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(54) Title: LIQUID CARTRIDGE

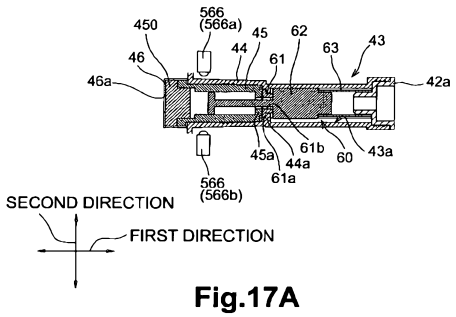

Fig.17A

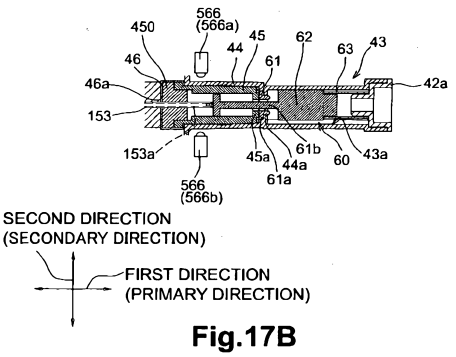

Fig.17B

(57) Abstract: An liquid cartridge includes a liquid storing portion configured to store liquid, a liquid outlet path communicating with an interior of the liquid storing portion, wherein the liquid outlet path is configured to receive a longitudinal object inserted into the liquid outlet path from an outside of the liquid cartridge, and a detector configured to detect that the longitudinal object is at a predetermined range of positions within the liquid outlet path.

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DESCRIPTION

LIQUID CARTRIDGE

Technical Field

[0001] The present invention relates to a liquid cartridge.

Background Art

[0002] A recording apparatus, such as a recording apparatus described in JP-A-8-80618, has a main unit and an ink cartridge configured to be mounted to the main unit. The recording apparatus has a sensor for the recording apparatus to determine completion of mounting of an ink cartridge to the main unit of the recording apparatus. Specifically, when the ink cartridge is mounted to a mounting portion of the main unit of the recording apparatus, a pair of resistors provided on a surface of the ink cartridge comes into contact with a pair of electrodes provided at the mounting portion, respectively, whereby the pair of electrodes is electrically connected to each other via the pair of resistors, which enables the determination that the ink cartridge is mounted in the mounting portion.

[0003] However, although the mounting of the ink cartridge to the mounting portion can be determined by the detection of the electric connection between the electrodes, it cannot be determined whether or not a hollow tube of the main unit has been inserted into an ink outlet path of the ink cartridge completely. Accordingly, it cannot be determined whether or not an ink path extending from the ink cartridge to the main unit has been formed.

[0004] A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

Disclosure of the Invention

[0005] Therefore, a need has arisen for a liquid cartridge which ameliorates one or more shortcomings of the related art. A technical advantage of the present invention is that it is possible to determine whether a hollow tube of a main unit has been inserted into a liquid outlet path of a liquid cartridge.

[0006] According to an aspect of the present invention, there is provided an liquid cartridge comprising: a liquid storing portion configured to store liquid; a liquid outlet path communicating with an interior of the liquid storing portion, wherein the liquid outlet path is configured to receive a longitudinal object inserted into the liquid outlet path from an

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outside of the liquid cartridge; and a detector configured to detect that the longitudinal object is at a predetermined range of positions within the liquid outlet path.

[0007] With this configuration, by the detector detecting whether or not the longitudinal object is at the predetermined range of positions, it becomes possible to determine whether or not the hollow tube has been correctly inserted into the liquid outlet path. Accordingly, the formation of a liquid path extending from the liquid cartridge to a main unit of a recording apparatus can be assured.

[0008] According to another aspect of the present invention, there is provided a printer comprising: the liquid cartridge of any one of claims 1 to 12; and the longitudinal object configured to inserted into the liquid outlet path of the liquid cartridge.

[0009] Other objects, features, and advantages will be apparent to persons of ordinary skill in the art from the following detailed description of the invention and the accompanying drawings.

Brief Description of Drawings

[0010] For a more complete understanding of the present invention, needs satisfied thereby, and the objects, features, and advantages thereof, reference now is made to the following description taken in connection with the accompanying drawing.

[0011] Fig. 1 is a perspective view of an ink jet printer comprising an ink cartridge according to a first embodiment of the present invention.

[0012] Fig. 2 is a schematic side view of the internal structure of the ink jet printer of Fig. 1.

[0013] Figs. 3A and 3B are perspective views of a maintenance unit of the ink jet printer of Fig. 1.

[0014] Figs. 4A to 4C are partial side views of the ink jet printer of Fig. 1, illustrating a capping operation.

[0015] Fig. 5 is a perspective view of an ink cartridge according to the first embodiment of the present invention.

[0016] Fig. 6 is a top view of the internal structure of the ink cartridge of Fig. 5.

[0017] Figs. 7A and 7B are partial horizontal cross-sectional views of the ink cartridge of Fig. 5, in which each of a first valve and a second valve is in a close state in Fig. 7A, and each the first valve and the second valve is in an open state in Fig. 7B.

[0018] Fig. 8 is a block diagram of the electrical configuration of the ink jet printer of Fig. 1.

[0019] Figs. 9A and 9B are partial horizontal cross-sectional views of a mounting portion and top views of the ink cartridge of Fig. 5, in which the ink cartridge is not yet mounted in the mounting portion in Fig. 9A, and the ink cartridge is completely mounted in the mounting portion in Fig. 9B.

[0020] Fig. 10 is a flowchart of control during a mounting of the ink cartridge to the mounting portion, according to the first embodiment of the present invention.

[0021] Fig. 11 is a block diagram of the electrical configuration of an ink jet printer, according to a second embodiment of the present invention.

according to a second embodiment of the present invention.

[0022] Fig. 12 is a flowchart of control during a mounting the ink cartridge to a mounting portion, according to the second embodiment of the present invention.

[0023] Fig. 13 is a partial horizontal cross-sectional view of an ink cartridge, according to a third embodiment of the present invention.

[0024] Fig. 14 is a flowchart of control during a mounting the ink cartridge to a mounting portion, according to a fourth embodiment of the present invention.

[0025] Figs. 15A and 15B are partial horizontal cross-sectional views of an ink cartridge according to a third modified embodiment, in which each of a first valve and a second valve is in a close state in Fig. 15A, and each the first valve and the second valve is in an open state in Fig. 15B.

[0026] Figs. 16A and 16B are partial horizontal cross-sectional views of the an cartridge according to a fourth modified embodiment, in which a first valve is in a close state in Fig. 16A, and the first valve is in an open state in Fig. 16B.

[0027] Figs. 17A and 17B are partial horizontal cross-sectional views of an ink cartridge according to a fifth modified embodiment, in which each of a first valve and a second valve is in a close state in Fig. 17A, and each the first valve and the second valve is in an open state in Fig. 17B.

Best Mode for Carrying Out the Invention

[0028] Embodiments of the present invention, and their features and advantages, may be understood by referring to Figs 1-17B, like numerals being used for like corresponding parts in the various drawings.

[0029] Referring to Figs. 1 and 2, an ink jet printer 1 comprises a main unit and ink cartridges 40 configured to be mounted to the main unit, according to a first embodiment of the present invention, the main unit of the ink jet printer 1 comprises a housing 1a having substantially a rectangular parallelepiped shape. The housing 1a has three openings 10d, 10b, and 10c formed in one of its vertically extending outer faces. The openings 10d, 10b, and 10c are vertically aligned in this order from above. The main unit of the ink jet printer 1 comprises doors 1d and 1c fitted into the openings 10d and 10c, respectively, and each of the doors 1d and 1c is configured to pivot about a horizontal axis at its lower end. When the doors 1d and 1c are pivoted to be opened and closed, the openings 10d and 10c are covered and uncovered, respectively. The main unit of the ink jet printer 1 comprises a sheet feed unit 1b inserted into the opening 10b. A sheet discharge portion 11 is provided at the top of

the housing 1a. The door 1d is disposed facing a transporting unit 21 (See Fig. 2) in a primary direction.

[0030] Referring to Fig. 2, the interior of the housing 1a of the ink jet printer 1 is divided into three spaces G1, G2, and G3 in the vertical direction in this order from above. Four ink jet heads 2, a maintenance unit 30, and the transporting unit 21 are disposed in the space G1, and the four ink jet heads 2 are configured to discharge inks of magenta, cyan, yellow, and black, respectively. The sheet feed unit 1b is disposed in the space G2. Four ink cartridges 40 are disposed in the space G3.

[0031] The sheet feed unit 1b and four ink cartridges 40 are configured to be mounted to and removed from the housing 1a in the primary direction. In this embodiment, a secondary direction is parallel with a transporting direction in which the transporting unit 21 transports sheets P. The primary direction is a direction perpendicular to the secondary direction. Each of the primary direction and the secondary direction is a horizontal direction. The main unit of the ink jet printer 1 comprises a controller 100 configured to control the sheet feed unit 1b, the maintenance unit 30, transporting unit 21, ink jet heads 2, etc.

[0032] Each of the four ink jet heads 2 extends in the primary direction, and the four ink jet heads 2 are arrayed in the secondary direction. The four ink jet heads 3 are supported by the housing 1a by way of a frame 3. The dimension of each ink jet head 2 in the primary direction is greater than the dimension of a sheet P in the primary direction. The ink jet printer 1 is a so-called line printer. The frame 3 is configured to vertically move by an elevator mechanism (not shown) in the housing 1a. The elevator mechanism is configured to move the frame 3, such that the ink jet heads 2 moves between a printing position (the position shown in Fig. 2) and a retracted position (see Fig. 4A) above the printing position, under the control of the controller 100.

[0033] Each ink jet head 2 has a layered structure comprising a path unit (not shown) in which ink paths including pressure chambers are formed, and an actuator unit (not shown) placed on the path unit. The actuator unit is configured to selectively apply pressure to ink in the pressure chambers. The bottom surface of each ink jet head 2 has a discharge surface 2a, where multiple discharge nozzles (not shown) for discharging ink are formed. Each ink jet head 2 is connected with a flexible tube (not shown), such that the interior of the ink jet head 2 is in fluid communication with the inner path of the flexible tube. Each flexible tube is connected to a mounting portion 150, such that the inner path of the flexible tube is in fluid communication with an ink supply path 154 formed in the mounting portion

150 (see Figs. 6A and 6B).

[0034] A sheet transport path along which sheets P are transported is formed in the housing 1a, extending from the sheet feed unit 1b toward the sheet discharge portion 11, as shown by the heavy arrows in Fig. 2. The sheet feed unit 1b comprises a sheet feed tray 23 and a sheet feed roller 25 attached to the sheet feed tray 23 configured to store multiple sheets P. The sheet feed roller 25 is configured to feed out the topmost sheet P in the sheet feed tray 23 by being driven by a sheet feed motor (not shown) that is controlled by the controller 100. The Sheet P fed out from the sheet feed roller 25 is sent to the transporting unit 21 being guided by guides 27a and 27b and being nipped by a feed roller pair 26.

[0035] Referring to Fig. 2, the transporting unit 21 comprises two belt rollers 6 and 7, and an endless transport belt 8 wound around the belt rollers 6 and 7. The belt roller 7 is a driving roller configured to rotate in the clockwise direction in Fig. 2 when a shaft thereof is driven by a transport motor (not shown) controlled by the controller 100. The belt roller 6 is a driven roller configured to rotate in the clockwise direction in Fig. 2 along with the running of the transport belt 8 caused by the rotation of the belt roller 7..

[0036] An outer surface 8a of the transport belt 8 has been subjected to silicone processing, so as to have adhesive properties. A nip roller 4 is disposed above the belt roller 6 sandwiching the transport belt 8 therebetween on the sheet transport path. The nip roller 4 is configured to press the sheet P fed out from the sheet feed unit 1b against the outer surface 8a of the transport belt 8. The sheet pressed against the outer surface 8a is held on the outer surface 8a by the adhesive properties thereof, and is transported toward the right side in Fig. 2.

[0037] A separating plate 5 is disposed above the belt roller 7 sandwiching the transport belt 8 on the sheet transport path. The separating plate 5 is configured to separate the sheet P, held on the outer surface 8a of the transport belt 8, from the outer surface 8a. The sheet P that has been separated is transported being guided by guides 29a and 29b and nipped by two feed roller pairs 28, and is discharged to the discharge portion 11 from an opening 12 formed through the housing 1a. One roller of each feed roller pair 28 is driven by a feed motor (not shown) controlled by the controller 100.

[0038] A platen 19 having substantially a rectangular parallelepiped shape is disposed within the loop of the transport belt 8. The platen 19 overlaps with the four ink jet heads 2 in the vertical direction. The upper surface of the platen 19 is in contact with the inner surface of the transport belt 8 at an upper portion of the loop of the transport belt 8,

and supports the transport belt 8 from the inside. Accordingly, the outer surface 8a of the transport belt 8 at the upper portion of the loop thereof faces the discharge surfaces 2a of the ink jet heads 2, and extends in parallel with the discharge surfaces 2a with a slight gap formed between the discharge surfaces 2a and the outer surface 8a. The sheet transport path extends through this gap. When the sheet P held on the outer surface 8a of the transport belt 8 passes immediately below the four ink jet heads 2, ink of each color is discharged toward the upper surface of the sheet P from a corresponding one of the ink jet heads 2 under control of the controller 100, thereby forming a desired color image on the sheet P.

[0039] Of the four ink cartridges 40, the ink cartridge 40 at the leftmost position in Fig. 2 stores black ink, and has a greater size in the secondary direction as compared to the other three ink cartridges 40. The ink cartridge 40 at the leftmost position has a greater ink capacity than the other three ink cartridges 40. The other three ink cartridges 40 have the same ink capacity, and stores magenta, cyan, and yellow inks, respectively.

[0040] When the four ink cartridges 40 are mounted in the housing 1a, the interior of an ink bag 42 (described later) of each ink cartridge 40 is in fluid communication with the ink supply path 154 (See Figs. 9A and 9B) which is in fluid communication with the interior of a corresponding one of the ink jet heads 2, such that the ink stored in the ink bag 42 can be supplied to the ink jet head 2. The maintenance unit 30 comprises pumps (not shown) for forcibly feeding ink from the ink cartridges 40 to the ink jet heads 2 under control of the controller 100, and the pumps are connected to the flexible tubes between the ink jet heads 2 and the mounting portions 150, respectively.

[0041] When the ink cartridge 40 is intended to be replaced, the door 1c is opened and the ink cartridge 40 is removed from the housing 1a via the opening 10c, and a new ink cartridge 40 is mounted in to the housing 1a via the opening 10c. In this embodiment, the ink cartridges 40 are configured to be individually mounted into the housing 1a, but in another embodiment, the four ink cartridges 40 may be loaded on a single cartridge tray to form an integral unit, and the unit may be mounted into the housing 1a.

[0042] Referring to Fig. 2, the maintenance unit 30 is provided between the four ink jet heads 2 and the transporting unit 21, and is provided for eliminating faulty ink discharge from the ink jet heads 2 if it occurs. The maintenance unit 30 comprises four plate-shaped members 32 disposed at equally-spaced intervals in the secondary direction, and four caps 31 which are fixed on the plate-shaped members 32 and are configured to cover the discharge surfaces 2a of the ink jet heads 2.

[0043] Referring to Fig. 3A, the dimension of each cap 31 in the primary direction is greater than the dimension of each cap 31 in the secondary direction. Similarly, although not shown in detail, the dimension of each discharge surface 2a in the primary direction is greater than the dimension of each cap 31 in the secondary direction. The cap 31 is made of an elastic material such as rubber, having a recess formed therein and the recess is opened upwards. The four caps 31 are disposed upstream of the corresponding ink jet heads 2 in the transporting direction, respectively, in the initial state. Specifically, the cap 31 (leftmost cap 31 in Fig. 2) which is positioned at the most upstream side, of all the four caps 32, is disposed upstream of the ink jet head 2 (left most ink jet head 2 in Fig. 2) which is positioned at the most upstream side, of all the ink jet heads 2, and the remaining three caps 31 are disposed between the ink jet heads 2, respectively, in the transporting direction. The four caps 31 are configured to be moved in the vertical direction and horizontal directions relative to the corresponding ink jet heads 2, respectively, in accordance with the motion of the maintenance unit 30.

[0044] Referring to Fig. 3A, the maintenance unit 30 comprises a pair of inner frames 33 sandwiching and holding the plate-shaped members 32. Each of the pair of inner frames 33 comprises upward-protruding corner portions 33a at both ends thereof in the secondary direction. One corner portion 33a of each inner frame 33 comprises a pinion gear 34 fixed to the shaft of a driving motor (not shown) to be controlled by the controller 100, so as to engage with a rack gear 35 extending in the secondary direction (the transporting direction). Fig. 3A shows only one pinion gear 34 positioned at the near side in Fig. 3A.

[0045] Referring to Fig. 3B, the maintenance unit 30 comprises an outer frame 36 provided on the perimeter of the pair of the inner frames 33, and partially enclosing the pair of the inner frames 33. The rack gears 35 are fixed on the inner surface of the outer frame 36. A pinion gear 37 fixed on a shaft of a driving motor (not shown) to be controlled by the controller 100 is provided on the outer frame 36, so as to engage with a rack gear 38 extending in the vertical direction. The rack gear 38 is supported by the housing 1a.

[0046] With this configuration, when two pinion gears 34 are rotated synchronously under control of the controller 100, the pair of inner frames 33 moves in the secondary direction. Also, rotating the pinion gear 37 under control of the controller 100 moves the outer frame 36 in the vertical direction.

[0047] At the initial position shown in Fig. 2, the maintenance unit 30 is positioned, such that three openings 39a formed between the plate-shaped members 32 face three

discharge surfaces 2a in the vertical direction, and an opening 39b formed between the plate-shaped member 32 positioned at the most downstream in the transporting direction and the corner portions 33a faces the other one of the discharge surfaces 2a in the vertical direction. When a capping operation covering the discharge surfaces 2a with the caps 31 is initiated from this initial state, the ink jet heads 2 are moved from the printing position to the retracted position by the elevator mechanism, as shown in Fig. 4A.

[0048] Subsequently, the pair of inner frames 33 moves to the downstream side of the transportation direction until the caps 31 face the discharge surfaces 2a in the vertical direction, respectively, as shown in Fig. 4B. Subsequently, the outer frame 36 is raised in the vertical direction, whereby the caps 31 are pressed against the discharge surfaces 2a, such that the caps 31 covers the discharge surfaces 2a, respectively, at a capping position, as shown in Fig. 4C. When the maintenance unit 30 and the ink jet head 3 move reversely, the caps 31 return from the capping position to the initial position, and the ink jet heads 2 return from the retracted position to the printing position.

[0049] Referring to Figs. 5 to 8, the ink cartridges 40 will be described. In Fig. 8, electric power supply lines are drawn as heavy lines, and signal lines are drawn as light lines. The ink cartridge 40 comprises a housing 41 having substantially a rectangular parallelepiped shape, the ink bag 42, as an example of a liquid storing portion, disposed within the housing 41, an ink outlet tube 43 connected to the ink bag 42 at one end, a first valve 50, and a second valve 60. The ink bag 42 is configured to store ink therein.

[0050] The dimension of the housing 41 in a first direction is greater than the dimension of the housing 41 in a second direction, and the dimension of the housing 41 in the second direction is greater than the dimension of the housing in a third direction. The first direction, the second direction, and the third direction are perpendicular to each other. When the ink cartridge 40 is mounted in the mounting portion 150, the first direction is aligned with the primary direction, the second direction is aligned with the secondary direction, and the third direction is aligned with the vertical direction.

[0051] Referring to Fig. 6, the interior of the housing 41 is divided into two chambers 41a and 41b in the first direction, with the ink bag 42 being disposed in the chamber 41a which is larger than the chamber 41b. The ink outlet tube 43 is disposed in the chamber 41b. As described above, the ink cartridge 40 for storing black ink is greater in size and ink capacity than the other three ink cartridges 40, but the difference is that the chamber 41a and ink bag 42 of the ink cartridge 40 for storing black ink are merely greater than those of the

other three ink cartridges 40 in the second direction. Therefore, the four ink cartridges 40 have almost the same structure, so description will be made regarding just one ink cartridge 40.

[0052] Referring to Figs. 6 to 7B, the ink bag 42 is connected to a connecting portion 42a, such that ink stored in the ink bag 42 can be supplied to the outside of the ink bag 42 through the connecting portion 42. The ink outlet tube 43 comprises a tube 44, e.g., a cylindrical tube 44, connected to the connecting portion 42a at a first end thereof, and a tube 45, e.g., a cylindrical tube 45, fitted into a second end (the left end in Figs. 7A and 7B) of the tube 44. The ink outlet tube 43 has an ink outlet path 43a formed therein. More specifically, a first end of the tube 45 is fitted into the tube 44, but a second end of the tube 45 is positioned outside of the tube 44. The ink outlet tube 43, i.e., the tubes 44 and 45, extends in the first direction, and therefore the ink outlet path 43a defined by the ink outlet tube 43 extends in the first direction. The ink outlet path 43a is configured to be in fluid communication with the interior of the ink bag 42 via the connecting portion 42a at a first end thereof, and to be in fluid communication with the outside of the ink cartridge 40 at a second end thereof. In this embodiment, the tubes 44 and 45 are each made of translucent, e.g., transparent or semi-transparent, resin, such that a detector, e.g., photo-sensor 66 (described later) can detect a valve member 62 (described later).

[0053] A ring-shaped flange 47 is provided at the second end of the tube 44 opposite the first end of the tube 44 connected to the connecting portion 42a. The flange 47 extends from an outer surface of the second end of the tube 44 in radial directions of the tube 44. A ring-shaped protrusion 48 extends from the flange 47 toward the ink bag 42 in the first direction. An O-ring 48a is fitted around the protrusion 48. The flange 47 is one of walls defining the chamber 41b, and is a portion of the housing 41. Another portion of the housing 41 is connected to the flange 47, sandwiching the O-ring 48a with the protrusion 48. Therefore, O-ring 48a reduces likelihoods that ink may leak around the flange 47.

[0054] Referring to Figs. 5 and 8, a contact 91 is provided on the outer surface of the flange 47. The contact 91 is aligned with an ink discharge opening 46a (described later) in the second direction. The contact 91 is electrically connected with the photo-sensor 66. In a modified embodiment, the contact 91 may be disposed at any position, as long as it is not positioned directly below the ink discharge opening 46a when the ink cartridge 40 is mounted to the mounting portion 150. Because the contact 91 for transmitting signal is provided so as to not be positioned directly below the ink discharge opening 46a, ink

dripping from the ink discharge opening 46a can be prevented from adhering to the contact 91.

