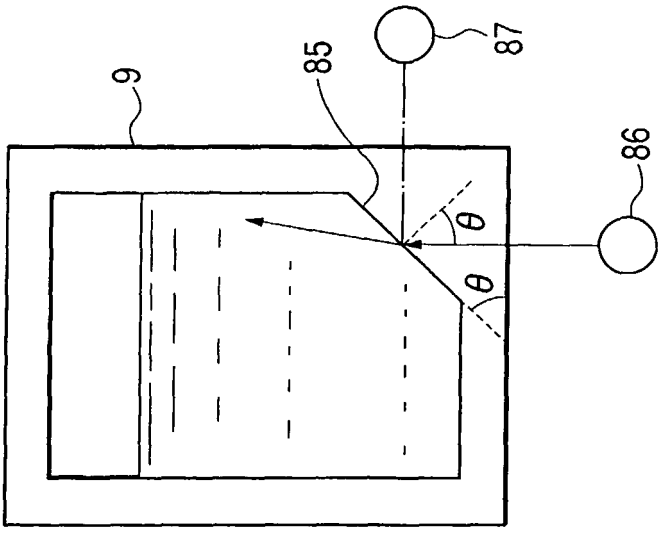


FIG. 19B

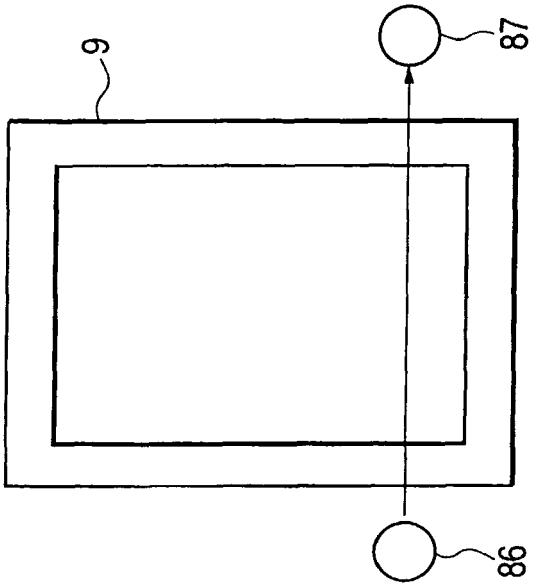


FIG. 19A

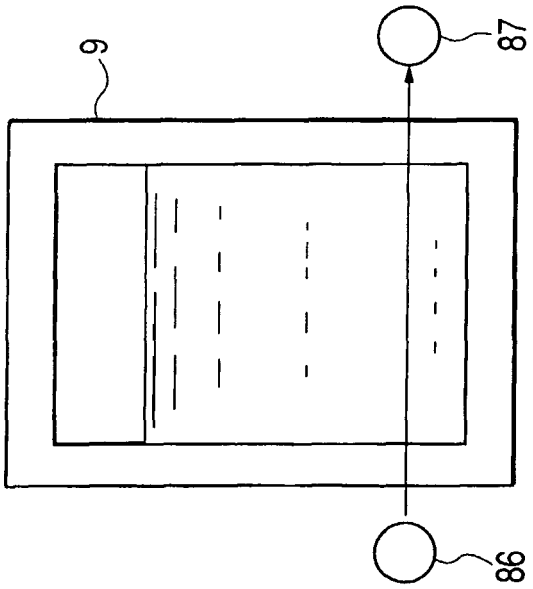


FIG. 20

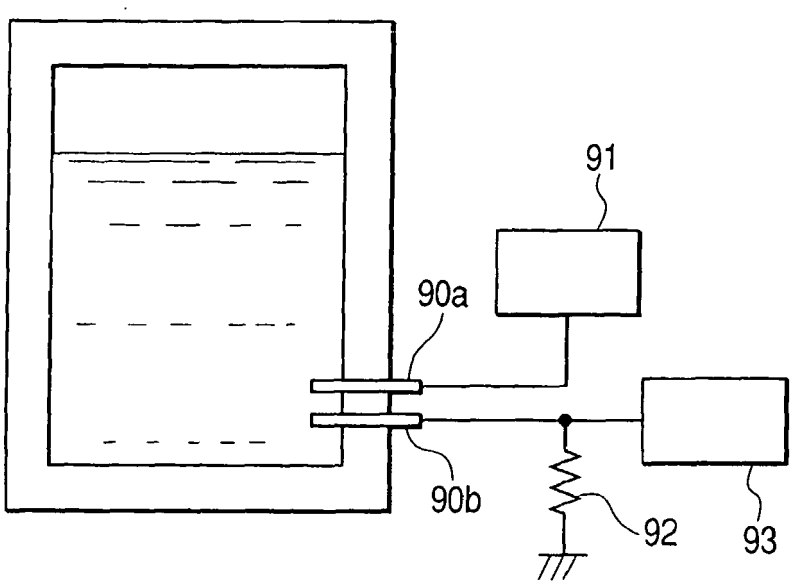


FIG. 21

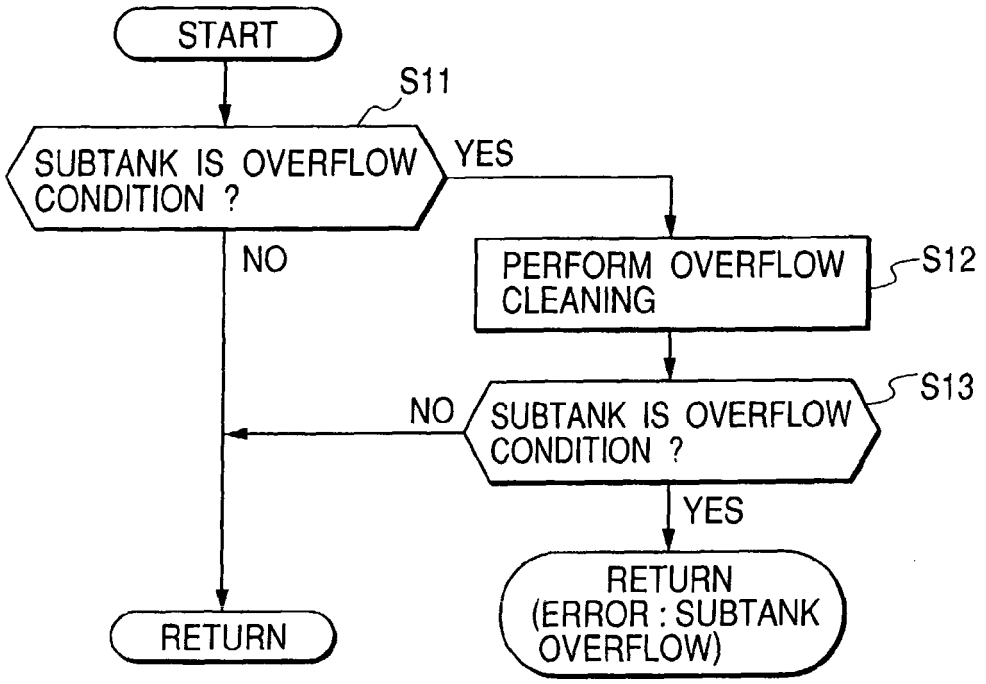

START
S11
SUBTANK IS OVERFLOW CONDITION ?
YES
NO
PERFORM OVERFLOW CLEANING
