



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.09.2010 Bulletin 2010/39

(51) Int Cl.:
B41J 2/175^(2006.01)

(21) Application number: **10156489.6**

(22) Date of filing: **15.03.2010**

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

(30) Priority: **27.03.2009 JP 2009080595**

(71) Applicant: **Brother Kogyo Kabushiki Kaisha**
Nagoya-shi, Aichi 467-8561 (JP)

(72) Inventors:
• **Kanbe, Tomohiro**
Nagoya-shi Aichi 467-8562 (JP)
• **Nakamura, Hirotake**
Nagoya-shi Aichi 467-8562 (JP)

(74) Representative: **Prüfer & Partner GbR**
European Patent Attorneys
Sohnckestraße 12
D-81479 München (DE)

(54) **Image recording apparatus**

(57) An image recording apparatus includes a cartridge mounting portion including an optical detector comprising a light-emitting portion configured to emit light and a light-receiving portion configured to receive the light emitted from the light-emitting portion. The light-receiving portion is configured to output a signal depending on an intensity of light received by the light-receiving portion. The image recording apparatus also includes an ink car-

tridge including a projecting portion configured to act on the light emitted from the light-emitting portion, causing the intensity of light received by the light-receiving portion to change, during an insertion of the ink cartridge into the cartridge mounting portion. The image recording apparatus further includes a controller configured to allow ink to be consumed in the image recording apparatus, based on a change of the signal output from the light-receiving portion.

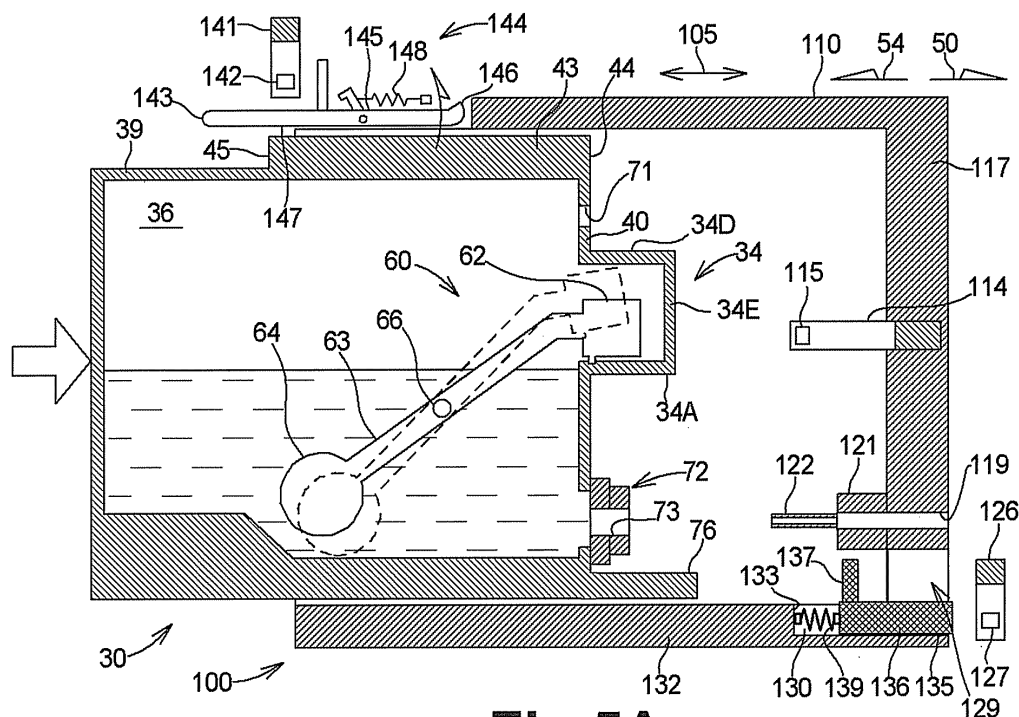


Fig.5A

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an image recording apparatus comprising a controller configured to allow ink to be consumed in the image recording apparatus.

2. Description of Related Art

[0002] A known image recording apparatus, e.g., an ink-jet printer is configured to record an image on a sheet of paper with ink. The image recording apparatus has a recording head and an ink cartridge for storing ink to be supplied to the recording head. The ink cartridge has an ink supply portion configured to allow ink in the interior of the ink cartridge to flow out to the exterior of the ink cartridge. Ink is supplied from the ink cartridge to the recording head through the ink supply portion. Ink supplied to the recording head is discharged selectively from nozzles formed in the recording head onto the sheet of paper. The image is recorded on the sheet of paper accordingly.

[0003] The known image recording apparatus has a cartridge mounting portion to which the ink cartridge is removably mounted. When the ink cartridge is mounted to the cartridge mounting portion, the ink supply portion functions so as to allow ink in the ink cartridge to be supplied to the recording head.

[0004] A known ink cartridge such as an ink cartridge described in JP-A-2007-196647 has a projecting portion projecting further outward than the ink supply portion, such that the projecting portion protects the ink supply portion from an external impact. Even when the ink cartridge is dropped onto a floor, the projecting portion collides with the floor surface, and hence the ink supply portion is prevented from being damaged.

[0005] If the projecting portion is broken and the projecting portion does not exist on the ink cartridge, the ink supply portion of the ink cartridge is susceptible to an external impact. If the projecting portion of an ink cartridge is broken and the ink supply portion of the cartridge is susceptible to an external impact, there is a higher possibility that the ink supply portion of the ink cartridge is damaged compared to an ink cartridge having the projecting portion. If the damage of the ink cartridge can be recognized visually from the appearance, a user is able to determine that the ink cartridge cannot (should not) be used. However, for example, when the interior of the ink supply portion is damaged, a user cannot find the damage of the ink cartridge. When the ink cartridge with the damaged ink supply portion is used in the image recording apparatus, ink leakage from the ink supply portion may occur or defective recording may occur because ink may not be supplied from the ink supply portion to the re-

cording head properly. Also, there is a risk such that air bubbles enter the ink supply path extending from the ink supply portion to the recording head and hence the recording head may perform blank discharges, in which ink is not discharged, which may cause the recording head to be broken.

SUMMARY OF THE INVENTION

[0006] Therefore, a need has arisen for image recording apparatus which overcome these and other shortcomings of the related art. A technical advantage of the present invention is that chances that a damaged ink cartridge is used in the image recording apparatus are reduced.

[0007] According to an embodiment of the present invention, an image recording apparatus comprises a cartridge mounting portion comprising a first optical detector comprising a first light-emitting portion configured to emit light and a first light-receiving portion configured to receive the light emitted from the first light-emitting portion. The first light-receiving portion is configured to output a signal depending on an intensity of light received by the first light-receiving portion. The image recording apparatus also comprises an ink cartridge configured to be mounted to the cartridge mounting portion by being inserted into the cartridge mounting portion in an insertion direction. The ink cartridge comprises an ink supply portion positioned on a front side of the ink cartridge with respect to the insertion direction, and configured to supply ink from an interior of the ink cartridge to an exterior of the ink cartridge, and a first projecting portion projecting further than the ink supply portion in the insertion direction, and configured to act on the light emitted from the first light-emitting portion, causing the intensity of light received by the first light-receiving portion to change, during an insertion of the ink cartridge into the cartridge mounting portion. The image recording apparatus further comprises a controller configured to allow ink to be consumed in the image recording apparatus, based on a change of the signal output from the first light-receiving portion.

[0008] With this configuration, during the insertion of the ink cartridge into the cartridge mounting portion, the first projecting portion acts on the light emitted from the first light-emitting portion. The first projecting portion may directly act on the light by intersecting a path of the light, or may indirectly act on the light by contacting and moving a movable member, such that the movable member intersects the path of the light. The intensity of light received by the first light-receiving portion is changed by the first projecting portion acting on the light emitted from the first light-emitting portion. Therefore, the signal output from the first light-receiving portion is changed. The controller allows ink to be consumed in the image recording apparatus based on the change of the signal output from the first light-receiving portion. If the ink cartridge having a broken first projection portion or no first projecting portion

is mounted to the cartridge mounting portion, nothing acts on the light emitted from the first light-emitting portion. Therefore, the signal output from the first light-receiving portion is not changed. In this case, the controller does not allow ink to be consumed in the image recording apparatus.

[0009] The controller allows ink to be consumed only when the ink cartridge having the first projecting portion, i.e., the ink cartridge having the ink supply portion less probable to be damaged is mounted to the cartridge mounting portion. Consequently, the ink leakage may be reduced or the chances of the breakdown of the recording head may be reduced.

[0010] The controller may be configured to allow ink to be consumed in the image recording apparatus when a level of the signal output from the first light-receiving portion changes to cross a first predetermined threshold value.

[0011] With this configuration, the function of the controller may not be affected by a small change of the output signal due to noise.

[0012] The first projecting portion may be configured to act on the light emitted from the first light-emitting portion when the ink cartridge reaches an ink supply position in which the ink cartridge can supply ink from the interior of the ink cartridge to the exterior of the ink cartridge in the cartridge mounting portion.

[0013] With this configuration, whether or not ink is allowed to be consumed may be determined in a state in which the ink cartridge can supply ink from the interior of the ink cartridge to the exterior of the ink cartridge.

[0014] The image recording apparatus further may comprise an output unit configured to output a signal when the ink cartridge has reached the ink supply position, and the controller may be configured to determine whether or not the signal output from the first light-receiving portion has changed when the controller receives the signal output from the output unit.

[0015] With this configuration, the controller may be able to obtain a timing for determining whether or not the signal output from the first light-receiving portion has changed, i.e., wither or not the first projecting portion is present. Therefore, an accurate determination of the presence or absence of the first projecting portion may be achieved.

[0016] The first projecting portion may be positioned below the ink supply portion when the ink cartridge is in a mounted position, in which the ink cartridge is mounted to the cartridge mounting portion.

[0017] With this configuration, even when the ink leaks from the ink supply portion, the leaked ink may be received by the first projecting portion.

[0018] The cartridge mounting portion may comprise a second optical detector comprising a second light-emitting portion configured to emit light and a second light-receiving portion configured to receive the light emitted from the second light-emitting portion. The ink cartridge may comprise a second projecting portion positioned at

a position different from the first projecting portion, and projecting further than the ink supply portion in the insertion direction. The second projecting portion may be configured to act on the light emitted from the second light-emitting portion, causing an intensity of light received by the second light-receiving portion to change, during the insertion of the ink cartridge into the cartridge mounting portion. The controller may be configured to allow ink to be consumed in the image recording apparatus, based on both the change of the signal output from the first light-receiving portion and a change of the signal output from the second light-receiving portion.

[0019] In order to protect the ink supply portion further reliably, the second projecting portion may be provided to the ink cartridge in addition to the first projecting portion. The controller may allow ink to be used based on both the change of the signal output from the first light-receiving portion and a change of the signal output from the second light-receiving portion.

[0020] The controller may be configured to allow ink to be consumed in the image recording apparatus when a level of the signal output from the first light-receiving portion changes to cross a first predetermined threshold value and when a level of the signal output from the second light-receiving portion changes to cross a second predetermined threshold value.

[0021] The first predetermined threshold value and the second predetermined threshold value may be the same value. Ink may be consumed in the image recording apparatus only when the ink cartridge having both the first projecting portion and the second projecting portion is mounted to the cartridge mounting portion, i.e., the ink cartridge having the ink supply portion far less probable to be damaged is mounted to the cartridge mounting portion. Consequently, the ink leakage may be reduced more or the chances of the breakdown of the recording head may be reduced more.

[0022] The ink cartridge may comprise a predetermined portion on the front side of the ink cartridge, and a plane connecting a projecting end of the first projection portion and the predetermined portion may be positioned in front of the ink supply portion in the insertion direction.

[0023] With this configuration, even when the ink cartridge is dropped, the ink supply portion may be reliably protected from an external impact.

[0024] The image recording apparatus further may comprise an ink tube connected to the cartridge mounting portion. When the controller allows ink to be consumed in the image recording apparatus, an image may be recorded with ink supplied from the ink cartridge or ink may be sucked from the ink cartridge into the ink tube and the ink tube may be filled with ink.

[0025] 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 THE DRAWINGS

[0026] 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.

[0027] Fig. 1 is a schematic cross-sectional view of an internal structure of a printer according to an embodiment of the present invention.

[0028] Fig. 2(A) is a perspective view of an ink cartridge according to an embodiment of the present invention, and Fig. 2(B) is a vertical cross-sectional view of the ink cartridge.

[0029] Figs. 3(A) and 3(B) are vertical cross-sectional views of a cartridge holder according to an embodiment of the present invention, in which a lock lever is in a lock position in Fig. 3(A) and in an unlock position in Fig. 3(B).

[0030] Fig. 4(A) is a perspective view of an optical detector, and Fig. 4(B) is a transparent perspective view of the optical detector.

[0031] Fig. 5(A) is a vertical cross-sectional view of the ink cartridge of Figs. 2(A) and 2(B) and the cartridge holder of Figs. 3(A) and 3(B), in which the ink cartridge is inserted into the cartridge holder, and Fig. 5(B) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which the ink cartridge is further inserted into the cartridge holder from the state shown in Fig. 5(A).