[0055] Referring to Figs. 5, 6, and 8, the housing 41 comprising a shoulder surface 41c which is positioned away from the flange 47 toward the ink bag 42. The shoulder surface 41c extends parallel with the flange 47, i.e., extends in the second direction and the third direction. An electric power input portion 92 is provided on the shoulder surface 41c. The contact 91 is positioned between the electric power input portion 92 and the ink discharge opening 46a in the second direction. The electric power input portion 92 is positioned further away from the ink discharge opening 46a than the contact 91 is in the secondary direction. Also, as shown in Fig. 8, the electric power input portion 92 is electrically connected to the photo-sensor 66. The electric power input portion 92 is configured to supply electric power to the photo-sensor 66 when the electric power input portion 92 is electrically connected to an electric power output portion 162 (described later). In a modified embodiment, the electric power input portion 92 may be disposed at any position, as long as it is not positioned directly below the ink discharge opening 46a when the ink cartridge 40 is mounted to the mounting portion 150. The electric power input portion 92 has a recess formed therein configured to receive the electric power output portion 162.

[0056] Because the electric power input portion 92 for transmitting electric power is provided so as not to positioned directly below the ink discharge opening 46a, ink dripping from the ink discharge opening 46a can be prevented from adhering to the electric power input portion 92. Moreover, because the electric power input portion 92 is positioned further away from the ink discharge opening 46a than the contact 91 is, adhesion of ink occurs even less readily. This can prevent the electric power input portion 92 from short-circuiting and damaging the photo-sensor 66. Also, because the electric power input portion 92 is provided on the shoulder surface 41c, and there is a distance between the electric power input portion 92 and the ink discharge opening 46a in the first direction, the distance between the electric power input portion 92 and the ink discharge opening 46a increases not only in the second direction but also in the first direction. Accordingly, adhesion of ink to the electric power input portion 92 may further be reduced.

[0057] Referring to Figs. 7A and 7B, the first valve 50 is disposed at the ink outlet path 43a defined by the tube 45 of the ink outlet tube 43. The first valve 50 comprises a sealing member 51 which is an elastic member positioned in the ink outlet path 43a and

contacting the inner surface of the tube 45 to close an opening of the ink outlet path 43a formed at the second end of the ink outlet path 43a. The first valve 50 comprises a spherical member 52, as a first valve member, disposed in the ink outlet path 43a defined by the tube 45, and a coil spring 53, as a first biasing member, disposed in the ink outlet path 43a defined by the tube 45. Each of the diameter of the spherical member 52 and the diameter of the coil spring 53 is less than the diameter of the ink outlet path 43a defined by the tube 45. A lid 46 is attached to the second end of the tube 45, such that the sealing member 51 does not come loose from the tube 45. An ink discharge opening 46a is formed through the lid 46.

[0058] The coil spring 53 extends in the first direction, and one end of the coil spring 53 is in contact with the spherical member 52 and the other end of the coil spring 53 is in contact with a platform portion 45a provided at the first end of the tube 45. The coil spring 53 is configured to constantly bias the spherical member 52 toward the sealing member 51. In this embodiment, the coil spring 53 is used as a biasing member, but a biasing member other than a coil spring may be used as long as the spherical member 52 can be biased toward the sealing member 51.

[0059] The sealing member 51 is made of an elastic material such as rubber or the like. The sealing member 51 has an opening 51a formed therethrough, and the opening 51a extends in the first direction at the middle of the sealing member 51. The sealing member 51 comprises a ring-shaped protrusion 51b fitted into the second end of the tube 45 and contacting the inner surface of the tube 45. The sealing member 51 also comprises a curved portion 51c facing the spherical member 52 and having a shape following the outer circumferential surface of the spherical member 52. The curved portion 51c is surrounded by the ring-shaped protrusion 51b. The diameter of the opening 51a is less than the outer diameter a hollow tube 153 (described later). When the hollow tube 153 is inserted into the opening 51a, the sealing member 51 contacts the outer surface of the hollow tube 153 while being elastically deformed. Therefore, ink leakage from between the sealing member 51 and the hollow tube 153 can be prevented.

[0060] The inner diameter of the ring-shaped protrusion 51b is slightly less than the diameter of the spherical member 52. The fluid communication between the ink outlet path 43a and the outside of the ink cartridge 40 via the opening 51a is prevented when the spherical member 52 contacts the ring-shaped protrusion 51b. The fluid communication between the ink outlet path 43a and the outside of the ink cartridge 40 via the opening 51a is

also prevented when the spherical member 52 contacts the curved portion 51c. In other words, the first valve 50 is configured to prevent ink in the ink outlet path 43a from flowing via the first valve 50 when the spherical member 52 contacts the ring-shaped protrusion 51b and/or the curved portion 51c. Moreover, forming the opening 51a in the sealing member 51 allows for easier insertion of the hollow tube 153 through the sealing member 51. Additionally, a situation can be avoided wherein the sealing member 51 is shaved off by the hollow tube 153 when the hollow tube 153 is inserted into or pulled out of the sealing member 51, and debris intrudes into an inner space 153a of the hollow tube 153. Risks can be reduced that such debris shaved off from the sealing member 51 intruded into the interior of the ink jet head 2.

[0061] Referring to Fig. 7B, when the hollow tube 153 is inserted into the opening 51a via the ink discharge opening 46a, the tip of the hollow tube 153 comes into contact with the spherical member 52 and the spherical member 52 moves so as to be separated from the curved portion 51c and the ring-shaped protrusion 51b. When this occurs, the state of the first valve 50 changes from a close state, in which the first valve 50 prevents ink in the ink outlet path 43a from flowing via the first valve 50, to an open state, in which the first valve 50 allows ink in the ink outlet path 43a to flow via the first valve 50. The hollow tube 153 has an opening 153b formed therethrough, and the inner space 153a of the hollow tube 153 communicates with the outside of the hollow tube 153 via the opening 153b. When the first valve 50 is in the open state, the opening 153b of the hollow tube 153 has passed through the opening 51a, so the inner space 153a of the hollow tube 153 and the ink outlet path 43a communicate with each other via the opening 153b. When the hollow tube 153 moves to be pulled out of the opening 51a, the spherical member 52 moves toward the ring-shaped protrusion 51b due to the biasing of the coil spring 53. When the spherical member 52 comes into contact with the ring-shaped protrusion 51b, the state of the first valve 50 changes from the open state to the close state. When the hollow tube 153 further moves to be pulled out of the opening 51a, the spherical member 52 comes into close contact with the curved portion 51c. Accordingly, the first valve 50 is configured to selectively be in the open state and the close state in accordance with insertion and removal of the hollow tube 153. Because the first valve 50 comprises the coil spring 53 biasing the spherical member 52 toward the sealing member 51, the structure of the first valve 50 is simplified and leakage of ink from the first valve 50 can be prevented.

[0062] Referring to Figs. 7A and 7B, the second valve 60 is provided at the ink outlet

path 43a between the ink bag 42 and the first valve 50. The second valve 60 comprises a valve seat 61, a valve member 62, as a second valve member, and a coil spring 63, as a second biasing member, disposed in the ink outlet path 43a. The tube 44 comprises a ring-shaped protrusion 44a protruding from the inner surface of the tube 44 into the ink outlet path 43a at a middle portion of the tube 44 in the first direction. The valve seat 61 is made of an elastic material such as rubber or the like, and comprises a flange 61a sandwiched between the ring-shaped protrusion 44a of the tube 44 and the platform portion 45a of the tube 45. The valve seat 61 has an opening 61b formed therethrough, and the opening 61b extends in the first direction at the middle of the valve seat 61, such that the interior of the tube 44 and the interior of the tube 45 communicate with each other to form the ink outlet path 43a. The valve member 62 and the coil spring 63 are disposed in the ink outlet path 43a defined by the tube 44, and each of the diameter of the valve member 62 and the diameter of the coil spring 63 is less than the diameter of the ink outlet path 43a defined by the tube 44.

[0063] One end of the coil spring 63 is in contact with the valve member 62 and the other end of the coil spring 63 is in contact with the connecting portion 42a. The coil spring 63 is configured to constantly bias the valve member 62 toward the valve seat 61 and the sealing member 51. The valve member 62 is configured to prevent ink in the ink outlet path 43a from flowing via the second valve 60 when the valve member 62 contacts a portion of the valve seat 61 surrounding the opening 61b, such that the portion of the valve seat 61 is elastically deformed by the biasing force of the coil spring 63. When this occurs, the valve member 62 is in a close state, and the fluid communication between the interior of the tube 44 and the interior of the tube 45 is prevented. Because the coil spring 63 is configured to bias the valve member 62 toward the sealing member 51, and because the first and second valves 50 and 60, i.e., the sealing member 51, the spherical member 52, the coil spring 53, the valve seat 61, the valve member 62, and the coil spring 63, are aligned on a single straight line in the first direction, the first and second valves 50 and 60 can be opened and closed when the hollow tube 153 is inserted into and pulled out of the sealing member 51 in the first direction/primary direction. The second valve 60 can be made with a simple structure, reducing opening/closing failure of the second valve 60. In this embodiment, the coil spring 63 is used as a biasing member, but a biasing member other than a coil spring may be used as long as the valve member 62 can be biased toward the valve seat 61.

[0064] The valve member 62 has a cylindrical shape, and is configured to slide on the

inner surface of the tube 44. A first end of the valve member 62 facing the connecting portion 42a has a protruding shape protruding in the first direction at the middle thereof. The coil spring 63 is fitted around the protruding portion of the valve member 62.

[0065] A pressing member 70 configured to press and move the valve member 62 in a direction opposite to a direction in which the coil spring 63 biases the valve member 62 is disposed in the ink outlet tube 43. The pressing member 70 is a cylindrical rod extending in the first direction through the opening 61b of the valve seat 61. The pressing member 70 is connected to a second end of the valve member 62 and is integral with the valve member 62. In this embodiment, the valve member 62 and pressing member 70 constitute a movable member. The pressing member 70 has a diameter less than the diameter of the opening 61b. The pressing member 70 has such a length that a gap is formed between the tip of the pressing member 70 and the spherical member 52 when the state of the first valve 50 changes from the open state to the close state (when the spherical member 52 moves toward the sealing member 51 to contact the ring-shaped protrusion 51b) while the second valve 60 is in the close state (the valve member 62 contacts the valve seat 61).

[0066] Referring to Fig. 7B, after the hollow tube 153 is inserted through the sealing member 51 and the first valve 50 becomes the open state, the spherical member 52 comes into contact with the tip of the pressing member 70. When the hollow tube 153 is further inserted, the pressing member 70 and valve member 62 move, and the valve member 62 moves away from the valve seat 61. Accordingly, the state of the second valve 60 changes from the close state to an open state in which the second valve 60 allows ink in the ink outlet path 43a to flow via the second valve 60. When this occurs, the interior of the tube 44 and the interior of the tube 45 of the ink outlet path 43a are brought into fluid communication, such that ink stored in the ink bag 42 flows into the inner space 153a of the hollow tube 153. When the hollow tube 153 is pulled out of the sealing member 51, the valve member 62 and pressing member 70 move due to the biasing of the coil spring 63 toward the valve seat 61, and the valve member 62 comes into close contact with the valve seat 61. Accordingly, the state of the second valve 60 changes from the open state to the close state. Thus, the second valve 60 also is configured to selectively be in the open state, in which the second valve 60 allows ink in the ink outlet path 43a to flow via the second valve 60, and the close state, in which the second valve 60 prevents ink in the ink outlet path 43a from flowing via the second valve 60.

[0067] The photo-sensor 66 electrically connected to the contact 91 is provided in the

chamber 41b of the housing 41. In another embodiment of the invention, the photo-sensor 66 may be disposed in the ink outlet path 43a. In yet another embodiment, the photo-sensor 66 may be integrally formed with tube 45, or another portion of the ink cartridge 40 along the ink outlet path 43a. The photo-sensor 66 is a reflection-detecting type optical sensor configured to detect the presence or absence of an object at a predetermined range of positions without contacting the object. In an embodiment of the invention, the photo-sensor 66 may be substantially aligned with at least a portion of the valve seat 61. The photo-sensor 66 is disposed so as to face the second end portion of the valve member 62 in the second direction when the second valve 60 is in the close state, as shown in Fig. 7A, and so as not to face the second end portion of the valve member 62 in the second direction when the second valve 60 is in open state, as shown in Fig. 7B. In an embodiment of the invention, the valve member 62 moves from the close state to the open state in the first direction. Thus, a distance between the valve member 62 and the photo-sensor 66 in the second direction when the valve member 62 is in the close state is the same as a distance between the valve member 62 and the photo-sensor 66 in the second direction when the valve member 62 is in the open state. The photo-sensor 66 comprises a light-emitting portion and a light-receiving portion, and a mirror face capable of reflecting light is formed at least on the second end portion of the valve member 62. When the photo-sensor 66 faces the valve member 62, the light emitted from the light-emitting portion is reflected at the mirror face of the valve member 62 and the reflected light is received at the light-receiving portion. Thereupon, the photo-sensor 66 outputs a signal indicating that the light-receiving portion is receiving light (hereinafter referred to as "detection signal A"). Referring to Fig. 8, this detection signal A is transmitted to the controller 100 of the main unit of the ink jet printer 1 via contacts 91 and 161. On the other hand, when the photo-sensor 66 does not face the valve member 62, the light emitted from the light-emitting portion is not reflected at the mirror face of the valve member 62, so no light is received at the light-receiving portion. Thereupon, the photo-sensor 66 outputs a signal indicating that the light-receiving portion is not receiving light (hereinafter referred to as "detection signal B"). This detection signal B is transmitted to the controller 100 of the main unit of the ink jet printer 1 via contacts 91 and 161. More specifically, the photo-sensor 66 is configured to output an analogue voltage signal in accordance with the intensity of light received at the light-receiving portion. If the output voltage is greater than a threshold voltage, the controller 100 recognizes it as the detection signal A, and if the output voltage is less than or equal to

the threshold voltage (including when the voltage is zero), the controller 100 recognizes it as the detection signal B. Alternatively, the photo-sensor 66 is configured to output a digital signal as the detection signal A when the intensity of light received at the light-receiving portion is greater than a threshold intensity, and output another digital signal as the detection signal B when the intensity of light received at the light-receiving portion is less than or equal to the threshold intensity (including when the intensity is zero). The controller 100 is configured to determine whether the second valve is in the open state or close state based on the signals the controller 100 receives. In this embodiment, upon receiving the detection signal A indicating that the light-receiving portion is receiving light, the controller 100 determines that the second valve 60 is in the close state, and upon receiving the detection signal B indicating that the light-receiving portion is not receiving light, the controller 100 determines that the second valve 60 is in the open state. In an embodiment of the invention, when the second valve 60 is in a close state, the valve member 62 may be substantially aligned with a center of photo-sensor 66, and when the second valve 60 is in an open state, the valve member 62 may not be aligned with the center of photo-sensor 66. The photo-sensor 66 is not restricted to a reflection-detecting type sensor, and in another embodiment, the photo-sensor 66 may be a light-transmission-detecting type optical sensor comprising a light-emitting portion and a light-receiving portion facing each other, and may detect whether an object is absent or present between the light-emitting portion and the light-receiving portion.

[0068] Referring to Figs. 8 to 9B, the main unit of the ink jet printer 1 comprises four mounting portions 150 arrayed in the secondary direction, to which the ink cartridges 40 are mounted, respectively. Because the mounting portions 150 have substantially the same structure, one mounting portion 150 will be described.

[0069] Referring to Figs. 9A and 9B, the mounting portion 150 has a recess 151 formed therein having a shape corresponding to the outer shape of the ink cartridge 40. A longitudinal object, e.g., the hollow tube 153 is provided at a base portion 151a defining an end of the recess 151 in the secondary direction. The ink supply path 154 is formed in the base portion 151a. The contact 161 electrically connected to the controller 100, and the electric power output portion 162 for outputting electric power from an electric power source 110 (see Fig. 8) of the main unit of the ink jet printer 1, are also provided at the base portion 551a.

[0070] The hollow tube 153 extends in the primary direction, and is disposed at a

position corresponding to the opening 51a when the ink cartridge 40 is mounted to the mounting portion 150. The hollow tube 153 has the inner space 153a formed therein, which is in fluid communicate with the ink supply path 154, and also has the opening 153b formed therethrough near the tip thereof to allow the inner space 153a to communicate with the outside of the hollow tube 53 (See Figs. 7A and 7B). When the ink cartridge 40 is mounted to mounting portion 150 and the hollow tube 153 is inserted into the sealing member 51, such that the opening 153b enters the ink outlet path 43a defined by the tube 45 past the opening 51a, the inner space 153a of the hollow tube 153 and the ink outlet path 43a are brought into fluid communicating via the opening 153b. When the ink cartridge 40 is removed from the mounting portion 150 and the hollow tube 153 is pulled out of the sealing member 51, such that the opening 153b enters the opening 51a, the fluid communicating between the inner space 153a of the hollow tube 153 and the ink outlet path 43a is blocked. Even if the inner space 153a of the hollow tube 153 communicates with the ink outlet path 43a via the opening 153b, ink stored in ink bag 42 does not flow into the inner space 153a until the second valve 60 becomes open state. The path extending from the opening 153b of the hollow tube 153 to the discharge nozzles of the ink jet head 2 is substantially a sealed path not open to the atmosphere. Thus, likelihoods that ink come into contact with air is reduced, and increase in the viscosity of the ink can be suppressed.

[0071] The contact 161 is aligned with the hollow tube 153 in the secondary direction, and disposed at a position corresponding to the contact 91 of the ink cartridge 40 when the ink cartridge 40 is mounted to the mounting portion 150. The contact 161 is a rod-shaped member extending in the primary direction, and is slidably supported. The contact 161 is biased from the base portion 151a outwards by a spring (not shown) in the primary direction, so as to be electrically connected to the contact 91 immediately before the hollow tube 153 is inserted into the sealing member 51 when the ink cartridge 40 is mounted to the mounting portion 150. In other words, the contact 161 is electrically connected to the contact 91 before the first valve 50 becomes the open state. Stated differently, the contact 161 is electrically connected to the contact 91 until the hollow tube 153 is pulled out of the sealing member 51 completely when the ink cartridge 40 is removed from the mounting portion 150.

[0072] The electric power output portion 162 is provided at a shoulder surface 151b formed on the base portion 151a. The electric power output portion 162 is disposed on the shoulder surface 151b at a position corresponding to the electric power input portion 92, and comprises a contact 163 protruding in the primary direction. The contact 163 is inserted

into the recess of the electric power input portion 92, and thereby electrically connected to the electric power input portion 92 when the ink cartridge 40 is mounted to the mounting portion 150. The contact 163 is electrically connected to the electric power input portion 92 immediately before the hollow tube 153 is inserted into the sealing member 51.

[0073] A sensor 170, which is connected to the controller 100, is provided in the recess 150, for detecting the presence and absence of the housing 41 in the mounting portion 150. The sensor 170 is a mechanical switch configured to detect whether or not an object is present by coming into contact with the object, and comprises a detecting portion 171 biased into the recess 151 from a housing of the sensor 170. When the detecting portion 171 comes into contact with the housing 41 and the detecting portion 171 enters into the housing of the sensor 170 against a biasing force, the sensor 170 outputs a signal indicating that the detecting portion 171 has entered into the housing of the sensor 170 (hereinafter referred to as "detection signal C") to the controller 100. When the ink cartridge 40 is removed from the mounting portion 150 and the detecting portion 171 and the housing 41 are no longer in contact, the detecting portion 171 comes out of the housing of the sensor 170 and the sensor 170 outputs a signal indicating that the detecting portion 171 has come out of the housing of the sensor 170 (hereinafter referred to as "detection signal D") to the controller 100. The controller 100 is configured to determine whether or not the ink cartridge 40 is mounted to the mounting portion 150 based on the signals the controller 100 receives. In this embodiment, upon receiving the detection signal C indicating that the detecting portion 171 has entered the housing of the sensor 170, the controller 100 determines that the ink cartridge 40 is mounted to the mounting portion 150 or the ink cartridge 40 is almost completely mounted to the mounting portion 150, and upon receiving the detection signal D indicating that the detecting portion 171 having come out of the housing of the sensor 170, the controller 100 determines that the ink cartridge 40 is not mounted to the mounting portion 150. The sensor 170 is not restricted to a mechanical switch. In another embodiment, the sensor 170 may be an optical sensor.

[0074] Referring to Figs. 2 and 8, a buzzer 13 is provided in the housing 1a. The buzzer 13 is controlled by the controller 100, and configured to emit multiple types of sounds whereby the user can be notified that, for example, "the ink cartridge 40 is not mounted correctly", "ready to print", and so forth.

[0075] When the ink cartridge 40 is intended to be mounted to the mounting portion 150, the door 1c is opened, and the ink cartridges 40 is mounted to the mounting portion 150.

Referring to Fig. 10, in step 1 (S1), the controller 100 determines whether or not mounting of the ink cartridges 40 to the mounting portions 150 has begun. This determination is made based on whether or not the controller 100 receives the detection signal C. As described above, the signal output from the sensor 170 changes from the detection signal D to the detection signal C, when the detecting portion 171 of the sensor 170 comes into contact with the housing 41. When the controller 100 does not receive the detection signal C from the sensor 170 but rather receives the detection signal D, the controller 100 determines that the mounting has not begun yet and stands by (repeats S1). When the controller 100 receives the detection signal C from the sensor 170, the controller 100 determines that the mounting has begun, and the flow proceeds to step 2 (S2).

[0076] In step 2, the controller 100 determines whether or not a mounting limit time has expired since the controller 100 initially receives the detection signal C, i.e., since the controller 100 determines that the mounting has begun at S1, by the time the controller 100 initially receives the detection signal B from the photo-sensor 66. This determination is made based on whether or not the time elapsed since the controller 100 initially receives the detection signal C at S1 has exceeded the mounting limit time stored in a storing portion 120 (see Fig. 8) of the main unit of the ink jet printer 1. If it is determined that the elapsed time has exceeded the mounting limit time, the flow advances to step 3 (S3). The controller 100 then controls the buzzer 13 to notify the user that "the ink cartridge is not mounted correctly to the mounting portion" with a sound from the buzzer 13. On the other hand, if the elapsed time has not exceeded the mounting limit time, the flow advances to step 4 (S4). For example, if the tip of the hollow tube 153 is broken off, if the pressing member 70 is fractured, or the mounting of the ink cartridge 40 is stopped before the second valve becomes the open state, the valve member 62 may not move. In such a case, this flow goes to step 3 (S3).