S12
S13
NO
SUBTANK IS OVERFLOW CONDITION ?
YES
RETURN
RETURN (ERROR : SUBTANK OVERFLOW)

FIG. 22

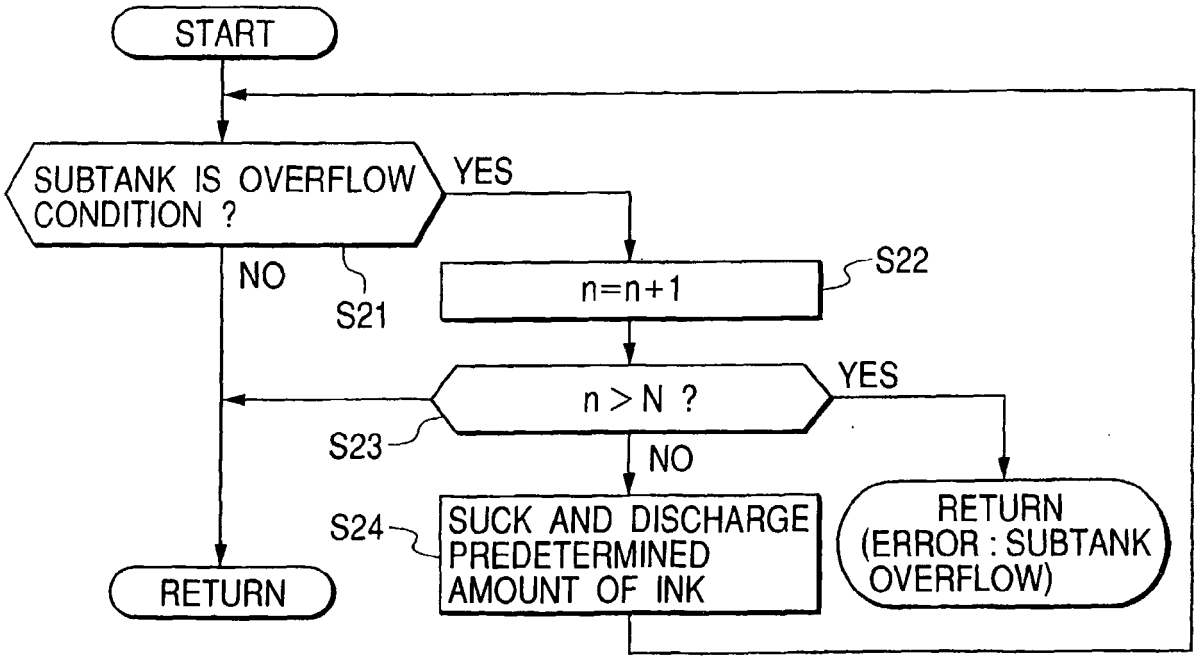

START
SUBTANK IS OVERFLOW CONDITION ?
YES
NO
S21
n=n+1
S22
n > N ?
YES
S23
NO
S24
SUCK AND DISCHARGE PREDETERMINED AMOUNT OF INK
RETURN
RETURN (ERROR : SUBTANK OVERFLOW)