[0032] Fig. 6(A) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which the ink cartridge is further inserted into the cartridge holder from the state shown in Fig. 5(B), and Fig. 6(B) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which mounting of the ink cartridge to the cartridge holder is completed.

[0033] Fig. 7(A) is a vertical cross-sectional view of the ink cartridge having a broken projecting portion and the cartridge holder, in which the ink cartridge is inserted into the cartridge holder, and Fig. 7(B) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which mounting of the ink cartridge to the cartridge holder is completed.

[0034] Fig. 8(A) shows time profiles of output signals from three optical detectors when the ink cartridge having a projecting portion is inserted into the cartridge holder, and Fig. 8(B) shows time profiles of output signals from three optical detectors when the ink cartridge having a broken projecting portion is inserted into the cartridge holder.

[0035] Fig. 9 is a block diagram of a controller.

[0036] Fig. 10 is a flowchart of a process performed by the controller.

[0037] Fig. 11(A) is a perspective view of an ink cartridge according to another embodiment of the present invention, and Fig. 2(B) is a vertical cross-sectional view of the ink cartridge.

[0038] Fig. 12(A) is a vertical cross-sectional view of the ink cartridge of Figs. 11(A) and 11(B) and a cartridge

holder according to another embodiment of the present invention, in which the ink cartridge is inserted into the cartridge holder, and Fig. 12(B) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which mounting of the ink cartridge to the cartridge holder is completed.

[0039] Fig. 13(A) is a perspective view of an ink cartridge according to yet another embodiment of the present invention, and Fig. 13(B) is a vertical cross-sectional view of the ink cartridge.

[0040] Fig. 14(A) is a vertical cross-sectional view of the ink cartridge of Figs. 13(A) and 13(B) and a cartridge holder according to yet another embodiment of the present invention, in which the ink cartridge is inserted into the cartridge holder, and Fig. 14(B) is a vertical cross-sectional view of the ink cartridge and the cartridge holder, in which mounting of the ink cartridge to the cartridge holder is completed.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0041] Embodiments of the present invention, and their features and advantages, may be understood by referring to Figs 1-14(B), like numerals being used for like corresponding parts in the various drawings

[0042] A first embodiment of the present invention will be described. Referring to Fig. 1, a printer 10, as an example of an image recording apparatus, is an ink-jet printer configured to perform image recording on a recording medium such as a sheet of paper by selectively discharging inks in respective colors from a recording head 21 as minute ink droplets. The printer 10 comprises an ink supply device 100. The ink supply device 100 comprises a cartridge holder 110, as an example of a cartridge mounting portion, and four ink cartridges 30 configured to be removably mounted to the cartridge holder 110 by being inserted into the cartridge holder 110 in a horizontal direction. A cover 19 is supported pivotally at a lower end of an opening 112 formed through the cartridge holder 110. The cover 19 pivots about the lower end of the opening 112, such that the cover 19 changes its position between an open position, in which the cover 19 does not cover the opening 112 and the interior of the cartridge holder 110 is exposed through the opening 112, and a close position, in which the cover 19 covers the opening 112 to hide the interior of the cartridge holder 110. The ink cartridge 30 is inserted into the cartridge holder 110 via the opening 112.

[0043] In the respective ink cartridges 30, inks to be used by the printer 10 are stored. More specifically, inks in respective colors; cyan, magenta, yellow, and black are stored in the ink cartridges 30 corresponding to the respective colors. The ink cartridge 30 and the recording head 21 are in fluid communication by a flexible ink tube 20. The recording head 21 is provided with a sub tank 28, and ink is stored temporarily in the sub tank 28. The recording head 21 selectively ejects the ink in the sub

tank 28 from nozzles 29.

[0044] A sheet of paper fed to a conveying path 24 from a feed tray 15 by a paper feed roller 23 is conveyed onto a platen 26 by a conveying roller pair 25. The recording head 21 ejects ink onto the sheet of paper passing over the platen 26. Accordingly, an image is recorded on the sheet of paper. The sheet of paper having passed over the platen 26 is discharged to a discharge tray 16 provided at most downstream side of the conveying path 24 by a discharge roller pair 22. Consumption of ink in the printer 10 comprises recoding an image with ink by the recording head 21, and purging the recording head 21 in which ink is sucked from the recording head 21 (and sucked from the ink cartridge 30 accordingly) for preventing the defective ejection of the ink from the nozzles 29 after the ink cartridge 30 is mounted to the cartridge holder 110.

[0045] The ink cartridge 30 has a container shape and is configured to store ink therein. The ink cartridge 30 comprises an ink chamber 36 formed therein. The ink cartridge 30 is inserted into the cartridge holder 110 in an upright position as shown in Fig. 2(A), in a direction indicated by an arrow 50 (hereinafter, referred to as an insertion direction 50). The ink cartridge 30 is mounted to the cartridge holder 110 in the upright position. In other words, the upright position is a mounted position of the ink cartridge 30.

[0046] The ink cartridge 30 has a substantially rectangular parallelepiped shape. The ink cartridge 30 has a flat shape, such that a width thereof in a width direction 51 is less than each of a height thereof in a height direction 52 and a depth thereof in a depth direction 53. The ink cartridge 30 is made, for example, of a translucent resin, e.g., transparent or semi-transparent resin. The ink cartridge 30 comprises an air communication opening 71, an ink amount detection portion 34, and an ink supply portion 72 on a front side of the ink cartridge 30 with respect to the insertion direction 50. More specifically, the ink cartridge 30 comprises a front wall 40 facing forward with respect to the insertion direction 50. The front wall 40 comprises the air communication opening 71 formed therethrough, the ink amount detection portion 34, and the ink supply portion 72.

[0047] The ink amount detection portion 34 has a substantially rectangular parallelepiped shape. The ink amount detection portion 34 projects outward (forward, e.g., rightward in Fig. 2(B)) from a middle portion of the front wall 40 with respect to the height direction 52. The ink amount detection portion 34 has an inner space 35 formed therein, and the inner space 35 is in fluid communication with the ink chamber 36. The inner space 35 is defined by a bottom wall 34A, side walls 34B, an upper wall 34D, and a front wall 34E of the ink amount detection portion 34. A light-blocking panel 62 of a detection arm 60, described later, is inserted into the inner space 35.

[0048] A user can visually see the light-blocking panel 62 through the ink amount detection portion 34, or an optical detector 114 (see Figs. 3(A) and 3(B)) can detect

light-blocking panel 62, such that the amount of ink in the ink chamber 36 is recognized. Therefore, the ink amount detection portion 34 is made of a translucent material, e.g., transparent or semi-transparent material. The distance between the side walls 34B in the width direction 51, i.e., the width of the ink amount detection portion 34 is less than the width of the front wall 40, such that the ink amount detection portion can enter a detection area 115 of the optical detector 114, described later.

[0049] The detection arm 60 is positioned in ink chamber 36. The detection arm 60 is configured to move according to the amount of ink stored in the ink chamber 36. The detection arm 60 comprises the light-blocking panel 62, an arm body 63, and a float 64.

[0050] The arm body 63 is pivotably supported by a supporting shaft 66 which is supported by side walls 41 of the ink cartridge 30. The supporting shaft 66 extends between the side walls 41. Accordingly, the detection arm 60 is pivotable in the ink chamber 36 in the directions indicated by an arrow 67 and an arrow 68.

[0051] The float 64 is provided at one end of the arm body 63. The float 64 has a hollow interior formed therein, and a predetermined buoyancy acts on the float 64 when the float 64 is submerged in ink. Therefore, the float 64 moves up and down according to increase and decrease of the amount of ink stored in the ink chamber 36. The detection arm 60 pivots according to the movement of the float 64. In another embodiment, the float 64 may not have a hollow interior therein, and a portion of the arm body 63 extending from the supporting shaft 66 to the float 64 and the float 64 may have the specific gravity less than the specific gravity of ink, such that a predetermined buoyancy acts thereon, or a portion of the portion of the arm body 63 extending from the supporting shaft 66 to the float 64 and the float 64 may have the specific gravity less than the specific gravity of ink, such that a predetermined buoyancy acts thereon.

[0052] The light-blocking panel 62 is provided at an end of the arm body 63 which is opposite from the float 64. When the ink amount in the ink chamber 36 is greater than or equal to a predetermined amount, the detection arm 60 pivots clockwise, i.e., the direction indicated by the arrow 67, in Fig. 2(B) about the supporting shaft 66 because of the buoyancy acting on the float 64, and the light-blocking panel 62 moves downward in the inner space 35. Then, the light-blocking panel 62 comes into contact with the bottom wall 34A of the ink amount detection portion 34 and remains in a lower position (the position indicated by the solid line in Fig. 2(B)). When the ink amount in the ink chamber 36 is reduced to the predetermined amount, a part of the float 64 is exposed from the ink surface, and the buoyancy is balanced out by the gravity. When the ink amount in the ink chamber 36 is further reduced to an amount less than the predetermined amount, the float 64 moves down as the ink surface in the ink chamber 36 is lowered. When this occurs, the detection arm 60 pivots counterclockwise i.e., the direction indicated by the arrow 68, in Fig. 2(B) about the

supporting shaft 66, and the light-blocking panel 62 moves upward in the inner space 35 and moves apart from the bottom wall 34A. Then, the light-blocking panel 62 comes into contact with the upper wall 34D and remains in an upper position (the position indicated by the broken line in Fig. 2(B)). In Fig. 2(B), the position of the detection arm 60 in which the light-blocking panel 62 contacts the bottom wall 34A is shown by the solid line, and the position of the detection arm 60 in which the light-blocking panel 62 is separated away from the bottom wall 34A is shown by the broken line.

[0053] The light-blocking panel 62 is aligned with an irradiated portion 34C in the width direction 51 when the light-blocking panel 62 is in the lower position. The irradiated portion 34C is a lower portion of the side wall 34sB. In contrast, when the light-blocking panel 62 is in the upper position, the light-blocking panel 62 is positioned above the irradiated portion 34C, and is not aligned with the irradiated portion 34C in the width direction 51.

[0054] Light emitted from the optical detector 114, described later, is blocked by the light-blocking panel 62, or is allowed to pass through the ink amount detection portion 34 in the width directions 51 depending on the position of the light-blocking panel 62 in the inner space 105 with respect to the height direction 52.

[0055] When the ink cartridge 30 is in an ink supply position in which the ink cartridge 30 can supply ink from the ink chamber 36 to the exterior of the ink cartridge 30 in the cartridge holder 110, light is emitted from a light-emitting portion of the optical detector 114 (see Figs. 3(A) and 3(B)), toward the irradiated portion 34C of the side walls 34B of the ink amount detection portion 34. When the light-blocking panel 62 is in the lower position (the position indicated by the solid line in Fig. 2(B)), the light passing through the irradiated portion 34C is blocked by the light-blocking panel 62. In contrast, when the light-blocking panel 62 is in the upper position (the position indicated by the broken line in Fig. 2(B)), the light passes through the inner space 35 without being blocked by the light-blocking panel 62 and reaches the light-receiving portion of the optical detector 114. Therefore, whether or not the predetermined amount or more of ink remains in the ink chamber 36 may be determined by analyzing a waveform of an output signal from the light-receiving portion or by detecting attenuation or the presence or absence of the output signal.

[0056] The air communication opening 71 is positioned at the front wall 40 above the ink amount detection portion 34. The air communication opening 71 penetrates through the front wall 40, and the exterior of the ink cartridge 30 can be in fluid communication with the ink chamber 36 via the air communication opening 71. The pressure in the ink chamber 36 may be maintained at the atmospheric pressure by air coming into the ink chamber 36 via the air communication opening 71. The ink supply portion 72 is positioned below the ink amount detection portion 34. The ink supply portion 72 is made of a resilient cylindrical member, such as rubber, and extends from

the front wall 40 forward in the insertion direction 50. The ink supply portion 72 has a through hole 73 formed through the center thereof, and the ink stored in the ink chamber 36 can flow out through the through hole 73. Although the through hole 73 is shown open in Fig. 2(B), the through hole 73 is closed by the resiliency of the ink supply portion 72. When the ink cartridge 30 is mounted to the cartridge holder 110, the ink supply tube 122 of the cartridge holder 110 is inserted into the through hole 73.

[0057] A imaginary plane 56 connecting a projecting end (front end) of a projecting portion 76 and a projecting end (front end) of the ink amount detection portion 34 is positioned in front of the ink supply portion 72 in the insertion direction 50. In other words, the ink supply portion 72 does not extend beyond the imaginary plane 56 in the insertion direction 50. Therefore, even when the ink cartridge 30 is dropped, the ink supply portion 72 does not directly receive an external impact, and therefore the ink supply portion 72 may be protected from the impact.

[0058] The ink cartridge 30 comprises a rib 43 extending in the depth direction 53. The rib 43 comprises two side surfaces extending upward from an upper wall 39 of the ink cartridge 30 and an upper surface connecting top ends of the both side surfaces with each other. The width of the rib 43 is less than the width of the upper wall 39 in the width direction 51. An end surface 44 of the rib 43 is flush with the front wall 40, and an engaging surface 45 opposite the end surface 44 is positioned at a middle portion of the upper wall 39 in the depth direction 53. The engaging surface 45 of the rib 43 is a portion with which a lock lever 145, described later, engages when the ink cartridge 30 is mounted to the cartridge holder 110 in the ink supply position.

