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(54) Image recording apparatus

(57) An image recording apparatus includes a liquid cartridge including a liquid chamber configured to store liquid therein and a cartridge mounting portion configured to receive the liquid cartridge. The liquid cartridge includes a supply opening which is open at an outer surface of the liquid cartridge, a connection opening formed at a lower portion of the liquid chamber with respect to an up-and-down direction, and a liquid path connecting the liquid chamber and the supply opening via the connection opening. When the liquid cartridge is mounted to the cartridge mounting portion, the connection opening is positioned at a front portion of the liquid chamber with respect to a front-and-rear direction and at a right or left portion of the liquid chamber with respect to a left-and-right direction.

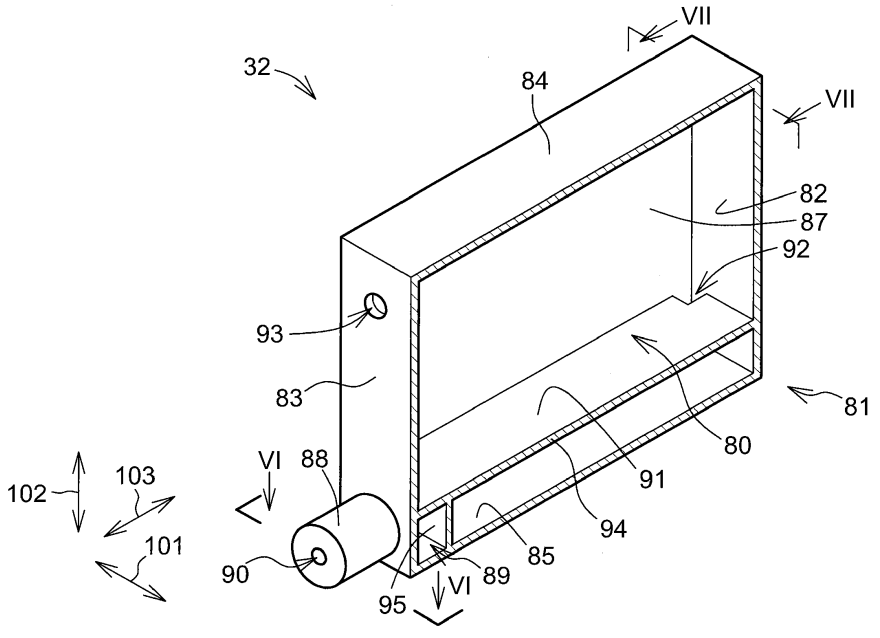

Fig.5

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an image recording apparatus, in which liquid is supplied from a liquid cartridge to a recording head mounted to a carriage via a tube.

2. Description of Related Art

[0002] As an example of an image recording apparatus, an ink-jet image recording apparatus is known, which records an image on a recording medium such as a sheet of paper by ejecting ink onto the recording medium based on an input signal. More specifically, the ink-jet image recording apparatus has a recording head and the recording head ejects ink from its nozzles onto a recording medium, such that an image is formed on the recording medium.

[0003] One type of known recording heads is mounted to a carriage and reciprocates together with the carriage in a predetermined direction relative to the recording medium. Driving force is transmitted to the carriage from a drive source such as a motor, and upon receiving the driving force the carriage reciprocates in the predetermined direction guided by a guide shaft or a guide rail. While the carriage is reciprocating, the recording head selectively ejects ink droplets onto the recording medium, and the ink droplets' landing on the recording medium forms an image on the recording medium.

[0004] As a way of supplying ink from an ink cartridge to a recording head, a flexible tube is provided between the ink cartridge and the recording head, as described in Patent Application Publication Nos. JP 2002-264363, JP 2001-199084, or JP 2010-30143. Because the tube is flexible, the tube flexes and stretches, following the reciprocal movement of the carriage. When the carriage is in a position closest to the ink cartridge, the tube is flexed, such that the tube extends, making a U-turn. When the cartridge is in a position farthest from the ink cartridge, the tube stretches, such that the tube extends, curving gently.

[0005] In general, when an image recording apparatus does not perform image recording, the nozzle surface of the recording head is configured to be covered by a cap because the nozzle surface may dry out if not covered by a cap or ink may leak from the nozzles. Nevertheless, when the image recording apparatus is powered off during the image recording operation, the carriage may stop and may not reach a position in which the recording head is supposed to be covered by the cap. Therefore there may be a situation in which the recording head is not capped.

[0006] When the image recording apparatus is transported or packed for repair purpose or other purposes while the recording head is not capped, the image recording apparatus may be oriented differently from when the image recording apparatus is in use. For example, when packed, the rear face of a thin flat body of the image recording apparatus may be oriented downwardly in order to reduce the foot print of the package. When this occurs, the liquid surface in the ink cartridge is positioned higher than the recording head, and all the ink stored in the ink cartridge may leak from the recording head. The same problem may arise when the left or right face of the body is oriented downwardly or when the body is placed upside down. The problem is significant when ink flow is not blocked by a valve or the like in an ink path extending from the ink cartridge, which is in communication with the atmosphere, to the recording head.

SUMMARY OF THE INVENTION

[0007] Therefore, a need has arisen for an image recording apparatus, which overcomes these and other shortcomings of the related art. A technical advantage of the present invention is that the likelihood may be reduced that all the liquid stored in a liquid cartridge leaks from the nozzles of a recording head when the position of an image recording apparatus is changed.

[0008] According to the present invention, an image recording apparatus according to claim 1 is provided.

[0009] With this configuration, when the image recording apparatus is oriented differently from when the image recording apparatus is in use while the liquid cartridge is mounted to the cartridge mounting portion, e.g., when the image recording apparatus is oriented such that the rear face of the image recording apparatus is positioned below the front face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the rear face of the image recording apparatus is positioned below the front face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a front portion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0010] Moreover, when the image recording apparatus is oriented such that the left face of the image recording apparatus is positioned below the right face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the left face of the image recording apparatus is positioned below the right face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a right por-

tion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0011] Furthermore, when the image recording apparatus is oriented such that the upper face of the image recording apparatus is positioned below the lower face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the upper face of the image recording apparatus is positioned below the lower face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a lower portion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0012] According to the present invention, an image recording apparatus according to claim 5 is provided.

[0013] With this configuration, when the image recording apparatus is oriented differently from when the image recording apparatus is in use while the liquid cartridge is mounted to the cartridge mounting portion, e.g., when the image recording apparatus is oriented such that the rear face of the image recording apparatus is positioned below the front face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the rear face of the image recording apparatus is positioned below the front face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a front portion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0014] Moreover, when the image recording apparatus is oriented such that the right face of the image recording apparatus is positioned below the left face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the right face of the image recording apparatus is positioned below the left face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a left portion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0015] Furthermore, when the image recording apparatus is oriented such that the upper face of the image recording apparatus is positioned below the lower face of the image recording apparatus, the liquid cartridge is positioned above the recording head. When the image recording apparatus is oriented such that the upper face of the image recording apparatus is positioned below the lower face of the image recording apparatus, the connection opening is positioned at an upper portion of the liquid chamber because the connection opening is formed at a lower portion of the liquid chamber when the image recording apparatus is in use. Therefore, the liquid surface in the liquid chamber is positioned below the connection opening, and liquid may not flow out of the liquid chamber to the liquid path. Thus, the likelihood may be reduced that all the liquid stored in the liquid cartridge leaks from the nozzles of the recording head.

[0016] Other objects, features, and advantages will be apparent to persons of ordinary skill in the art from the following detained description of the invention and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] 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 drawings.

Fig. 1 is a perspective view of a multi-function apparatus according to an embodiment.

Fig. 2 is a vertical, cross-sectional view of the multi-function apparatus.

Fig. 3 is a plan view of an inner structure of a printer portion of the multi-function apparatus.

Fig. 4 is a vertical, cross-sectional view of a cartridge mounting portion and an ink cartridge, in which the ink cartridge is mounted to the cartridge mounting portion.

Fig. 5 is a perspective view of the ink cartridge, in which a left wall is removed.

Fig. 6 is a perspective view of the ink cartridge, in which the cartridge is cut along the line VI-VI in **Fig. 5.**

Fig. 7 is a cross-sectional view of the ink cartridge along the line VII-VII in **Fig. 5.**

Fig. 8 is a cross-sectional view of the ink cartridge viewed from the upper-wall side toward a partitioning wall, in which a rear wall is positioned facing downward.

Fig. 9 is a cross-sectional view of the ink cartridge showing the same cross-section as **Fig. 7,** in which

the left wall is positioned facing downward.

Fig. 10 is a cross-sectional view of the ink cartridge showing the same cross-section as **Fig. 7,** in which the upper wall is positioned facing downward.

Fig.11 is a perspective view of an ink cartridge according to a modified embodiment, in which a left wall is removed.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0018] Embodiments of the present invention, and their features and advantages, may be understood by referring to **Figs. 1-11,** like numerals being used for like corresponding parts in the various drawings.

[General structure of a multi-function apparatus 10]

[0019] Referring to **Figs. 1 and 2,** a multi-function apparatus 10 comprises an image recording apparatus, e.g., a printer portion 11, and a scanner portion 12. The multi-function apparatus 10 functions as a printer, a scanner, a copier, and a facsimile machine. The multi-function apparatus 10, i.e., the printer portion 11 is configured to be used in a position shown in **Fig. 1.**

[0020] The printer portion 11 is positioned on the lower side of the multi-function apparatus 10, and the scanner portion 12 is positioned on the upper side of the multi-function apparatus 10. The printer portion 11 is configured to be connected to an external information device and is configured to record an image and texts based on print data including image data and text data transmitted from the external information device. The scanner portion 12 comprises a so-called flat-bed scanner.

[0021] The multi-function apparatus 10 has substantially a rectangular parallelepiped shape with its dimension in an up-and-down direction 102 being less than its dimension in a left-and-right direction 101 and its dimension in a front-and-rear direction 103. The multi-function apparatus 10 has a front face and a rear face opposite the front face in the front-and-rear direction 103. The front face of the multi-function apparatus 10 faces a user when the user uses the multi-function apparatus 10. The printer portion 11 has an opening 13 formed at the front face. The printer portion 11 comprises a paper feed tray 20 and a paper discharge tray 21, and the paper feed tray 20 and the paper discharge tray 21 are exposed to the outside of the printer portion 11 via opening 13. Sheets of paper as recording medium stacked in the paper feed tray 20 are fed one by one for printing, and are discharged onto the discharge tray 21 after images are printed thereon.