[0077] In step 4, the controller 100 determines whether or not the second valve 60 is in the open state. This determination is made on whether the controller 100 receives the detection signal B. As described above, when the valve member 62 moves, such that the photo-sensor 66 and the valve member 62 no longer face each other, the detection signal A which has been output from the photo-sensor 66 changes to the detection signal B. If the controller 100 receives the detection signal A and determines that the second valve 60 is in the close state, the flow returns to step 2, and if the controller 100 receives the detection signal B and determines that the second valve 60 is in the open state, the flow advances to

step 5 (S5).

[0078] From the time when the detection signal C starts to be output from the sensor 170 until the second valve 60 becomes the open state, the followings occur. First, during the period of time after the detection signal C starts to be output from the sensor 170 to the controller 100 and before the hollow tube 153 starts to be inserted to the opening 51a, the contact 91 and the contact 161 are electrically connected, and the contact 163 of the electric power output portion 162 and the electric power input portion 92 are electrically connected. Accordingly, the photo-sensor 66 and the controller 100 are electrically connected, such that the controller 100 can receive signals output from the photo-sensor 66, and electric power is supplied to the photo-sensor 66. Subsequently, as the hollow tube 153 is inserted into the opening 51a, the tip of the hollow tube 153 comes into contact with the spherical member 52 and the spherical member 52 moves toward the second valve 60 (to the right in Figs. 7A and 7B), such that the spherical member 52 is separated from the curved portion 51c and the ring-shaped protrusion 51b, and the state of the first valve 50 changes from the close state to the open state. Subsequently, the spherical member 52 comes into contact with the tip of the pressing member 70 and the pressing member 70, spherical member 52, and valve member 62 move toward the connecting portion 42a (to the right in Figs. 7A and 7B). The valve member 62 and the valve seat 61 are separated from each other, and the state of the second valve 60 changes from the close state to the open state. Thus, when the second valve 60 becomes the open state, the contact 91 and the contact 161 are in electrical contact, so the controller 100 can receive the detection signal B output from the photo-sensor 66. The determination of whether or not the second valve 60 is in the open state in step 4 thus also includes determination of whether the hollow tube 153 has been correctly inserted into the ink cartridge 40. In other words, with the photo-sensor 66 indirectly detecting whether the hollow tube 153 is at a predetermined range of positions within the ink outlet path 43a by detecting whether the valve member 62 is at a predetermined range of positions (a range positions where the valve member 62 is more than a predetermined distance away from the valve seat 61), the controller 100 can determine whether or not the hollow tube 153 has been correctly inserted into the ink outlet path 43a, and therefore it can be assured that an ink path has been correctly formed from the ink cartridge 40 to the main unit of the ink jet printer 1, e.g., to the mounting portion 150.

[0079] In step 5 (S5), the controller 100 controls the buzzer 13 to emit a sound from the buzzer 13, indicating "ready to print". Thus, the mounting of the ink cartridge 40 is

completed.

[0080] When ink stored in the ink cartridge 40 is used up, the door 1c of the ink jet printer 1 is opened and the ink cartridge 40 is removed from the mounting portion 150. As the ink cartridge 40 is moved to be removed, the spherical member 52, valve member 62, and pressing member 70 move together toward the sealing member 51 (to the left in Figs. 7A and 7B) while contacting each other, due to the biasing forces of the coil springs 53 and 63. In other words, the spherical member 52, valve member 62, and pressing member 70 move in a direction opposite to a direction in which they move when the hollow tube 153 is inserted into the sealing member 51. When the valve member 62 comes into contact with the valve seat 61, the state of the second valve 60 changes from the open state to the close state, and the flow of ink from the ink bag 42 to the inner space 153a of the hollow tube 153 stops. At this time, the signal output from the photo-sensor 66 to the controller 100 changes from the detection signal B to the detection signal A, and the controller 100 determines that the second valve 60 is in the close state.

[0081] Subsequently, only the spherical member 52 moves along with the hollow tube 153, such that the spherical member 52 and the tip of the pressing member 70 are separated. The spherical member 52 then comes into contact with the ring-shaped protrusion 51b and curved portion 51c, so the state of the first valve 50 changes from the open state to the close state. Thus, the state of each of the first and second valves 50 and 60 changes from the open state to the close state in accordance with the movement of the hollow tube 153 pulled out of the sealing member 51. The first valve 50 becomes the close state after the second valve 60 becomes the close state.

[0082] After the ink cartridge 40 moves further and the hollow tube 153 is pulled out of the sealing member 51 completely, the contact between the contact 91 and contact 161, and the contact between the electric power input portion 92 and contact 163, are cut off. When the housing 41 is separated from the detecting portion 171 and the detecting portion 171 comes out of the sensor 170, the detection signal D is output from the sensor 170 to the controller 100. Accordingly, the controller 100 can determine that the ink cartridge 40 has been removed from the mounting portion. In this way, the old ink cartridge 40 is removed form the mounting portion 105, and a new ink cartridge 40 is mounted to the mounting portion 105.

[0083] Method for manufacturing and refurbishing the ink cartridge 40 will be described. When the ink cartridge 40 is manufactured, the housing 41 is first fabricated

divided into two, and parts such as the ink bag 42 and ink outlet tube 43 are assembled in the first half of the housing 41, as shown in Fig. 6. The second half of the housing 41 is then attached to the first half of the housing 41. Next, a predetermined amount of ink is injected into the ink bag 42 via the ink outlet path 43a. Thus, manufacturing of the ink cartridge 40 is completed.

[0084] In a modified embodiment, parts of the ink cartridge 40 other than the housing 41 are assembled, to which ink is injected. And then, the assembled parts are attached into the housing 40.

[0085] When a used ink cartridges 40 is refurbished, first, the ink bag 42, ink outlet tube 43, and so forth are washed. Next, a predetermined amount of ink is injected into the ink bag 42. Thus, refurbishing of ink cartridge 40 is completed.

[0086] As described above, according to the first embodiment, when the ink cartridge 40 is mounted to the mounting portion 150, the spherical member 52 and the movable member (pressing member 70 and valve member 62) move due to insertion of the hollow tube 153, and whether or not the valve member 62 is in the open state can be determined by the detection of the photo-sensor 66, and also whether or not the hollow tube 153 has been correctly inserted into the ink cartridges 40 can be determined. In other words, by the photo-sensor 66 detecting whether or not the movable member is in the predetermined position, it can be determined whether or not the hollow tube 153 has been properly inserted into the ink outlet path 43a. Accordingly, it can be assured that the ink path extending from the ink cartridge 40 to the main unit of the ink jet printer 1, e.g., to the mounting portion 150, has been correctly formed.

[0087] As an example, if the tip of the hollow tube 153 is broken off, the hollow tube 153 cannot move the valve member 62 when the ink cartridge 40 is mounted to the mounting portion 150, and therefore ink cannot be supplied to the ink jet head 2 when printing is performed. In such a case, printing failure will occur. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified (S3). Hence, the printing failure can be avoided. As another example, when a user stops the mounting of the ink cartridge 40 after the hollow tube 153 is inserted into the sealing member 51 and before the hollow tube 153 starts to move the valve member 62, ink cannot be supplied to the ink jet head 2 when printing is performed. In such a case, printing failure will occur. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path

43a, and the error is notified (S3). Hence, the printing failure can be avoided. As yet another example, when a user stops the mounting of the ink cartridge 40 after the valve member 62 starts to move but before the valve member 62 moves to a position sufficiently away from the valve seat 61, printing failure may occur because the gap between the valve member 62 and the valve seat 61 is too small and sufficient flow rate of ink may not be obtained when printing is performed. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified. Hence, the printing failure can be avoided.

[0088] Providing the coil spring 63 biasing the valve member 62 toward the sealing member 51 enables accurate positioning of the valve member 62 which moves by being pressed by the hollow tube 153, whereby the detection by the photo-sensor 66 can be more precise.

[0089] Because the movable member functions as the valve member 62, the determination of whether the ink path has been correctly formed from the ink cartridge 40 to the main body of the ink jet printer 1, e.g., to the mounting portion, and the opening/closing of the second valve 60 can be simultaneously achieved. Therefore, the over all costs of manufacturing the ink jet printer 1 can be reduced.

[0090] Also, due to the first valve 50 being provided, sealing of the ink within the ink cartridge 40 can be performed more securely.

[0091] In a first modified embodiment, the pressing member 70 is not integral with the valve member 62, but is integral with the spherical member 52. In a second modified embodiment, the pressing member 70 is integral with neither the spherical member 52 nor the valve member 62, and is positioned between the spherical member 52 and the valve member 62. The same advantages as in the first embodiment can be obtained by these modified embodiments as well. Further, in the first embodiment and the first and second modified embodiments, the photo-sensor 66 may detect the spherical member 52 instead of the valve member 62. Determination of whether or not the hollow tube 153 has been correctly inserted can be made by this arrangement as well.

[0092] In a third modified embodiment, referring to Figs 15A and 15B, the first valve 50 comprises a sealing member 450 which is an elastic member positioned in the ink outlet path 43a and contacting the inner surface of the tube 45 to close the opening of the ink outlet path 43a formed at the second end of the ink outlet path 43a, and the first valve 50 does not comprise a spherical member and a coil spring. An opening is not formed through

the sealing member 450. In this modified embodiment, the number of parts can be reduced as compared to the first embodiment and the first and second modified embodiments. A pressing member 470 according to this third modified embodiment comprises a wide-diameter portion 471 extending from the outer surface of the tip of the pressing member 470. The wide-diameter portion 471 has a diameter slightly less than the inner diameter of the tube 45. Accordingly, referring to Fig. 15B, the pressing member 470 and the tip of the hollow tube 153 come into contact in a stable manner. The sealing member 450 is made of the same material as the sealing member 51 in the first embodiment.

[0093] In this third modified embodiment, when the hollow tube 153 is inserted into the sealing member 450 for the first time, the sealing member 450 as the first valve becomes the open state when the hollow tube 153 passes through the sealing member 450 (when the tip of the hollow tube 153 goes beyond the right end of the sealing member 450 in Figs. 15A and 15B, the hollow tube 153 penetrates through the sealing member 450, thereby elastically deforming the sealing member 450, i.e., compressing the sealing member 450 to allow hollow tube 153 to pass therethrough, without removing any portion of sealing member 450. As shown in Figs. 15A and 15B, the elastic deformation of sealing member 450 may transition the first valve to the open state). However, once the hollow tube 153 is pulled out of the sealing member 450 and then the hollow tube 153 is inserted into the sealing member 450 again, the sealing member 450 as the first valve becomes the open state when the tip of the hollow tube 153 is inserted into the sealing member 450 (when the tip of the hollow tube 153 goes beyond the left end of the sealing member 450 in Figs. 15A and 15B). More specifically, an opening is formed through the sealing member 450 when the hollow tube 153 is inserted through the sealing member 450 for the first time, whereby the sealing member 450 becomes the open state. When the hollow tube 153 is pulled out of the sealing member 450, the opening formed through the sealing member 450 is closed off by the elastic force of the sealing member 450, and thereby the sealing member 450 becomes the close state (the opening formed through the sealing member 450 is closed off by the sealing member 450 elastically reforming to seal the hole created by the penetration of hollow tube 153, thereby transitioning the first valve to the close state). When the hollow tube 153 is inserted into the sealing member 450 again, the opening of the sealing member 450 which has been closed is opened by the insertion of the tip of the hollow tube 153 therein, and thereby the sealing member 450 becomes the open state.

[0094] Referring to Fig. 15A, because a gap is formed between the sealing member

450 and the tip of the pressing member 470 in the first direction when the hollow tube 153 is not inserted into the sealing member 450, the second valve 60 becomes the open state after the sealing member 450 as the first valve becomes the open state,.

[0095] When the hollow tube 153 is pulled out of the sealing member 450 from a state in which the hollow tube 153 is in the ink outlet path 43a and the valves 450 and 60 are in the open state, the second valve 60 becomes the close state first, and then the sealing member 450 becomes the close state when the hollow tube 153 is pulled out of the sealing member 450 completely.

[0096] In the third modified embodiment, the gap is formed between the sealing member 450 and the tip of the pressing member 470 when the hollow tube 153 is not inserted into the sealing member 450. Nevertheless, in another embodiment, there may be no gap between the sealing member 450 and the tip of the pressing member 470 when the hollow tube 153 is not inserted into the sealing member 450. In other words, the sealing member 450 and the tip of the pressing member 470 may constantly be in contact when the hollow tube 153 is not inserted into the sealing member 450. In this case, when the hollow tube 153 comes into contact with the pressing member 470, the sealing member 450 as the first valve is already in the open state, and further insertion of the hollow tube 153 from this state causes the second valve 60 to become the open state. When the hollow tube 153 is pulled out of the sealing member 450, the sealing member 450 becomes the close state after the second valve 60 becomes the close state.

[0097] Also, in a fourth modified embodiment, referring to Figs. 16A and 16B, the ink cartridge 40 does not comprise the second valve 60, but comprises a movable member 662 which moves in accordance with the insertion of the hollow tube 153 in the ink outlet path 43a, instead of the second valve 60. More specifically, the ink cartridge 40 does not comprise the valve seat 61 and the valve member 62, but comprises the movable member 662. The movable member 662 is biased by the coil spring 63 to contact the ring-shaped protrusion 44a. The pressing member 70 is connected to the movable member 662 and is integral with the movable member 662, similarly to the first embodiment. After the hollow tube 153 is inserted through the sealing member 51 and the first valve 50 becomes the open state, the spherical member 52 comes into contact with the tip of the pressing member 70. When the hollow tube 153 is further inserted, the pressing member 70 and the movable member 662 move, and the movable member 662 moves away from the ring-shaped protrusion 44a. The movable member 662 has openings 662a formed therethrough in the

first direction. Ink is allowed to pass through the openings 662a regardless of whether the movable member 662 contacts the ring-shaped portion 44a or not. As such the movable member 662 allows ink to pass therethrough regardless of the position of the movable member 662 and does not prevent ink from passing therethrough. In this case, in step 4 (S4), the determination by the controller 100 does not correspond to the determination of whether or not the second valve 60 is in the open state, but corresponds to the determination of whether or not the hollow tube 153 has been correctly inserted into the ink cartridge 40. Also, the movable member 662 is preferably configured to be biased by a biasing member in a direction opposite to the insertion direction of the hollow tube 153, while the movement of the movable member 662 is restricted to within a predetermined range. The photo-sensor 66 is configured to detect the position of this movable member 662, thereby indirectly detecting the position of the hollow tube 153 inserted into the ink outlet path 43a. Because the second valve 60 is not provided in this modified embodiment, higher reliability may be required for the first valve 50 to reduce ink leakage. In this fourth modified embodiment, for example, if the hollow tube 153 is broken off from its base portion, the hollow tube 153 may not be able to be inserted into the first valve 50 when the ink cartridge 40 is mounted to the mounting portion 150, and therefore the first valve 50 may not become the open state. When this occurs, ink cannot be supplied to the ink jet head 2 when printing is performed, and printing failure will occur. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified (S3). Hence, the printing failure can be avoided. For another embodiment, if the tip of the hollow tube 153 is broken off, the broken tip of the hollow tube 153 may damage the sealing member 51 when the ink cartridge 40 is mounted to the mounting portion 150. In such a case, ink may leak from the damaged sealing member 51. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified (S3). Accordingly, a user may notice that the hollow tube 153 is broken, and therefore ink leakage due to the broken hollow tube 153 can be avoided before happens.

[0098] In the above described first embodiment and first to fourth modified embodiments, the photo sensor 66 is configured to indirectly detect that the hollow tube 153 is at a predetermined range of positions within the ink outlet path 43a by detecting that the movable member (pressing member 70 and valve member 62) is positioned at a predetermined range of positions. Nevertheless, referring to Figs. 17A and 17B, according

to a fifth modified embodiment, a photo sensor 566 is configured to directly detect that the hollow tube 153 is at a predetermined range of positions within the ink outlet path 43a. The photo sensor 566 is a light-transmission-detecting type optical sensor comprising a light-emitting portion 566a and a light-receiving portion 566b facing each other via the ink outlet tube 43, and is configured to detect whether the hollow tube 153 is positioned at a predetermined range of positions within the ink outlet path 43a. Referring to Fig. 17A, when the hollow tube 153 is not inserted into the sealing member 51, light emitted from the light-emitting portion 566a passes through the ink outlet path 43a and reaches the light-receiving portion 566b. Therefore, the intensity of light received at the light-receiving portion 566b is greater than a threshold value, and the photo sensor 566 transmits the detection signal A. Referring to Fig. 17B, when the hollow tube 153 is inserted into the sealing member 51 and reaches a position in the ink outlet path 43a between the light-emitting portion 566a and the light-receiving portion 566b, light emitted from the light-emitting portion 566a is at least partially blocked by the hollow tube 153. Therefore, the intensity of light received at the light-receiving portion 566b is less than or equal to the threshold value, and the photo sensor 566 transmits the detection signal B.

In this case, in step 4 (S4), the determination by the controller 100 does not correspond to the determination of whether or not the second valve 60 is in the open state, but corresponds to the determination of whether or not the hollow tube 153 has been correctly inserted into the ink cartridge 40.

[0099] In this fifth modified embodiment, for example, if the hollow tube 153 is broken off from its base portion, the hollow tube 153 may not be able to be inserted into the first valve 50 when the ink cartridge 40 is mounted to the mounting portion 150, and therefore the first valve 50 may not become the open state. When this occurs, ink cannot be supplied to the ink jet head 2 when printing is performed, and printing failure will occur. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified (S3). Hence, the printing failure can be avoided. For another embodiment, if the tip of the hollow tube 153 is broken off, the broken tip of the hollow tube 153 may damage the sealing member 51 when the ink cartridge 40 is mounted to the mounting portion 150. In such a case, ink may leak from the damaged sealing member 51. Nevertheless, in such a case, it is determined that the hollow tube 153 has not been properly inserted into the ink outlet path 43a, and the error is notified (S3). Accordingly, a user may notice that the hollow tube 153 is broken, and therefore ink

leakage due to the broken hollow tube 153 can be avoided before happens.

[0100] In a sixth modified embodiment, a magnetic sensor is used instead of the photo sensor 66. In this embodiment, the second valve member 62 comprises a magnet, and the magnetic sensor comprises a hall element. When the second valve member 62 faces the sensor, the magnetic flux density at the hall element is high, and the sensor outputs the detection signal A. When the second valve member 62 does not face the sensor, the magnetic flux density at the hall element is low, and the sensor outputs the detection signal B.

[0101] In a seventh modified embodiment, the hollow tube 153 is movable relative to the mounting portion 150. When the ink cartridge 40 is not mounted to the mounting portion 150, the hollow tube 153 is retracted within the base portion 150A. When the ink cartridge 40 is mounted to the mounting portion 150, and when the controller 100 determines that the electric power output portion 162 and the electric power input portion 92 are electrically connected and the contacts 161 and 91 are electrically connected, the controller 100 controls an actuator (not shown) to move the hollow tube 153 out of the base portion 150A to be inserted into the ink outlet path 43a of the ink cartridge 40.

[0102] Referring to Figs. 11 and 12 an ink cartridge 240 according to a second embodiment of the present invention comprises a controller 90, and a storing portion 125 connected to the controller 90, in addition to the components of the ink cartridge 40 of the first embodiment. Note that components which are the same as or equivalent to those in the first embodiment will be denoted with the same reference numerals and description thereof will be omitted.

[0103] Referring to Fig. 11, the controller 90 provided to the ink cartridge 240 is electrically connected to the contact 91. Also, the controller 90 is electrically connected to the electric power input portion 92. When the electric power input portion 92 is electrically connected to the electric power output portion 162, electric power is supplied to the controller 90 and the photo-sensor 66. The photo-sensor 66 according to this second embodiment is not directly connected to the contact 91, and is connected to the controller 90. Accordingly, the photo-sensor 66 outputs the detection signal A and detection signal B to the controller 90. The controller 90 then transmits the detection signal A and detection signal B received from the photo-sensor 66 to the controller 100 of the ink jet printer 1 via the contacts 91 and 161.

[0104] Incidentally, when the ink cartridge 240 is mounted to the mounting portion

150, ink may leak from the discharge nozzles of the corresponding ink jet head 2. When the mounting of the ink cartridge 240 to the mounting portion 150 is completed and the ink cartridge 240 stops moving, ink may still move in the ink bag 42 with its inertia. This movement of ink in the ink bag 42 may cause pressure fluctuation in ink, and such pressure fluctuation may be transferred to ink in the ink jet head 2 and may push ink out of the discharge nozzles. The amount of ink leakage from the discharge nozzles depends on the speed at which the ink cartridge 240 is mounted to the mounting portion 150 and the amount of ink stored in the ink cartridge 240.

[0105] The storing portion 125 stores the data shown in the Table 1 below. Table 1 shows whether or not there is need to perform a maintenance by the maintenance unit 30 for the ink jet heads 2 when the ink cartridge 240 is mounted to the mounting portion 150, and the amount of ink leakage from the discharge nozzles of the ink jet heads 2. Specifically, whether or not there is need to perform the maintenance, and the amount of ink leakage, are shown corresponding to three time ranges T1 to T3 and four ink amount ranges V1 to V4. As for an example of the time ranges T1 to T3, the time range T1 is a range from 0 second to less than 0.5 seconds (0 sec. ≤ T1 < 0.5 sec.), the time range T2 is a range from 0.5 seconds to less than 1.5 seconds (0.5 sec. ≤ T2 < 1.5 sec.), and the time range T3 is a range from 1.5 seconds to less than 2.5 seconds (1.5 sec. ≤ T3 < 2.5 sec.), with the ranges being adjacent to each other. Also, as for an example of ink amount ranges V1 to V4, the ink amount range V1 is a range from 0 milliliter to less than 500 milliliters (0 ml ≤ V1 < 500 ml), the ink amount range V2 is a range from 500 milliliters to less than 700 milliliters (500 ml ≤ V2 < 700 ml), the ink amount range V3 is a range from 700 milliliters to less than 800 milliliters (700 ml ≤ V3 < 800 ml), and the ink amount range V4 is a range from 800 milliliters to less than 1000 milliliters (800 ml ≤ V4 < 1000 ml), with the ranges being adjacent to each other.