[0059] The ink cartridge 30 comprises the projecting portion 76. The projecting portion 76 is configured to indirectly act on light passing through a detection area 127 of an optical detector 126 (see Fig. 3(A)) during an insertion of the ink cartridge 30 into the cartridge holder 110. The projecting portion 76 is positioned at a lower end of the front wall 40 when the ink cartridge 30 is in the upright position shown in Fig. 2(A). The projecting portion 76 is positioned below the ink supply portion 72, and projects outward (forward) in the insertion direction 50 from the front wall 40. In this embodiment, the width of the projecting portion 76 is the same as the width of the front wall 40 in the width direction 51. The projecting portion 76 projects outward (forward) further than the ink supply portion 72 in the insertion direction 50. In other words, the projecting distance of the projecting portion 76 (the distance from the front wall 40 to the projecting end of the projecting portion 76) is greater than the projecting distance of the ink supply portion 72 (the distance from the front wall 40 to the projecting end of the ink supply portion 72). The projecting portion 76 is configured to contact and move, i.e., press a sliding member 135 (see Fig. 3) slidably supported in the cartridge holder 110 and causes the sliding member 135 to slide in the insertion

direction 50 during the insertion of ink cartridge 30 into the cartridge holder 110.

[0060] The ink supply device 100 is provided in the printer 10. The ink supply device 100 is configured to supply ink to the recording head 21 (see Fig. 2) provided in the printer 10. The ink supply device 100 comprises the cartridge holder 110 to which a plurality of the ink cartridges 30 can be mounted.

[0061] Referring to Figs. 3(A) and 3(B), the cartridge holder 110 is configured to accommodate the ink cartridges 30 in the interior thereof. The cartridge holder 110 has an opening 112 at the front side of the printer 10 (left side in Figs. 3(A) and 3(B)). The ink cartridges 30 are inserted into the cartridge holder 110 through the opening 112 in a horizontal direction.

[0062] The cartridge holder 110 comprises an end wall 117 opposite the opening 112. An opening 119 is formed through the lower portion of the end wall 117 from the inner surface of the end wall 117 to the outer surface of the end wall 117. A connecting portion 121 and an ink supply tube 122 are provided at the inner surface of the end wall 117 so as to be in fluid communication with the opening 119. The flexible ink tube 20 (see Fig. 1) is connected to the outer surface of the end wall 117 so as to be in fluid communication with the opening 119. When the ink cartridge 30 is mounted to the cartridge holder 110, the ink supply tube 122 is inserted into the through hole 73 of the ink supply portion 72. Accordingly, an ink path extending from the ink chamber 36 of the ink cartridge 30 via the through hole 73 of the ink supply portion 72 and the ink supply tube 122 to the connecting portion 121 is formed, and the ink stored in the ink chamber 36 is supplied to the recording head 21 via the ink tube 20.

[0063] The optical detector 114 is provided at a middle portion of the end wall 117 of the cartridge holder 110 with respect to the height direction 52. The optical detector 114 is configured to detect the light-blocking panel 62 of the detection arm 60 positioned in the ink cartridge 30 mounted to the cartridge holder 110. The configuration of the optical detector 114 is similar to the configuration of the optical detector 126. In this embodiment, the optical detector 114 is a light-transmissive photo interrupter having the light-emitting portion and the light-receiving portion. The light-emitting portion is configured to emit light such as visible light or infrared light toward the light-receiving portion. The light-emitting portion is, for example, a light-emitting diode. The light-receiving portion is configured to receiving the light emitted from the light-emitting portion. The light-receiving portion is, for example, a photo transistor. The light-emitting portion and the light-receiving portion are positioned so as to oppose to each other in the width direction 51. The optical detector 114 is provided for each ink cartridge 30. That is, if the cartridge holder 110 is configured to accommodate four ink cartridges 30, four optical detectors 114 corresponding to the four ink cartridges 30 respectively are provided in the cartridge holder 110.

[0064] The optical detector 114 is electrically connect-

ed to a controller 90 (see Fig. 9), and an electric signal output from the light-receiving portion is input to the controller 90. In this embodiment, when the ink cartridge 30 is positioned in the ink supply position in the cartridge holder 110, a lower portion of the ink amount detection portion 34 enters the detection area 115 extending from the light-emitting portion to the light-receiving portion of the optical detector 114. In other words, the irradiated portion 34C (see Fig. 2) of the side walls 34B of the ink amount detection portion 34 is positioned in the detection area 115. The controller 90 determines whether the remaining amount of ink stored in the ink chamber 36 becomes less than the predetermined amount based on the output signal, which depend on intensity of light received by the light-receiving portion, from the optical detector 114 when the ink amount detection portion 34 enters the detection area 115.

[0065] The optical detector 126 is provided outside of the cartridge holder 110 adjacent to the lower end of the end wall 117. The optical detector 126 is configured to indirectly detect the presence and absence of the projecting portion 76 of the ink cartridge 30 when the ink cartridge 30 is mounted to the cartridge holder 110. Referring to Figs. 4(A) and 4(B), the optical detector 126 comprises a light-emitting portion 125 configured to emit light and a light-receiving portion 128 configured to receive the light emitted from the light-emitting portion 125. The light-emitting portion 125 and the light-receiving portion 128 are positioned in a housing 123 formed of resin shaped into a substantially U-shape. In this embodiment, the optical detector 126 is a light-transmissive photo interrupter having the light-emitting portion 125 and the light-receiving portion 128 positioned so as to face each other in the width direction 51. The optical detector 126 is electrically connected to the controller 90 (see Fig. 9), and an electric signal output from the light-receiving portion 128 is input to the controller 90. The signal output from the light-receiving portion 128 depends on intensity of light received by the light-receiving portion 128. In another embodiment, a reflection detecting type of a photo-interrupter may be employed instead of the optical detector 126.

[0066] Referring to Figs. 3(A) and 3(B), the cartridge holder 110 is provided with the sliding member 135. The sliding member 135 is provided for each ink cartridge 30. If the cartridge holder 110 is configured to accommodate four ink cartridges 30, four sliding members 135 corresponding to the four ink cartridges 30 respectively are provided.

[0067] The sliding member 135 is configured as a separate member from the ink cartridge 30 and the cartridge holder 110. The sliding member 135 is positioned in a recess 130 formed in a bottom wall 132 of the cartridge holder 110 adjacent to the end wall 117. An opening 129 is formed through the end wall 117 in the insertion direction 50 at a lower portion of the end wall 117. The recess 130 continues to the opening 129. The sliding member 135 is configured to slide in recess 130 along a bottom

surface of the recess 130 in the insertion/removal directions 105 of the ink cartridge 30. The sliding member 135 is slidable between a position away from the detection area 127 of the optical detector 126 as shown in Fig. 3 (A) and a position positioned in the detection area 127 as shown in Fig. 3(B). In other words, the optical detector 126 is positioned such that the detection area 127 of the optical detector 126 is positioned within the sliding range of the sliding member 135.

[0068] The sliding member 135 is provided with an contact portion 137 with which the projecting member 76 of the ink cartridge 30 comes into contact during the insertion of the ink cartridge 30 into the cartridge holder 110. The contact portion 137 projects upward from a main body 136 of the sliding member 135. The contact portion 137 is positioned in the line of travel of the projecting portion 76 during the insertion of the ink cartridge 30 into the cartridge holder 110.

[0069] A coil spring 139 is positioned in the recess 130. One end of the coil spring 139 is connected to an end surface 133 of the recess 130 positioned at the opening 112 side of the recess 130. The other end of the coil spring 139 is connected to the main body 136 of the sliding member 135, such that the coil spring 139 is positioned between the end surface 133 of the recess 130 and the main body 136 of the sliding member 135. When the coil spring 139 has a natural length, i.e., when an external force is not applied to the sliding member 135, the sliding member 135 is positioned closer to the end surface 133 than the optical detector 126 is. During the insertion of the ink cartridge 30 into the cartridge holder 110, the projecting member 76 of the ink cartridge 30 presses the contact portion 137. Upon receipt of a pressing force from the projecting portion 76, the sliding member 135 moves in the insertion direction 50, and the coil spring 139 is expanded. When this occurs, the coil spring 139 tries to contract, and therefore the sliding member 135 receives a pulling force from the coil spring 139 in a removal direction 54 toward the opening 112. Then, when the ink cartridge 30 reaches the ink supply position, the sliding member 135 enters the detection area 127 to block the light passing through the detection area 127. When the sliding member 135 enters the detection area 127, the presence of the projecting portion 76 is indirectly detected, and the signal output from the light-receiving portion 128 of the optical detector 126 changes. In this manner, the projecting portion 76 indirectly acts on the light passing through the detection area 127 by contacting and moving the sliding member 135, such that the sliding member 135 enters the detection area 127 and intersects the path of the light in the detection area 127.

[0070] Referring to Figs. 3(A) and 3(B), the cartridge holder 110 is provided with a lock mechanism 144. When the ink cartridge 30 is in the ink supply position, the lock mechanism 144 restricts the movement of the ink cartridge 30 in the removal direction 54 opposite from the insertion direction 50 and restrains the ink cartridge 30 in the ink supply position. The lock mechanism 144 is

positioned on the opposite side of the cartridge holder 110 from the optical detector 126 in the vertical direction (the height direction 52). In other words, the optical detector 126 is positioned on the opposite side from the lock mechanism 144. The lock mechanism 144 is positioned at an upper portion of the cartridge holder 110 adjacent to the opening 112 of the cartridge holder 110.

[0071] The lock mechanism 144 comprises the lock lever 145 and a coil spring 148 configured to apply an urging force to the lock lever 145. The lock lever 145 is supported by the cartridge holder 110 via a shaft, and is configured to pivot between an unlock position shown in Fig. 3(B) and a lock position shown in Fig. 3 (A). The coil spring 148 urges the lock lever 145 toward the lock position. An end of the lock lever 145 in the insertion direction 50 is an engaging end 146 configured to come into contact with the engaging surface 45 of the ink cartridge 30, such that the ink cartridge 30 is locked with respect to the removal direction 54 against an urging force applied from the coil spring 139 transmitted via the sliding member 135.

[0072] An optical detector 141 is provided adjacent to the lock mechanism 144. The optical detector 141 has a configuration similar to the optical detector 126 described above, and comprises a detection area 142. An operation portion 143 and a detection portion 147 are provided on the lock lever 145 opposite from the engaging end 146. The optical detector 141 is arranged, such that the detection area 142 is positioned in a range of rotation of the detection portion 147 of the lock lever 145. Therefore, the detection portion 147 is configured to enter the detection area 142 according to the position of the lock lever 145. In this embodiment, when the lock lever 145 is in the lock position, the detection portion 147 is positioned in the detection area 142, and when the lock lever 145 is in the unlock position, the detection portion 147 is positioned out of the detection area 142. The signal output from the light-receiving portion of the optical detector 141 depends on intensity of light received by the light-receiving portion of the optical detector 141. Whether the lock lever 145 is in the lock position or in the unlock position is determined based on the signal output from the optical detector 141 when the detection portion 147 is in the detection area 142, or when the detection portion 147 is positioned out of the detection area 142.

[0073] Referring to Fig. 5(A), when the ink cartridge 30 is inserted into the cartridge holder 110 in the insertion direction 50, the end surface 44 of the rib 43 comes into contact with the engaging end 146 of the lock lever 145. When the ink cartridge 30 is further inserted, the lock lever 145 pivots counterclockwise, and the engaging end 146 is moved upward, such that the position of the lock lever 145 is changed from the lock position to the unlock position. The engaging end 146 having moved upward is placed on the upper surface of the rib 43. Thereafter, when the ink cartridge 30 is further inserted, the engaging end 146 slides over the upper surface of the rib 43. Then, when the engaging end 146 passes the engaging surface

45 of the rib 43, the lock lever 145 pivots clockwise, and the engaging end 146 moves downward (See Fig. 6(A)).

[0074] Before the ink cartridge 30 is inserted into the cartridge holder 110, the lock lever 145 is in the lock position (see Fig. 3(A)), and light of the optical detector 141 is blocked by the detection portion 147 of the lock lever 145 in the detection area 142. Therefore, the signal output from the optical detector 141 is a LOW-level signal (see Fig. 8(A)). When the ink cartridge 30 is inserted and the lock lever 145 pivots to the unlock position, the detection portion 147 is moved to a position out of the detection area 142. Therefore, the signal output from the optical detector 141 is changed from the LOW-level signal to a HI-level signal at a timing T0 in Fig. 8(A).

[0075] Referring to Fig. 5(B), when the ink cartridge 30 is further inserted, the front wall 34E of the ink amount detection portion 34 passes through the detection area 115 of the optical detector 114 between a timing T1 and a timing T2 in Fig. 8(A). Nevertheless, because the front wall 34E is translucent, the signal output from the optical sensor 114 is unchanged and remains as a HI-level signal between the timing T1 and the timing T2 in Fig. 8(A).

[0076] Referring to Fig. 5(B), the projecting portion 76 comes into contact with the contact portion 137 of the sliding member 135, and the projecting portion 76 presses the contact portion 137 in the insertion direction 50.