[0022] The multi-function apparatus 10 comprises an operation panel 14 at its upper portion of the front face. Input operations are performed at the operation panel 14 for having the printer portion 11 and the scanner portion 12 work. The operation panel 14 comprises a plurality of buttons for the input operations and a display for indicating the status of the multi-function apparatus 10 and some error messages. When the multi-function apparatus 10 is connected to the external information device, the multi-function apparatus 10 also works based on inputs transmitted from the external information device via communication software such as a print driver and a scanner driver.

[Printer portion 11]

[0023] Referring to **Fig. 2,** the paper feed tray 20 is positioned at the bottom most portion of the multi-function apparatus 10. The paper discharge tray 21 is positioned above the paper feed tray 20. The printer portion 11 comprises an image recording unit 24. The printer portion 11 has a paper conveying path 23 formed therein. A sheet of paper is fed from the paper feed tray 20 rearward (toward the rear face of the multi-function apparatus 10) in the front-and-rear direction 103, and then turns upward, making a U-turn forward (toward the front face of the multi-function apparatus 10) in the front-and-rear direction 103. Subsequently, the sheet of paper is conveyed to the image recording unit 24, which records an image on the sheet of paper, and then discharged to the paper discharge tray 21.

[0024] The paper feed tray 20 has a container shape with its upper side opened, having an inner space formed therein. The sheets of paper are stacked in the inner space of the paper feed tray 20.

[0025] The paper discharge tray 21 comprises an upper surface onto which the sheets of paper are discharged. The paper discharge tray 21 partly overlaps the paper feed tray 20 in the up-and-down direction 102, but is shifted from the paper feed tray 20 forward (toward the front face of the multi-function apparatus 10) in the front-and-rear direction 103. Therefore, the paper discharge tray 21 is not positioned directly above the paper feed tray 20 at a rear side of the multi-function apparatus 10.

[0026] The printer portion 11 comprises a paper feed roller 25 directly above the paper feed tray 20 at a rear side of the paper feed tray 20. The paper feed roller 25 is configured to feed the sheets of paper stacked on the paper feed tray 20 one by one to the paper conveying path 23. The paper feed roller 25 is configured to rotate when receiving driving force from a motor (not shown). The printer portion 11 comprises a paper feed arm 26, and the paper feed arm 26 is pivotally supported at its one end. The paper feed roller 25 is rotatably supported at the free end of the paper feed arm 26. When the paper feed arm 26 pivots, the paper feed roller 25 moves toward and away from the paper feed tray 20. The paper feed arm 26 is urged downward by a spring (not shown) or by its own weight, and the paper feed roller 25 contacts the upper most one of the sheets of paper stacked in the paper feed tray 20. The position of the paper feed arm 26 and the paper feed roller 25 depends on how many sheets of paper are stacked in the paper feed tray 20. When the paper feed roller 25 rotates, the upper most

sheet of paper is fed to the paper conveying path 23 by the frictional force between the outer surface of the paper feed roller 25 and the sheet of paper.

[0027] The paper conveying path 23 extends from a rear side of the paper feed tray 20, goes upward, turning forward in the front-and-rear direction 103, and then extends up to the paper discharge tray 21 via the image recording unit 24. The paper conveying path 23 is formed between outside guide surfaces and inside guide surfaces at positions other than where the image recording unit 24 is provided. For example, the printer portion 11 comprises an outside guide member 18 and an inside guide member 19, and the paper conveying path 23 is formed between the outside guide member 18 and the inside guide member 19 at a position where the paper conveying path 23 curves at a rear side of the multi-function apparatus 10 with respect to the front-and-rear direction 103. The outside guide member 18 and the inside guide member 19 are supported by a frame 40 of the multi-function apparatus 10 or the like.

[0028] The image recording unit 24 comprises a carriage 38, a recording head 39 mounted to the carriage 38, and a platen 42 facing the recording head 39 with a predetermined gap formed therebetween in the up-and-down direction 102.

[0029] The printer portion 11 comprises a conveying roller 60 and a pinch roller on the upstream side of the image recording unit 24 along the paper conveying path 23. In **Fig. 2,** the pinch roller is hidden by another part of the printer portion 11. The pinch roller is positioned below the conveying roller 60, and contacts and is urged toward the conveying roller 60. The conveying roller 60 is configured to rotate, driven by a motor (not shown). While pinching the sheet of paper therebetween, the conveying roller 60 and the pinch roller are configured to convey the sheet of paper onto the platen 42.

[0030] The printer portion 10 comprises a discharge roller 62 and a spur on the downstream side of the image recording unit 24 along the paper conveying path 23. In **Fig. 2,** the spur is hidden by another part of the printer portion 10. The spur is positioned above the discharge roller 62, and contacts and is urged toward the discharge roller 62. The discharge roller 62 is configured to rotate, driven by a motor (not shown). While pinching the sheet of paper therebetween, the discharge roller 62 and the spur are configured to convey the sheet of paper onto the paper discharge tray 21. The conveying roller 60, the pinch roller, the discharge roller 62, and the spur correspond to a conveying mechanism.

[Image recording unit 24]

[0031] Referring to **Figs. 2 to 4,** the printer portion 11 comprises four ink tubes 41. The printer portion 11 also comprises a cartridge mounting portion 110 positioned apart and away from the carriage 38 and four liquid cartridges, e.g., four ink cartridges 32 configured to be mounted to the cartridge mounting portion 110. The recording head 39 mounted to the carriage 38 is configured to be supplied with ink via the ink tubes 41 from the ink cartridges 32 respectively. More specifically, the ink cartridges 32 store cyan, magenta, yellow, and black inks respectively, and those inks are supplied to the recording head 39 via the ink tubes 41 respectively. In **Fig. 3,** the ink cartridges 32 and the cartridge mounting portion 110 are schematically illustrated in alternate long and short dash lines. While the carriage 38 is reciprocating, the recording head 39 selectively ejects ink droplets of the respective colors from its nozzles formed therein, such that an image is recorded on a sheet of paper being conveyed over the platen 42.

[0032] Referring to **Fig. 3,** the printer portion 11 comprises a pair of guide rails 43, 44 positioned above the paper conveying path 23. The guide rails 43, 44 are spaced apart from each other in a paper conveying direction, which is a direction toward the front face of the multi-function apparatus 10 in the front-and-rear direction 103 (from top to bottom in **Fig. 3**), forming a gap therebetween. Each of the guide rails 43, 44 extends in a direction intersecting the paper conveying direction, e.g., the left-and-right direction 101. The guide rails 43, 44 are positioned in the printer portion 11 and form a part of a frame supporting each element of the printer portion 11. The carriage 38 is placed on the guide rails 43, 44 over the gap formed between the guide rails 43, 44. The carriage 38 is configured to slide on the guide rails 43, 44 in the direction that the guide rails 43, 44 extends, e.g., the left-and-right direction 101.

[0033] The guide rail 44 comprises an edge portion 45 at its upstream side with respect to the paper conveying direction, and the edge portion 45 is bent upward at substantially a right angle. The carriage 38 supported on the guide rails 43, 44 comprises a sandwiching member such as a roller pair, and the sandwiching member slidably sandwiches the edge portion 45 in the front-and-rear direction 103. By the sandwiching member sandwiching the edge portion 45, the position of the carriage 38 is determined with respect to the paper conveying direction, i.e., the front-and-rear direction 103, and the carriage 38 can slide in the direction intersecting the paper conveying direction, e.g., the left-and-right direction 101. That is, the carriage 38 is configured to be supported on the guide rails 43, 44, the position of which being determined by the edge portion 45 with respect to the paper conveying direction, and reciprocate in the direction intersecting the paper conveying direction.

[0034] The printer portion 11 comprises a belt drive mechanism 46 at the upper surface of the guide rail 44. The belt drive mechanism 46 comprises a drive pulley (hidden under the carriage 38 in **Fig. 3**) and a driven pulley 48 positioned adjacent to the both ends of the paper conveying path 23 in the left-and-right direction 101, and an endless round timing belt 49 wound around the drive pulley and the driven pulley 48. The timing belt 49 comprises teeth on its inner surface. When driving force is transmitted to the drive pulley from a motor (not shown),

the drive pulley rotates, such that the timing belt 49 rotates around the drive pulley and the driven pulley 48.

[0035] The carriage 38 is coupled to the timing belt 49 on its bottom side. When the timing belt 49 moves, the carriage 38 reciprocates on and along the guide rails 43, 44, such that the recording head 39 mounted to the carriage 38 reciprocates together with the carriage 38 in the left-and-right direction 101 above the paper conveying path 23.

[0036] The carriage 38 comprises a carriage main body and a cover 31. The carriage main body has substantially a rectangular parallelepiped shape with an opening formed in its upper face. The cover 31 is attached to the carriage main body, such that the cover 31 covers the opening of the carriage main body. The recording head 39 is accommodated in a space formed in the carriage main body and the cover 31. The nozzle surface of the recording head 39, which is the lower surface of the recording head 39 and in which the nozzles are formed, is exposed to a space below the carriage main body.

[0037] Referring to **Fig. 2,** the platen 42 is disposed below the paper conveying path 23, facing the recording head 39. Although the frame 40 of the multi-function apparatus 10 supports the platen 42 from below, the platen 42 is not illustrated in **Fig. 3,** and therefore the frame 40 can be seen in **Fig. 3.** The platen 42 extends over a middle region of the range of the reciprocal movement of the carriage 38 in the left-and-right direction 101, and is configured to support a sheet of paper passing through the middle region. The width of the platen 42 is greater than the width of the sheet of paper in the left-and-right direction 101. A predetermined amount of distance is maintained between the sheet of paper supported on the platen 42 and the recording head 39. Ink droplets ejected through the nozzles of the recording head 39 land onto the sheet of paper.

[0038] The recording surface, i.e., the surface of the sheet of paper on which an image is recorded extends in the left-and-right direction 101 and the front-and-rear direction 103 when the sheet is supported on the platen 42. In other words, the carriage 38 configured to reciprocate in the left-and-right direction 101 is configured to move in a direction along the recording surface of the sheet of paper.

[0039] Referring to **Fig. 3,** ink cartridges 32 storing inks of respective colors are configured to be mounted to the cartridge mounting portion 110 of the printer portion 11.