FIG. 23

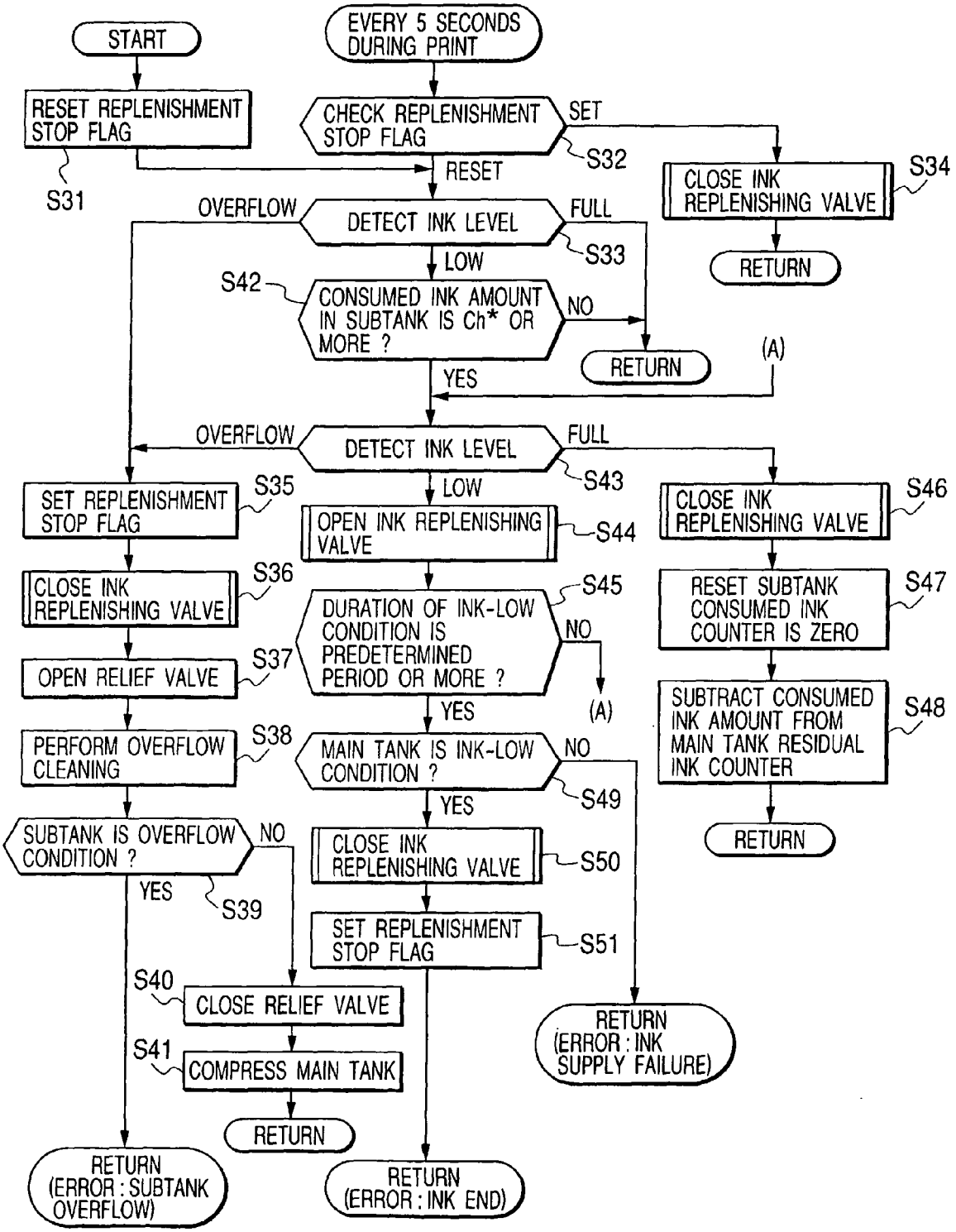

START
RESET REPLENISHMENT STOP FLAG
S31
EVERY 5 SECONDS DURING PRINT
CHECK REPLENISHMENT STOP FLAG
SET
S32
RESET
CLOSE INK REPLENISHING VALVE
S34
RETURN
OVERFLOW
DETECT INK LEVEL
FULL
S33
LOW
S42
CONSUMED INK AMOUNT IN SUBTANK IS Ch* OR MORE ?
NO
RETURN
(A)
YES
OVERFLOW
DETECT INK LEVEL
FULL
S43
LOW
SET REPLENISHMENT STOP FLAG
S35
OPEN INK REPLENISHING VALVE
S44
CLOSE INK REPLENISHING VALVE
S46
CLOSE INK REPLENISHING VALVE
S36
S45
DURATION OF INK-LOW CONDITION IS PREDETERMINED PERIOD OR MORE ?
NO
RESET SUBTANK CONSUMED INK COUNTER IS ZERO
S47
OPEN RELIEF VALVE
S37
(A)
YES
SUBTRACT CONSUMED INK AMOUNT FROM MAIN TANK RESIDUAL INK COUNTER
S48
PERFORM OVERFLOW CLEANING
S38
MAIN TANK IS INK-LOW CONDITION ?
NO
S49
RETURN
YES
SUBTANK IS OVERFLOW CONDITION ?
NO
CLOSE INK REPLENISHING VALVE
S50
YES
S39
SET REPLENISHMENT STOP FLAG
S51
S40
CLOSE RELIEF VALVE
RETURN (ERROR : INK SUPPLY FAILURE)
S41
COMPRESS MAIN TANK
RETURN
RETURN (ERROR : SUBTANK OVERFLOW)
RETURN (ERROR : INK END)