[0106]

Table 1

		Ink amount range			
		V1	V2	V3	V4
Time Range	T1	Maintenance unnecessary	Maintenance necessary	Maintenance necessary	Maintenance necessary
		No ink leakage	Ink leakage about 0 ml	Ink leakage minute	Ink leakage small
	T2	Maintenance unnecessary	Maintenance unnecessary	Maintenance necessary	Maintenance necessary
		No ink leakage	No ink leakage	Ink leakage about 0 ml	Ink leakage minute
	T3	Maintenance unnecessary	Maintenance unnecessary	Maintenance unnecessary	Maintenance necessary
		No ink leakage	No ink leakage	No ink leakage	Ink leakage about 0 ml

[0107] The storing portion 125 stores data indicating that there is no ink leakage and the maintenance is unnecessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V1, and if a mounting time falls within either one of the time ranges T1 to T3. The mounting time is a period of time from the time when the mounting of the ink cartridge 240 to the mounting portion 150 is started to the time when the state of the second valve 60 changes from the close state to the open state.

[0108] Also, the storing portion 125 stores data indicating that there is ink leakage of about 0 ml and the maintenance is necessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V2, and if the mounting time falls within the time range T1. The storing portion 125 stores data indicating that there is no ink leakage and the maintenance is unnecessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V2, and if the mounting time falls within either one of the time ranges T2 and T3. In other words, the storing portion 125 stores data indicating that when the mounting time is below 0.5 seconds (predetermined time) there may be slight ink leakage (although it may be 0 ml), and that the maintenance is necessary.

[0109] Also, the storing portion 125 stores data indicating that there is minute ink leakage (e.g., around 1 ml) and the maintenance is necessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V3, and if the mounting time falls within the time range T1. The storing portion 125 stores data indicating that there is ink leakage of about 0 ml and the maintenance is necessary, if the ink

amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V3, and if the mounting time falls within the time range T2. The storing portion 125 stores data indicating that there is no ink leakage and the maintenance is unnecessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V3, and if the mounting time falls within the time range T3. In other words, when the amount of ink stored in the ink cartridge 240 falls within the range of V3, the maintenance is necessary if the mounting time is below 1.5 seconds (predetermined time), and the maintenance is unnecessary if the time range is greater than or equal to 1.5 seconds.

[0110] Also, the storing portion 125 stores data indicating that there is a small amount of ink leakage (e.g., around 3 ml) and the maintenance is necessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V4, and if the mounting time falls within the time range T1. The storing portion 125 stores data indicating that there is minute ink leakage and the maintenance is necessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V4, and if the mounting time falls within the time range T2. The storing portion 125 stores data indicating that there is ink leakage of about 0 ml and the maintenance is necessary, if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 falls within the range of V4, and if the mounting time falls within the time range T3. Further, the storing portion 125 stores data indicating that there is no ink leakage and maintenance is unnecessary, if the mounting time is greater than or equal to 2.5 seconds (predetermined time), and if the ink amount stored in the ink cartridge 240 mounted in the mounting portion 150 is less than 1000 ml.

[0111] Thus, the storing portion 125 stores data indicating the predetermined time (0 seconds, 0.5 seconds, 1.5 seconds, or 2.5 seconds) serving as a boundary (threshold) indicating whether or not there is necessity to perform the maintenance, for each of the ink amount ranges V1 to V4. In other words, for the ink amount range V1, the predetermined time of 0 seconds is stored, for ink amount range V2 the predetermined time of 0.5 seconds is stored, for ink amount range V3 the predetermined time of 1.5 seconds is stored, and for ink amount range V4 the predetermined time of 2.5 seconds is stored. These predetermined times are longer, the greater the ink amounts indicated by ink amount ranges V1 to V4 are.

[0112] Also, the storing portion 125 comprises a flash memory which can be rewritten by the controller 90 or an external device (the controller 100 or the like), and also

stores data indicating the ink amount stored in the ink cartridge 240. Accordingly, an ink amount obtained by subtracting the ink amount consumed by printing and the ink amount consumed by purging from the ink amount of the ink cartridge 240 stored immediately prior to rewriting, can be rewritten in the storing portion 125 by the controller 100. Further, the storing portion 125 also stores the ink leakage amounts, so the ink amount can be corrected at the time of rewriting the ink amount. In other words, the controller 90 can rewrite the ink amount from which the ink leakage amount at the time of mounting the ink cartridge 240 to the mounting portion 150 has also been subtracted. Accordingly, the storing portion 125 can accurately store the current amount of ink stored in the ink cartridge 240.

[0113] When a used ink cartridge 240 is refurbished, the amount of ink injected into the ink cartridge 240 may be more or less than the amount of ink stored in the ink cartridge 240 when the ink cartridge 240 is originally manufactured. In such a case, the data indicating the injected amount of ink can be easily rewritten. Also, because the storing portion 125 is provided to the ink cartridge 240, the storage capacity of the storing portion 120 of the main unit of the ink jet printer 1 can be reduced.

[0114] Referring to Fig. 12, when the ink cartridge 240 is intended to be mounted to the mounting portion 150, step H1 to step H3 are performed in the same way as the step 1 to step 4 of the above-described first embodiment. In step H4, the controller 100 determines whether or not the second valve 60 is in the open state. This determination is made on whether the controller 100 receives the detection signal B. As described above, when the valve member 62 moves, such that the photo-sensor 66 and the valve member 62 no longer face each other, the detection signal A which has been output from the photo-sensor 66 changes to the detection signal B. If the controller 100 receives the detection signal A and determines that the second valve 60 is in the close state, the flow returns to step H2, and if the controller 100 receives the detection signal B and determines that the second valve 60 is in the open state, the flow advances to step H5. Like in the first embodiment, the determination of whether or not the second valve 60 is in the open state in step H4 also includes the determination of whether the hollow tube 153 has been correctly inserted into the ink cartridge 240.

[0115] From the time when the detection signal C starts to be output from the sensor 170 until the second valve 60 becomes the open state, the followings occurs. First, during the period of time after the detection signal C starts to be output from the sensor 170 to the controller 100 and before the hollow tube 153 starts to be inserted to the opening 51a, the

contact 91 and the contact 161 are electrically connected, and the contact 163 of the electric power output portion 162 and the electric power input portion 92 are electrically connected. Accordingly, the two controllers 90 and 100 are electrically connected, such that the two controllers 90 and 100 can exchange signals with each other, and also electric power is supplied to the controller 90 and the photo-sensor 66. Also, when the contact 91 and the contact 161 are connected, time data signal indicating the time at which the controller 100 determines the start of mounting (the time at which the controller 100 initially receives the detection signal C from the sensor 170) is output from the controller 100 to the controller 90. Subsequently, as the hollow tube 153 is inserted into the opening 51a, the tip of the hollow tube 153 comes into contact with the spherical member 52 and the spherical member 52 moves toward the second valve 60 (to the right in Figs. 7A and 7B), such that the spherical member 52 is separated from the curved portion 51c and ring-shaped protrusion 51b, and the state of the first valve 50 changes from the close state to the open state. Subsequently, the spherical member 52 comes into contact with the tip of the pressing member 70, and the spherical member 52, the pressing member 70, and the valve member 62 move toward the connecting portion 42a (to the right in Figs. 7A and 7B). The valve member 62 and the valve seat 61 then are separated from each other, and the state of the second valve 60 changes from the close state to the open state. Thus, when the second valve 60 becomes the open state, the contact 91 and the contact 161 are electrically connected, so the controller 100 can receive the detection signal B output from the controller 90.

[0116] Next, in step H5, the controller 90 calculates the mounting time between the time when the mounting of the ink cartridge 240 to the mounting portion 150 was stared (the time at which the controller 100 initially received the detection signal C from the sensor 170), which can be known from the time date transmitted from the controller 100 to the controller 90, and the time when the controller 90 initially received the detection signal B from the photo-sensor 66. In step H6, the controller 90 reads in the date indicating the current amount of ink stored in the ink cartridge 240 and the data shown in the Table 1, stored in the storing portion 125. Next, in step H7, the controller 90 determines whether or not the data in the storing portion 125 has been read in step 6. If there is no data stored in the storing portion 125 and accordingly no data can be read in, an error signal is output from the controller 90 to the controller 100, and the flow advances to step H8. In step 8, the controller 100 which has received the error signal controls the buzzer 13 to notify the user that there is an abnormality in the storing portion 125. On the other hand, if it is determined

in step 7 that the controller 90 successfully read in the data of the storing portion 125, the flow advances to step H9.

[0117] In step H9, the controller 90 determines which of the time ranges T1 to T3 the mounting time calculated in step 5 falls within, and also determines which of the ink amount ranges V1 to V4 the amount of ink read in step H7 falls within, and determines whether or not there is necessity to perform the maintenance for the ink cartridge 240 this time. In other words, determination is made regarding whether or not the mounting time (one of T1 to T3) is below the predetermined time indicating the boundary (threshold) of whether or not the maintenance is required, with regard to the ink amount range (one of V1 to V4) corresponding to the amount of ink stored in the ink cartridge 240.

[0118] If the controller 90 determines that there is no need to perform the maintenance, the flow advances to step H12.

[0119] If the controller 90 determines that the maintenance needs to be performed, the flow advances to step H10, and the controller 90 outputs a signal to the controller 100 requesting starting of the maintenance. Then, the controller 100 first controls the elevator mechanism, such that the ink jet heads 2 moves from the printing position to the retracted position (see Fig. 4A). Next, the controller 100 controls the driving motor to move the caps 31 to positions facing the discharging faces 2a (see Fig. 4B). The controller 100 then controls the driving motor to position the caps 31 at capping positions near the discharging faces 2a.

[0120] Next, the controller 100 drives the pumps for a predetermined period of time, and forcibly feeds ink from the ink cartridges 240 to the ink jet heads 2. Accordingly, a predetermined amount of ink is purged from the ink jet heads 2 within the caps 31. Subsequently, the controller 100 controls the driving motor to return the caps 31 from the purging position to the initial position. At this time, the controller 100 may control a wiping mechanism (not shown), e.g., a wiper (not shown) and a driving motor (not shown) for driving the wiper included in the maintenance unit 30, so as to wipe ink adhering to the discharging faces 2a due to the purging operation. The controller 100 then controls the elevator mechanism to return the ink jet heads 2 from the retracted position to the printing position. Thus, the maintenance ends. When the maintenance ends, the controller 100 outputs a signal notifying the controller 90 of ending of the maintenance.

[0121] Next, in step H11, the controller 90 rewrites the date of the amount of ink stored in the storing portion 125. Specifically, first determination is made regarding

whether the amount of ink leakage is approximately 0 ml, the minute amount, or the small amount. Next, the ink amount of ink stored in the storing portion 125 is rewritten with a value obtained by subtracting the amount of ink leakage that has been determined and the amount of ink consumed in purging operations from the currently stored amount of ink. The amount of ink consumed in the purging operation is not restricted to a certain predetermined amount, and may be adjusted as appropriate taking into consideration environmental conditions such as temperature and the like, and in such a case, the controller 100 needs to notify the controller 90 of the amount of ink consumed in the purging operation. Thereafter, the flow advanced to step H12.

[0122] Next, in step H13, the controller 90 outputs a signal to the controller 100 indicating that printing can be performed. The controller 100 which has received this signal then controls the buzzer 13 to emit a sound from the buzzer 13 to notify the user of "ready to print". Thus, mounting of the ink cartridge 240 is completed. In another embodiment, rewriting of the amount of ink in step H11 may be performed after step H12 and before the printing is performed.

[0123] In the ink jet printer 1 according to this second embodiment, in addition to the above-described steps H10 and H11, the controller 100 or controller 90 is configured to rewrite the amount of ink by subtracting the amount of ink consumed in one printing operation after the ink cartridge 240 has been mounted to the mounting portion 150 from the amount of ink immediately before that operation was performed. Accordingly, even if an ink cartridge 240 with a certain amount of ink remaining therein is removed from the mounting portion 150 and mounted again to the mounting portion 150, the maintenance can be performed on the ink jet head 2 only in cases in which the mounting time (falling within one of T1 to T3) calculated by the controller 90 is below the predetermined time corresponding to the remaining amount of ink (falling within one of V1 to V4). Accordingly, unnecessary maintenance can be avoided.

[0124] When ink stored in the ink cartridge 40 is used up, the door 1c of the ink jet printer 1 is opened and the ink cartridge 240 is removed from the mounting portion 150, in the same way as in the first embodiment described above. As the ink cartridge 240 is moved to be removed, the spherical member 52, valve member 62, and pressing member 70 move toward the sealing member 51 (to the left in Figs. 7A and 7B) while contacting each other, due to the biasing forces of the coils springs 53 and 63. When the valve member 62 comes into contact with the valve seat 61, the state of the second valve 60 changes from the

open state to the close state, and the flow of ink from the ink bag 42 to the inner space 153a of the hollow tube 153 stops. At this time, the signal output from the photo-sensor 66 to the controller 90 changes from the detection signal B to the detection signal A, and the controller 90 determines that the second valve 60 is in the close state.

[0125] Subsequently, only the spherical member 52 moves along with the hollow tube 153, such that the spherical member 52 and the tip of the pressing member 70 are separated. The spherical member 52 then comes into contact with the ring-shaped protrusion 51b and curved portion 51c, so the state of the first valve 50 changes from the open state to the close state. Thus, the state of each of the first and second values 50 and 60 changes from the open state to the close state in accordance with the movement of the hollow tube 153 pulled out of the sealing member 51. The first valve 50 becomes the close state after the second valve 60 becomes the close state.

[0126] After the ink cartridge 240 moves further and the hollow tube 153 is pulled out of the sealing member 51 completely, the contact between the contact 91 and contact 161, and the contact between the electric power input portion 92 and contact 163, are cut off. When the housing 41 is separated from the detecting portion 171 and the detecting portion 171 comes out of the sensor 170, the detection signal D is output from the sensor 170 to the controller 100. Accordingly, the controller 100 can determine that the ink cartridge 240 has been removed from the mounting portion 150. In this way, the old ink cartridge 240 is removed form the mounting portion 105, and a new ink cartridge 240 is mounted to the mounting portion 105.

[0127] Method for manufacturing and refurbishing the ink cartridge 240 will be described. When the ink cartridge 240 is manufactured, the housing 41 is first fabricated divided into two, and parts such as the ink bag 42 and ink outlet tube 43 are assembled in the first half of the housing 41. The second half of the housing 41 is then attached the first half of the housing 41. Next, a predetermined amount of ink is injected into the ink bag 42 via the ink outlet path 43a. Further, the data shown in Table 1 and data indicating the ink amount that has been injected is stored in the storing portion 125 of the ink cartridge 240. Thus, manufacturing of the ink cartridge 240 is completed.

[0128] In a modified embodiment, parts of the ink cartridge 240 other than the housing 41 are assembled, to which ink is injected. And then, the assembled parts are attached into the housing 240. Subsequently, the predetermined data is stored in the storing portion 125.

[0129] When a used ink cartridges 40 is refurbished, first, the ink bag 42, ink outlet tube 43, and so forth are washed. Next, a predetermined amount of ink is injected into the ink bag 42. Then, the data of the amount of ink stored in the storing portion 125 of the ink cartridge 240 is replaced with the date indicating the amount of ink that has been injected. Thus, refurbishing of ink cartridge 40 is completed.

[0130] As described above, according to this second embodiment, when the ink cartridge 240 is mounted to the mounting portion 150, the spherical member 52 and the movable member (pressing member 70 and valve member 62) move due to insertion of the hollow tube 153, and whether or not the valve member 62 is in the open state can be determined by the detection of the photo-sensor 66, and also whether or not the hollow tube 153 has been correctly inserted into the ink cartridges 240 can be determined. Accordingly, the same advantages as in the first embodiment can be obtained.

[0131] Also, in the ink jet printer 1 according to this second embodiment, when the ink cartridge 240 is mounted to the mounting portion 150, the controller 90 calculates the mounting time. When the position of the ink cartridge 240 at which the sensor 170 initially detects the ink cartridge 240 is defined as a first position, and the position of the ink cartridge 240 at which the second valve 60 becomes the open state, the distance between the first position and the second position in the mounting direction is substantially constant. The first position also can be defined as the position of the ink cartridge 240 at which the signal output from the sensor 170 changes from the detection signal D to the detection signal C from the detecting portion 171 by the contact between the detection portion 171 of the sensor 170 and the housing 41. The second position also can be defined as the position of the ink cartridge 240 at which the signal output from the photo-sensor 66 changes from the detection signal A to the detection signal B when the photo-sensor 66 moves relative to the valve member 62 from a state facing the valve member 62 to a state not facing the valve member 62. Therefore, by calculating the time that the ink cartridge 240 requires to move between the first position and the second position as the mounting time, how fast the ink cartridge 240 was mounted to the mounting portion 150 can be known. When the ink cartridge 240 is mounted at a slow speed, the mounting time is long, and the pressure fluctuation generated in ink at the time of mounting is small. On the other hand, when the ink cartridge 240 is mounted at a fast speed, the mounting time is short, and the pressure fluctuation at the time of mounting is great. Whether or not the calculated mounting time is below the predetermined time based on the data shown in Table 1, i.e., whether or not the

maintenance needs to be performed, is determined by the controller 90. Accordingly, when the ink cartridge 240 is mounted to the mounting portion 150 at high speed, the maintenance of the ink jet heads 2 can be performed, thereby preventing faulty discharge from occurring at the ink jet head 2 beforehand.

[0132] Also, the storing portion 125 stores the predetermined time serving as the boundary (threshold) of whether or not the maintenance is necessary for each ink amount range V1 to V4, the maintenance can be performed on the ink jet heads 2 only in cases where the mounting time which the controller 90 has calculated is below the predetermined time corresponding to the relevant ink amount range V1 to V4. Accordingly, unnecessary maintenance can be avoided. Also, the predetermined times serving as the boundaries (thresholds) are longer, the greater the amount of ink indicated by the ink amount range V1 to V4 is. Accordingly, whether or not the maintenance of the ink jet heads 2 is necessary can be determined with high precision, and faulty discharge at the ink jet heads 2 can be prevented even better.

[0133] Also, in the ink cartridge 240 according to this second embodiment, the maintenance unit 30 and the controller 100 controlling the maintenance unit 30 are provided to the main unit of the ink jet head 1, so if the mounting time is below the predetermined time stored in the storing portion 125, the maintenance of the ink jet head 2 can be performed. Accordingly, faulty discharge at the ink jet head 2 can be prevented. Also, in the method for refurbishing the ink cartridge 240 according to this second embodiment, the ink cartridge 240 enjoying the above-described advantages can be refurbished.

[0134] In a modified embodiment of the second embodiment, the sensor 170 is provided at such a position that the sensor 170 can detect the housing 41 at the time when the state of the first valve 50 changes from the close state to the open state. In this case, the detection signal C output from the sensor 170 to the controller 100 indicates the first valve 50 is the open state, and the detection signal D output from the sensor 170 to the controller 100 indicates the close state of the first valve 50. Also, in this modified embodiment, for example, the ring-shaped protrusion 51b is made longer in the first direction, such that when the ink cartridge 240 is mounted to the mounting portion 150 the first valve 50 becomes the open state after the second valve 60 becomes the open state. In such a case, the mounting time is a period of time between the time when the state of the first valve 50 changes from the close state to the open state and the time when the state of the second valve 60 changes from the close state to the open state. Thus, the same advantages as in the second

embodiment can be obtained.

[0135] Referring to Fig. 13, an ink cartridge 340 according to a third embodiment of the present embodiment, comprises a tube 244 instead of the tube 44. The difference between the tube 244 and the tube 44 is that the portion of tube 244 into which the tube 45 is fitted is longer than that of tube 44 in the first direction. Accordingly, compared to the first embodiment, more portion of the tube 45 is positioned in the tube 44, such that the ink discharge opening 46a is positioned closer to the flange 47 (compare Figs. 7A and 7B and Fig. 13). A photo-sensor 266 configured to detect the presence or absence of an object is disposed in the housing 41 adjacent the first valve 50. A reflection-detecting type optical sensor comprising a light-emitting portion and light-receiving portion can be used for the photo-sensor 266 for example. A mirror face capable of reflecting light is formed at least on a portion of the spherical member 52. Other configurations are the same as in the first and second embodiments, and accordingly will be denoted with the same reference numerals and specific description thereof will be omitted.

[0136] The photo-sensor 266 is connected to the controller 90 and the electric power input portion 92. Referring to Fig. 13, the photo-sensor 266 is disposed so as not to face the spherical member 52 when the ring-shaped protrusion 51b and the spherical member 52 are in contact, and to face the spherical member 52 when the ring-shaped protrusion 51b and the spherical member 52 are separated, as indicated in Fig. 13 as a double-dot dashed line. When the photo-sensor 266 faces the spherical member 52, the photo-sensor 266 outputs a signal indicating that the light-receiving portion is receiving light (hereinafter referred to as "detection signal E"). On the other hand, when the photo-sensor 266 does not face the spherical member 52, the photo-sensor 266 outputs a signal indicating that the light-receiving portion is not receiving light (hereinafter referred to as "detection signal F"). These signals are transmitted to the controller 100 of the main unit of the ink jet printer 1 via the controller 90, and the controller 100 receives these signals, and accordingly can determine the open state and the close state of the first valve 50. In this embodiment, when the controller 100 receives the detection signal E indicating that the light-receiving portion is receiving light the controller 100 determines that the first valve 50 is in the open state, and when the controller 100 receives the detection signal F indicating that the light-receiving portion is not receiving light, the controller 100 determines that the first valve 50 is in the close state.

[0137] When the ink cartridge 340 is mounted to the mounting portion 150, first, step

H1 to step H4 are performed in the same way as in the second embodiment. The contact 91 and the contact 161, and the contact 163 of the electric power output portion 162 and the electric power input portion 92, are electrically connected, before the first valve 50 becomes the open state, such that the two controllers 90 and 100 are electrically connected and capable of exchanging signals with each other, and also electric power is supplied to the controller 90 and the photo-sensors 66 and 266. In a modified embodiment of this third embodiment, in step H2, the controller 100 may determine whether the mounting limit time has expired since the controller 100 initially receives the detection signal E from the photo-sensor 266 by the time the controller 100 initially receives the detection signal B from the photo-sensor 66. In the case of this modified embodiment, the mounting limit time stored in the storing portion 120 is different from the mounting limit time of the first and second embodiments. Further, in the case of this modified embodiment, the mounting limit time may be stored in the storing portion 125, and the controller 90 may perform the processing in step H2. Also, the controller 90 may determine whether or not the second valve 60 is in the open state in step H4. In this case, the detection signal B indicating the open state of the second valve 60 does not need to be output from the controller 90 to the controller 100.

[0138] Next, in step H5, the controller 90 calculates the mounting time between the time when the controller 90 initially received the detection signal E from the photo-sensor 266 and the time when the controller 90 initially received the detection signal B from the photo-sensor 66. Subsequently, step H6 to step H13 are performed in the same way as in the second embodiment. Because the time for calculating the mounting time is changed from the time at which the controller 100 initially receives the detection signal C from the sensor 170 in the second embodiment to the time when the controller 90 initially received the detection signal E from the photo-sensor 266 (the time at which the state of the first valve 50 changes from the close state to the open state), so the data shown in Table 1 should be different from the date of the second embodiment accordingly.