[0040] Four ink tubes 41 extend from the cartridge mounting portion 110 to the carriage 38, corresponding to the four colors of ink. The ink tubes 41 are configured to supply the respective inks to the recording head 39 mounted to the carriage 38. In other words, the inks flow from the ink cartridges 32 to the recording head 39 through the ink tubes 41 respectively.

[0041] Referring to **Fig. 3,** each of the ink tubes 41 is connected to the cartridge mounting portion 110 at one end of the ink tube 41. Ink tubes 41 extend from the cartridge mounting portion 110 in the left-and-right direction 101 and then curve forward in the front-and-rear direction 103. The printer portion 11 comprises a clip 36, and the ink tubes 41 are held together by the clip 36 at a position close to the front face of the multi-function apparatus 10. The ink tubes 41 extend from the clip 36 rearward in the front-and-rear direction 103, making a U-turn, and then extend in the left-and-right direction 101 to be connected to the carriage 38. The ink tubes 41 are flexible, so that the ink tubes 41 flex and stretch between the clip 36 and the carriage 38, following the reciprocal movement of the carriage 38.

[Cartridge mounting portion 110]

[0042] Referring to **Fig. 3,** the cartridge mounting portion 110 is positioned further forward than the nozzles of the recording head 39 with respect to the front-and-rear direction 103 and positioned to the right of the paper conveying path 23 with respect to the left-and-right direction 101. The cartridge mounting portion 110 is configured to receive four ink cartridges 32 storing cyan, magenta, yellow, and black inks respectively. The portions of the cartridge mounting portion 110 to which the four ink cartridges 32 are configured to be mounted have the same structure, and therefore the cartridge mounting portion 110 will be described below with an example of one portion of the cartridge mounting portion 110 to which one ink cartridge 32 is configured to be mounted.

[0043] Referring to **Fig. 4,** the cartridge mounting portion 110 comprises a case 111 having an opening 112 formed on the font-face side of the printer portion 11. The ink cartridge 32 is inserted into and removed from the case 111 through the opening 112 along the front-and-rear direction 103. Referring to **Fig. 1,** the printer portion 11 comprises a cover 16 to the right of the opening 13. When the cover 16 is opened, the opening 112 of the case 111 is exposed to the outside of the printer portion 11.

[0044] Referring back to **Fig. 4,** the cartridge mounting portion 110 comprises an ink needle 122 positioned at a lower portion of a rear side of the case 111 with respect to the front-and-rear direction 103. The ink needle 122 is a cylindrical resin tube. The ink needle 122 is connected to an ink path 75 at an outer face of the case 111 which is opposite from the opening 112. In other words, the ink needle 122 is connected to the ink path 75 at an outer face of a rear wall of the case 111, which wall defines an inner space of the case 111 and is positioned at the rear of the case 111 with respect to the front-and-rear direction 103. Each ink path 75 extending from the ink needle 122 rearward in the front-and-rear direction 103 extends upward and is connected to the ink tube 41.

[Ink cartridge 32]

[0045] Referring to **Fig. 4,** the ink cartridge 32 is a container configured to store ink. The ink cartridge 32 has a space formed therein, and the space is an ink chamber

80 configured to store ink. The ink chamber 80 corresponds to a liquid chamber.

[0046] The ink cartridge 32 is configured to be inserted into and removed from the cartridge mounting portion 110 along the front-and-rear direction 103 in an upright state with its lower face in **Fig. 4** facing downward and its upper face in **Fig. 4** facing upward. Moreover, the ink cartridge 32 is used in the upright state with its lower face in **Fig. 4** facing downward and its upper face in **Fig. 4** facing upward.

[0047] The ink cartridge 32 comprises a main body 81 having a substantially rectangular parallelepiped shape. The main body 81 has a substantially rectangular parallelepiped shape with its dimension in the left-and-right direction 101 being less than its dimension in the up-and-down direction 102 and its dimension in the front-and-rear direction 103.

[0048] The main body 81 comprises a front wall 82 and a rear wall 83 spaced apart in the front-and-rear direction 103, an upper wall 84 and a lower wall 85 spaced apart in the up-and-down direction 102, and a left wall 86 and a right wall 87 spaced apart in the left-and-right direction 101 (see **Fig. 7**). The ink chamber 80 is formed in the inner space surrounded by these walls. The ink chamber 80 may be a space defined by the outer walls of the main body 81 or may be a space defined by a frame and a film provided inside the main body 81. In this embodiment, the ink chamber 80 is configured to store ink freely. When ink is stored freely, ink is not held against the gravity in the inner spaces of a three dimensional network structure such as a sponge or form, but ink is stored in the ink chamber 80, such that ink flows freely with the gravity. In this embodiment, the outer faces of the front wall 82, the rear wall 83, the upper wall 84, the lower wall 85, the left wall 86, and the right wall 87 correspond to a front end, a rear end, an upper end, a lower end, a left end, and a right end of the ink cartridge 32 respectively.

[0049] The ink cartridge 32 comprises an ink supply portion 88 at a lower portion of the rear wall 83 of the main body 81. The ink supply portion 88 has a cylindrical shape and has an inner space which is in fluid communication with the ink chamber 80 via an ink path 89. The end of the ink supply portion 88 is open, and ink can flow out of the inner space of the ink supply portion 88 to the outside of the ink cartridge 32 via the opening of the ink supply portion 88. This opening is an ink supply opening 90. The ink supply opening 90 corresponds to a supply opening. The ink supply portion 88 is positioned below a bottom surface 91 of the ink chamber 80 with respect to the up-and-down direction 102.

[0050] The ink cartridge 32 has an atmosphere communication opening 93 at an upper portion of the rear wall 83 of the main body 81. The atmosphere communication opening 93 extends though the rear wall 83, and an air layer in an upper portion of the ink chamber 80 is in communication with the atmosphere outside the ink cartridge 32 via the atmosphere communication opening 93. Although not shown in the drawings, a check valve may be provided at the atmosphere communication opening 93, which check valve is configured to allow fluid to flow from the outside of the ink cartridge 32 to the ink chamber 80 and configured to restrict the flow of fluid from the ink chamber 80 to the outside of the ink cartridge 32. Alternatively, an air permeable film may be provided at the atmosphere communication opening 93, and the air permeable film is configured to allow gat to pass therethrough, but prevents ink from passing therethrough. Alternatively, the atmosphere communication opening 93 may be connected to a labyrinth-like path provided further outside than the atmosphere communication opening 93, such that it may be more difficult for ink to flow out of the atmosphere communication opening 93 to the outside of the ink cartridge 32. Alternatively, an ink-absorbing member may be provided in the cartridge mounting portion 110 at a position corresponding to the atmosphere communication opening 93, so that the ink-absorbing member can absorb ink leaking out of the atmosphere communication opening 93.

[0051] When the ink cartridge 32 is mounted to the cartridge mounting portion 110, it is preferable that the nozzles of the recording head 39 are positioned above the ink surface (gas-liquid interface) in the ink chamber 80. Because the ink surface in the ink chamber 80 may not exceed the height of the atmosphere communication opening 93, it may be sufficient if the nozzles of the recording head 39 are positioned above the atmosphere communication opening 93. The atmosphere communication opening 93 corresponds to an atmosphere communication portion.

[0052] Referring to **Figs. 4 and 5,** the ink path 89 is formed in the main body 81 below the ink chamber 80. The ink path 89 corresponds to a liquid path. The ink path 89 is a path connecting the ink supply portion 88 and the ink chamber 80, such that ink can flow between the ink supply portion 88 and the ink chamber 80. In **Fig. 5,** the left wall 86 is removed.

[0053] The ink path 89 is connected to the ink chamber 80 via a connection opening 92. The connection opening 92 is formed at the lowest portion of the bottom surface 91 of the ink chamber 80 with respect to the up-and-down direction 102. Therefore, the bottom surface 91 does not have to a horizontal surface, but may be an inclined surface or curved surface which goes down toward the connection opening 92.

[0054] The connection opening 92 is positioned at a front portion of the ink chamber 80 with respect to the front-and-rear direction 103 and at a right portion of the ink chamber 80 with respect to the left-and-right direction 101. In this embodiment, the connection opening 92 is positioned at a front end of the ink chamber 80 with respect to the front-and-rear direction 103 and at a right end of the ink chamber 80 with respect to the left-and-right direction 101. That is, the connection opening 92 is defined by the inner surface of the front wall 82 and the inner surface of the right wall 87. The ink supply opening 90 is positioned at the center of the main body 81 with

respect to the left-and-right direction 101. The connection opening 92 is offset to the right of the ink supply opening 90 with respect to the left-and-right direction 101.

[0055] The shape of the connection opening 92 is not limited to a specific shape, but may be rectangular as shown in **Fig. 5,** or circular or polygonal. The size of the connection opening 92 is adjusted according to an initial amount of ink stored in the ink chamber 80. More specifically, the size of the connection opening 92 is chosen in order for the ink surface in the ink chamber 80 to be positioned below the connection opening 92 even when the ink cartridge 32 is oriented, such that the rear wall 83, the upper wall 84, or the left wall 86 faces downward, as described below.

[0056] Referring to **Figs. 5 and 6,** the ink path 89 is a space defined by a portioning wall 94 having the bottom surface 91 of the ink chamber 80, an L-shaped partitioning wall 95 facing the rear wall 83 and the right wall 87, the front wall 82, the rear wall 83, the lower wall 85, and the right wall 87. The partitioning wall 94 is spaced apart from the lower wall 85 in the up-and-down direction 102, and faces the lower wall 85. The partitioning wall 94 is connected to the front wall 82, the rear wall 83, the right wall 86, and the left wall 87. The partitioning wall 95 is spaced apart from the rear wall 83 forward in the front-and-rear direction 103, and faces the rear wall 83. The partitioning wall 95 also is spaced apart from the right wall 87 to the left in the left-and-right direction 101, and faces the right wall 87. The partitioning wall 95 is connected to the left wall 86, the front wall 82, the lower wall 85, and the partitioning wall 94.

[0057] The ink path 89 extends from a corner formed between the front wall 82 and the right wall 87 toward the rear wall 83 along the right wall 87 in the front-and-rear direction 103 and reaches a corner formed between the rear wall 83 and the right wall 87. The ink path 89 then extends from the corner formed between the rear wall 83 and the right wall 87 toward the left wall 86 along the rear wall 83 in the left-and-right direction 101. In other words, in the cross-section shown in **Fig. 6,** the ink path 89 has an L shape extending along the right wall 87 and the rear wall 83. The ink path 89 is connected to the inner space of the ink supply portion 88 at the rear wall 83.