FIG. 24

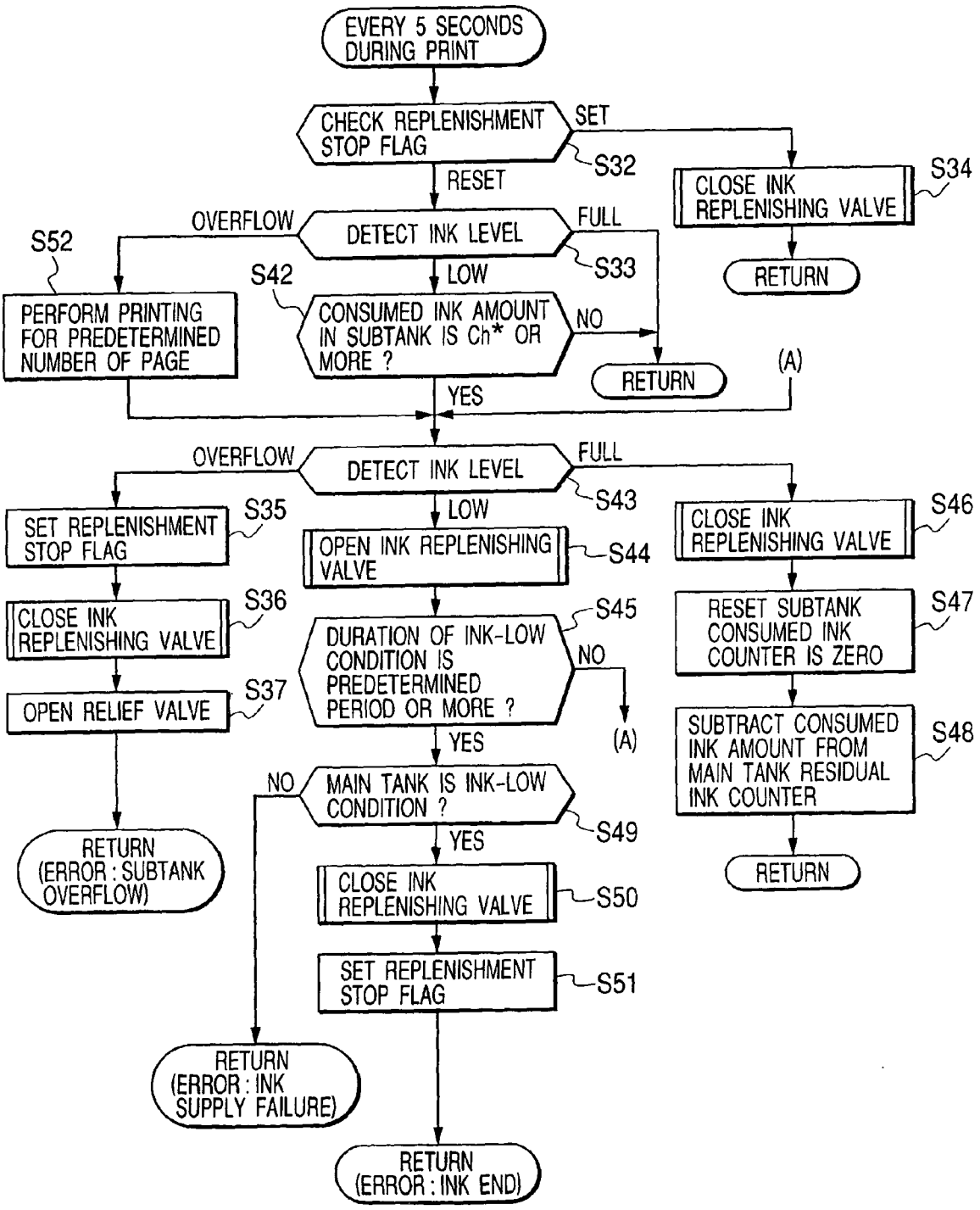

EVERY 5 SECONDS DURING PRINT
CHECK REPLENISHMENT STOP FLAG
SET
S32
RESET
CLOSE INK REPLENISHING VALVE
S34
RETURN
OVERFLOW
DETECT INK LEVEL
FULL
S33
S52
S42
LOW
PERFORM PRINTING FOR PREDETERMINED NUMBER OF PAGE
CONSUMED INK AMOUNT IN SUBTANK IS Ch* OR MORE ?
NO
RETURN
(A)
YES
OVERFLOW
DETECT INK LEVEL
FULL
S43
SET REPLENISHMENT STOP FLAG
S35
LOW
OPEN INK REPLENISHING VALVE
S44
CLOSE INK REPLENISHING VALVE
S46
CLOSE INK REPLENISHING VALVE
S36
DURATION OF INK-LOW CONDITION IS PREDETERMINED PERIOD OR MORE ?
S45
NO
RESET SUBTANK CONSUMED INK COUNTER IS ZERO
S47
OPEN RELIEF VALVE
S37
(A)
YES
SUBTRACT CONSUMED INK AMOUNT FROM MAIN TANK RESIDUAL INK COUNTER
S48
NO
MAIN TANK IS INK-LOW CONDITION ?
S49
RETURN (ERROR : SUBTANK OVERFLOW)
YES
RETURN
CLOSE INK REPLENISHING VALVE
S50
SET REPLENISHMENT STOP FLAG
S51
RETURN (ERROR : INK SUPPLY FAILURE)
RETURN (ERROR : INK END)