[0077] When the ink cartridge 30 is further inserted, the sliding member 135 receives a force from the projecting portion 76 and starts to move in the insertion direction 50. When this occurs, the coil spring 139 is elongated with the movement of the sliding member 135. Accordingly, a force causing the coil spring 139 to contract is generated in the coil spring 139. The force generated in the coil spring 139 acts on the sliding member 135 as a force to move the sliding member 135 in the removal direction 54 opposite the insertion direction 50. In other words, the sliding member 135 is resiliently urged in the removal direction 54 by the coil spring 139.

[0078] Then, referring to Fig. 6(A), when the ink cartridge 30 reaches the ink supply position in the cartridge holder 110, the irradiated portion 34C of the ink amount detection portion 34 is positioned in the detection area 115 of the optical detector 114. The ink supply position is a position in which the ink cartridge 30 can supply ink from the ink chamber 36 to the ink supply tube 122 in the cartridge holder 110, and in this embodiment, is a position where the ink supply tube 122 is inserted into the through hole 73 of the ink supply portion 72 as shown in Fig. 6(A) and 6(B). When the irradiated portion 34C enters the detection area 115, if the predetermined amount or more of ink is stored in the ink chamber 36, that is, when the light-blocking panel 62 is in the lower position (solid line), the light is blocked by the light-blocking panel 62 in the detection area 115. In this case, the signal output from the optical detector 114 is changed from the HI-level signal to the LOW-level signal at a timing T3 in Fig. 8(A). In contrast, when the amount of ink in the ink chamber 36 is less than the predetermined amount, that is, when the

light-blocking panel 62 is in the upper position (broken line), the light passing through the detection area 115 is not blocked by the light-blocking panel 62, and hence the signal remains as the HI-level signal (see a broken line in Fig. 8(A)).

[0079] During the insertion of the ink cartridge 30 up to the ink supply position, the sliding member 135 is pressed by the projecting portion 76, and hence the sliding member 135 enters the detection area 127 of the optical detector 126. When this occurs, the signal output from the light-receiving portion 128 of the optical detector 126 is changed from a HI-level signal to a LOW-level signal at a timing T4 in Fig. 8(A).

[0080] Referring to Fig. 6(A), when the ink cartridge 30 reaches the ink supply position, the engaging surface 45 of the rib 43 has passed the engaging end 146 of the lock lever 145. Because the engaging end 146 is not supported by the upper surface of the rib 43 any longer, the lock lever 145 pivots clockwise, and the engaging end 146 moves down and comes into contact with the upper wall 39 of the ink cartridge 30. When this occurs, the light of the optical detector 141 is blocked by the detection portion 147 of the lock lever 145 in the detection area 142. Accordingly, the signal output from the optical detector 141 is changed from the HI-level signal to the Low-level signal at a timing T5 in Fig. 8(A).

[0081] Subsequently, when the pressing force acting on the ink cartridge 30 by a user in the insertion direction 50 is released, the projecting portion 76 of the ink cartridge 30 receives a force in the removal direction 54 from the coil spring 139 via the sliding member 135. Referring to Fig. 6(B), the ink cartridge 30 receiving the force is caused to move in the removal direction 54, and the ink cartridge 30 is moved in the removal direction 54 by an amount corresponding to a clearance provided between the engaging end 146 of the lock lever 145 and the engaging surface 45 of the rib 43. The engaging end 146 and the engaging surface 45 are brought into contact with each other, such that the movement of the ink cartridge 30 in the removal direction 54 is prevented.

[0082] In contrast, referring to Figs. 7(A) and 7(B), when an ink cartridge 30' having a broken projecting portion 76 is inserted into the cartridge holder 110, even when the ink cartridge 30' reaches the ink supply position, the sliding member 135 does not move in the insertion direction 50. Therefore, even when the ink cartridge 30' is mounted to the cartridge holder 110, the signal output from the light-receiving portion 128 of the optical detector 126 constantly remains as the HI-level signal (see Fig. 8(B)). In other words, the signal output from the light-receiving portion 128 of the optical detector 126 is not changed.

[0083] In this embodiment, because the ink cartridge 30' has the broken projection portion 76, the ink supply portion 72 of the ink cartridge 30' is susceptible to an external impact. Similarly, if the ink cartridge 30' does not have the projection portion 76 at all, the ink supply portion 72 of the ink cartridge 30' is susceptible to an

external impact. In such cases, the possibility that the ink supply portion 72 is damaged by the external impact is higher. When the ink cartridge 30' is mounted to the cartridge holder 110 and is used in the printer 10, the ink leakage due to the damage of the ink supply portion 72 may occur, or defective recording may occur because ink may not be supplied from the ink supply portion 72 to the recording head 21 properly. Also, air bubbles may enter the ink tube 20 and may be accumulated in the sub tank 28 of the recording head 21. In such a case, when an actuator (for example, a piezoelectric actuator) which makes the ink to be discharged from the nozzles 29 is driven, a force generated by the driven actuator may be absorbed by the air bubbles, and the ink may be not discharged from the nozzles 29. Also, there may be a case where heat is generated because the actuator is driven excessively, which may lead to such problem that the recording head 21 is broken due to the heat. In order to reduce such problems, in this embodiment, the controller 90 is configured to allow the image recording and the purging in the printer 10 based on the fact that the signal output from the light-receiving portion 128 of the optical detector 126 is changed.

[0084] Referring to Fig. 9, the controller 90 is configured to control the entire operation of the printer 10. The controller 90 is configured as a microcomputer comprising a CPU 91, a ROM 92, a RAM 93, an EEPROM 94, and an ASIC 95.

[0085] The ROM 92 stores programs for the CPU 91 to control various operations of the printer 12, including a program for performing a process shown in Fig. 10. The RAM 93 is used as a storage area for temporally storing data or signals or a work area for the data processing, for the CPU 91 to execute the programs described above. The RAM 93 stores levels of the signals output from the optical detectors 114, 126, and 141 (HI or LOW) as time-series data. The EEPROM 94 stores setting, flags, and the like which are to be retained even after the power source is turned OFF.

[0086] The optical detector 126, the optical detector 141, and the optical detector 114 are electrically connected to the ASIC 95. Although not shown in Fig. 9, a drive circuit configured to drive respective rollers such as the paper feed roller 23 and the conveying roller pair 25 (see Fig. 2), an input unit configured to input image recording instructions to the controller 90 and the like, and a display unit configured to display information relating to the printer 10 are also electrically connected.

[0087] The light-receiving portion 128 of the optical detector 126 outputs an analogue electric signal (voltage signal or current signal) depending on the intensity of light received by the light-receiving portion 128. The signal output from the light-receiving portion 128 is supplied to the controller 90. The controller 90 determines the output signal to be the HI-level signal when the level of the signal (voltage value or current value) is greater than or equal to a first predetermined threshold value and to be the LOW-level signal when the level of the signal is less

than the first predetermined threshold value. In this embodiment, when the light of the optical detector 126 is blocked in the detection area 127, the level of signal is less than the first predetermined threshold value, and hence the output signal is determined as the LOW-level signal. Also, when the light passing through the detection area 127 is not blocked, because the level of signal is greater than or equal to the first predetermined threshold value, the output signal is determined as the HI-level signal.

[0088] Similarly, the light-receiving portion of the optical detector 141 outputs an analogue electric signal (voltage signal or current signal) depending on the intensity of light received by the light-receiving portion. The signal output from the light-receiving portion is supplied to the controller 90. The controller 90 determines the output signal to be the HI-level signal when the level of the signal (voltage value or current value) is greater than or equal to a second predetermined threshold value and to be the LOW-level signal when the level of the signal is less than the second predetermined threshold value. In this embodiment, when the light of the optical detector 141 is blocked in the detection area 142, the level of signal is less than the second predetermined threshold value, and hence the output signal is determined as the LOW-level signal. Also, when the light passing through the detection area 142 is not blocked, because the level of signal is greater than or equal to the second predetermined threshold value, the output signal is determined as the HI-level signal. The second predetermined threshold value may be the same as the first predetermined threshold value.

[0089] Similarly, the light-receiving portion of the optical detector 114 outputs an analogue electric signal (voltage signal or current signal) depending on the intensity of light received by the light-receiving portion. The signal output from the light-receiving portion is supplied to the controller 90. The controller 90 determines the output signal to be the HI-level signal when the level of the signal (voltage value or current value) is greater than or equal to a third predetermined threshold value and to be the LOW-level signal when the level of the signal is less than the third predetermined threshold value. In this embodiment, when the light of the optical detector 114 is blocked in the detection area 115, the level of signal is less than the third predetermined threshold value, and hence the output signal is determined as the LOW-level signal. Also, when the light passing through the detection area 115 is not blocked, because the level of signal is greater than or equal to the third predetermined threshold value, the output signal is determined as the HI-level signal. The third predetermined threshold value may be the same as the first predetermined threshold value and the second predetermined threshold value.

[0090] In this embodiment, when the ink cartridge 30 is not mounted to the cartridge holder 110, the controller 90 does not allow ink to be consumed in the printer 10. The controller 90 is configured to allow ink to be con-

summed in the printer 10 based on the change of the signal output from the light-receiving portion 128 of the optical detector 126.

[0091] Referring to Fig. 10, when the signal output from the optical detector 141 changes from the LOW-level signal to the HI-level signal (at the timing T0 in Figs. 8(A) and 8(B)), the controller 90 starts the process of Fig. 10. This change of the signal output from the optical detector 141 means that the ink cartridge 30 is started to be inserted into the cartridge holder 110. At the timing T0, the signal output from the optical detector 126 is the HI-level signal. In Step S1, whether the ink cartridge 30 has reached the ink supply position in the cartridge holder 110 is determined. In other words, whether the ink cartridge 30 is locked at the ink supply position by the lock mechanism 144 is determined. Specifically, it is determined whether the signal output from the optical detector 141 has changed from the HI-level signal to the LOW-level signal. When the signal has changed from the HI-level signal to the LOW-level signal, it is determined that the ink cartridge 30 has reached the ink supply position.

[0092] When it is determined that the ink cartridge 30 has reached the ink supply position (Yes in S1), whether or not the signal output from the optical detector 126 is the LOW-level signal is determined in Step S2. This determination corresponds to the determination as to whether or not the ink cartridge 30 has the projecting portion 76. For example, referring to Fig. 8(A), when the signal output from the optical detector 126 is the LOW-level signal at the timing T5, which is when the signal output from the optical detector 141 changes from the HI-level signal to the LOW-level signal, it means that the sliding member 135 is positioned in the detection area 127, and that the light is blocked in the detection area 127. Therefore, it means that the ink cartridge 30 has the projecting portion 76 which presses the sliding member 135. In contrast, referring to Fig. 8(B), when the signal output from the optical detector 126 is the HI-level signal at the timing T5, it means that the ink cartridge 30' has the broken projecting portion 76 or does not have the projecting portion 76 at all.

[0093] In Step S2, when it is determined that the signal output from the optical detector 126 is the LOW-level signal, i.e., when it is determined that the signal output from the optical detector 126 has changed from the HI-level signal to the LOW-level signal (Yes in S2), the controller 90 allows ink to be consumed in the printer 10 (in S3). For example, a bit flag for allowing ink to be consumed is set in a register of the CPU 91. The change from the HI-level signal to the LOW-level signal means that the level of the signal has changed to cross the first predetermined threshold value from a value greater than the first predetermined threshold value to a value less than the first predetermined threshold value.

[0094] In contrast, in Step S2, when it is determined that the signal output from the optical detector 126 is the HI-level signal, i.e., when it is determined that the signal output from the optical detector 126 remains as the HI-

level signal (No in S2), the controller 90 does not allow ink to be consumed in the printer 10 (in S4). For example, a bit flag for preventing ink to be consumed is set in the register of the CPU 91.

[0095] In this manner, in the printer 10 of this embodiment, the presence or absence of the projecting portion 76 is determined based on the change of the signal output from the optical detector 126 during the insertion of the ink cartridge 30 into the cartridge holder 110. Then, when it is determined that the projecting portion 76 is present, ink is allowed to be consumed. In contrast, when it is determined that the projecting portion 76 is not present or broken, ink is not allowed to be consumed. Therefore, ink is allowed to be consumed only when the ink cartridge 30 having the ink supply portion 72 less probable to be damaged is mounted to the cartridge holder 110, and ink is not allowed to be consumed when the ink cartridge 30 having the ink supply portion 72 more probable to be damaged is mounted to the cartridge holder 110. Therefore, the ink leakage in the cartridge holder 110, the defective recording due to the defective ink supply, or the breakdown of the recording head 21 due to entry of the air bubbles to the recording head 21 may be reduced.

[0096] In the embodiment described above, whether or not the signal output from the optical detector 126 is the LOW-signal (S2) is determined when it is determined that the signal output from the optical detector 141 has changed from the HI-level signal to the LOW-level signal (Yes in S1). However, it is also possible to determine whether or not the signal output from the optical detector 126 is the LOW-signal (S2) at a timing when a trigger signal is supplied from an external source after the ink cartridge 30 is locked at the ink supply position by the lock mechanism 144. It is also possible to provide a cover sensor configured to detect an opening and closing movement of the cover 19 (see Fig. 1) at the opening 112 and determine whether or not the signal output from the optical detector 126 is the LOW-signal (S2) when a signal supplied from the cover sensor when the opening 112 is covered by the cover 19.