[0058] Referring to **Fig. 7,** the ink path 89 has a cross-section taken along the left-and-right direction 101 and the up-and-down direction 102, and the cross-section has a width W1 in the left-and-right direction 101. The ink chamber 80 has a cross-section taken along the left-and-right direction 101 and the up-and-down direction 102, and the cross-section has a width W2 in the left-and-right direction 101. The width W1 of the ink path 89 is less than the width W2 of the ink chamber 80 (W1 < W2). The ink path 89 has a volume V1 and the ink chamber has a volume V2, and the volume V1 of the ink path 89 is less than the volume V2 of the ink chamber 80 (V1 < V2).

[0059] The ink cartridge 32 may comprise a remaining-ink-amount detection portion provided at the main body 81 for the multi-function apparatus 10 to determine a remaining amount of ink in the ink chamber 80. Nevertheless, such a remaining-ink-amount detection portion or the like may not directly be related to the present invention, and therefore the detailed description of the remaining-ink-amount detection portion or the like is omitted here.

[0060] The ink supply portion 88 may comprise a valve provided in the inner space of the ink supply portion 88, and the valve may close the ink supply opening 90. In such a case, when the ink cartridge 32 is mounted to the cartridge mounting portion 110, the ink needle 122 pushes and moves the valve, such that the ink supply opening 90 is opened and ink flows out of the ink chamber 80 into the ink needle 122 via the ink path 89.

[0061] Alternatively, the ink supply portion 88 may comprise an elastic film such as rubber provided in the inner space of the ink supply portion 88, and the elastic film may close the ink supply opening 90. In such a case, when the ink cartridge 32 is mounted to the cartridge mounting portion 110, the ink needle 122 penetrates through the elastic film, such that the ink supply opening 90 is opened and ink flows out of the ink chamber 80 into the ink needle 122 via the ink path 89.

[0062] When the ink cartridge 32 is mounted to the cartridge mounting portion 110, the atmospheric air can enter the ink chamber 90 via the atmosphere communication opening 93. There is no valve provided in the ink path 75 and the ink tube 41. In other words, when the ink cartridge 32 is mounted to the cartridge mounting portion 110, there is no element or mechanism which prevents ink flow in the path extending from the ink chamber 80 up to the recording head 39.

[State of the ink cartridge 32 when the position of the multi-function apparatus 10 is changed]

[0063] When the multi-function apparatus 10 does not perform image recording, the carriage 38 is moved to a home position on the right side of the multi-function apparatus 10 with respect to the left-and-right direction 101 (the right side in **Fig. 3**), and the nozzle surface of the recording head 39 is covered by a cap (not shown) because the nozzle surface may dry out if not covered by the cap or ink may leak from the nozzles. Nevertheless, when the multi-function apparatus 10 is powered off during the image recording operation, the carriage 38 may stop and may not reach the home position. Therefore, there may be a situation in which the recording head 39 is not capped.

[0064] When the multi-function apparatus 10 is in use, the multi-function apparatus 10 take the position as shown in **Fig 1,** and the nozzle surface of the recording head 39 is positioned above the ink surface in the ink chamber 80 of the ink cartridge 32 mounted to the cartridge mounting portion 110. Therefore, negative pressure is generated at the nozzles of the recording head 39, such that ink in the nozzles is pulled toward the ink-

cartridge 32 side.

[0065] When the multi-function apparatus 10 is packed for repair purpose or other purposes while the recording head 39 is not capped, the multi-function apparatus 10 may be oriented differently from when the multi-function apparatus 10 is in use. For example, when packed, the rear face of the thin flat body of the multi-function apparatus 10 may be oriented downwardly in order to reduce the foot print of the package. In other words, the rear face of the multi-function apparatus 10 may be positioned below the front face of the multi-function apparatus 10. When this occurs, the ink surface in the ink chamber 80 of the ink cartridge 23 mounted to the cartridge mounting portion 110 is positioned above the nozzle surface of the recording head 39 with respect to the gravitational direction, and the negative pressure is not generated at the nozzles of the recording head 39 any more. On the contrary, positive pressure is generated, pushing ink toward the outside of the nozzles. When this occurs, the menisci of ink in the nozzles may be broken, and the likelihood becomes high that ink positioned above the nozzles of the recording head 39 leaks from the nozzles.

[0066] Referring to **Fig. 8,** when the ink chamber 80 has an initial amount of ink therein, the ink chamber 80 has an ink surface 96. When the multi-function apparatus 10 is oriented, such that the rear face of the multi-function apparatus 10 faces downward, i.e., when the rear face of the multi-function apparatus 10 is positioned below the front face of the multi-function apparatus 10, the rear wall 83 of the ink cartridge 32 mounted to the cartridge mounting portion 110 is positioned below the front wall 82 of the ink cartridge 32 mounted to the cartridge mounting portion 110 as shown in **Fig. 8.** The connection opening 92 connecting the ink chamber 80 and the ink path 89 is positioned at the uppermost position in the ink chamber 80, and therefore, the ink surface 96 is positioned below the connection opening 92. Accordingly, ink does not flow out of the ink chamber 80 into the ink path 89 when the multi-function apparatus 10 is oriented like this.

[0067] Referring to **Fig. 9,** when the multi-function apparatus 10 is oriented, such that the left face of the multi-function apparatus 10 faces downward, i.e., when the left face of the multi-function apparatus 10 is positioned below the right face of the multi-function apparatus 10, the left wall 86 of the ink cartridge 32 mounted to the cartridge mounting portion 110 is positioned below the right wall 87 of the ink cartridge 32 mounted to the cartridge mounting portion 110 as shown in **Fig. 9.** The connection opening 92 connecting the ink chamber 80 and the ink path 89 is positioned at the uppermost position in the ink chamber 80, and therefore the ink surface 96 is positioned below the connection opening 92. Accordingly, ink does not flow out of the ink chamber 80 into the ink path 89 when the multi-function apparatus 10 is oriented like this.

[0068] Referring to **Fig. 10,** when the multi-function apparatus 10 is oriented, such that the upper face of the multi-function apparatus 10 faces downward, i.e., when the upper face of the multi-function apparatus 10 is positioned below the lower face of the multi-function apparatus 10, the upper wall 84 of the ink cartridge 32 mounted to the cartridge mounting portion 110 is positioned below the lower wall 85 of the ink cartridge 32 mounted to the cartridge mounting portion 110 as shown in **Fig. 10.** The connection opening 92 connecting the ink chamber 80 and the ink path 89 is positioned at the uppermost position in the ink chamber 80 and therefore the ink surface 96 is positioned below the connection opening 92. Accordingly ink does not flow out of the ink chamber 80 in to the ink path 89 when the multi-function apparatus 10 is oriented like this.

[0069] When the multi-function apparatus 10 is oriented, such that the right face of the multi-function apparatus 10 faces downward, i.e., when the right face of the multi-function apparatus 10 is positioned below the left face of the multi-function apparatus 10, the ink cartridge 32 is positioned below the nozzle surface of the recording head 39 in most cases. Therefore, negative pressure is generated in the nozzles of the recording head 39, such that ink is pulled toward the ink-cartridge 32 side. Accordingly, there is little likelihood that ink leaks from the nozzles of the recording head 39.

[0070] Although this is a rare case, there is a situation that the carriage 38 is in the home position on the right side of the multi-function apparatus 10 with respect to the left-and-right direction 101, but the nozzle surface of the recording head 39 is not covered by the cap. When the multi-function apparatus 10 is oriented, such that the right face of the multi-function apparatus 10 faces downward in this situation, the nozzle surface of the recording head 39 and the ink surface 96 in the ink chamber 80 may be positioned at almost the same height. When this occurs, because the height difference between the nozzle surface of the recording head 39 and the ink surface 96 in the in chamber 80 is small, positive pressure pushing ink toward the outside of the nozzles is small (if any). There is little likelihood that the menisci of ink in the nozzles are broken, and therefore there is little likelihood that ink leaks from the nozzles of the recording head 39.

[0071] When the multi-function apparatus 10 is oriented, such that the front face of the multi-function apparatus 10 faces downward, i.e., when the front face of the multi-function apparatus 10 is positioned below the rear face of the multi-function apparatus 10, the ink cartridge 32 is positioned below the nozzle surface of the recording head 39. Therefore, negative pressure is generated in the nozzles of the recording head 39, such that ink is pulled toward the ink-cartridge 32 side. Accordingly, there is little likelihood that ink leaks from the nozzles of the recording head 39.

[Advantages]

[0072] According to the ink cartridge 32 of the above-described embodiment, because the connection opening 92 connecting the ink chamber 80 and the ink path 89 is positioned at a lower portion of the ink chamber 80 with

respect to the up-and-down direction 102, at a front portion of the ink chamber 80 with respect to the front-and-rear direction 103, and at a right portion of the ink chamber 80 with respect to the left-and-right direction 101, even if the multi-function apparatus 10 is oriented differently from when the multi-function apparatus 10 is in use, the likelihood may be reduced that all the ink stored in the ink chamber 80 leaks from the nozzles of the recording head 39.

[0073] Moreover, because the connection opening 92 is positioned at the front end of the ink chamber 80 with respect to the front-and-rear direction 103 and at the right end of the ink chamber 80 with respect to the left-and-right direction 101, the ink chamber 80 can store a relatively large amount of ink therein as an initial amount. Nevertheless, even if the connection opening 92 is not positioned at the front end of the ink chamber 80 with respect to the front-and-rear direction 103 and at the right end of the ink chamber 80 with respect to the left-and-right direction 101, the above described advantage can be achieved as long as the connection opening 92 is positioned at a front portion of the ink chamber 80 with respect to the front-and-rear direction 103, and at a right portion of the ink chamber 80 with respect to the left-and-right direction 101 and the amount of ink stored in the ink chamber 80 is chosen appropriately.

[0074] Moreover, because the volume V1 of the ink path 89 is less than the volume V2 of the ink chamber 80, even if ink in the ink path 89 flows out, the amount of ink flowing out of the ink cartridge 32 is small.

[0075] Moreover, because the width W1 of the ink path 89 in the left-and-right direction 101 is less than the width W2 of the ink chamber 80 in the left-and-right direction 101, the flow resistance of the ink path 89 is greater than the flow resistance of the ink chamber 80. It is more difficult for ink to flow in the ink path 89.