FIG. 25

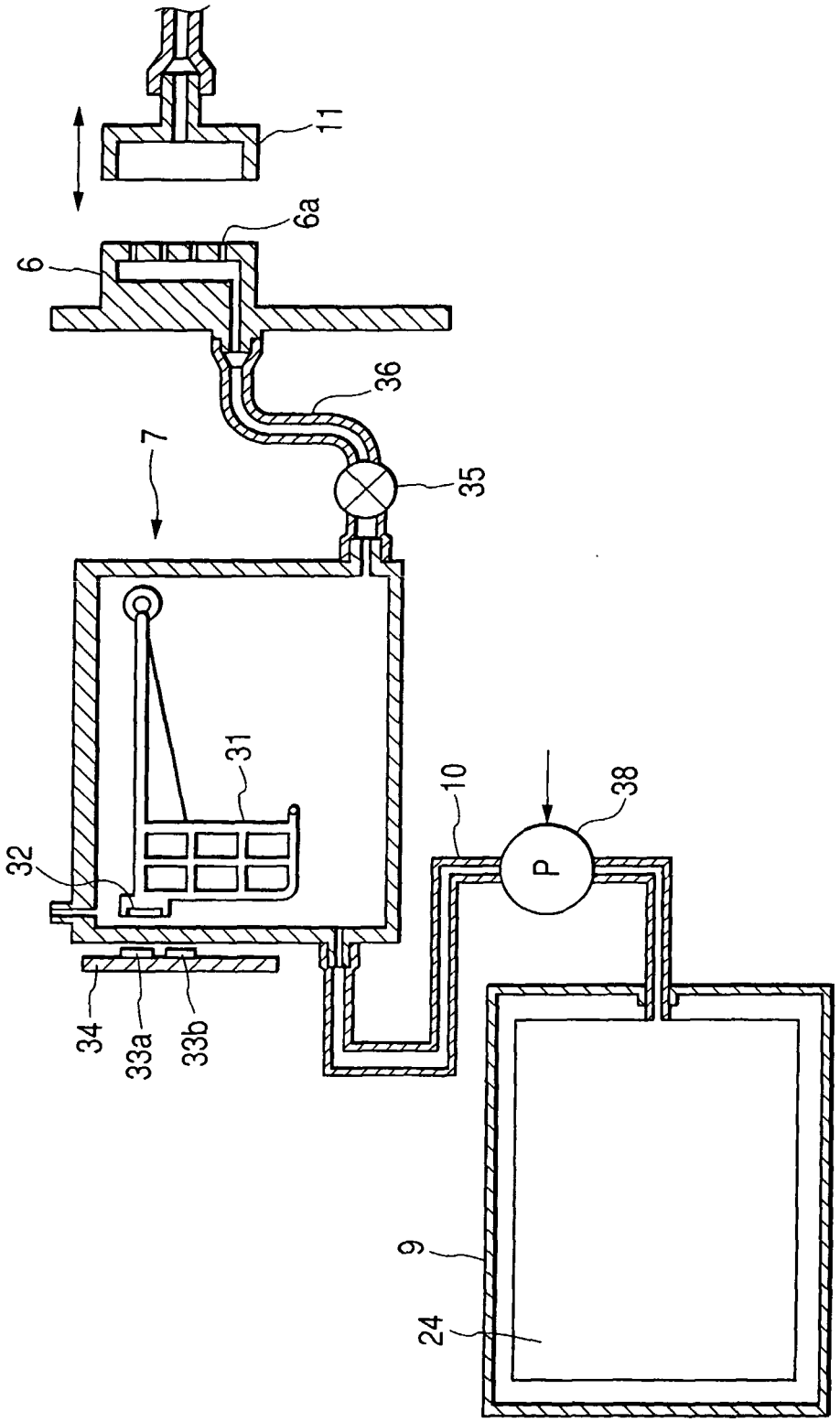


FIG. 26

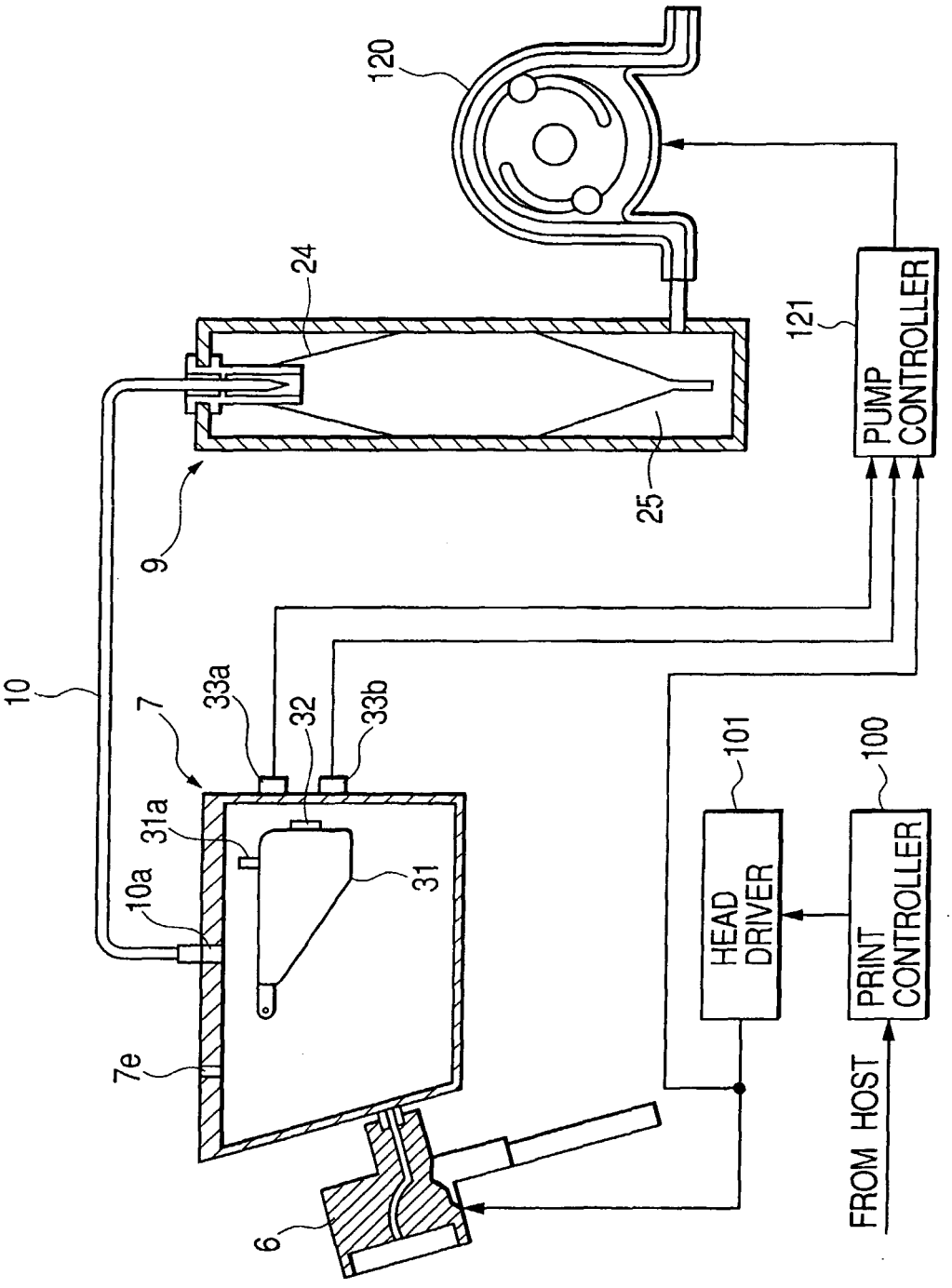

120
24
121
PUMP CONTROLLER
25
9
10
7
33a
32
33b
101
100
31a
31
HEAD DRIVER
PRINT CONTROLLER
10a
7e
FROM HOST
6

FIG. 27

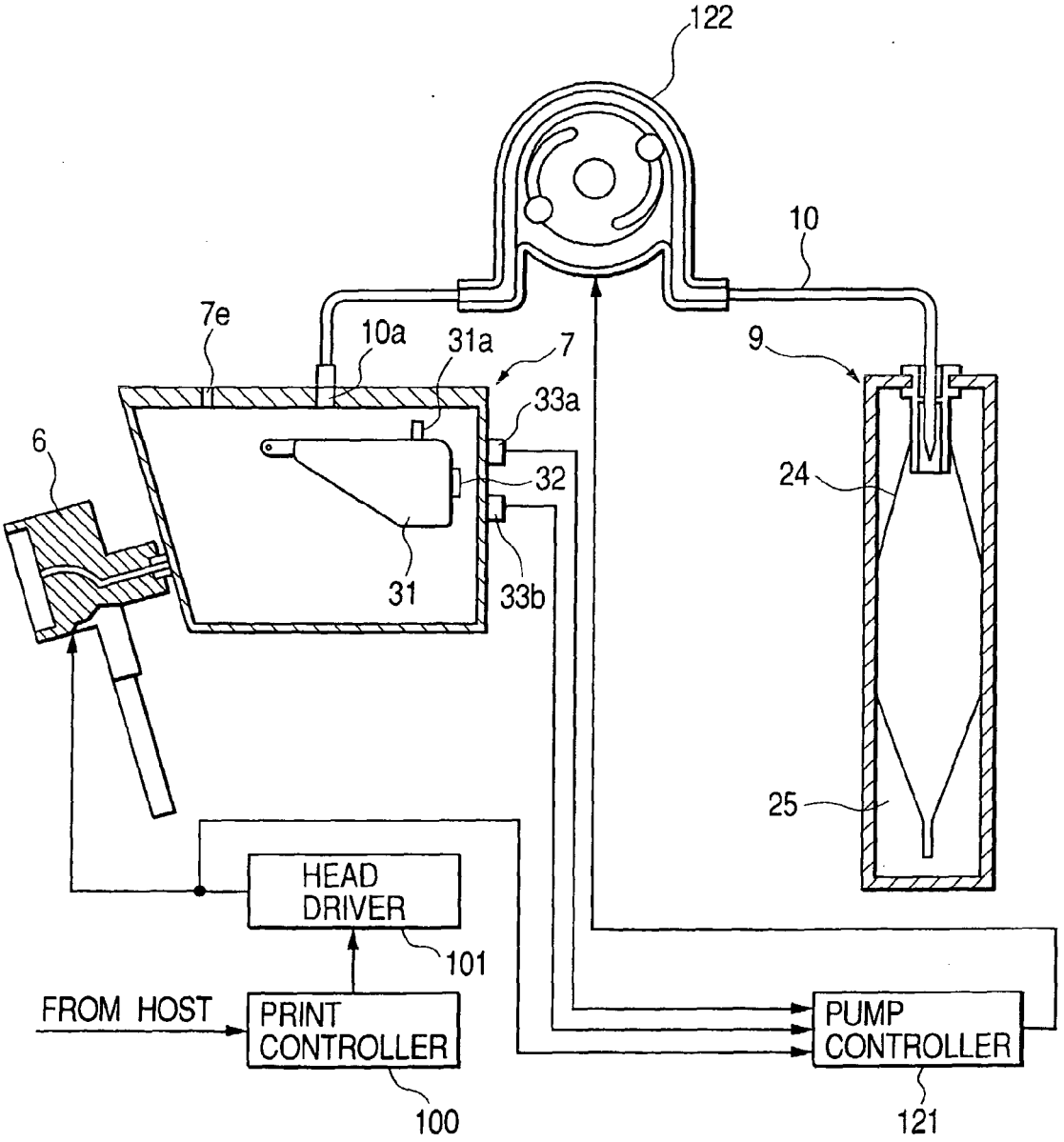

122
10
7e
10a
31a