[0097] The reflection-detecting type photo interrupter, which is configured to detect reflected light, may be employed instead of the optical detector 126. When the reflection-detecting type photo interrupter is employed instead of the optical detector 126, the HI-level and LOW-level of the signal output from the optical detector 126 in Figs. 8(A) and 8(B) is inverted. In this case, the controller 90 determines whether or not the signal output from the optical detector 126 is the HI signal, i.e., whether the signal output from the optical detector 126 has changed from the LOW-level signal to the HI-level signal, in Step S2. The change from the LOW-level signal to the HI-level signal means that the level of the signal has changed to cross the first predetermined threshold value from a value less than the first predetermined threshold value to a value greater than the first predetermined threshold value. When the controller 90 determines that the signal output from the optical detector 126 is the HI-level signal, the

controller 90 allows ink to be consumed in Step S3.

[0098] Referring to Fig. 11 (A) to Fig. 12(B), the second embodiment of the invention will be described. Common components to those in the first embodiment described above are designated by the same reference numerals as those used in the first embodiment, and description thereof will be omitted.

[0099] The second embodiment is different from the first embodiment in that an ink cartridge 150 comprises the projecting portion 153 projecting from the end surface 44 of the rib 43 in the insertion direction 50, and in that an optical detector 151 is provided in a cartridge holder 155.

[0100] The projecting portion 153 is positioned at an upper portion of the front wall 40 of the ink cartridge 150. The projecting portion 153 is positioned above the ink supply portion 72 and above the ink amount detection portion 34. The ink supply portion 72 is positioned between the projecting portion 153 and the projecting portion 76. The projecting portion 153 has a width which is less than the width of the rib 43 in the width directions 51 and is configured to enter a detection area 152 of the optical detector 151. The projecting portion 153 projects further than the ink supply portion 72 in the insertion direction 50. In this embodiment, the distance the projecting portion 153 projects from the front wall 40 in the insertion direction 50 is the same as the distance the projecting portion 76 projects from the front wall 40 in the insertion direction 50.

[0101] The optical detector 151 is provided at a position corresponding to the projecting portion 153 in the cartridge holder 155. The optical detector 151 has the same configuration as the optical detector 126 described above, and comprises a light-emitting portion configured to emit light and a light-receiving portion configured to receive the light emitted from the light-emitting portion. The light-emitting portion and the light-receiving portion of the optical detector 151 are positioned so as to face each other in a horizontal direction (in the width direction 51). The optical detector 151 is positioned at an upper portion of the inner side of the end wall 117 of the cartridge holder 155. The optical detector 151 is configured to detect the presence or absence of the projecting portion 153 of the ink cartridge 150 mounted to the cartridge holder 155. As shown in Fig. 12(B), when the ink cartridge 150 is in the ink supply position, the projecting portion 153 enters the detection area 152 of the optical detector 151 and blocks the light passing through the detection area 152.

[0102] Because the ink cartridge 150 comprises the projecting portion 153 in addition to the projecting portion 76, the ink supply portion 72 is protected from an external impact more reliably when the ink cartridge 150 is dropped. In contrast, when any one of the projecting portion 76 and the projecting portion 153 is broken, the ink supply portion 72 may be damaged. In this embodiment, when the ink cartridge 150 in which any one of the projecting portion 76 and the projecting portion 153 is broken

or not present is in the ink supply position in the cartridge holder 155, the signal output from one of the optical detector 126 and the optical detector 151 is not changed and remains as the HI-level signal. In this embodiment, the controller 90 determines the output signal from the optical detector 151 to be a HI-level signal when the level of the signal (voltage value or current value) is greater than or equal to a fourth predetermined threshold value and to be a LOW-level signal when the level of the signal is less than the fourth predetermined fourth value. In this embodiment, when the light of the optical detector 151 is blocked in the detection area 152, the level of signal is less than the fourth predetermined threshold value, and hence the output signal is determined as the LOW-level signal. Also, when the light passing through the detection area 152 is not blocked, because the level of signal is greater than or equal to the fourth predetermined threshold value, the output signal is determined as the HI-level signal. The fourth predetermined threshold value may be the same as the first predetermined threshold value, the second predetermined threshold value, and the fourth threshold value.

[0103] In this embodiment, when it is determined that the signals output from both the optical detector 126 and the optical detector 151 are the LOW-level signals, i.e., the signals output from both the optical detector 126 and the optical detector 151 have changed from the HI-level signals to the LOW-level signals in Step S2 of the flowchart in Fig. 10, the controller 90 allows ink to be consumed in S3. The change from the HI-level signals to the LOW-level signals means that the level of the signal output from the optical detector 126 has changed to cross the first predetermined threshold value from a value greater than the first predetermined threshold value to a value less than the first predetermined threshold value, and the level of the signal output from the optical detector 151 has changed to cross the fourth predetermined threshold value from a value greater than the fourth predetermined threshold value to a value less than the fourth predetermined threshold value. In contrast, in Step S2, when it is determined that the signal of at least one of the optical detector 126 and the optical detector 151 is the HI-level signal, i.e., the signal of at least one of the optical detector 126 and the optical detector 151 remains as the HI-level signal, the controller 90 does not allow ink to be consumed in S4. In this configuration, ink is allowed to be consumed in the printer 10 only when the ink cartridge 150 having both the projecting portion 76 and the projecting portion 153 is mounted to the cartridge holder 155. Accordingly, the ink leakage in the cartridge holder 110 due to the damage of the ink supply portion 72, the defective recording due to the defective ink supply, and the breakdown of the recording head 21 due to the entry of the air bubbles to the recording head 21 may be reduced.

[0104] Referring Figs. 13(A) to 14(B), a third embodiment of the present invention will be described. Common components to those in the first embodiment described

above are designated by the same reference numerals as those used in the first embodiment and description thereof will be omitted.

[0105] Referring to Figs. 13(A) and 13(B), the third embodiment is different from the first embodiment in that a rib 167 is provided in the projecting portion 76. Referring to Figs. 14(A) and 14(B), the third embodiment is different from the first embodiment in that the sliding member 135, the coil spring 139, the opening 129, and the recess 130 are not provided in a cartridge holder 165, and in that an optical detector 163 is provided instead of the optical detector 126.

[0106] The rib 167 is positioned in an upper surface of the projecting portion 76. An upper end of the rib 167 is flush with the upper surface of the projecting portion 76. The rib 167 extends to a projecting end of the projecting portion 76 in the insertion direction 50, such that a light-emitting portion and a light-receiving portion of the optical detector 163 can sandwich the rib 167. The rib 167 enters a detection area 164 of the optical detector 163.

[0107] The optical detector 163 is provided at a position corresponding to the rib 167 in the cartridge holder 165. The optical detector 163 has the same configuration as the optical detector 126. The optical detector 163 is provided on a lower portion of the inner side of the end wall 117 of the cartridge holder 165. The optical detector 163 is configured to detect the presence or absence of the rib 167 of the ink cartridge 30 mounted to the cartridge holder 165. The detection area 164 of the optical detector 163 is positioned inside the cartridge holder 165. Referring to Fig. 14(B), when the ink cartridge 30 is positioned in the ink supply position, the rib 167 of the projecting portion 76 enters the detection area 164 of the optical detector 163 and blocks the light of the optical detector 163. Accordingly, the rib 167 is directly detected by the optical detector 163. In other words, the rib 167 of the projecting portion 76 directly acts on the light passing through the detection area 164 of the optical detector 163 by intersecting the path of the light in the detection area 164.

[0108] In this configuration as well, ink is allowed to be consumed only when the ink cartridge 30 having the projecting portion 76 is mounted to the cartridge holder 165. Accordingly, the ink leakage in the cartridge holder 165 due to the damage of the ink supply portion 72, the defective recording due to the defective ink supply, and the breakdown of the recording head 21 due to the entry of the air bubbles to the recoding head 21 may be reduced.

[0109] Although the light is blocked by the sliding member 135, the projecting portion 153, the rib 167, or the detection portion 147 entering the respective detection areas 115, 127, 142, and 152 of the optical detectors 114, 126, 141, and 151 in the embodiments described above, the sliding member 135, the projecting portion 153, the rib 167, or the detection portion 147 may not necessarily have to block the complete amount of light emitted from the light-emitting portions of the respective optical detectors 114, 126, 141, and 151. For example,

the sliding member 135, the projecting portion 153, the rib 167, or the detection portion 147 may be configured to change the path of the light emitted from the light-emitting portion by reflecting or diffracting the entirety or part of the light, or may be a frosted glass, an aperture, or a slit, such that the intensity of light is attenuated to less than the predetermined value.

[0110] The ink supply portion 72 may comprise a valve mechanism configured to allow and prevent fluid communication between the ink chamber 36 and the exterior of the ink cartridge 30 via the ink supply portion 72. If the projection portion 76 is broken, there is a possibility that the valve mechanism of ink supply portion 72 is damaged. Nevertheless, when the ink cartridge 30, which has a broken projection portion 76 and therefore may have a broken valve mechanism, is mounted to the cartridge holder 110, ink is not allowed to be consumed in the printer 10 according to the above-described embodiments.

[0111] 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.

Claims

1. An image recording apparatus (10) comprising:

a cartridge mounting portion (110) comprising a first optical detector (126) comprising a first light-emitting portion (125) configured to emit light and a first light-receiving portion (128) configured to receive the light emitted from the first light-emitting portion, wherein the first light-receiving portion is configured to output a signal depending on an intensity of light received by the first light-receiving portion;
an ink cartridge (30) configured to be mounted to the cartridge mounting portion by being inserted into the cartridge mounting portion in an insertion direction (50), wherein the ink cartridge comprises:

an ink supply portion (72) positioned on a front side of the ink cartridge with respect to the insertion direction, and configured to supply ink from an interior of the ink cartridge to an exterior of the ink cartridge; and
a first projecting portion (76) projecting further than the ink supply portion in the inser-

tion direction, and configured to act on the light emitted from the first light-emitting portion, causing the intensity of light received by the first light-receiving portion to change, during an insertion of the ink cartridge into the cartridge mounting portion; and

a controller (90) configured to allow ink to be consumed in the image recording apparatus, based on a change of the signal output from the first light-receiving portion.

2. The image recording apparatus of claim 1, wherein the controller is configured to allow ink to be consumed in the image recording apparatus when a level of the signal output from the first light-receiving portion changes to cross a first predetermined threshold value.
3. The image recording apparatus of claim 1 or 2, wherein the first projecting portion is configured to act on the light emitted from the first light-emitting portion when the ink cartridge reaches an ink supply position in which the ink cartridge can supply ink from the interior of the ink cartridge to the exterior of the ink cartridge in the cartridge mounting portion.
4. The image recording apparatus of claim 3, further comprising an output unit (141) configured to output a signal when the ink cartridge has reached the ink supply position, wherein the controller is configured to determine whether or not the signal output from the first light-receiving portion has changed when the controller receives the signal output from the output unit.
5. The image recording apparatus of any one of claims 1 to 4, wherein the first projecting portion is positioned below the ink supply portion when the ink cartridge is in a mounted position, in which the ink cartridge is mounted to the cartridge mounting portion.
6. The image recording apparatus of any one of claims 1 to 5, wherein the cartridge mounting portion comprises a second optical detector (151) comprising a second light-emitting portion configured to emit light and a second light-receiving portion configured to receive the light emitted from the second light-emitting portion, wherein the ink cartridge comprises a second projecting portion (153) positioned at a position different from the first projecting portion, and projecting further than the ink supply portion in the insertion direction, wherein the second projecting portion is configured to act on the light emitted from the second light-emitting portion, causing an intensity of light received by the second light-receiving portion to change, during the insertion of the ink cartridge into the cartridge

mounting portion, and

wherein the controller is configured to allow ink to be consumed in the image recording apparatus, based on both the change of the signal output from the first light-receiving portion and a change of the signal output from the second light-receiving portion.

7. The image recording apparatus of claim 6, wherein the controller is configured to allow ink to be consumed in the image recording apparatus when a level of the signal output from the first light-receiving portion changes to cross a first predetermined threshold value and when a level of the signal output from the second light-receiving portion changes to cross a second predetermined threshold value.
8. The image recording apparatus of any one of claims 1 to 7, wherein the ink cartridge comprises a predetermined portion (34) on the front side of the ink cartridge, wherein a plane (56) connecting a projecting end of the first projection portion and the predetermined portion is positioned in front of the ink supply portion in the insertion direction.
9. The image recording apparatus of any one of claims 1 to 8, further comprising an ink tube (20) connected to the cartridge mounting portion, wherein when the controller allows ink to be consumed in the image recording apparatus, an image is recorded with ink supplied from the ink cartridge or ink is sucked from the ink cartridge into the ink tube and the ink tube is filled with ink.