[0076] Moreover, because the ink supply opening 90 is positioned at a lower portion of the rear wall 83, when the upper wall 84 is positioned below the lower wall 85, not all the ink in the ink path 89 flows out.

[0077] Moreover, because the connection opening 92 is offset to the right of the ink supply opening 90 with respect to the left-and-right direction 101, i.e., the ink supply opening 90 is positioned to the left of the connection opening 92 with respect to the left-and-right direction 101, when the multi-function apparatus 10 is oriented, such that the right face of the multi-function apparatus 10 faces downward after ink stored in the ink chamber 80 has been consumed to some extent, the ink surface in the ink chamber 80 is positioned below the ink supply opening 90. Therefore, although there is little likelihood that ink leaks from the nozzles of the recording head 39 when the multi-function apparatus 10 is oriented, such that the right face of the multi-function apparatus 10 faces downward for the reason stated above, there is less likelihood that ink leaks from the nozzles of the recording head 39.

[0078] Moreover, because the connection opening 92 is positioned at the lowest portion of the bottom surface 91 of the ink chamber 80 with respect to the up-and-down direction 102, almost all the ink in the ink chamber 80 flows out of the ink chamber 80 when the multi-function apparatus 10 is in use.

[0079] Moreover, when the multi-function apparatus 10 is in use, the ink chamber 80 is positioned above the ink supply opening 90 with the bottom surface 91 positioned between the ink chamber 80 and the ink supply opening 90 with respect to the up-and-down direction 102, and therefore almost all the ink in the ink chamber 80 flow out via the ink supply opening 90.

[Modified embodiment]

[0080] Referring to **Fig. 11,** the ink cartridge 32 according to a modified embodiment has a mirror image of the ink cartridge 32 of the above-described embodiment (the ink cartridge 32 of **Fig. 5**) relative to a plane extending along the up-and-down direction 102 and the front-and-rear direction 103. In the above-described embodiment, the cartridge mounting portion 110 is positioned further forward than the nozzles of the recording head 39 with respect to the front-and-rear direction 103 and positioned to the right of the paper conveying path 23 with respect to the left-and-right direction 101, and the ink cartridge 32 mounted to the cartridge mounting portion 110 comprises the connection opening 92 positioned at a lower portion of the ink chamber 80 with respect to the up-and-down direction 102, at a front portion of the ink chamber 80 with respect to the front-and-rear direction 103, and at a right portion of the ink chamber 80 with respect to the left-and-right direction 101. On the other hand, in this modified embodiment, the cartridge mounting portion 110 is positioned further forward than the nozzles of the recording head 39 with respect to the front-and-rear direction 103 and positioned to the left of the paper conveying path 23 with respect to the left-and-right direction 101, and the ink cartridge 32 mounted to the cartridge mounting portion 110 comprises the connection opening 92 positioned at a lower portion of the ink chamber 80 with respect to the up-and-down direction 102, at a front portion (preferably at the front end) of the ink chamber 80 with respect to the front-and-rear direction 103, and at a left portion (preferably at the left end) of the ink chamber 80 with respect to the left-and-right direction 101 as shown in **Fig. 11.** In this modified embodiment, the same advantages as the above-described embodiment can be achieved.

[0081] 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 understood by 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 merely illustrative and that the scope of the invention is defined by the following claims.

Claims

1. An image recording apparatus comprising:

a carriage configured to move in a left-and-right direction along a recording surface of a recording medium;
a recording head mounted to the carriage and having nozzles formed therein, wherein the recording head is configured to eject liquid droplets though the nozzles;
a conveying mechanism configured to convey the recording medium along a conveying path to a position below the carriage with respect to an up-and-down direction;
a liquid cartridge comprising a liquid chamber configured to store liquid therein;
a cartridge mounting portion positioned further forward than the nozzles of the recording head with respect to a front-and-rear direction and positioned to the right of conveying path with respect to the left-and-right direction, wherein the cartridge mounting portion is configured to receive the liquid cartridge; and
a tube connecting the cartridge mounting portion and the recording head, through which liquid can flow between the cartridge mounting portion and the recording head,
wherein the liquid cartridge comprises:

a supply opening which is open at an outer surface of the liquid cartridge and is configured to supply the liquid stored in the liquid chamber to the tube;
a connection opening formed at a lower portion of the liquid chamber with respect to the up-and-down direction;
a liquid path connecting the liquid chamber and the supply opening via the connection opening; and
an atmosphere communication portion configured to bring the liquid chamber into communication with the atmosphere outside the liquid cartridge,
wherein when the liquid cartridge is mounted to the cartridge mounting portion, the connection opening is positioned at a front portion of the liquid chamber with respect to the front-and-rear direction and at a right portion of the liquid chamber with respect to the left-and-right direction.

2. The image recording apparatus of claim 1, wherein the liquid cartridge comprises a front end and a rear end with respect to the front-and-read direction, a left end and a right end with respect to the left-and-right direction, and an upper end and a lower end with respect to the up-and-down direction, wherein when the liquid chamber has an initial amount of liquid stored therein, the liquid stored in the liquid chamber has a surface which is:

positioned below the connection opening when the liquid cartridge is oriented such that the rear end of the liquid cartridge is positioned below the front end of the liquid cartridge;
positioned below the connection opening when the liquid cartridge is oriented such that the left end of the liquid cartridge is positioned below the right end of the liquid cartridge; and
positioned below the connection opening when the liquid cartridge is oriented such that the upper end of the liquid cartridge is positioned below the lower end of the liquid cartridge.

3. The image recording apparatus of claim 1 or 2, wherein the connection opening is offset to the right of the supply opening with respect to the left-and-right direction.

4. The image recording apparatus of any one of claims 1 to 3, wherein the connection opening is positioned at a front end of the liquid chamber with respect to the front-and-read direction and at a right end of the liquid chamber with respect to the left-and-right direction.

5. An image recording apparatus comprising:

a carriage configured to move in a left-and-right direction along a recording surface of a recording medium;
a recording head mounted to the carriage and having nozzles formed therein, wherein the recording head is configured to eject liquid droplets though the nozzles;
a conveying mechanism configured to convey the recording medium along a conveying path to a position below the carriage with respect to an up-and-down direction;
a liquid cartridge comprising a liquid chamber configured to store liquid therein;
a cartridge mounting portion positioned further forward than the recording head with respect to a front-and-rear direction and positioned to the left of conveying path with respect to the left-and-right direction, wherein the cartridge mounting portion is configured to receive the liquid cartridge; and
a tube connecting the cartridge mounting portion and the recording head, through which liquid can

flow between the cartridge mounting portion and the recording head,
wherein the liquid cartridge comprises:

a supply opening which is open at an outer surface of the liquid cartridge and is configured to supply the liquid stored in the liquid chamber to the tube;
a connection opening formed at a lower portion of the liquid chamber with respect to the up-and-down direction;
a liquid path connecting the liquid chamber and the supply opening via the connection opening; and
an atmosphere communication portion configured to bring the liquid chamber into communication with the atmosphere outside the liquid cartridge,
wherein when the liquid cartridge is mounted to the cartridge mounting portion, the connection opening is positioned at a front portion of the liquid chamber with respect to the front-and-rear direction and at a left portion of the liquid chamber with respect to the left-and-right direction.

6. The image recording apparatus of claim 5, wherein the liquid cartridge comprises a front end and a rear end with respect to the front-and-read direction, a left end and a right end with respect to the left-and-right direction, and an upper end and a lower end with respect to the up-and-down direction, wherein when the liquid chamber has an initial amount of liquid stored therein, the liquid stored in the liquid chamber has a surface which is:

positioned below the connection opening when the liquid cartridge is oriented such that the rear end of the liquid cartridge is positioned below the front end of the liquid cartridge;
positioned below the connection opening when the liquid cartridge is oriented such that the right end of the liquid cartridge is positioned below the left end of the liquid cartridge; and
positioned below the connection opening when the liquid cartridge is oriented such that the upper end of the liquid cartridge is positioned below the lower end of the liquid cartridge.

7. The image recording apparatus of claim 5 or 6, wherein the connection opening is offset to the left of the supply opening with respect to the left-and-right direction.

8. The image recording apparatus of any one of claims 5 to 7, wherein the connection opening is positioned at a front end of the liquid chamber with respect to the front-and-read direction and at a left end of the liquid chamber with respect to the left-and-right direction.

9. The image recording apparatus of any one of the claims 1 to 8, wherein the liquid chamber has a first volume and the liquid path has a second volume which is less than the first volume.

10. The image recording apparatus of claim 9, wherein the liquid chamber has a first cross-section taken along the left-and-right direction and the up-and-down direction, and the first cross-section has a first width in the left-and-right direction, wherein the liquid path has a second cross-section taken along the left-and-right direction and the up-and-down direction, and the second cross-section has a second width in the left-and-right direction, wherein the second width is less than the first width.

11. The image recording apparatus of any one of claims 1 to 10, wherein when the liquid cartridge is mounted to the cartridge mounting portion, the supply opening is positioned at a lower portion of the rear end of the liquid cartridge.

12. The image recording apparatus of any one of claims 1 to 11, wherein the liquid chamber has a bottom surface with respect to the up-and-down direction, and the connection opening is formed at the lowest portion of the bottom surface with respect to the up-and-down direction.

13. The image recording apparatus of any of claims 1 to 12, wherein the liquid chamber has a bottom surface with respect to the up-and-down direction, and when the liquid cartridge is mounted to the cartridge mounting portion, the liquid chamber is positioned above the supply opening with the bottom surface positioned between the liquid chamber and the supply opening with respect to the up-and-down direction.