7
9
33a
6
32
24
31
33b
25
HEAD
DRIVER
101
FROM HOST
PRINT
CONTROLLER
PUMP
CONTROLLER
100
121

FIG. 28

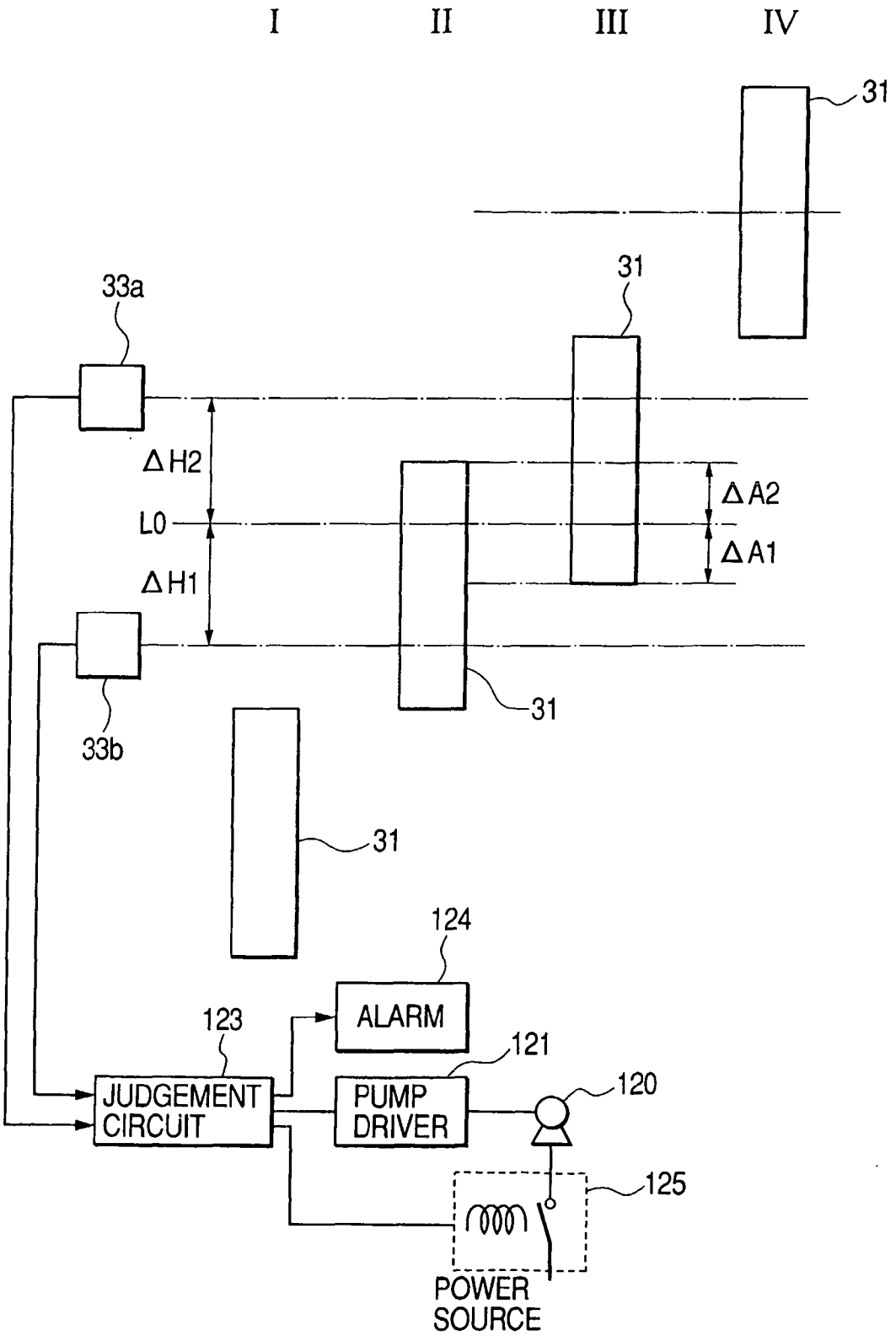

I
II
III
IV
31
33a
31
ΔH2
L0
ΔH1
ΔA2
ΔA1
33b
31
31
124
ALARM
123
121
JUDGEMENT CIRCUIT
PUMP DRIVER
120
125
POWER SOURCE

FIG. 29