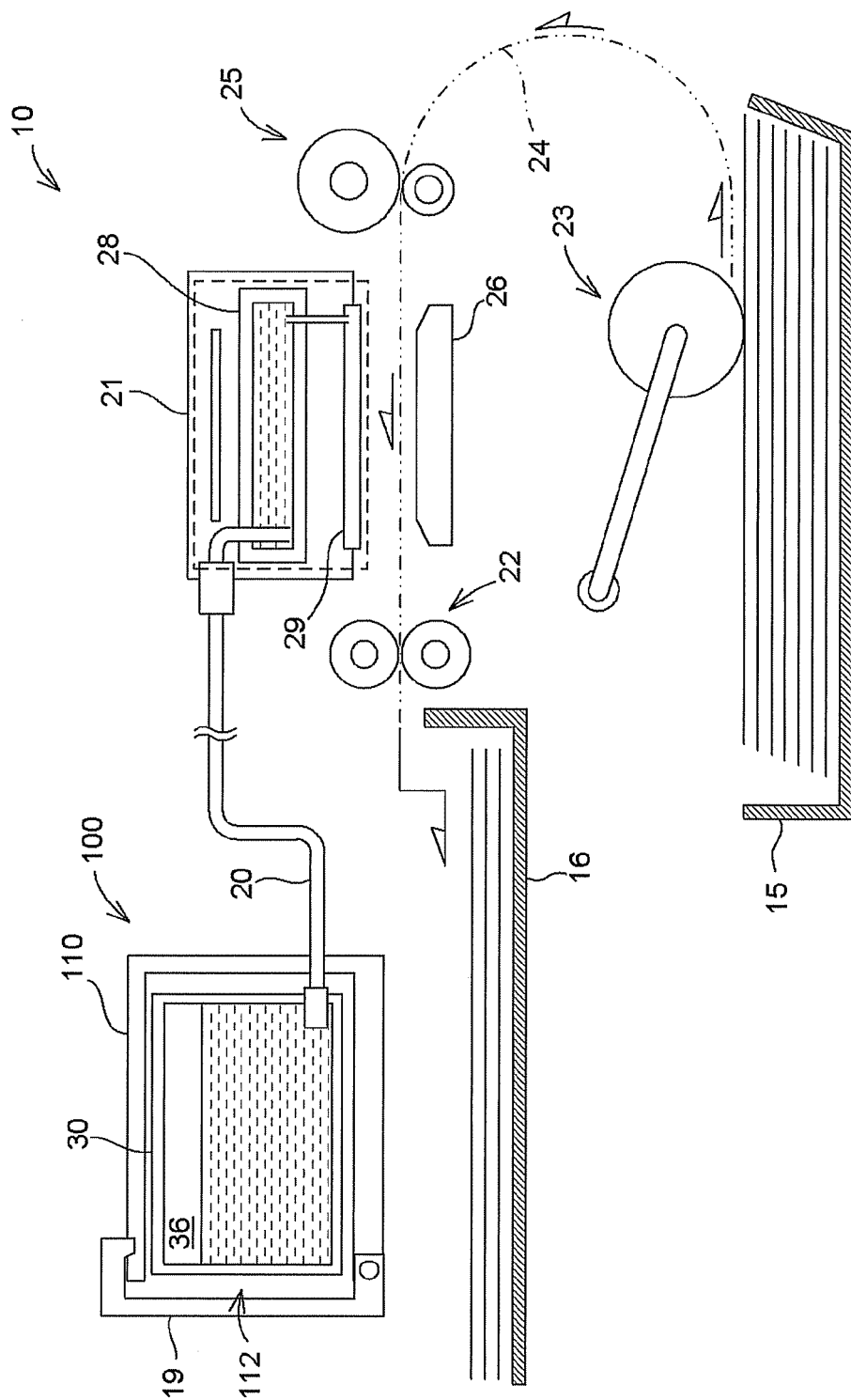


Fig.1

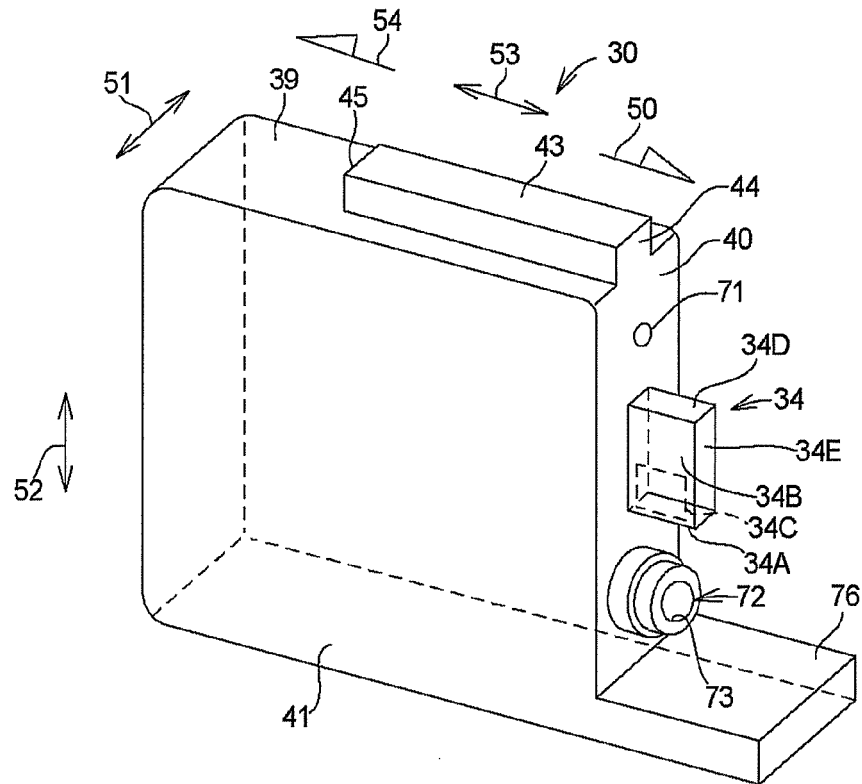


Fig.2A

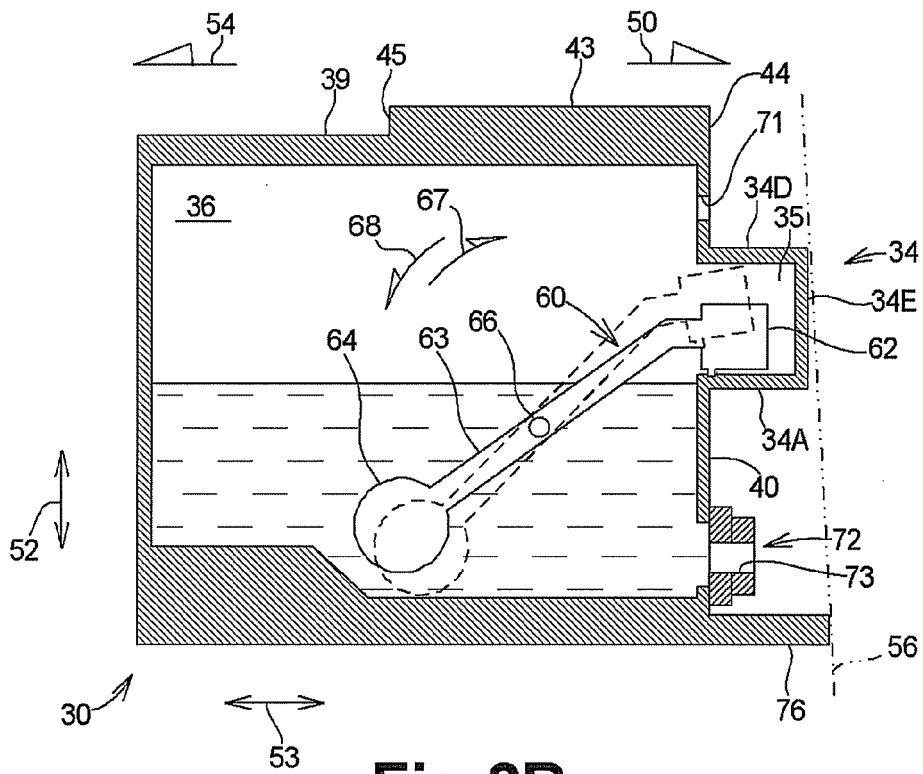


Fig.2B

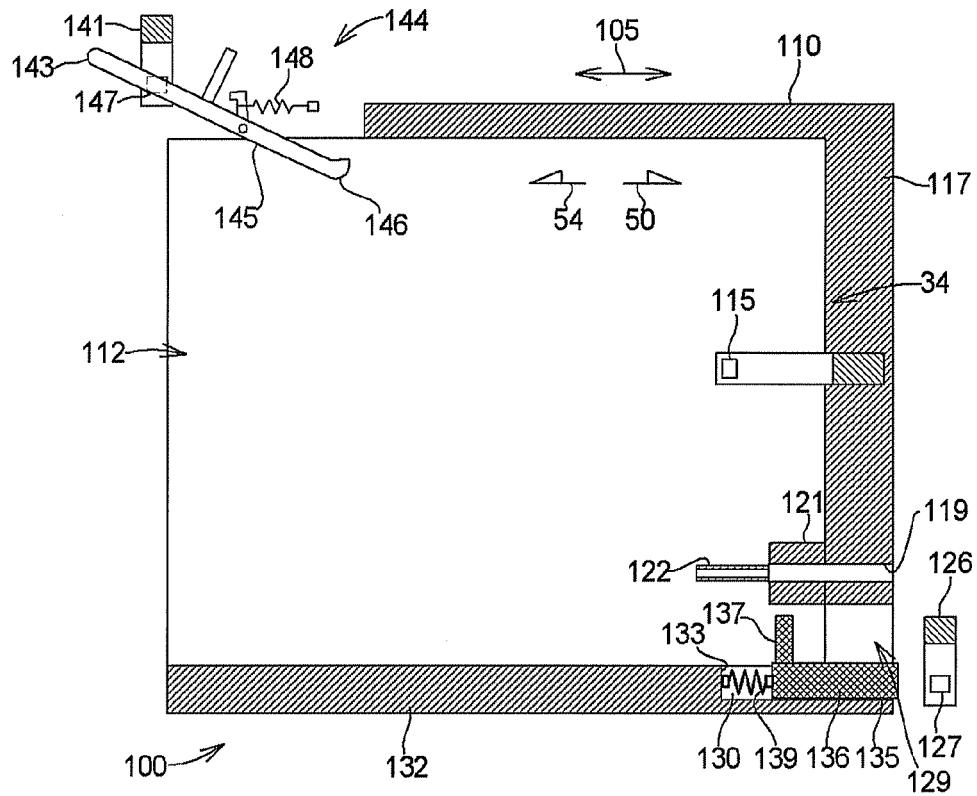


Fig. 3A

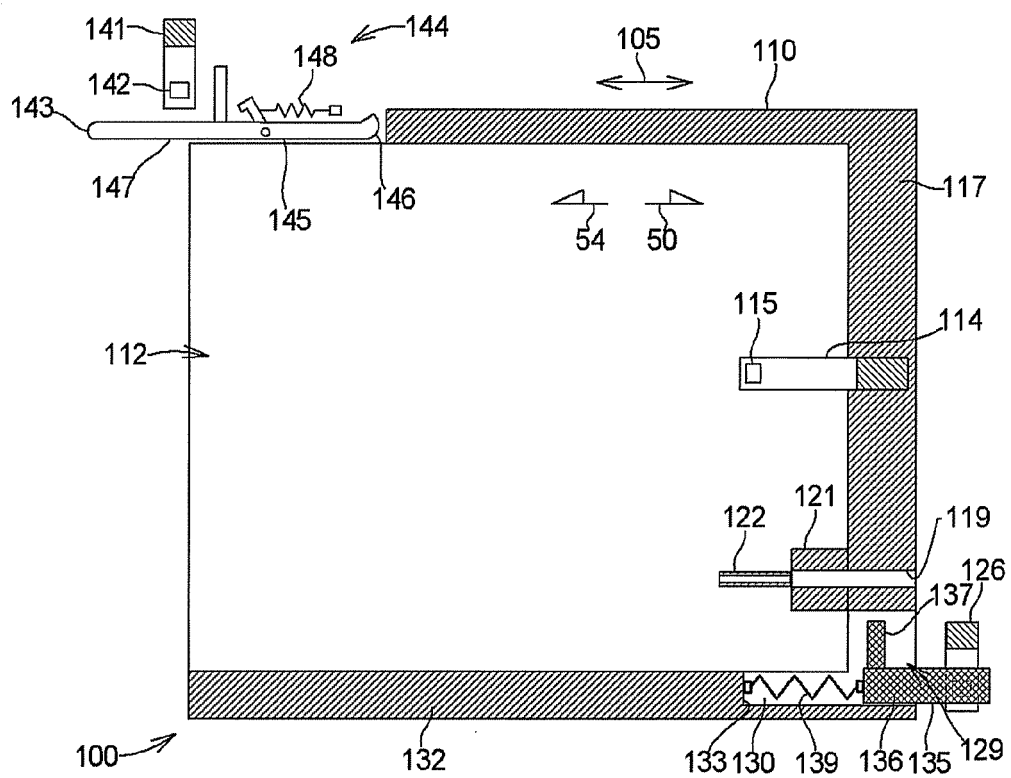


Fig.3B