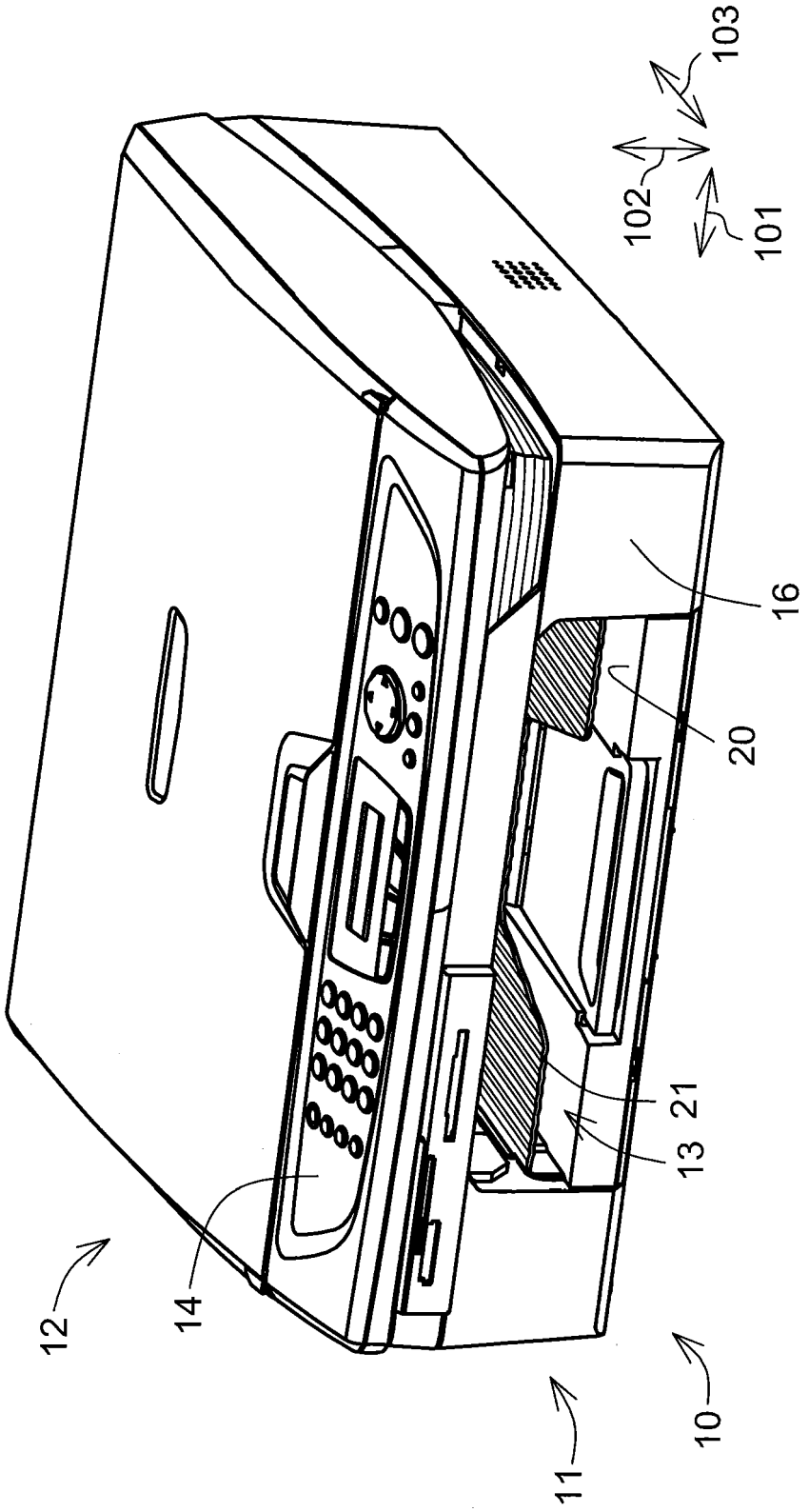

Fig.1

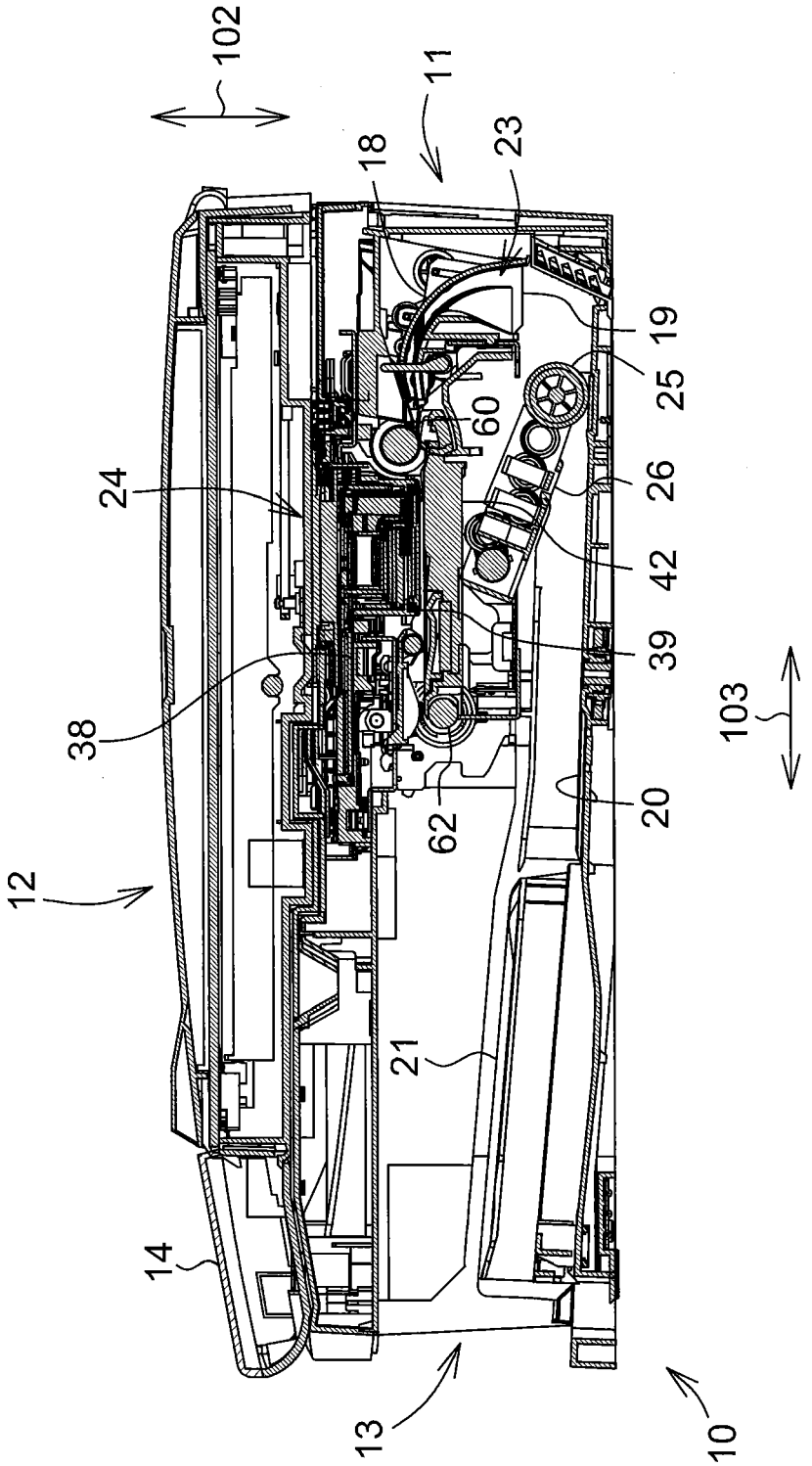

Fig.2

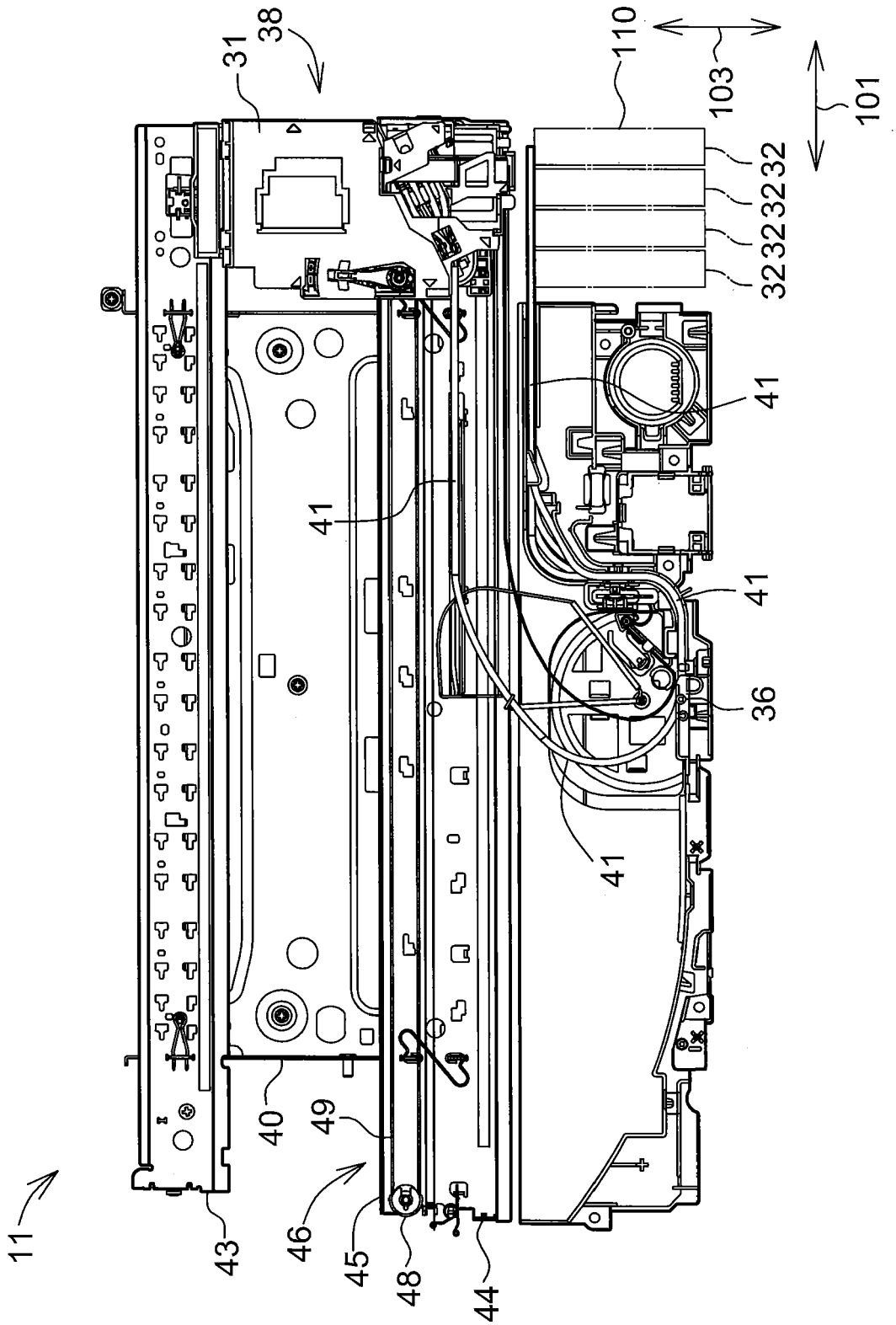

Fig.3