[0139] When ink stored in the ink cartridge 340 is used up, the door 1c of the ink jet printer 1 is opened and the ink cartridge 240 is removed from the mounting portion 150, in the same way as in the first and second embodiments described above. As the ink cartridge 340 is moved to be removed, the spherical member 52, the valve member 62, and the pressing member 70 move toward the sealing member 51 (to the left in Fig. 13) while contacting each other, due to the biasing forces of the coil springs 53 and 63. In other words, the spherical member 52, the pressing member 70, and valve member 62 move in a direction

opposite to a direction in which the hollow tube 153 is inserted into the ink outlet path 43a. When the valve member 62 comes into contact with the valve seat 61, the state of the second valve 60 changes from the open state to the close state, and the signal output from the photo-sensor 66 to the controller 90 changes from the detection signal B to the detection signal A, and the controller 90 determines that the second valve 60 is in the close state. Subsequently, when the spherical member 52 comes into contact with the ring-shaped protrusion 51b, i.e., when the state of the first valve 50 changes from the open state to the close state, the signal output from the photo-sensor 266 to the controller 90 changes from the detection signal E to the detection signal F, and the controller 90 determine that the first valve 50 is in the close state.

[0140] After the ink cartridge 340 moves further and the hollow tube 153 is pulled out of the sealing member 51 completely, the contact between the contact 91 and contact 161, and the contact between the electric power input portion 92 and contact 163, are cut off. When the housing 41 is separated from the detecting portion 171 and the detecting portion 171 comes out of the sensor 170, the detection signal D is output from the sensor 170 to the controller 100. Accordingly, the controller 100 can determine that the ink cartridge 340 has been removed from the mounting portion 150. In this way, the old ink cartridge 340 is removed form the mounting portion 105, and a new ink cartridge 340 is mounted to the mounting portion 105.

[0141] As described above, as in the first and second embodiments, according to this third embodiment, when the ink cartridge 340 is mounted to a mounting portion 150, whether or not the hollow tube 153 has been correctly inserted into the ink cartridges 340 can be determined. Accordingly, the same advantages as in the first and second embodiments can be obtained.

[0142] In the ink jet printer 1 according to this third embodiment, when the ink cartridge 340 is mounted to the mounting portion 150, the controller 90 calculates the mounting time and determines whether or not there is need to perform the maintenance. Accordingly, the same advantages as in the second embodiment can be obtained. Also, the photo-sensor 266 for detecting the absence and the presence of the first valve 50 at a predetermined position is provided, and the controller 90 calculates the mounting time between the time at which the detection signal B indicating that the second vale 60 is in the open state is initially output from the photo-sensor 66 and the at which the detection signal E indicating that the first valve 50 is in the open state is initially output from the photo-

sensor 266, and therefore the mounting time can be accurately calculated as compared with the second embodiment. This is because the distance which the ink cartridge 340 moves for calculating the mounting time is shorter. If the moving distance is shorter, the influence of the variation of the speed at which a user mounts the ink cartridge 340 to the mounting portion 150 is smaller, and accordingly the mounting time is calculated accurately. In this third embodiment, because the signals output from the photo-sensors 66 and 266 are used for calculating the mounting time, the sensor 170 may not be provided in the mounting portion 150.

[0143] In a modified embodiment of the third embodiment, the ring-shaped protrusion 51b is made longer in the first direction, such that when the ink cartridge 340 is mounted to the mounting portion 150 the first valve 50 becomes open state after the second valve 60 becomes the open state. In this case as well, the mounting time is a period of time between the time at which the detection signal B indicating that the second vale 60 is in the open state is initially output from the photo-sensor 66 and the time at which the detection signal E indicating that the first valve 50 is in the open state is initially output from the photo-sensor 266. Thus, the same advantages as in the third embodiment can be obtained.

[0144] In a modified embodiment of the second or third embodiment, instead of the controller 90, the controller 100 may perform the process performed by the controller 90. More specifically, the controller 100 may perform the process of steps H5 to H7 and steps H9 to H11 instead of the controller 90. In this case, the controller 90 does not have to be provided to the ink cartridge 240 or 340. In this case as well, the same advantages as in the second and third embodiments can be obtained.

[0145] In another modified embodiment of the second or third embodiment, instead of the ink cartridge 240 or 340, the main unit of the ink jet printer 1 may comprise the storing portion 125. Also, the storing portion 125 may store different predetermined times (the times serving as the boundaries (thresholds) of whether or not the maintenance is needed), depending on the specifications (models) of the main unit of the ink jet printer 1 to which the ink cartridge 240 or 340 is mounted. Specifically, if the length of the path extending from the hollow tube 153 to the discharge nozzles of the ink jet head 2 is longer than a reference length, predetermined times which are shorter than reference predetermined times, respectively, may be stored in the storing portion 125, and if the length of the path extending from the hollow tube 153 to the discharge nozzles of the ink jet head 2 is shorter than the reference length, predetermined times which are longer than reference

predetermined times, respectively, may be stored in the storing portion 125. Also, the predetermined times may depend on meniscus withstanding pressure instead of the path length. Specifically, if the diameter of the discharge nozzle of the ink jet head 2 is greater than a reference diameter (the meniscus withstanding pressure is smaller than a reference withstanding pressure), predetermined times which are shorter than reference predetermined times, respectively, may be stored in the storing portion 125, and if the diameter of the discharge nozzle of the ink jet head 2 is less than a reference diameter, predetermined times which are longer than reference predetermined times, respectively, may be stored in the storing portion 125. Selection of the reference predetermined times and the predetermined times are performed by the controller 100 taking into consideration the specification of the main unit of the ink jet printer 1 is being used. Additionally, the storing portion 125 may store different ink leakage amounts, depending on the specifications of the main unit of the ink jet printer 1 to which the ink cartridge 240 or 340 is mounted.

[0146] In yet another modified embodiment of the second or third embodiment, instead of the ink cartridge 240 or 340, the main unit of the ink jet printer 1 may comprise the storing portion 125. Also, the storing portion 125 may store may store coefficients by which the predetermined times already stored in the storing portion 125 multiplied, respectively, depending on the specifications (models) of the main unit of the ink jet printer 1 to which the ink cartridge 240 or 340 is mounted. Specifically, if the length of the path extending from the hollow tube 153 to the discharge nozzles of the ink jet head 2 is longer than a reference length, coefficients which causes the predetermined times to be shorter than reference predetermined times may be stored in the storing portion 125, and if the length of the path is shorter than the reference length, coefficients which causes the predetermined times to be longer than reference predetermined times may be stored in the storing portion 125. Also, the coefficients may depend on meniscus withstanding pressure instead of the path length. Specifically, if the diameter of the discharge nozzle of the ink jet head 2 is greater than a reference diameter, coefficients which causes the predetermined times to be shorter than reference predetermined times may be stored in the storing portion 125, and if the diameter of the discharge nozzle of the ink jet head 2 is less than a reference diameter, coefficients which causes the predetermined times to be longer than reference predetermined times may be stored in the storing portion 125. Selection of the reference predetermined times and the coefficients are performed the controller 100 taking into consideration the specification of the main unit of the ink jet printer 1 is being used.

Additionally, the storing portion 125 may store different ink leakage amounts, depending on the specifications of the main unit of the ink jet printer 1 to which the ink cartridge 240 or 340 is mounted.

[0147] Referring to Fig. 14, processes performed by the controller 100 according to a fourth embodiment of the prevent invention when the ink cartridge 40 is mounted to the mounting portion 150 will be described. Note that components which are the same as or equivalent to those in the first embodiment will be denoted with the same reference numerals and description thereof will be omitted.

[0148] When the ink cartridge 40 is intended to be mounted to the mounting portion 150, in step Y1, the controller 100 determines whether or not mounting of the ink cartridges 40 to the mounting portions 150 has begun. This determination is made based on whether or not the controller 100 receives the detection signal C. As described above, the signal output from the sensor 170 changes from the detection signal D to the detection signal C, when the detecting portion 171 of the sensor 170 comes into contact with the housing 41. When the controller 100 does not receive the detection signal C from the sensor 170 but rather receives the detection signal D, the controller 100 determines that the mounting has not begun yet and stands by (repeats Y1). When the controller 100 receives the detection signal C from the sensor 170, the controller 100 determines that the mounting has begun, and the flow proceeds to step Y2.

[0149] In step Y2, the controller 100 determines whether or not a mounting limit time has expired since the controller 100 initially receives the detection signal C, i.e., since the controller 100 determines that the mounting has begun at Y1. This determination is made based on whether or not the time elapsed since the controller 100 initially receives the detection signal C at Y1 has exceeded the mounting limit time stored in a storing portion 120 (see Fig. 8) of the main unit of the ink jet printer 1. If it is determined that the elapsed time has exceeded the mounting limit time, the flow advances to step Y3. The controller 100 then controls the buzzer 13 to notify the user that "the ink cartridge is not mounted correctly to the mounting portion" with a sound from the buzzer 13. On the other hand, if the elapsed time has not exceeded the mounting limit time, the flow advances to step Y4.

[0150] In step Y4, the controller 100 determines whether or not the second valve 60 is in the close state. This determination is made on whether the controller 100 receives the detection signal A. If the controller 100 receives the detection signal A and determines that the second valve 60 is in the close state, the advances to Step Y5. If the controller 100 does

not receive the detection signal A and does not determine that the second valve 60 is in the close state, the flow returns to step Y2

[0151] In step Y5, the controller 100 determines whether or not the second valve 60 is in the open state. This determination is made on whether the controller 100 receives the detection signal B. As described above, when the valve member 62 moves, such that the photo-sensor 66 and the valve member 62 no longer face each other, the detection signal A which has been output from the photo-sensor 66 changes to the detection signal B. If the controller 100 does not receive the detection signal B (still receives the detection signal A) and does not determine that the second valve 60 is in the open state, the flow advances to step Y6, and if the controller 100 receives the detection signal B and determines that the second valve 60 is in the open state, the flow advances to step Y7.

[0152] In step Y6, the controller 100 determines whether or not the mounting limit time has expired since the controller 100 initially receives the detection signal C, i.e., since the controller 100 determines that the mounting has begun at Y1, similarly to step Y2. If it is determined that the elapsed time has exceeded the mounting limit time, the flow advances to step Y3. The controller 100 then controls the buzzer 13 to notify the user that "the ink cartridge is not mounted correctly to the mounting portion" with a sound from the buzzer 13. On the other hand, if the elapsed time has not exceeded the mounting limit time, the flow returns to step Y5.

[0153] From the time when the detection signal C starts to be output from the sensor 170 until the second valve 60 becomes the open state, the followings occur. First, during the period of time after the detection signal C starts to be output from the sensor 170 to the controller 100 and before the hollow tube 153 starts to be inserted to the opening 51a, the contact 91 and the contact 161 are electrically connected, and the contact 163 of the electric power output portion 162 and the electric power input portion 92 are electrically connected. Accordingly, the photo-sensor 66 and the controller 100 are electrically connected, such that the controller 100 can receive signals output from the photo-sensor 66, and electric power is supplied to the photo-sensor 66. Subsequently, as the hollow tube 153 is inserted into the opening 51a, the tip of the hollow tube 153 comes into contact with the spherical member 52 and the spherical member 52 moves toward the second valve 60 (to the right in Figs. 7A and 7B), such that the spherical member 52 is separated from the curved portion 51c and the ring-shaped protrusion 51b, and the state of the first valve 50 changes from the close state to the open state. Subsequently, the spherical member 52 comes into contact with the tip of the

pressing member 70 and the pressing member 70, spherical member 52, and valve member 62 move toward the connecting portion 42a (to the right in Figs. 7A and 7B). The valve member 62 and the valve seat 61 are separated from each other, and the state of the second valve 60 changes from the close state to the open state. Thus, when the second valve 60 becomes the open state, the contact 91 and the contact 161 are in electrical contact, so the controller 100 can receive the detection signal B output from the photo-sensor 66. The determination of whether or not the second valve 60 is in the open state in step Y5 thus also includes determination of whether the hollow tube 153 has been correctly inserted into the ink cartridge 40. In other words, with the photo-sensor 66 indirectly detecting whether the hollow tube 153 is at a predetermined range of positions within the ink outlet path 43a by detecting whether the valve member 62 is at a predetermined range of position (a range position where the valve member 62 is more than a predetermined distance away from the valve seat 61), the controller 100 can determine whether or not the hollow tube 153 has been correctly inserted into the ink outlet path 43a, and therefore it can be assured that an ink path has been correctly formed from the ink cartridge 40 to the main unit of the ink jet printer 1, e.g., to the mounting portion 150.

[0154] In step Y7, the controller 100 controls the buzzer 13 to emit a sound from the buzzer 13, indicating "ready to print". Thus, the mounting of the ink cartridge 40 is completed.

[0155] When ink stored in the ink cartridge 40 is used up, the door 1c of the ink jet printer 1 is opened and the ink cartridge 40 is removed from the mounting portion 150. As the ink cartridge 40 is moved to be removed, the spherical member 52, valve member 62, and pressing member 70 move together toward the sealing member 51 (to the left in Figs. 7A and 7B) while contacting each other, due to the biasing forces of the coil springs 53 and 63. In other words, the spherical member 52, valve member 62, and pressing member 70 move in a direction opposite to a direction in which they move when the hollow tube 153 is inserted into the sealing member 51. When the valve member 62 comes into contact with the valve seat 61, the state of the second valve 60 changes from the open state to the close state, and the flow of ink from the ink bag 42 to the inner space 153a of the hollow tube 153 stops. At this time, the signal output from the photo-sensor 66 to the controller 100 changes from the detection signal B to the detection signal A, and the controller 100 determines that the second valve 60 is in the close state.

[0156] Subsequently, only the spherical member 52 moves along with the hollow

tube 153, such that the spherical member 52 and the tip of the pressing member 70 are separated. The spherical member 52 then comes into contact with the ring-shaped protrusion 51b and curved portion 51c, so the state of the first valve 50 changes from the open state to the close state. Thus, the state of each of the first and second valves 50 and 60 changes from the open state to the close state in accordance with the movement of the hollow tube 153 pulled out of the sealing member 51. The first valve 50 becomes the close state after the second valve 60 becomes the close state.

[0157] After the ink cartridge 40 moves further and the hollow tube 153 is pulled out of the sealing member 51 completely, the contact between the contact 91 and contact 161, and the contact between the electric power input portion 92 and contact 163, are cut off. When the housing 41 is separated from the detecting portion 171 and the detecting portion 171 comes out of the sensor 170, the detection signal D is output from the sensor 170 to the controller 100. Accordingly, the controller 100 can determine that the ink cartridge 40 has been removed from the mounting portion. In this way, the old ink cartridge 40 is removed form the mounting portion 105, and a new ink cartridge 40 is mounted to the mounting portion 105.

[0158] In a modified embodiment of either one of the above described embodiment, a display may be provided on the housing 1a instead of the buzzer 13, so as to display images on the display instead of sounds to notify the user. Also, the buzzer and the display may be used together.

[0159] In the above-described first to fourth embodiments, electric power is supplied to the components provided in the ink cartridge, such as the photo-sensors 66 and 266, controller 90, etc. when the ink cartridge is mounted to the mounting portion 150, but in a modified embodiment, the ink cartridge comprises a battery instead of the electric power input portion 92, and a mechanical switch configured to control, e.g., selectively enable and stop, the supply of electric power from the battery to these components. In this case, the mechanical switch enables the supply of electric power from the battery to the components by coming into contact with a wall surface of the recess 151 of the mounting portion 150 when the ink cartridge is mounted to the mounting portion 150. When the mechanical switch moves away from the wall, the supply of electric power from the battery to the components is stopped. Also, the mechanical switch is preferably configured to supply electric power from the battery to the components at the same time when the electric power input portion 92 and the electric power output portion 162 are electrically connected. Thus,

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the same advantages as in the first to third embodiments can be obtained.

[0160] While the sensor configured to detect that the longitudinal object is at a predetermined range of positions is an optical sensor or a magnetic sensor in the above-described embodiments, the sensor can be an electrical switch, a resistance sensor, or any further means known to a skilled person for fulfilling the detection functionality.

[0161] While the invention has been described in connection with various example structures and illustrative embodiments, it will be understood by those skilled in the art that other variations and modifications of the structures and embodiments described above may be made without departing from the scope of the invention. Other structures and embodiments will be apparent to those skilled in the art from a consideration of the specification or practice of the invention disclosed herein. It is intended that the specification and the described examples are illustrative with the true scope of the invention being defined by the following claims.

Industrial Applicability

[0162] The liquid cartridge of the present invention can be widely used for home and office uses.

[0163] Where the terms “comprise”, “comprises”, “comprised” or “comprising” are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components, or group thereto.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An liquid cartridge comprising:

a liquid storing portion configured to store liquid;

a liquid outlet path communicating with an interior of the liquid storing portion, wherein the liquid outlet path is configured to receive a longitudinal object inserted into the liquid outlet path from an outside of the liquid cartridge; and

a detector configured to detect that the longitudinal object is at a predetermined range of positions within the liquid outlet path.

2. The liquid cartridge of claim 1, wherein the detector is configured to detect that the longitudinal object is at the predetermined range of positions within the liquid outlet path by detecting a movable member configured to be moved by an action of the longitudinal object.

3. The liquid cartridge of claim 2, wherein the movable member is provided within the liquid outlet path.

4. The liquid cartridge of claim 3, wherein the movable member is configured to be moved by the longitudinal object by being pressed by the longitudinal object.

5. The liquid cartridge of any one of claims 1 to 4, further comprising:

an elastic member provided at an opening of the liquid outlet path, and configured to elastically deform, through which the longitudinal object can pass.

6. The liquid cartridge of any one of claims 2 to 4, further comprising:

a first valve provided at an opening of the liquid outlet path and configured to selectively allow liquid to flow via the first valve and prevent liquid from flowing via the first valve, wherein the first valve comprises:

an elastic member having an opening formed therethrough, and configured such that the longitudinal object is inserted through the opening of the elastic member;

a first valve member provided in the liquid outlet path, and configured to selectively move toward and away from the elastic member; and

a first biasing member configured to bias the first valve member toward the elastic member,

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wherein the first valve member is configured to move by being pressed by the longitudinal object inserted through the opening of the elastic member.

7. The liquid cartridge of claim 6, wherein the first valve member comprises the movable member.

8. The liquid cartridge of claim 6, wherein the movable member is configured to move in accordance with a movement of the first valve member.

9. The liquid cartridge of any one of claims 2 to 8 wherein the movable member is biased toward the opening of the liquid outlet path.

10. The liquid cartridge of any one of claims 2 to 6, 8 and 9, further comprising:

a second valve provided in the liquid outlet path, wherein the second valve comprises:

a second valve member comprising the movable member,

a valve seat having an opening formed therethrough; and

a second biasing member configured to bias the second valve member toward the valve seat,

wherein when the second valve member contacts the valve seat liquid is prevented from flowing via the opening of the valve seat, and when the second valve member is separated from the valve seat liquid is allowed to flow via the opening of the valve seat.

11. The liquid cartridge of claim 1, wherein the detector is configured to detect that the longitudinal object is at the predetermined range of positions within the liquid outlet path by directly detecting the longitudinal object.

12. The liquid cartridge of any one of claims 1 to 11, wherein the detector is configured to output a detection signal in accordance with the detected predetermined range of positions of the longitudinal object.

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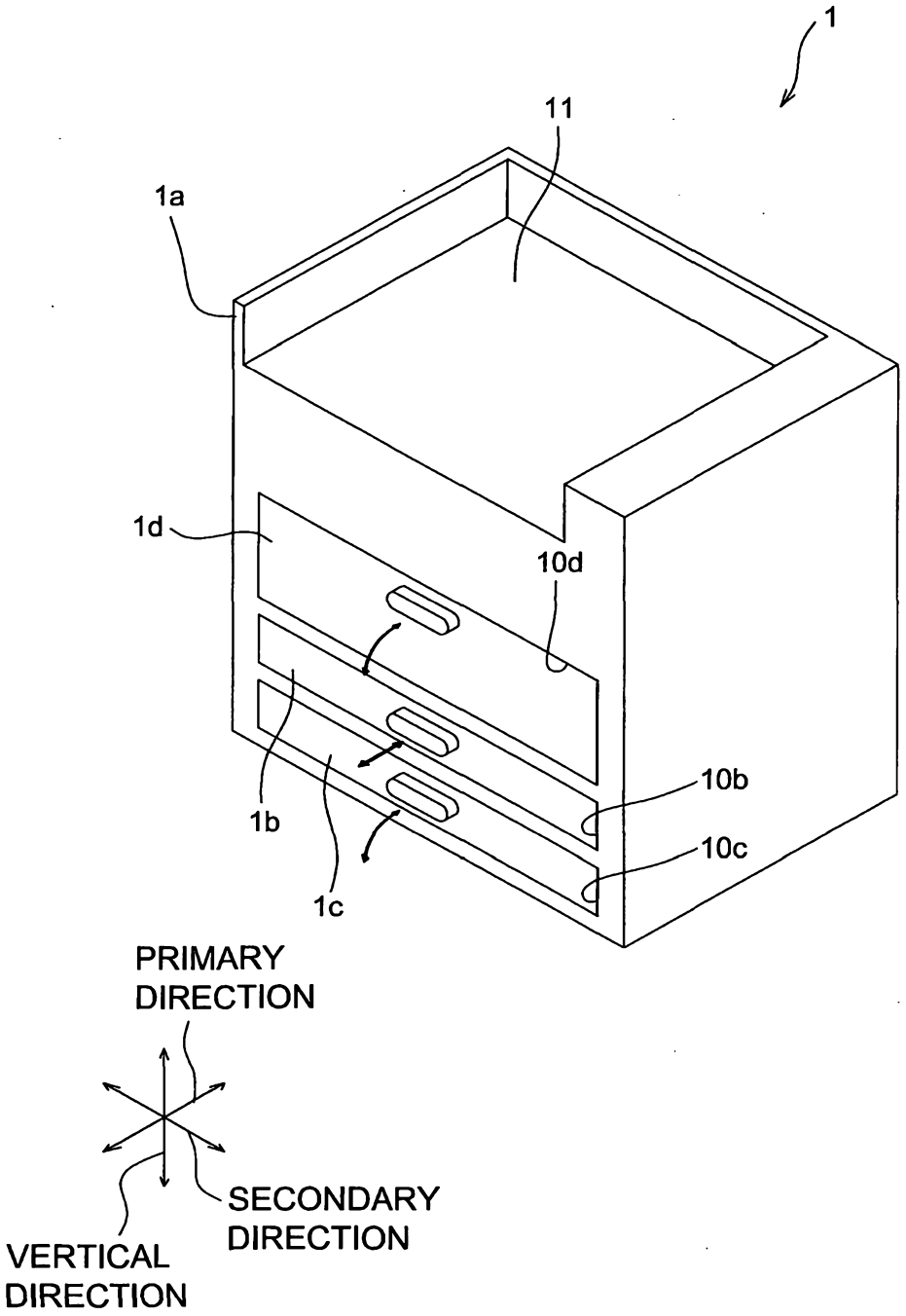
13. A printer comprising:

the liquid cartridge of any one of claims 1 to 12; and

the longitudinal object configured to inserted into the liquid outlet path of the liquid cartridge.