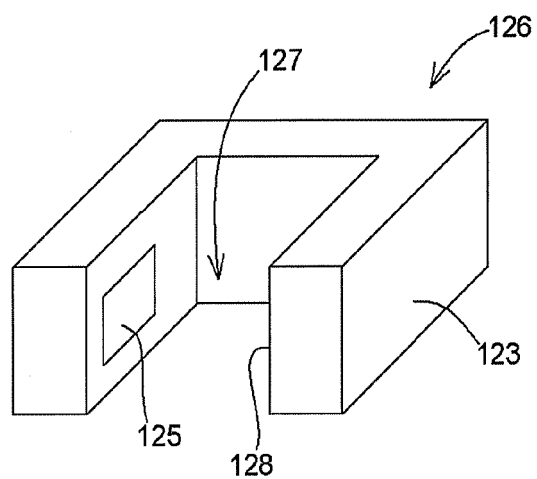


Fig.4A

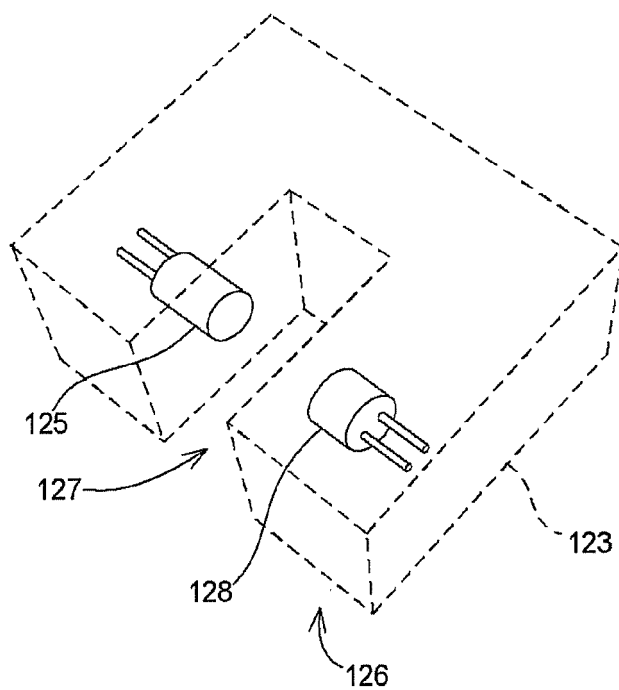


Fig.4B

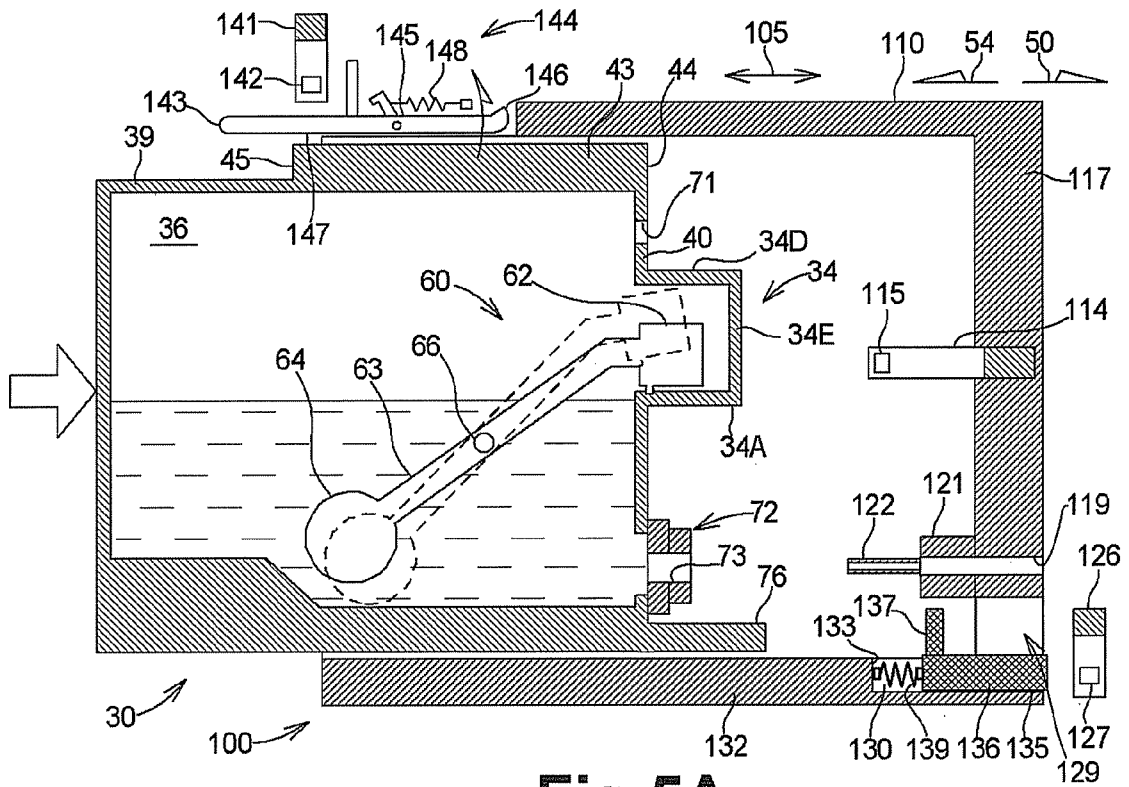


Fig.5A

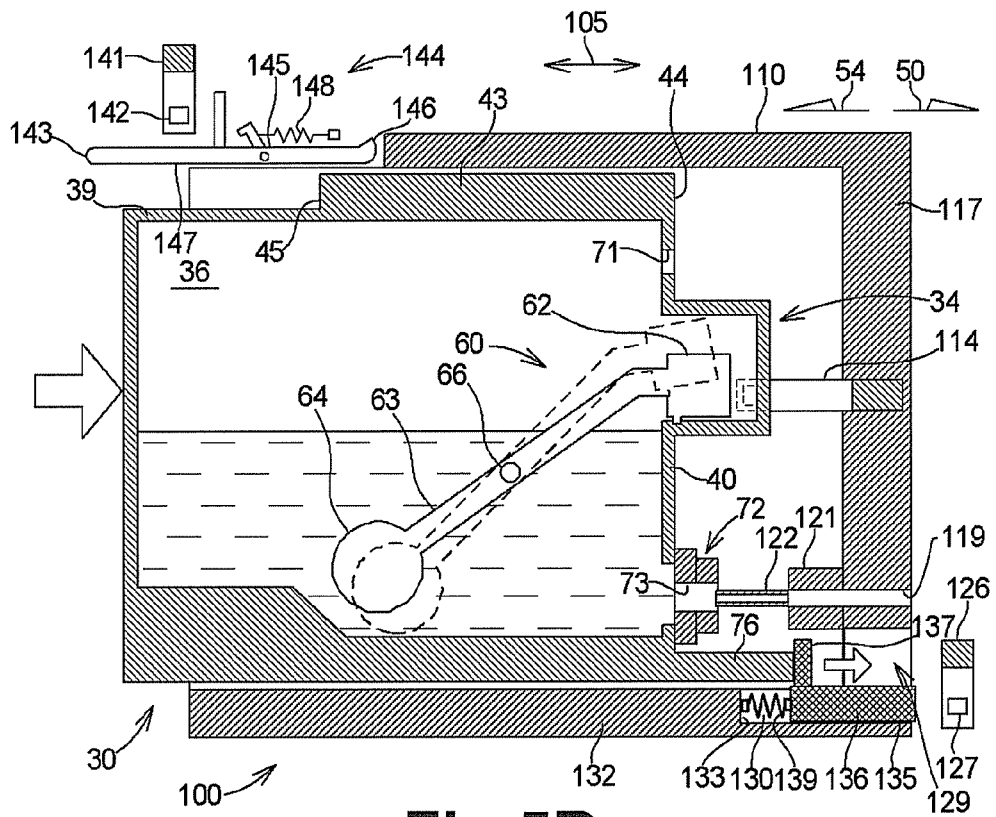
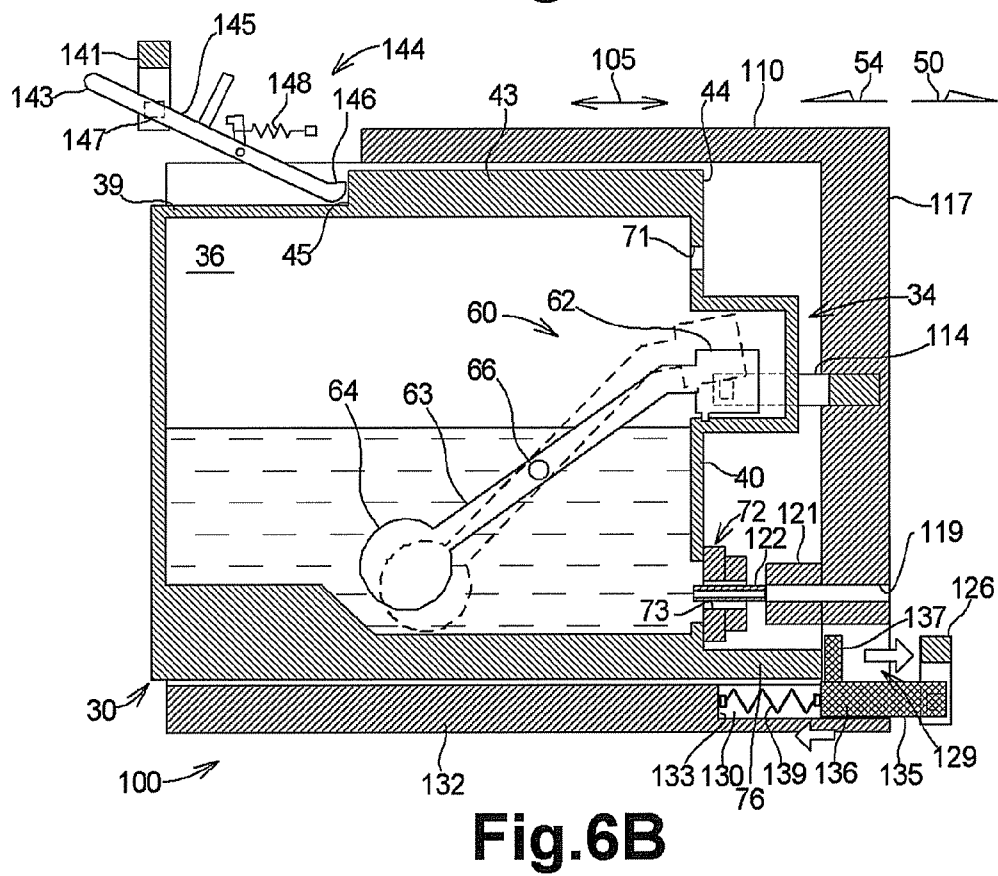
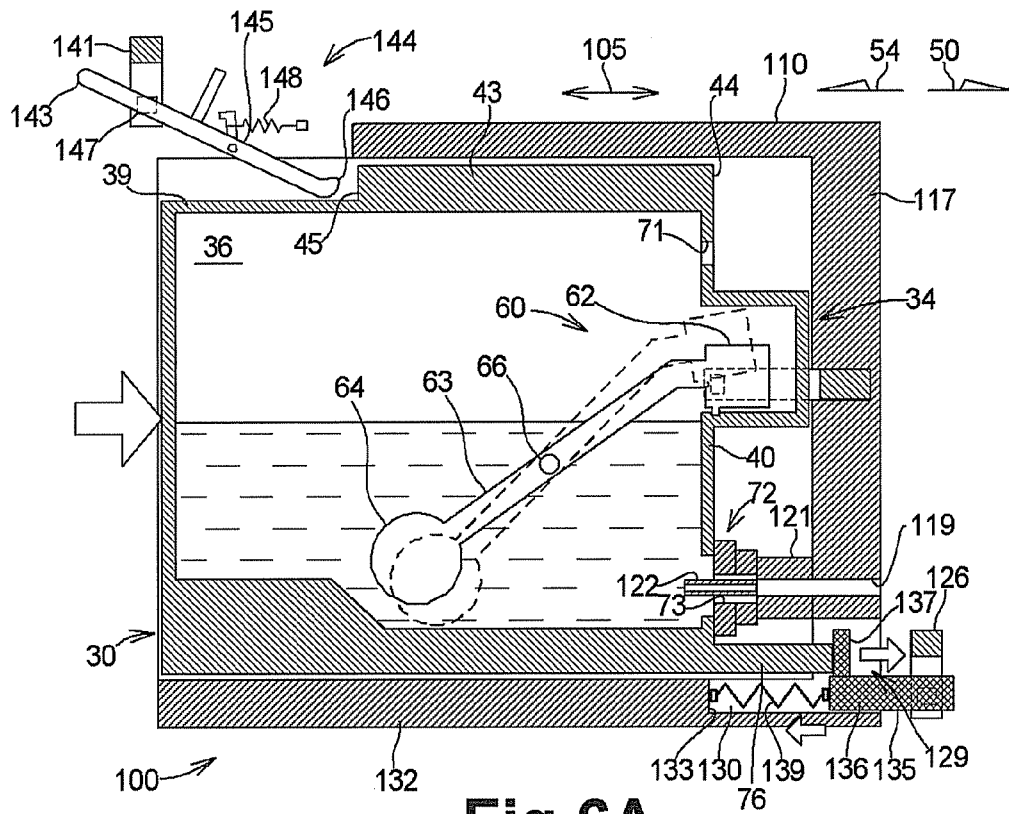