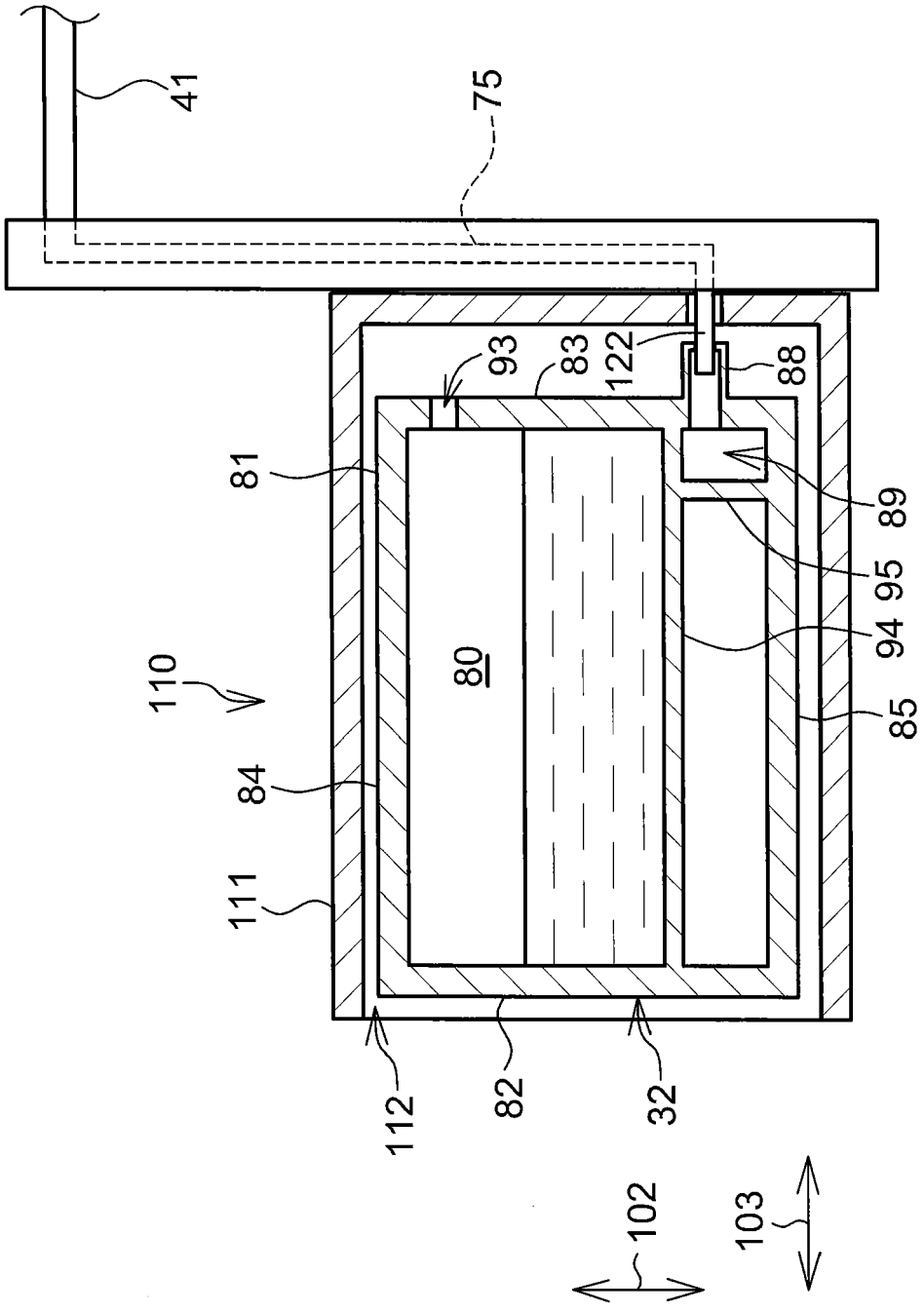

Fig.4

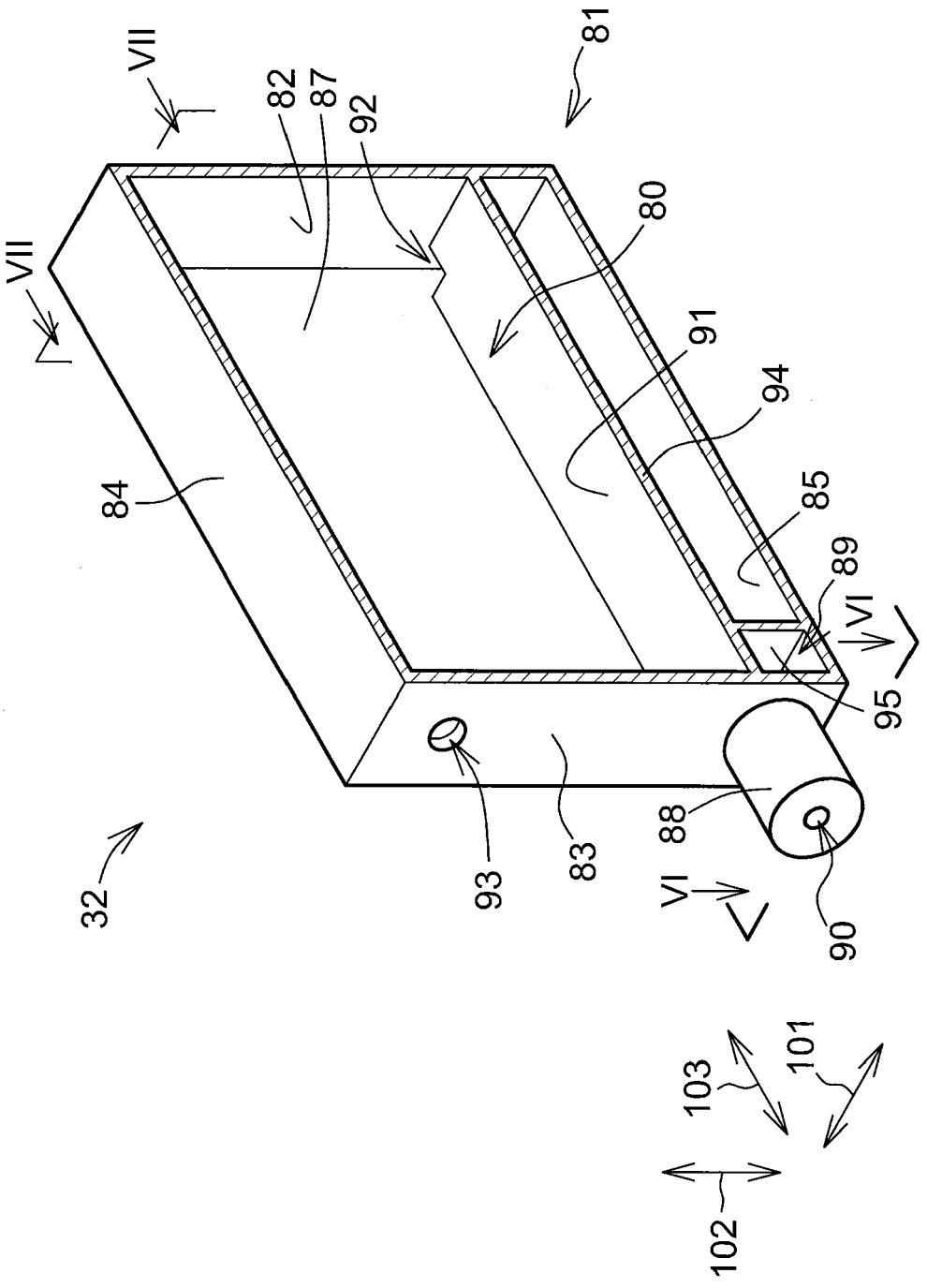
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Fig.5