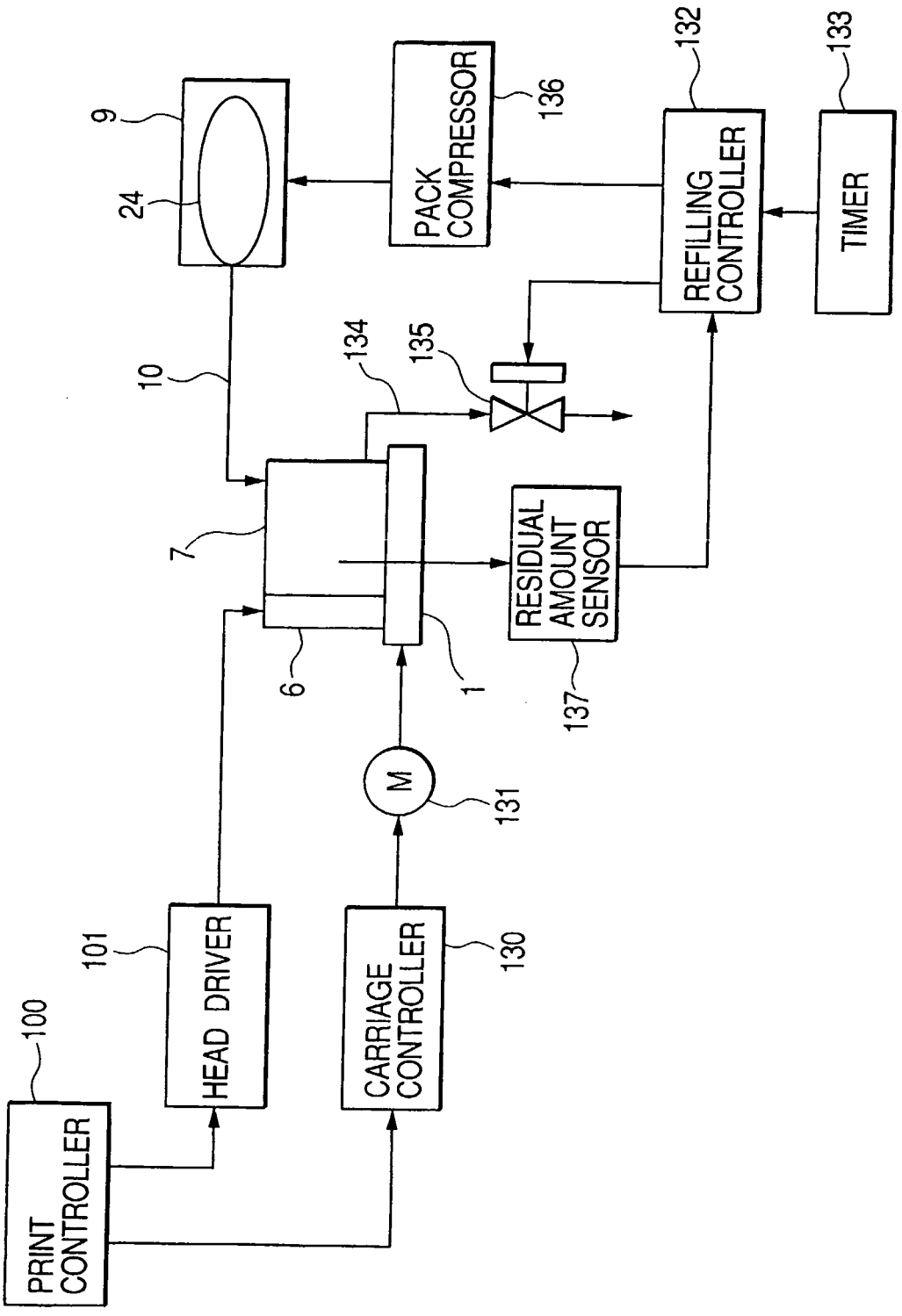

PRINT CONTROLLER
100
HEAD DRIVER
101
CARRIAGE CONTROLLER
130
M
131
RESIDUAL AMOUNT SENSOR
137
PACK COMPRESSOR
136
REFILLING CONTROLLER
132
TIMER
133
9
24
10
134
135
7
6
1

FIG. 30

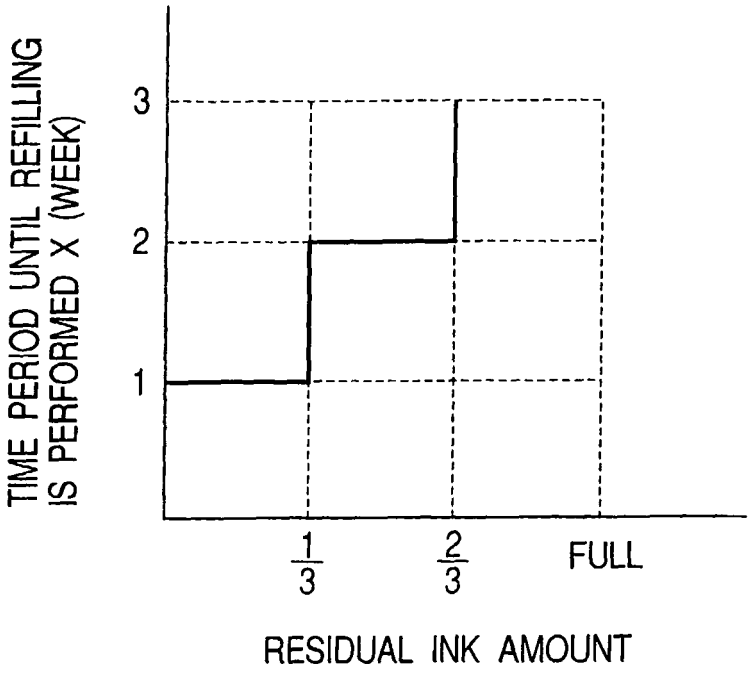
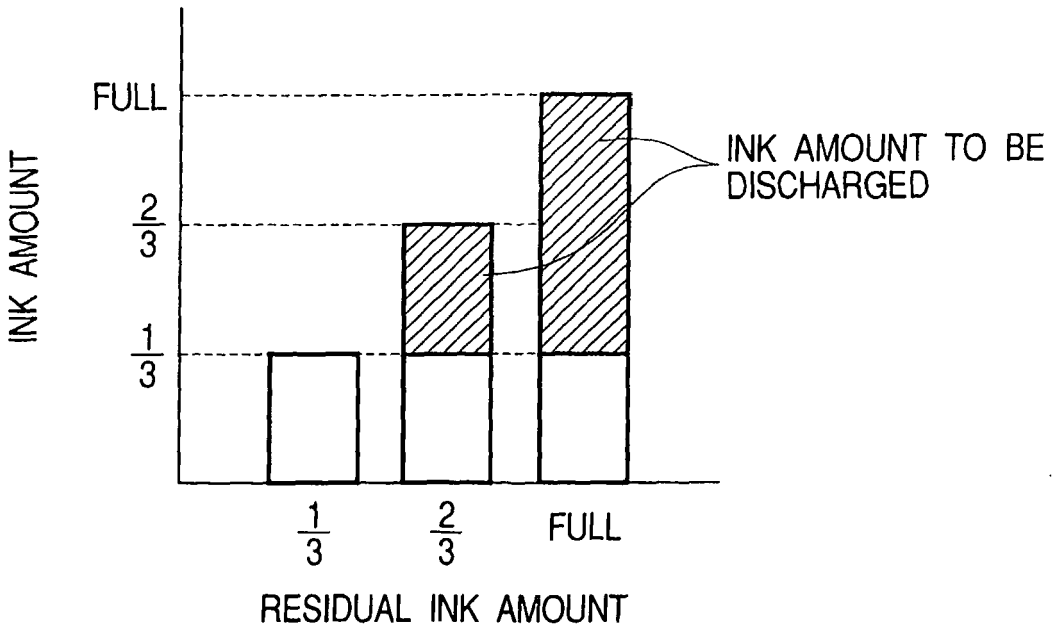

TIME PERIOD UNTIL REFILLING IS PERFORMED X (WEEK)
3
2
1
1/3
2/3
FULL
RESIDUAL INK AMOUNT

FIG. 31


INK AMOUNT
FULL
2/3
1/3
INK AMOUNT TO BE DISCHARGED
1/3
2/3
FULL
RESIDUAL INK AMOUNT

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

- WO 9941083 A **[0010]**