14. The printer of claim 13, wherein the longitudinal object is a hollow tube configured to extract liquid stored in the liquid storing portion to the outside of the liquid cartridge.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10b
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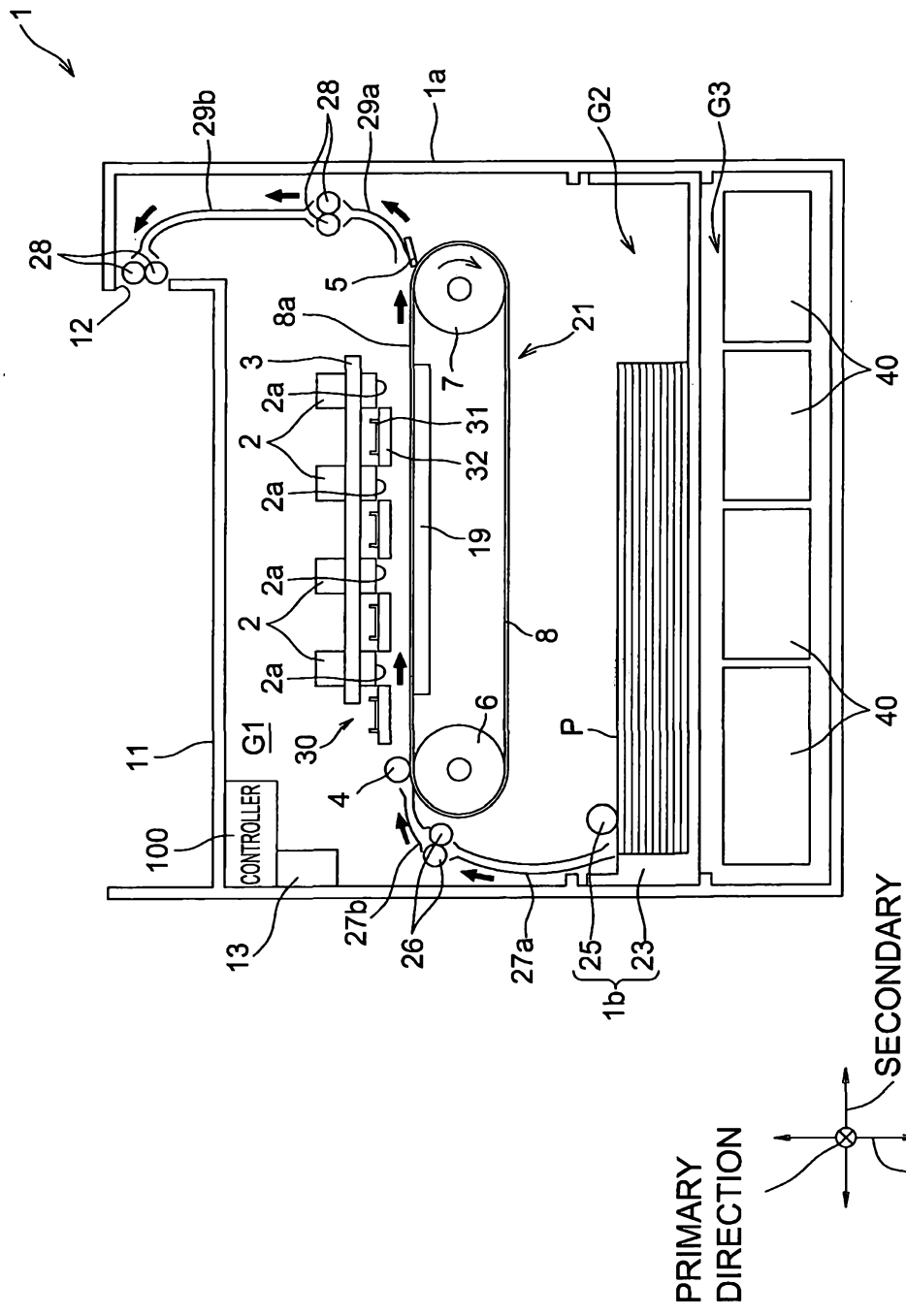
1c
PRIMARY DIRECTION
SECONDARY DIRECTION
VERTICAL DIRECTION

Fig.1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19
8
6
P
11
G1
30
4
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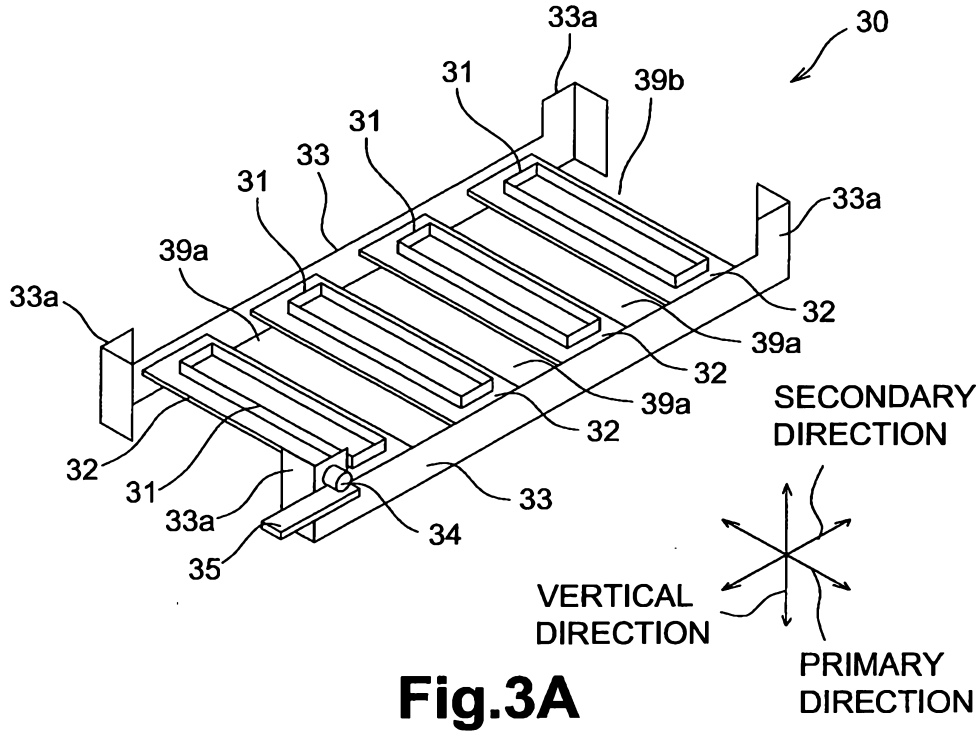
VERTICAL DIRECTION

Fig.2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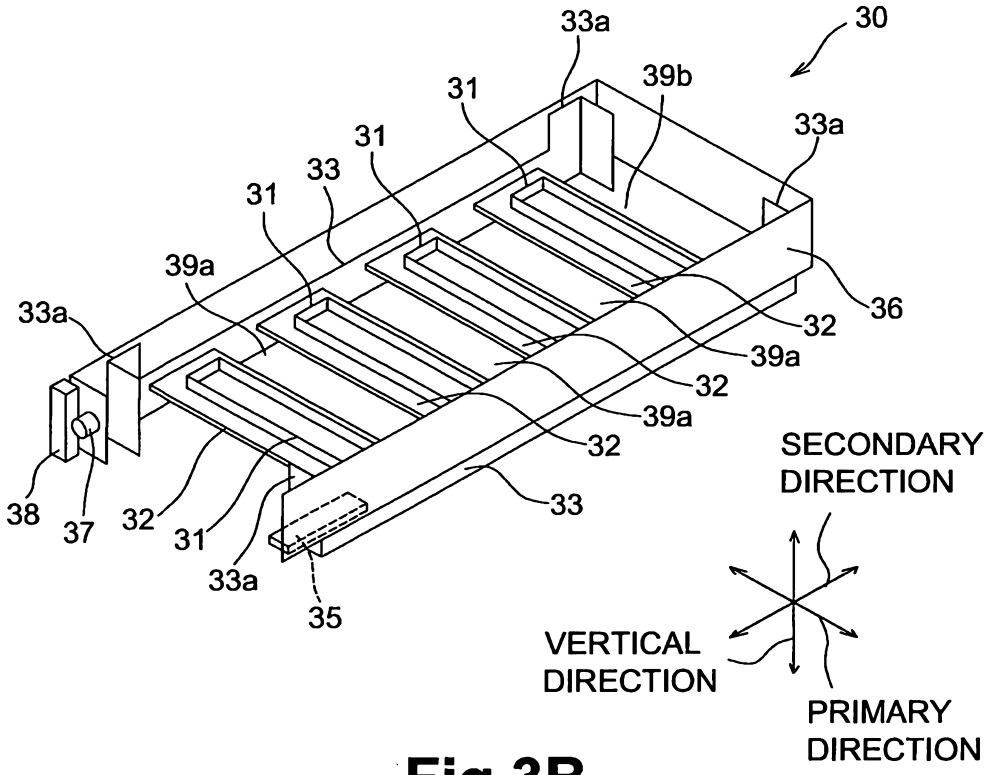
VERTICAL DIRECTION
PRIMARY DIRECTION

Fig.3A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VERTICAL DIRECTION
PRIMARY DIRECTION

Fig.3B

Fig.4A

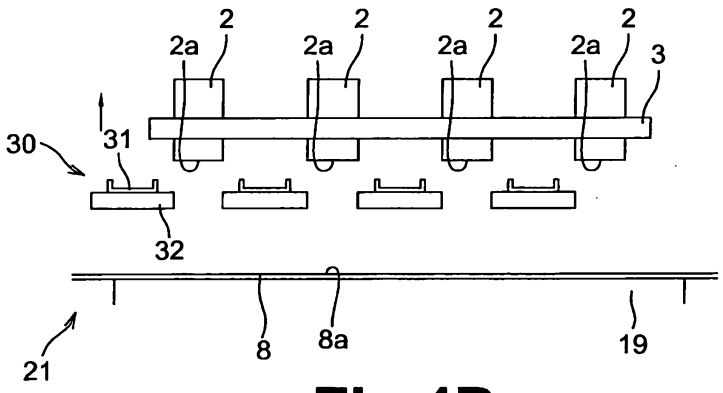


Fig.4B

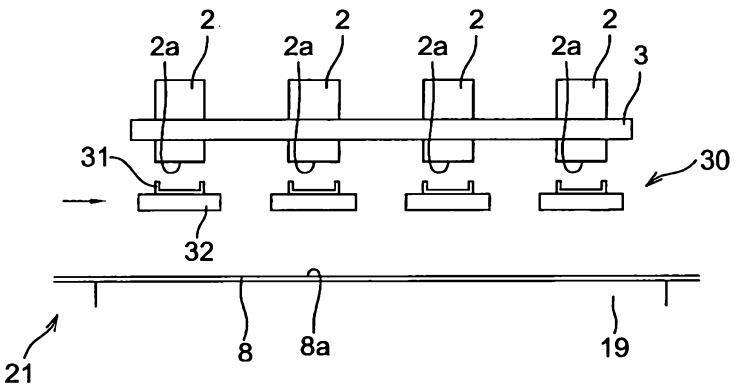
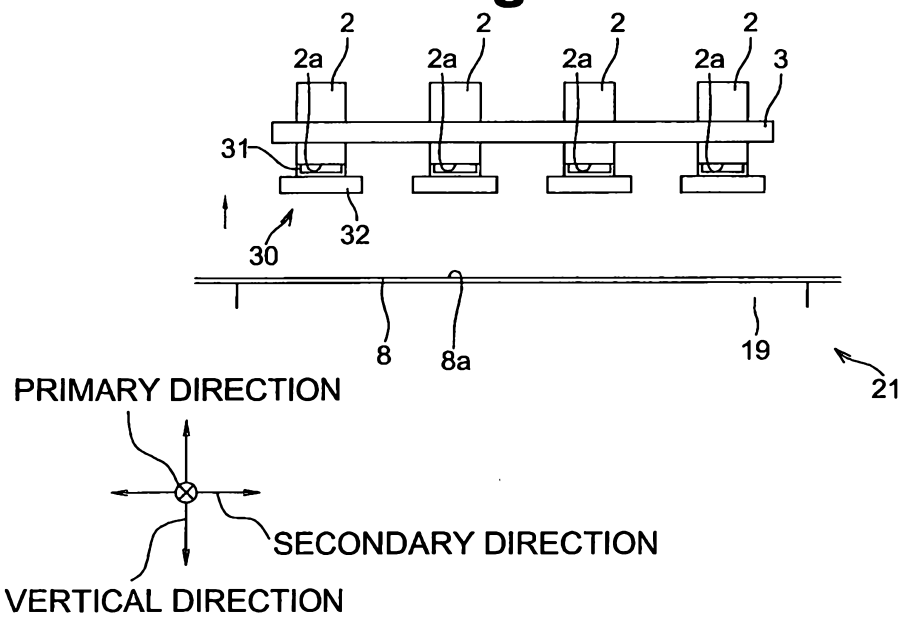


Fig.4C



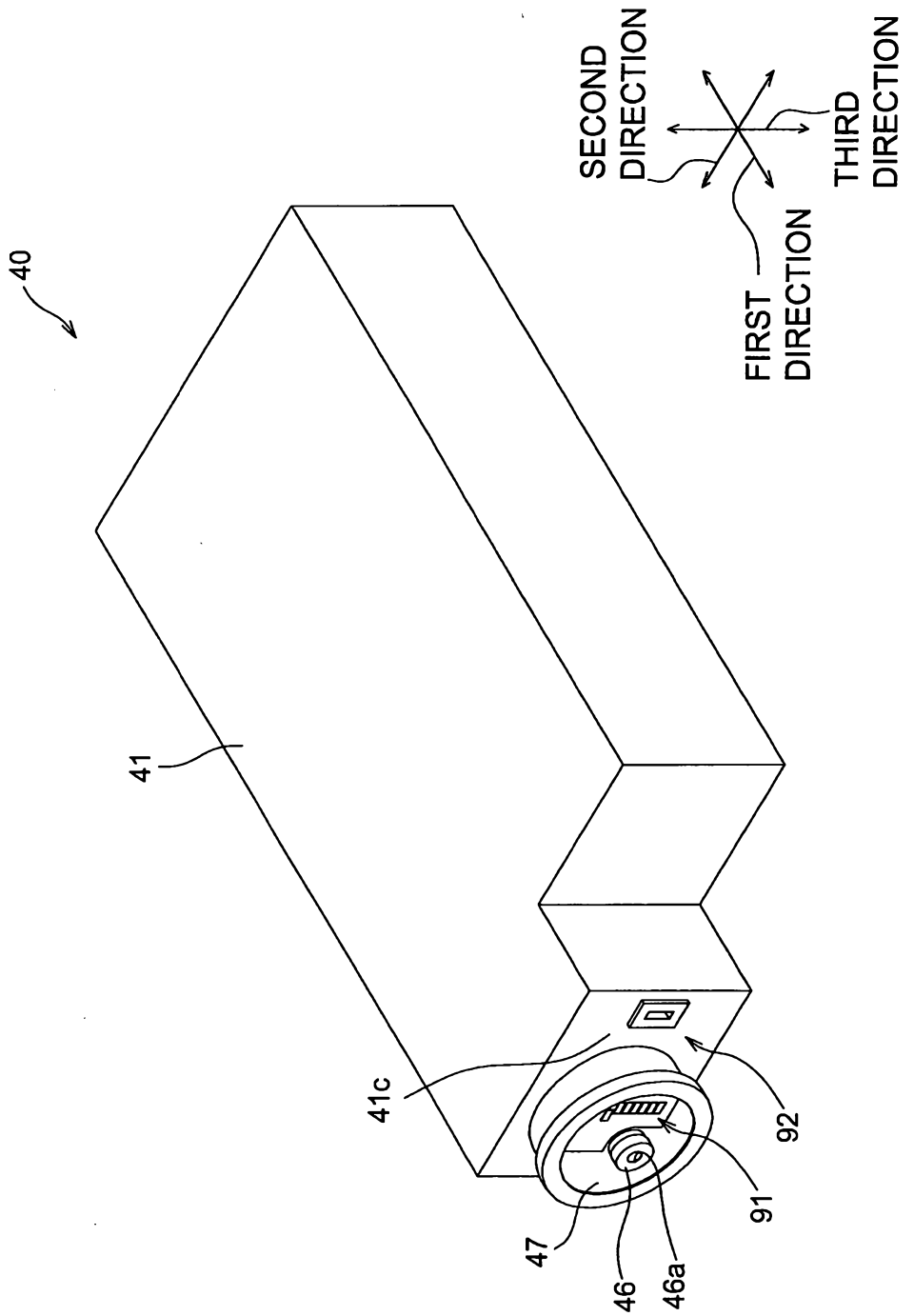

40
41
41c
92
91
47
46
46a
SECOND DIRECTION
THIRD DIRECTION
FIRST DIRECTION

Fig.5

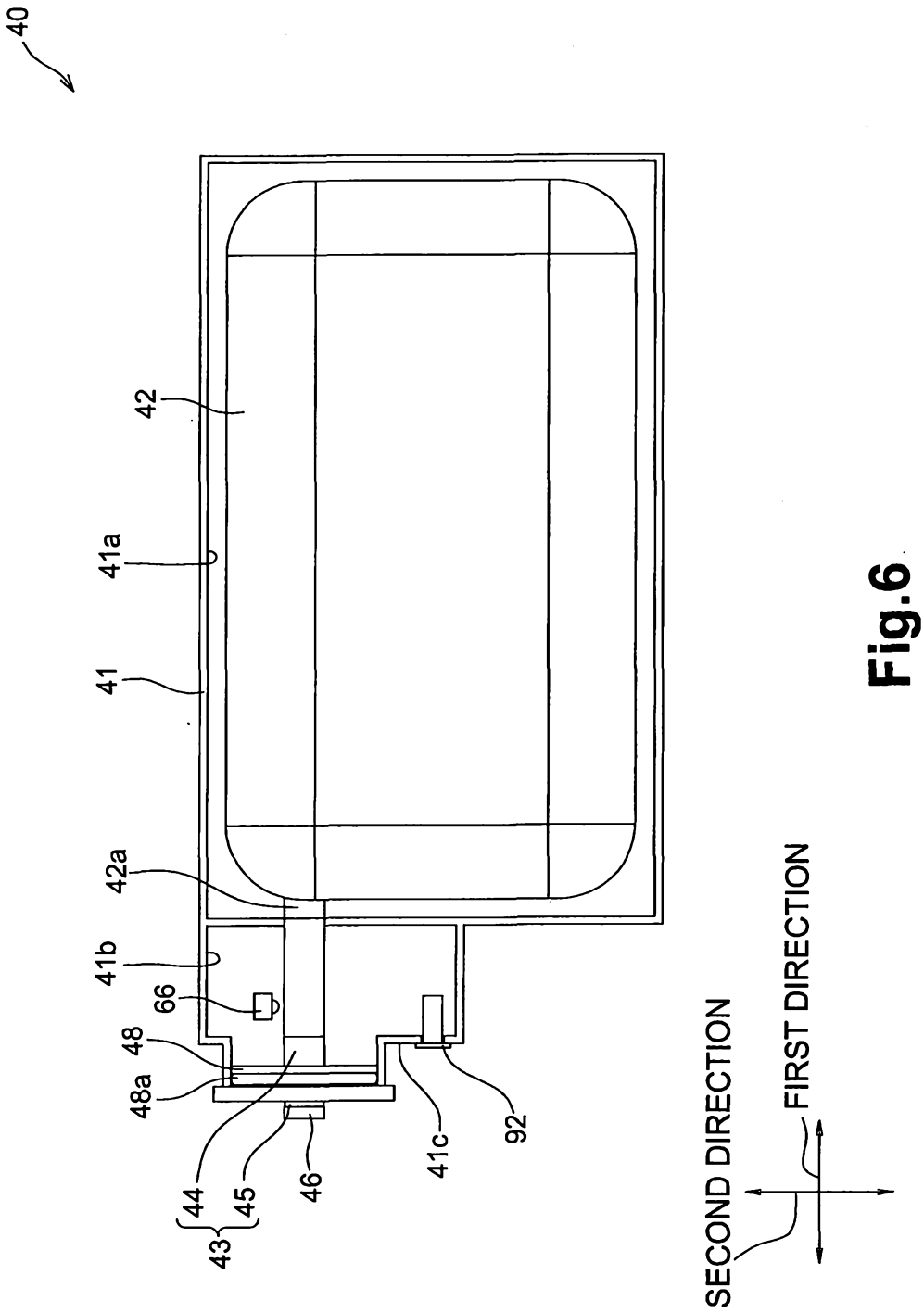

40
42
41a
41
42a
41b
66
48
48a
44
45
43
46
41c
92
SECOND DIRECTION
FIRST DIRECTION

Fig.6

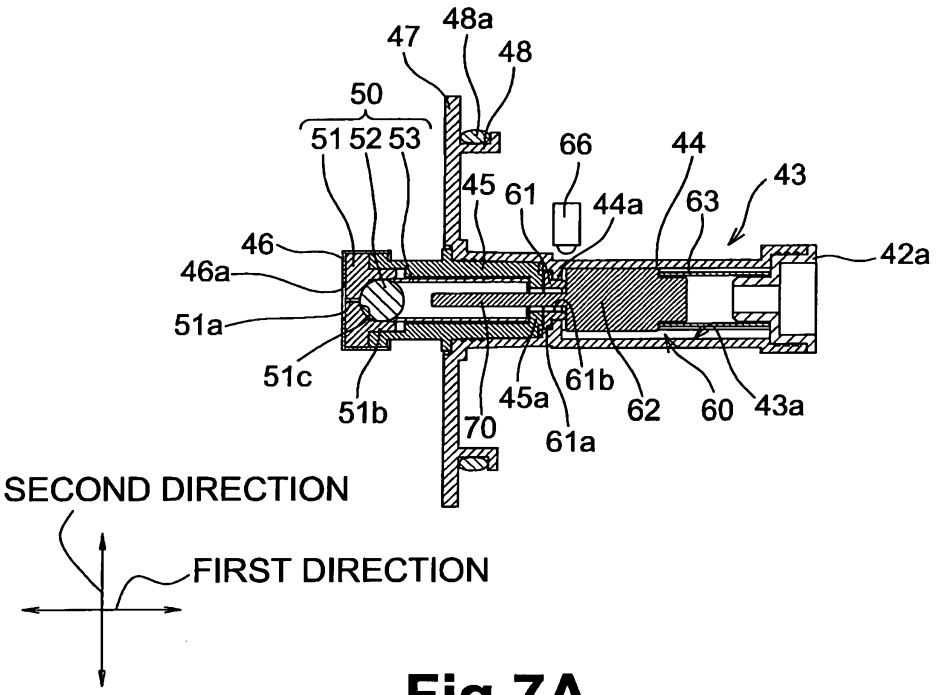

47
48a
48
50
51 52 53
66
44
43
45
61
44a
63
46
42a
46a
51a
51c
51b
45a
61b
62
60
43a
70
61a
SECOND DIRECTION
FIRST DIRECTION