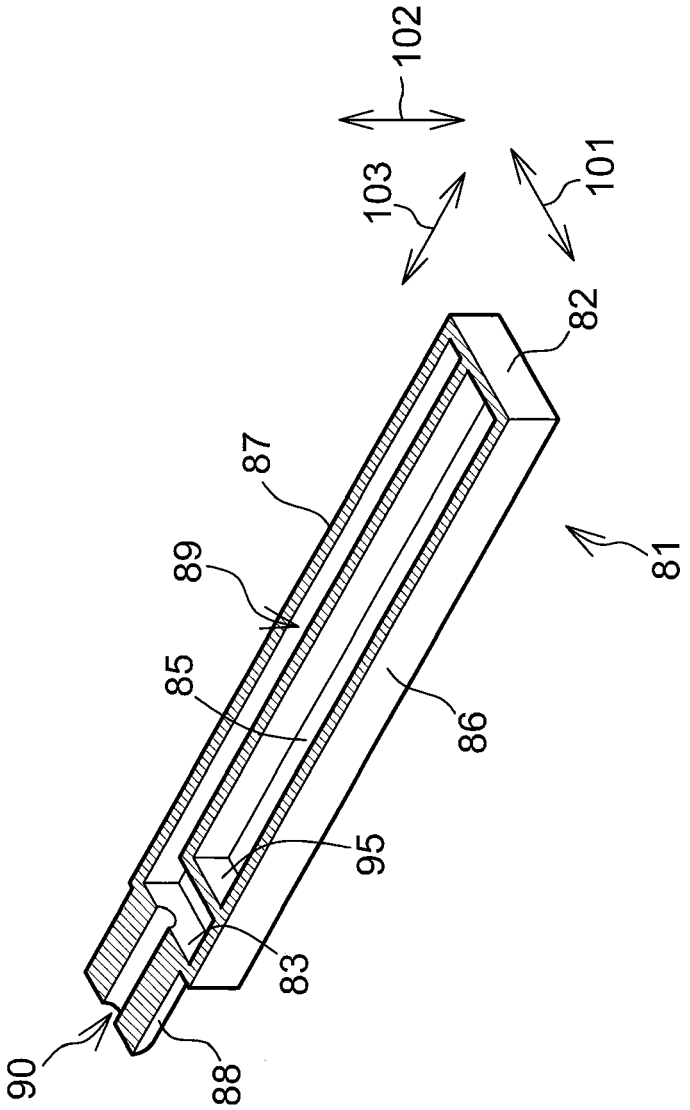

Fig.6

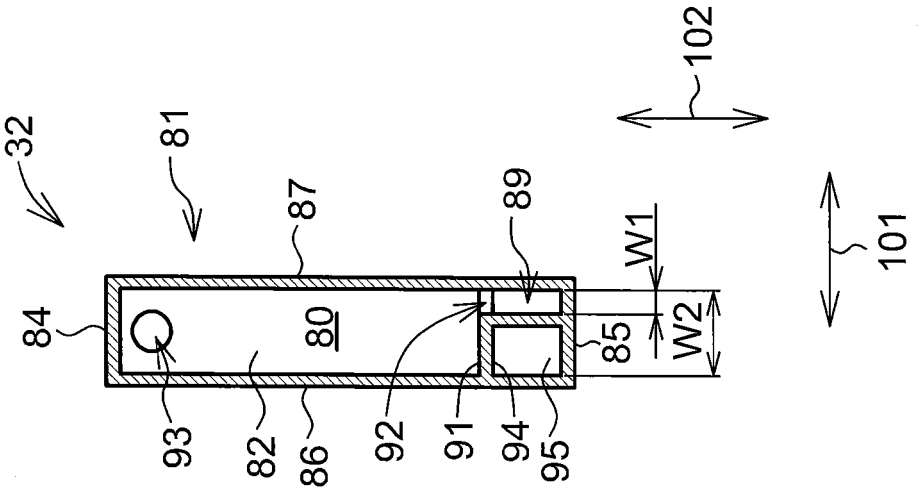

Fig.7

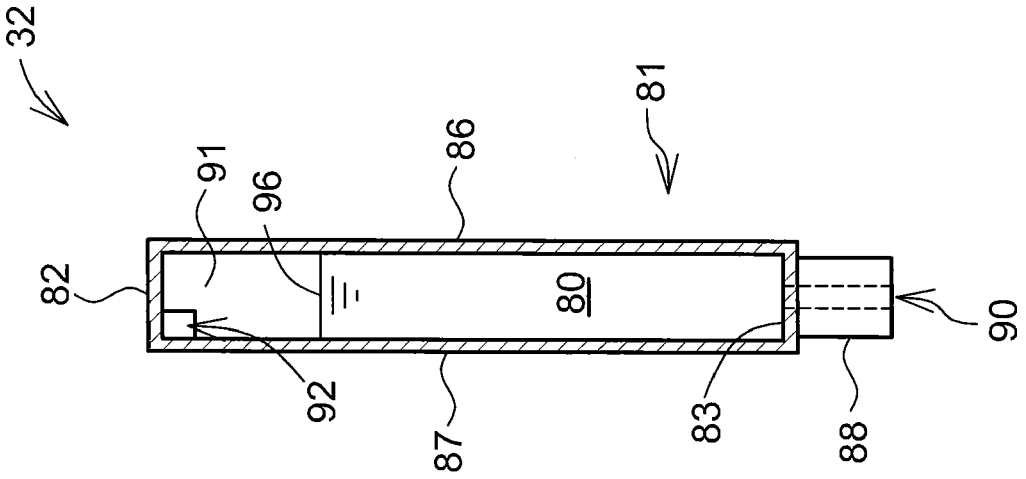

Fig.8

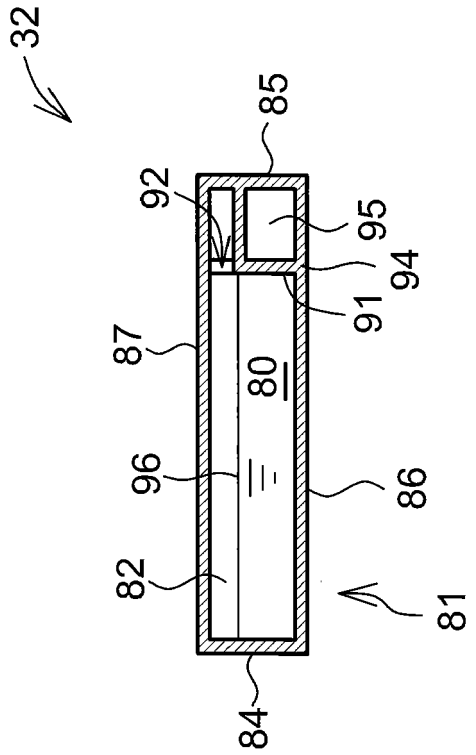

Fig.9

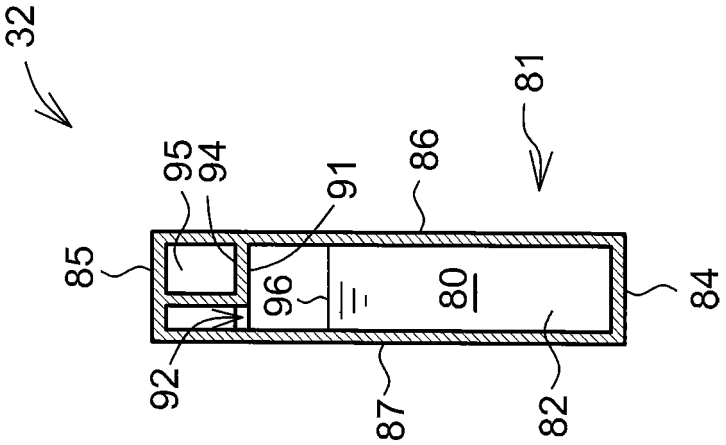

Fig.10

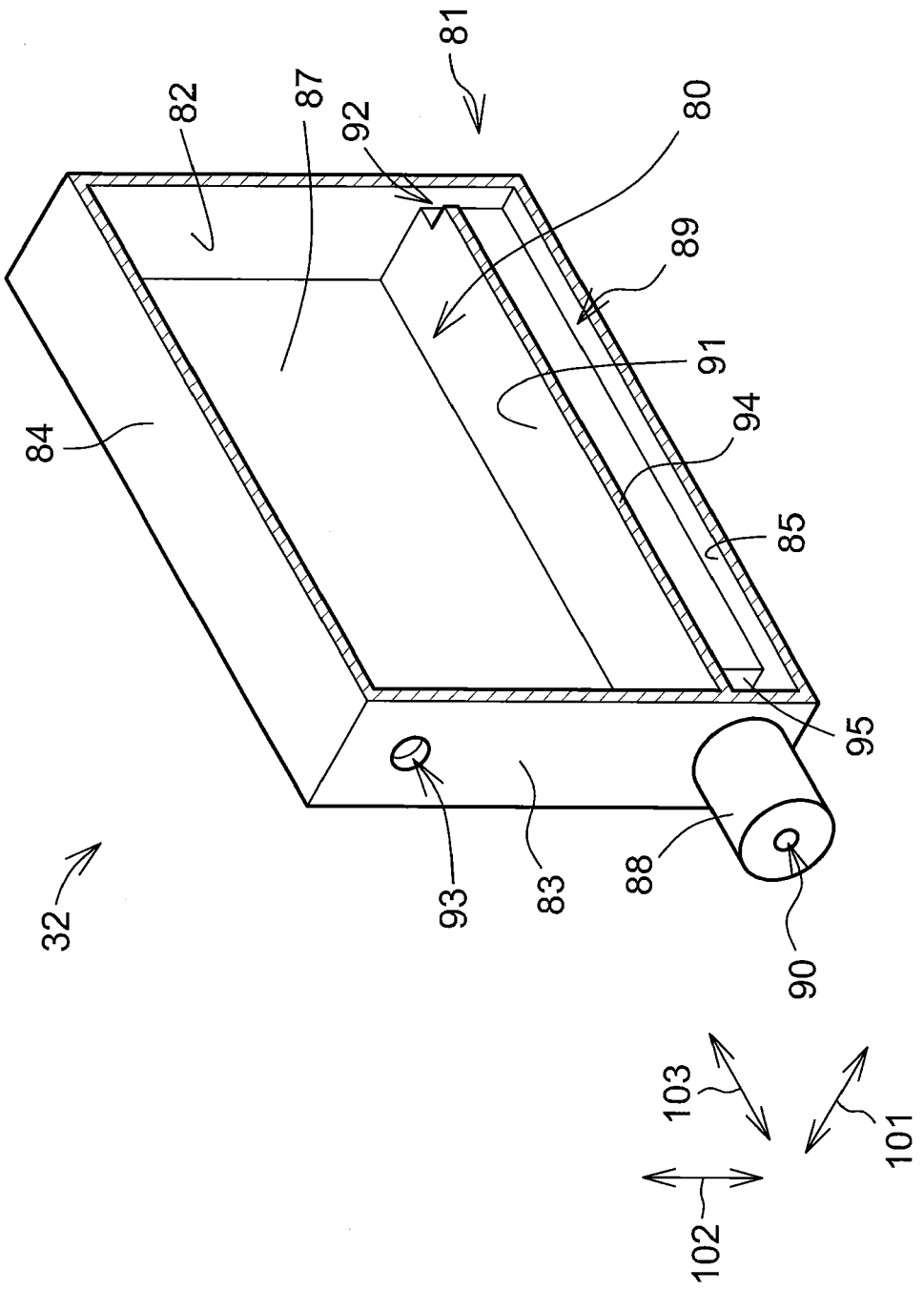

Fig.11

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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 2138

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 208 618 A1 (BROTHER IND LTD [JP]) 21 July 2010 (2010-07-21) * paragraphs [0025], [0032], [0043]; figures 1,2 *	1-13	INV. B41J2/175
X	US 2003/038865 A1 (INAMURA SHUSUKE [JP]) 27 February 2003 (2003-02-27) * paragraphs [0039], [0040]; figures 1,2 *	1-13	
X	EP 1 726 437 A2 (GRAPHTEC KK [JP]) 29 November 2006 (2006-11-29) * paragraphs [0027], [0028]; figures 4a, 4b, 5, 8 *	1,5	
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X	EP 0 832 748 A2 (HEWLETT PACKARD CO [US]) 1 April 1998 (1998-04-01) * column 4, line 54 - column 9, line 5; figures 3b, 3f *	1,5	TECHNICAL FIELDS SEARCHED (IPC) B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 July 2014	Adam, Emmanuel

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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04-07-2014

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