Fig.7A

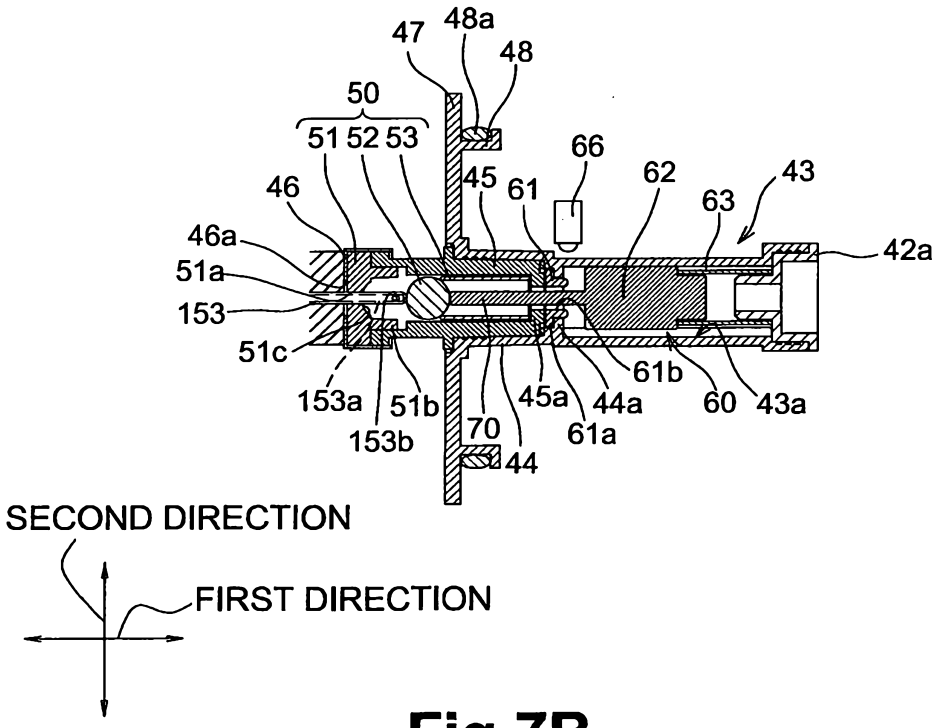

47
48a
48
50
51 52 53
66
62
43
46
45
61
63
46a
42a
51a
153
51c
61b
153a
51b
45a
44a
60
43a
153b
70
61a
44
SECOND DIRECTION
FIRST DIRECTION

Fig.7B

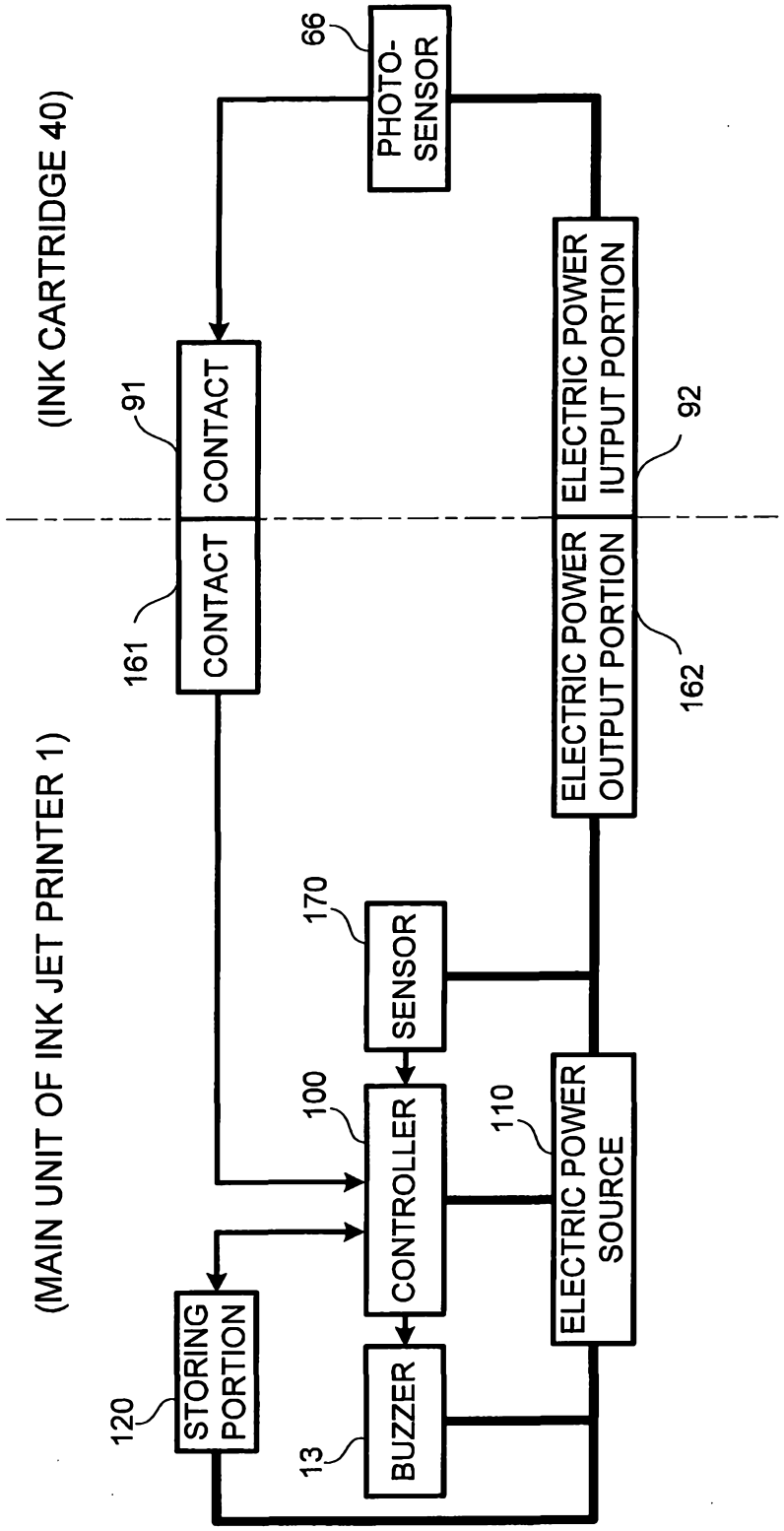

(INK CARTRIDGE 40)
(MAIN UNIT OF INK JET PRINTER 1)
66
PHOTO-SENSOR
91
CONTACT
161
CONTACT
ELECTRIC POWER IUTPUT PORTION
92
ELECTRIC POWER OUTPUT PORTION
162
170
SENSOR
100
CONTROLLER
110
ELECTRIC POWER SOURCE
120
STORING PORTION
13
BUZZER

Fig.8

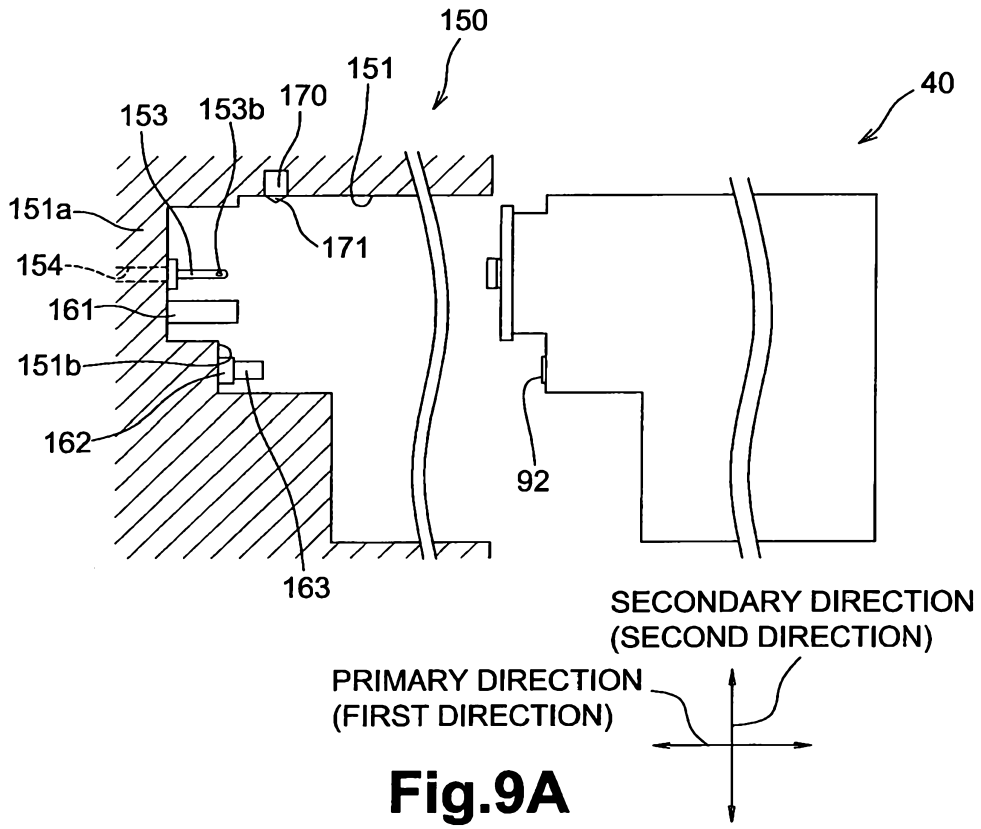

150
151
153
153b
170
40
151a
171
154
161
151b
162
92
163
SECONDARY DIRECTION
(SECOND DIRECTION)
PRIMARY DIRECTION
(FIRST DIRECTION)

Fig.9A

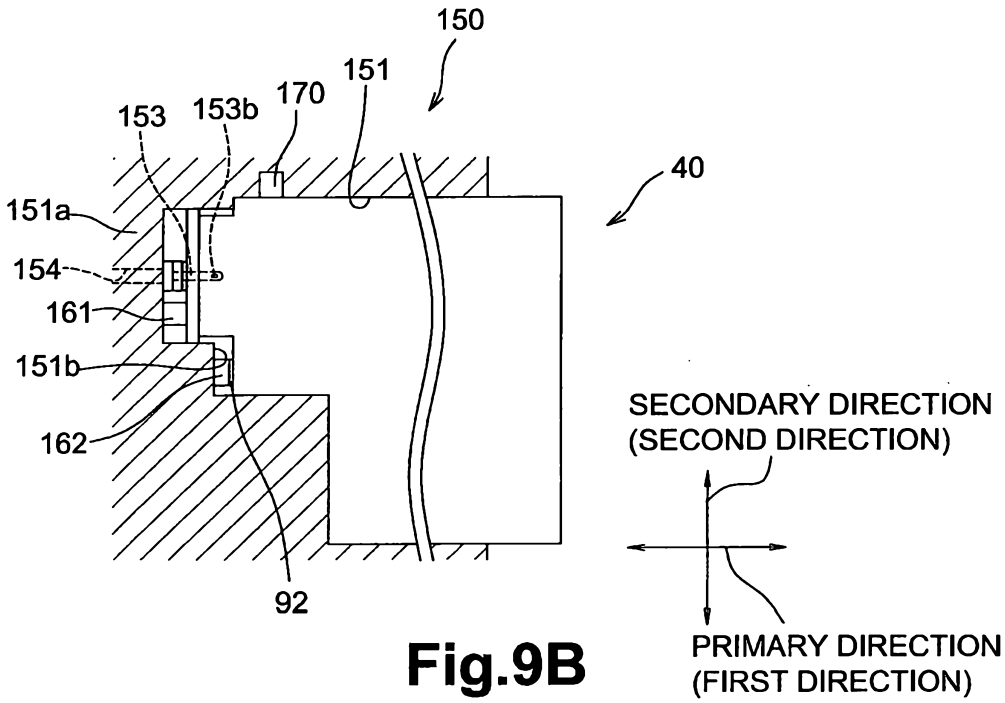

150
151
153
153b
170
40
151a
154
161
151b
162
92
SECONDARY DIRECTION
(SECOND DIRECTION)
PRIMARY DIRECTION
(FIRST DIRECTION)

Fig.9B

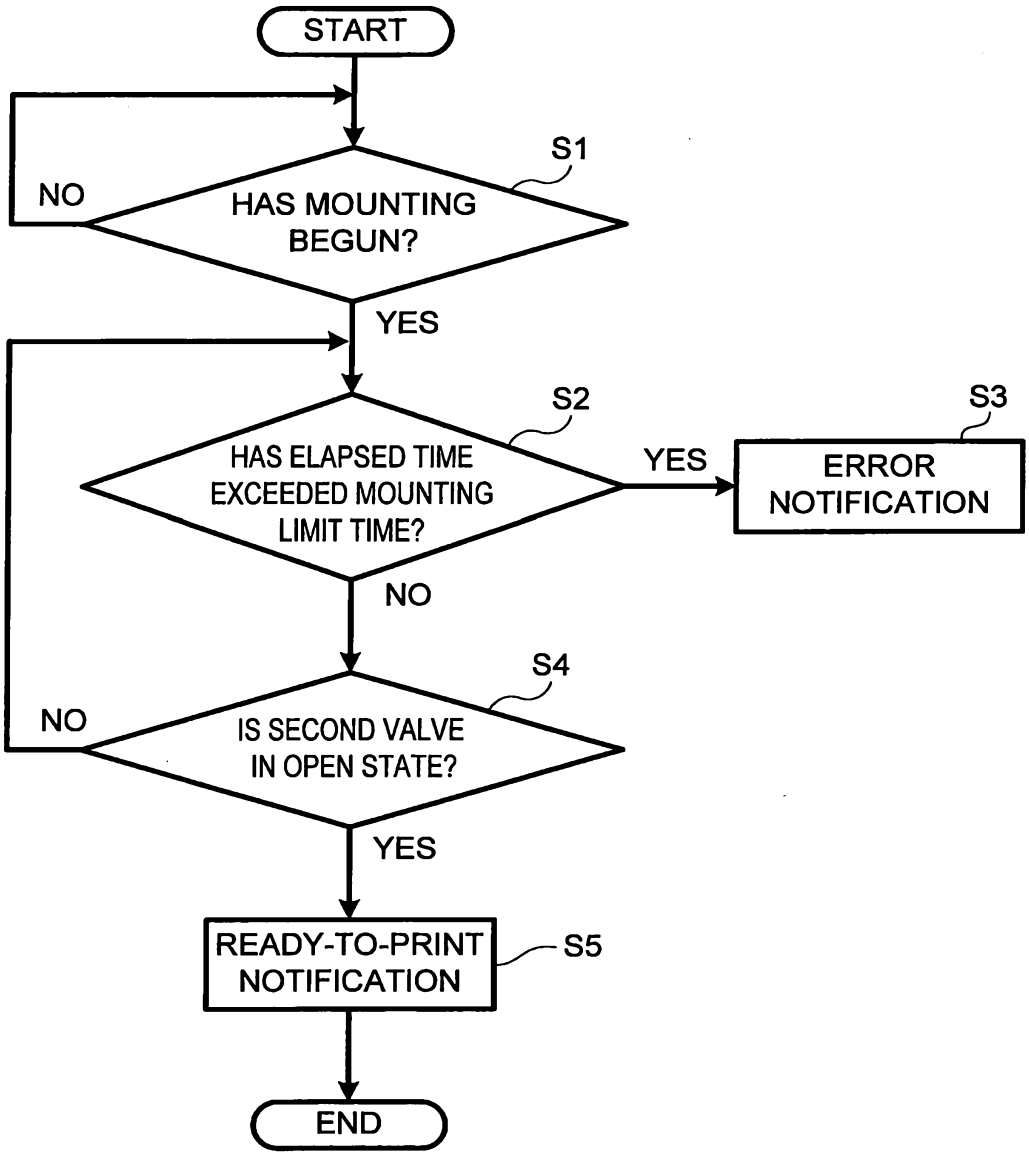

START
S1
NO
HAS MOUNTING BEGUN?
YES
S2
S3
HAS ELAPSED TIME EXCEEDED MOUNTING LIMIT TIME?
YES
ERROR NOTIFICATION
NO
S4
NO
IS SECOND VALVE IN OPEN STATE?
YES
READY-TO-PRINT NOTIFICATION
S5
END

Fig.10

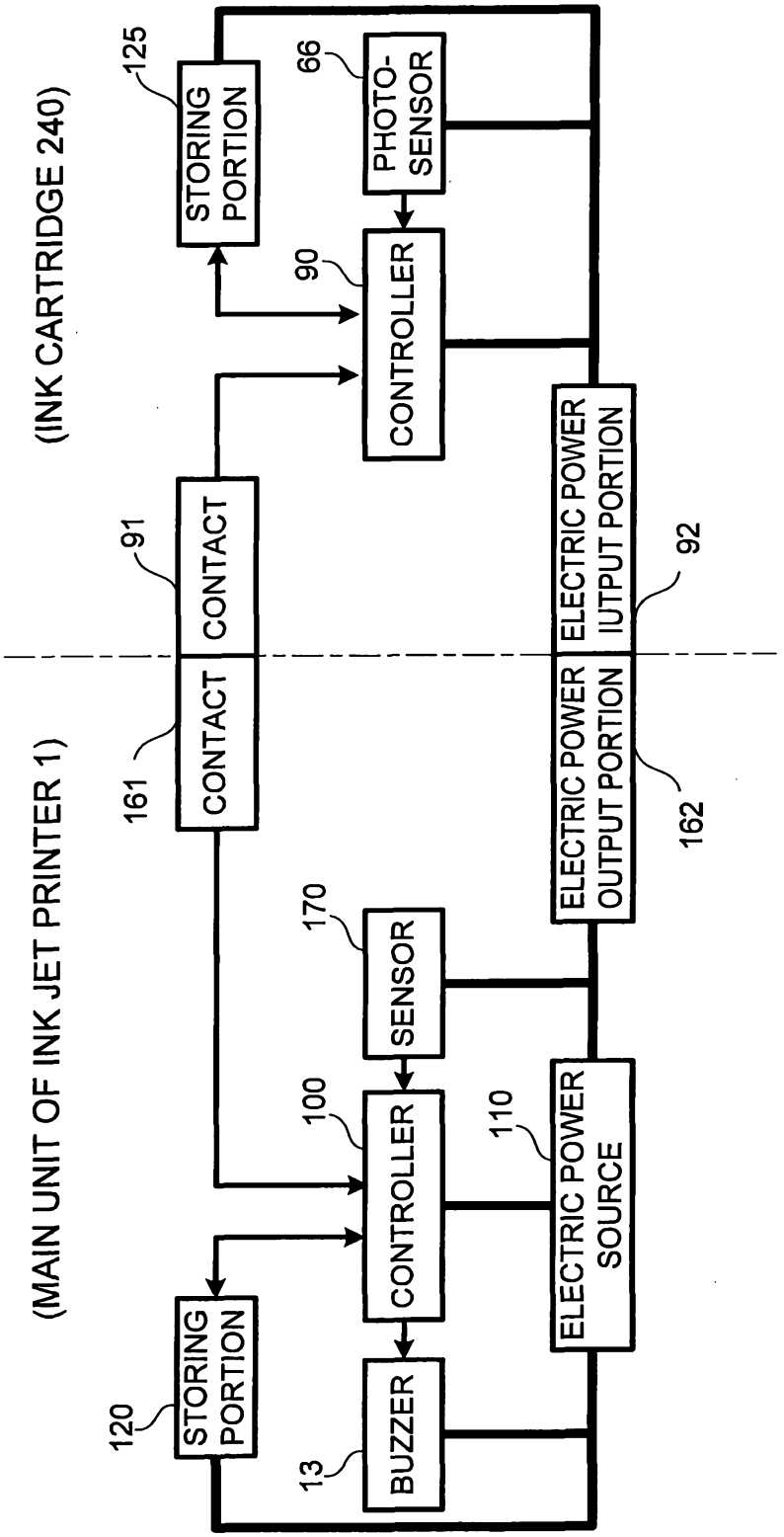

(MAIN UNIT OF INK JET PRINTER 1)
(INK CARTRIDGE 240)
CONTACT
161
91
CONTACT
STORING PORTION
120
125
PHOTO-SENSOR
66
CONTROLLER
90
CONTROLLER
100
SENSOR
170
BUZZER
13
ELECTRIC POWER SOURCE
110
ELECTRIC POWER OUTPUT PORTION
162
ELECTRIC POWER IUTPUT PORTION
92

Fig.11

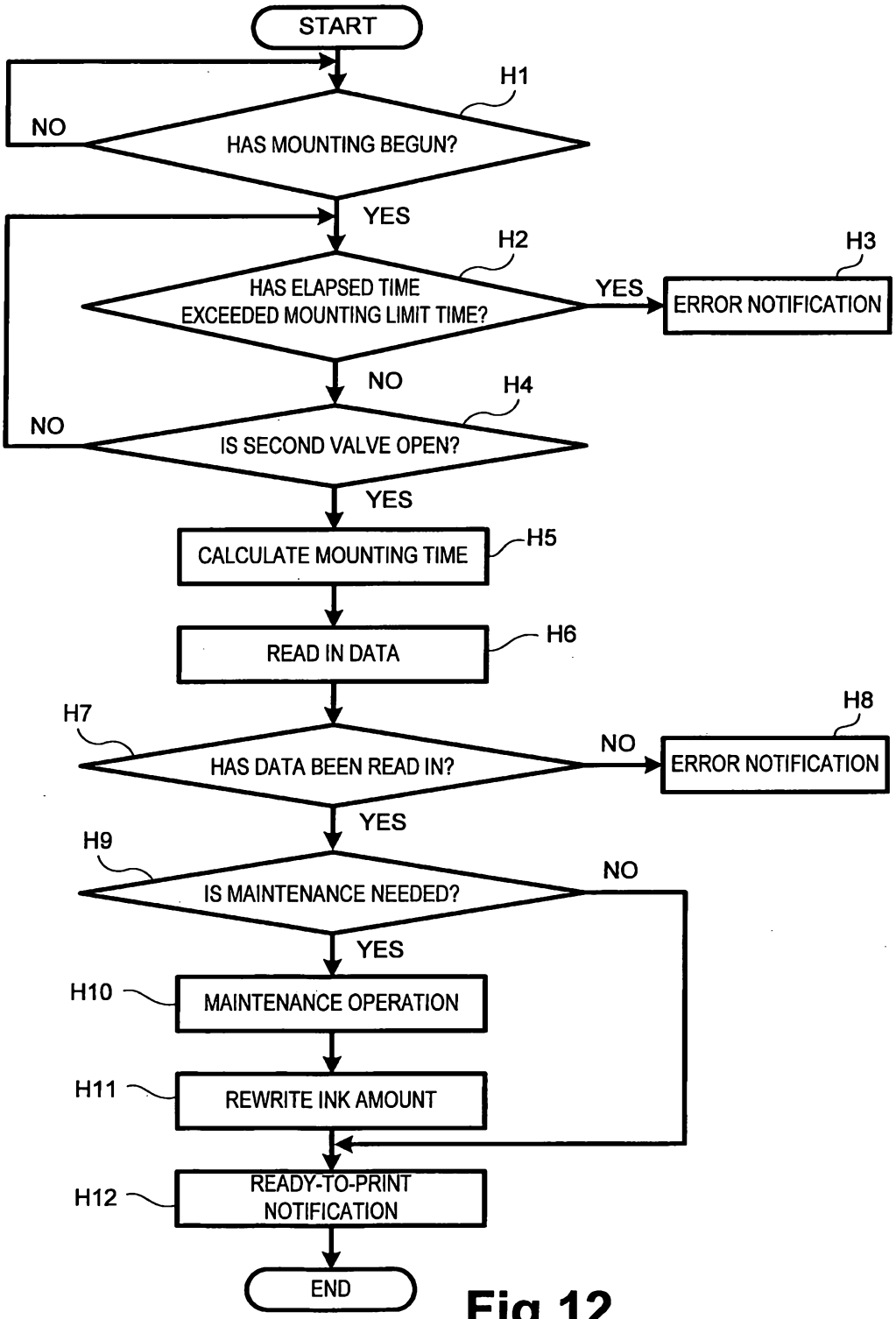
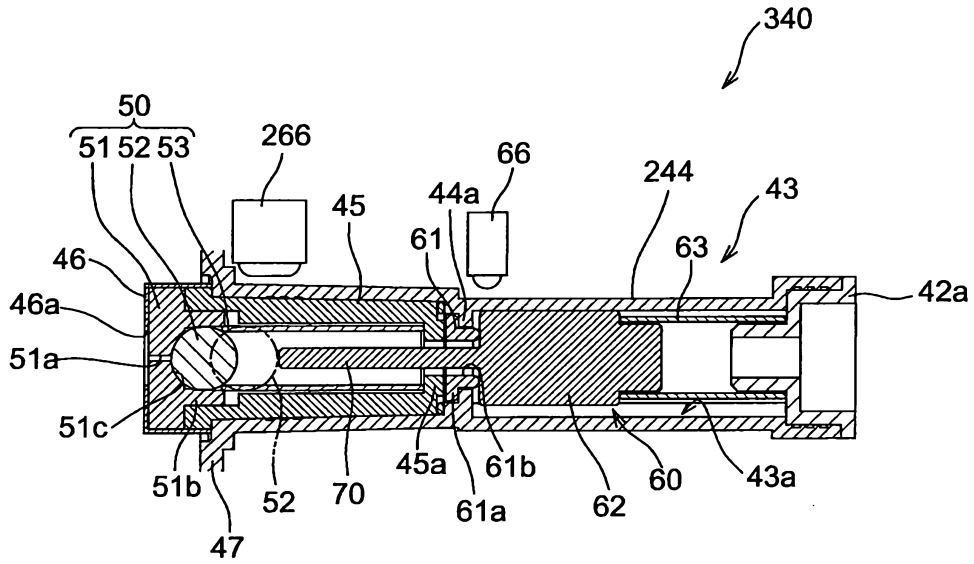

START
H1
HAS MOUNTING BEGUN?
NO
YES
H2
HAS ELAPSED TIME EXCEEDED MOUNTING LIMIT TIME?
YES
H3
ERROR NOTIFICATION
NO
H4
IS SECOND VALVE OPEN?
NO
YES
CALCULATE MOUNTING TIME
H5
READ IN DATA
H6
H7
HAS DATA BEEN READ IN?
NO
H8
ERROR NOTIFICATION
YES
H9
IS MAINTENANCE NEEDED?
NO
YES
H10
MAINTENANCE OPERATION
H11
REWRITE INK AMOUNT
H12
READY-TO-PRINT NOTIFICATION
END

Fig.12


340
50
51 52 53
266
66
244
43
45
44a
61
63
46
42a
46a
51a
51c
51b
52
70
45a
61b
61a
62
60
43a
47

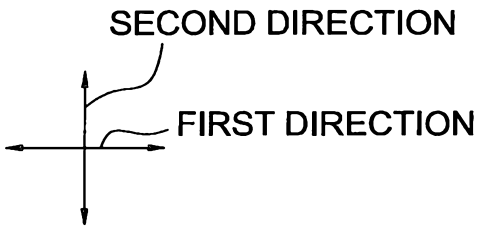

SECOND DIRECTION
FIRST DIRECTION

Fig.13

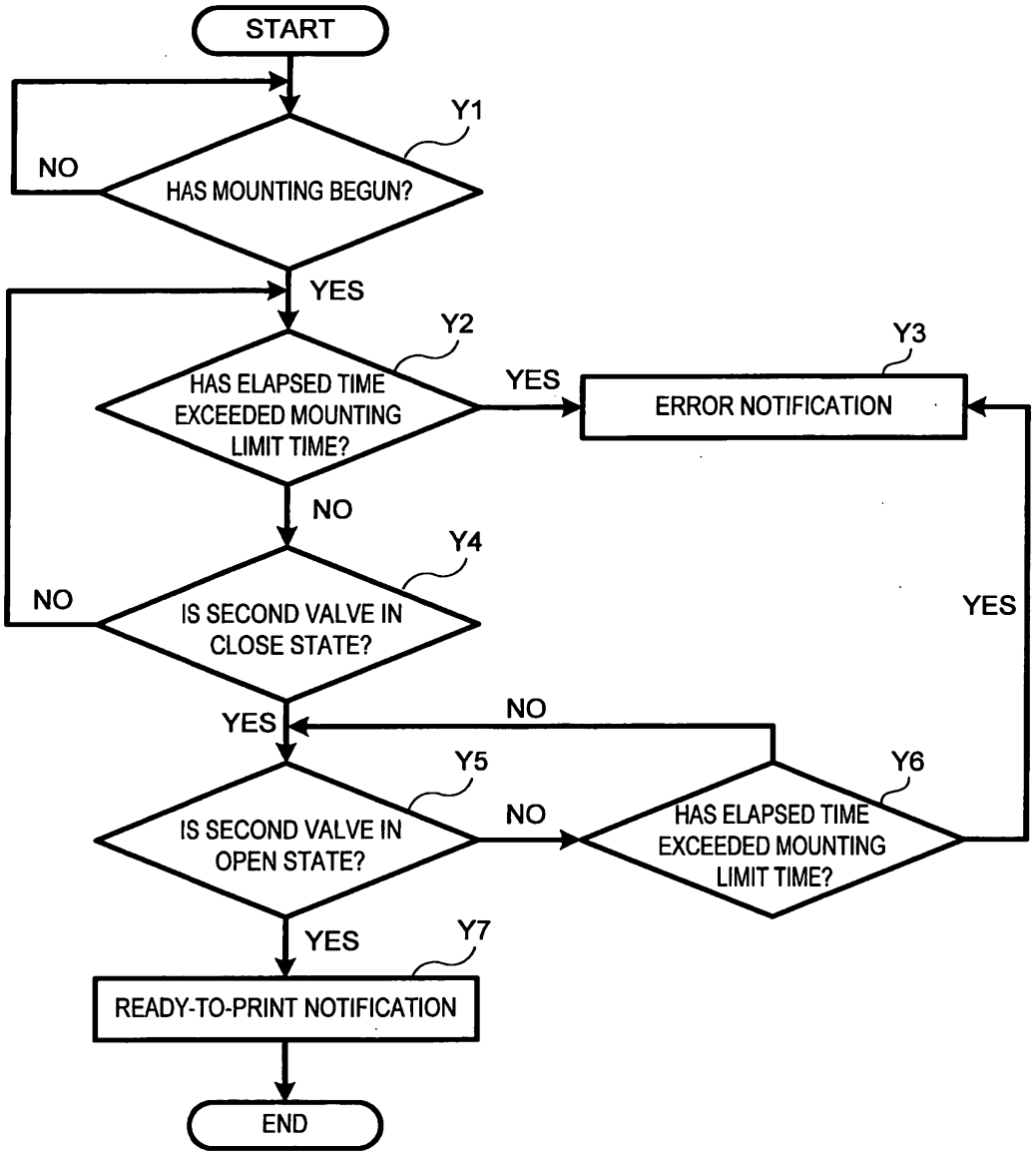

START
Y1
HAS MOUNTING BEGUN?
NO
YES
Y2
HAS ELAPSED TIME EXCEEDED MOUNTING LIMIT TIME?
YES
Y3
ERROR NOTIFICATION
NO
Y4
IS SECOND VALVE IN CLOSE STATE?
NO
YES
YES
NO
Y5
IS SECOND VALVE IN OPEN STATE?
NO
Y6
HAS ELAPSED TIME EXCEEDED MOUNTING LIMIT TIME?
YES
Y7
READY-TO-PRINT NOTIFICATION
END

Fig.14

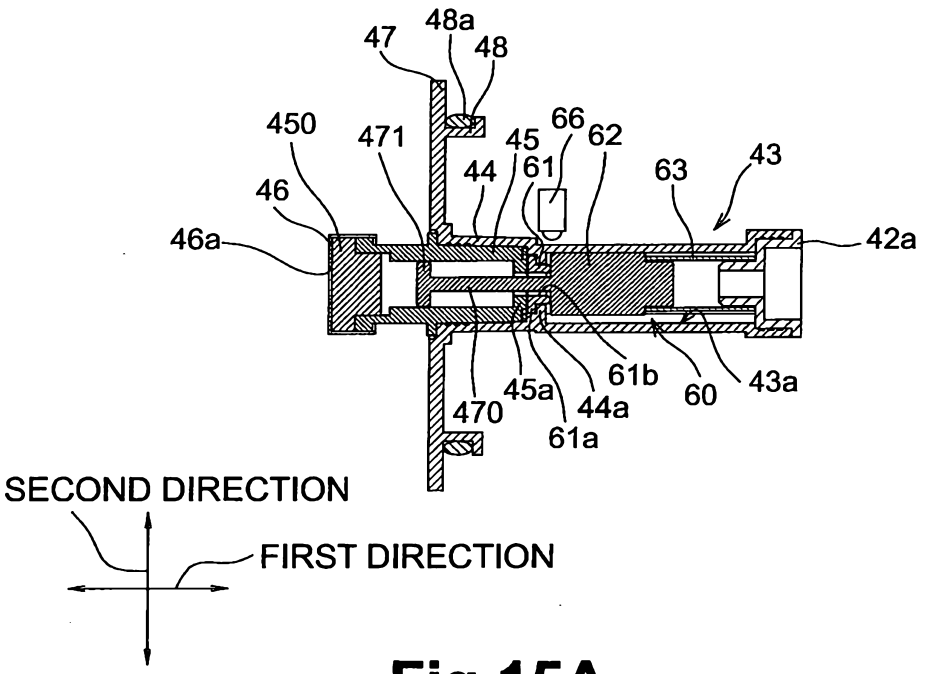


Fig.15A

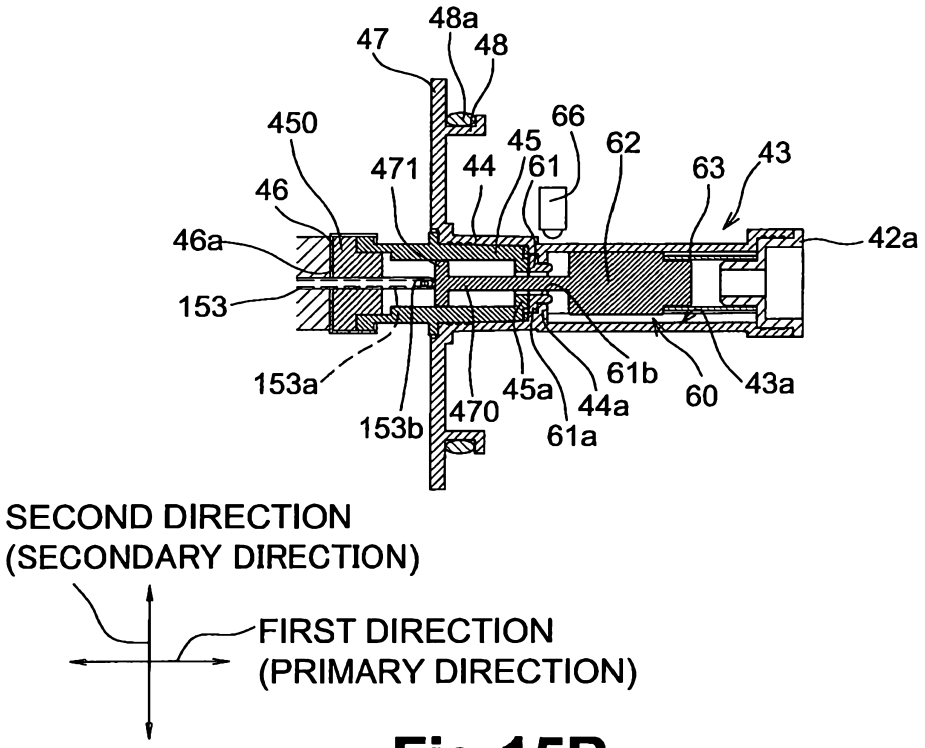


Fig.15B

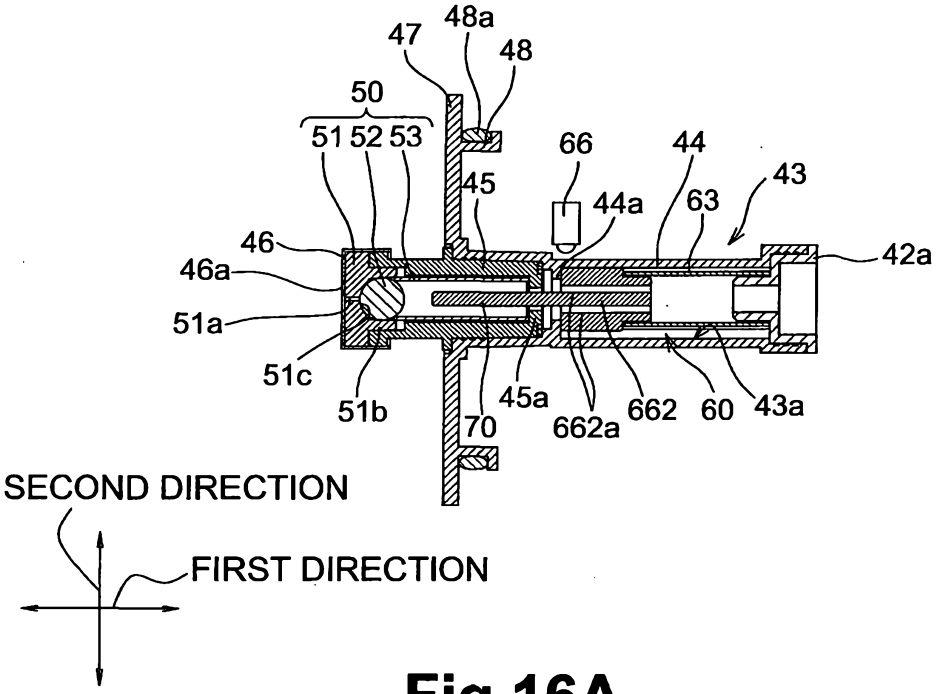


Fig.16A

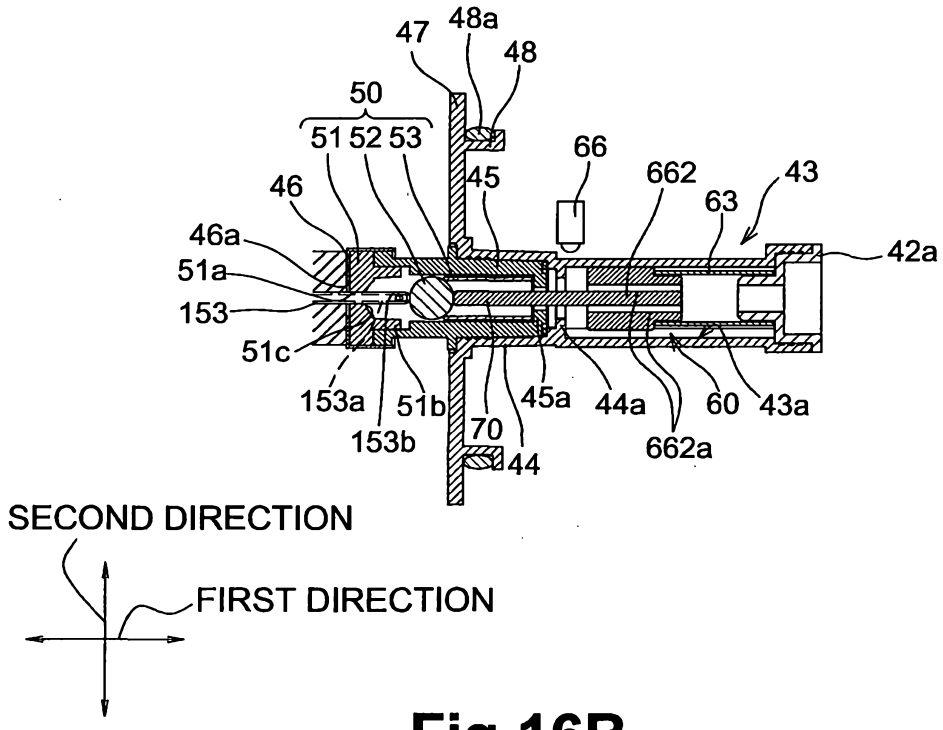


Fig.16B

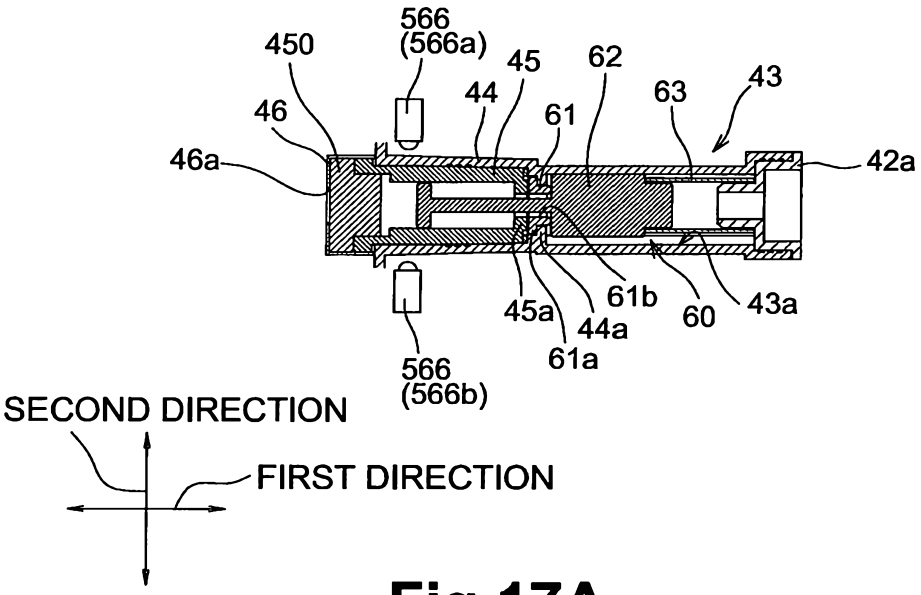


Fig.17A

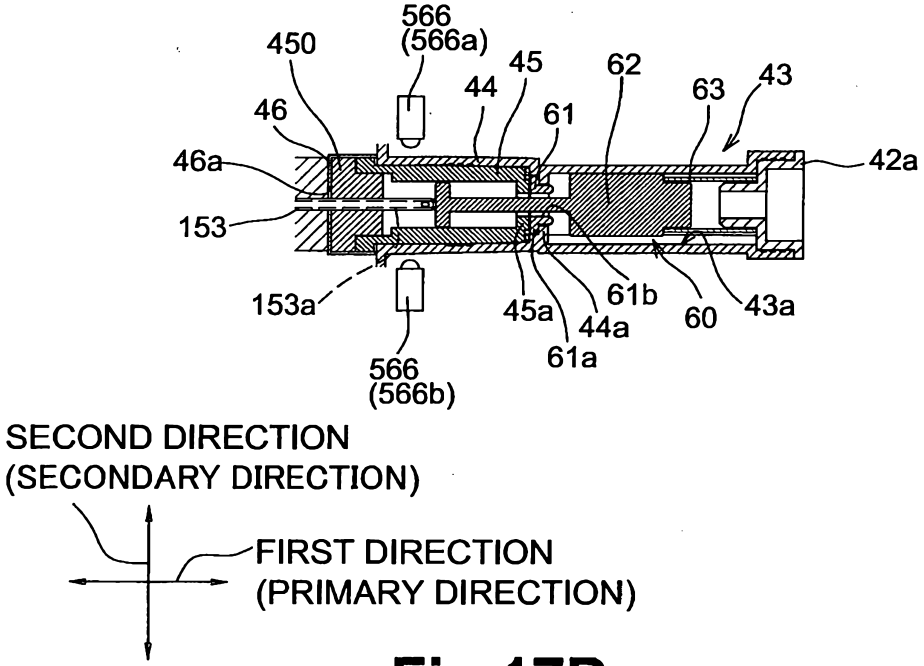


Fig.17B