Fig.5B



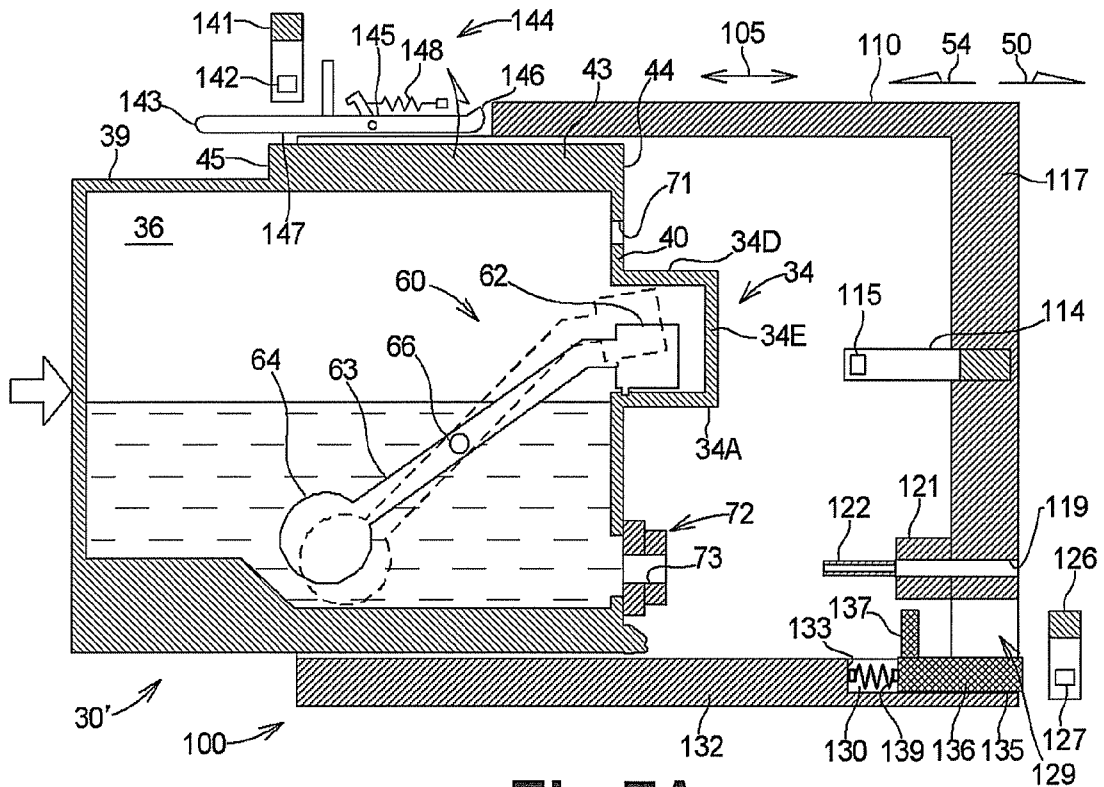


Fig. 7A

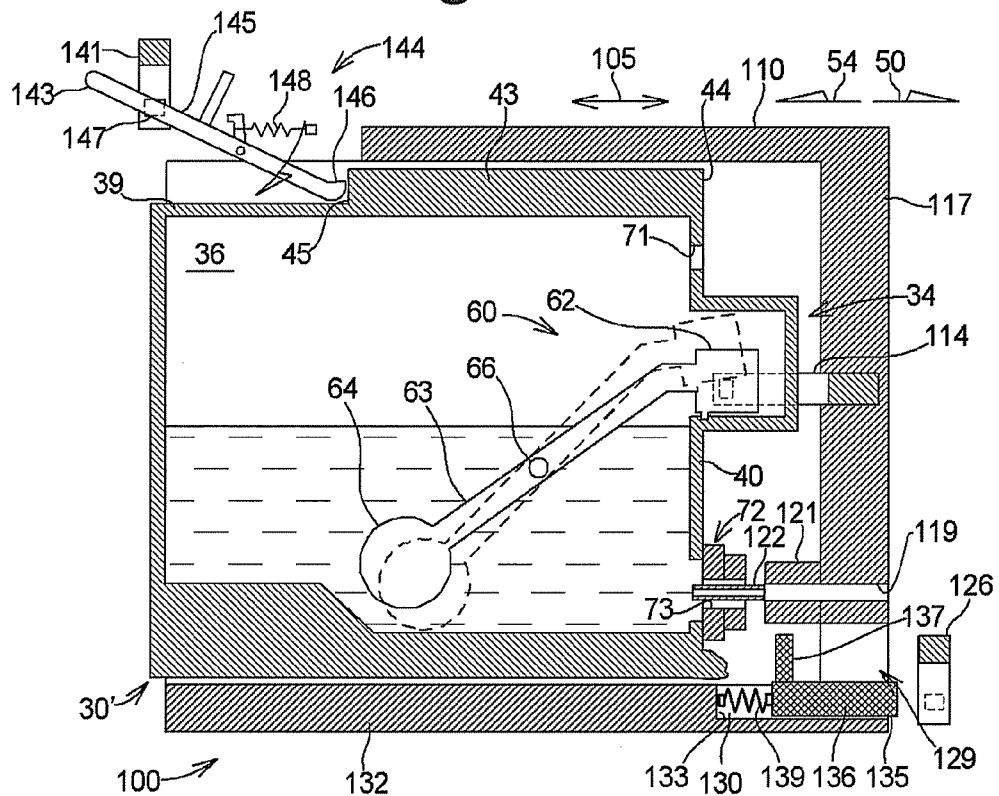


Fig.7B

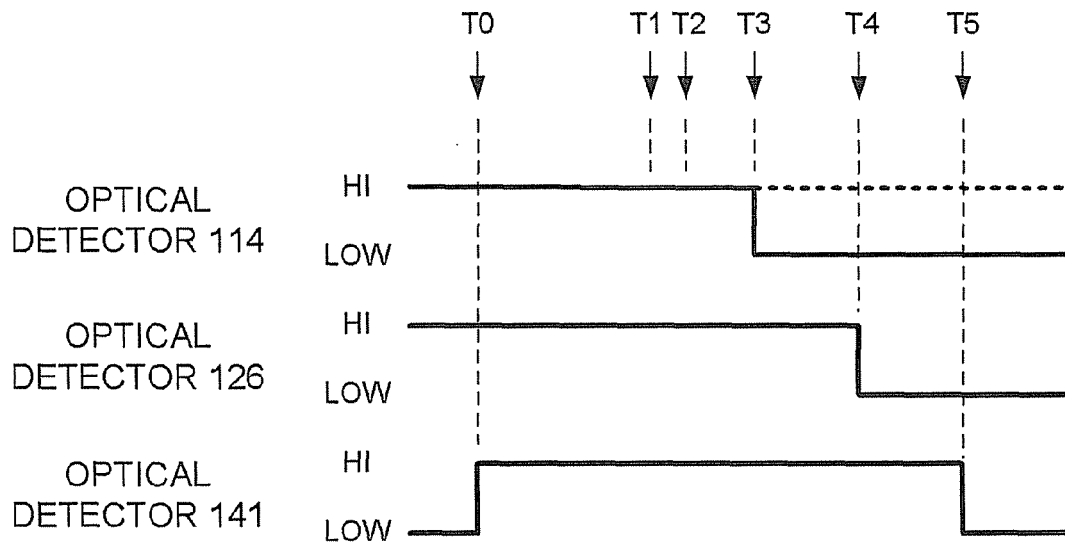


Fig.8A

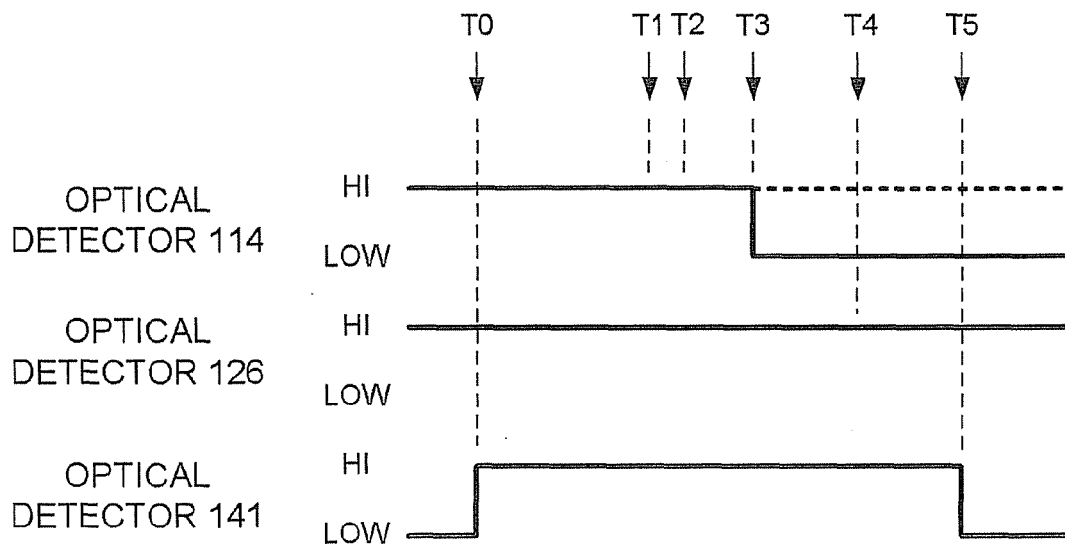


Fig.8B

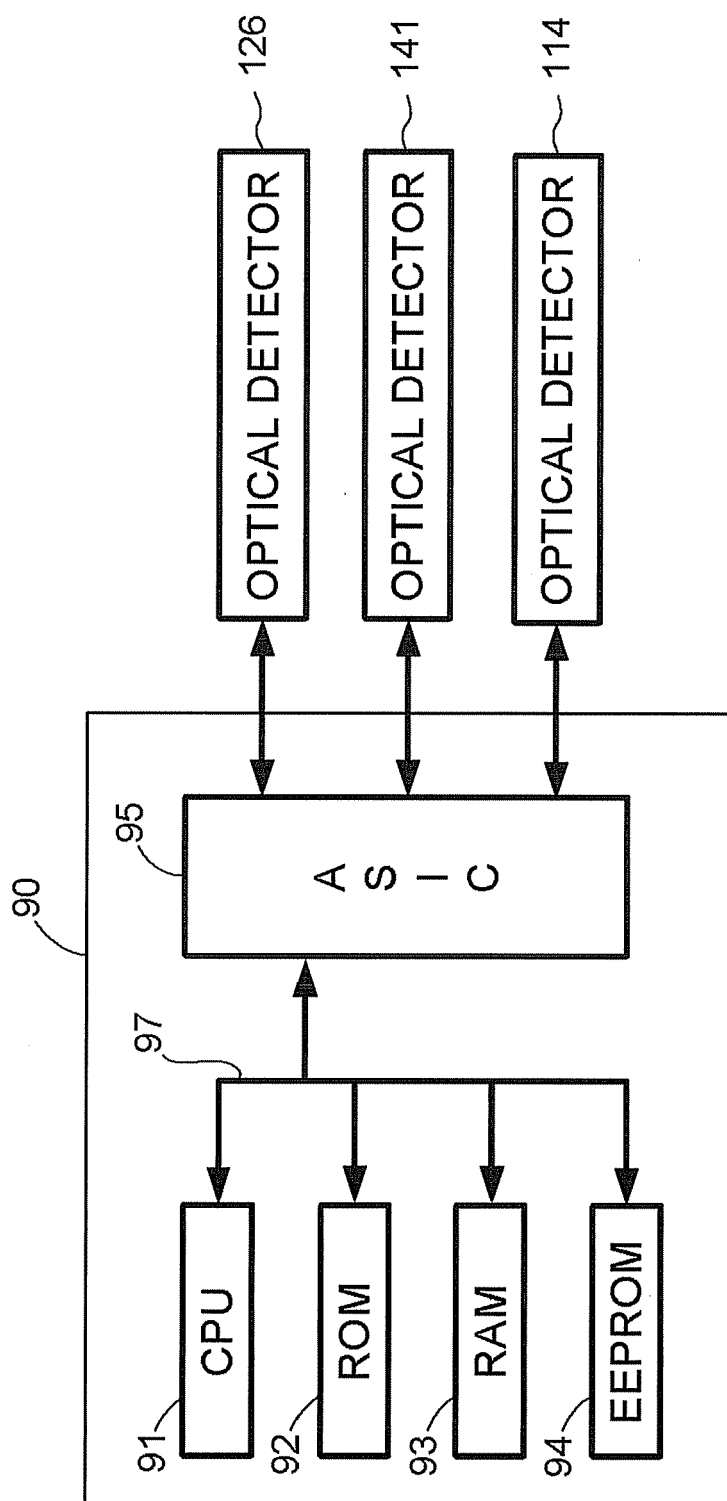
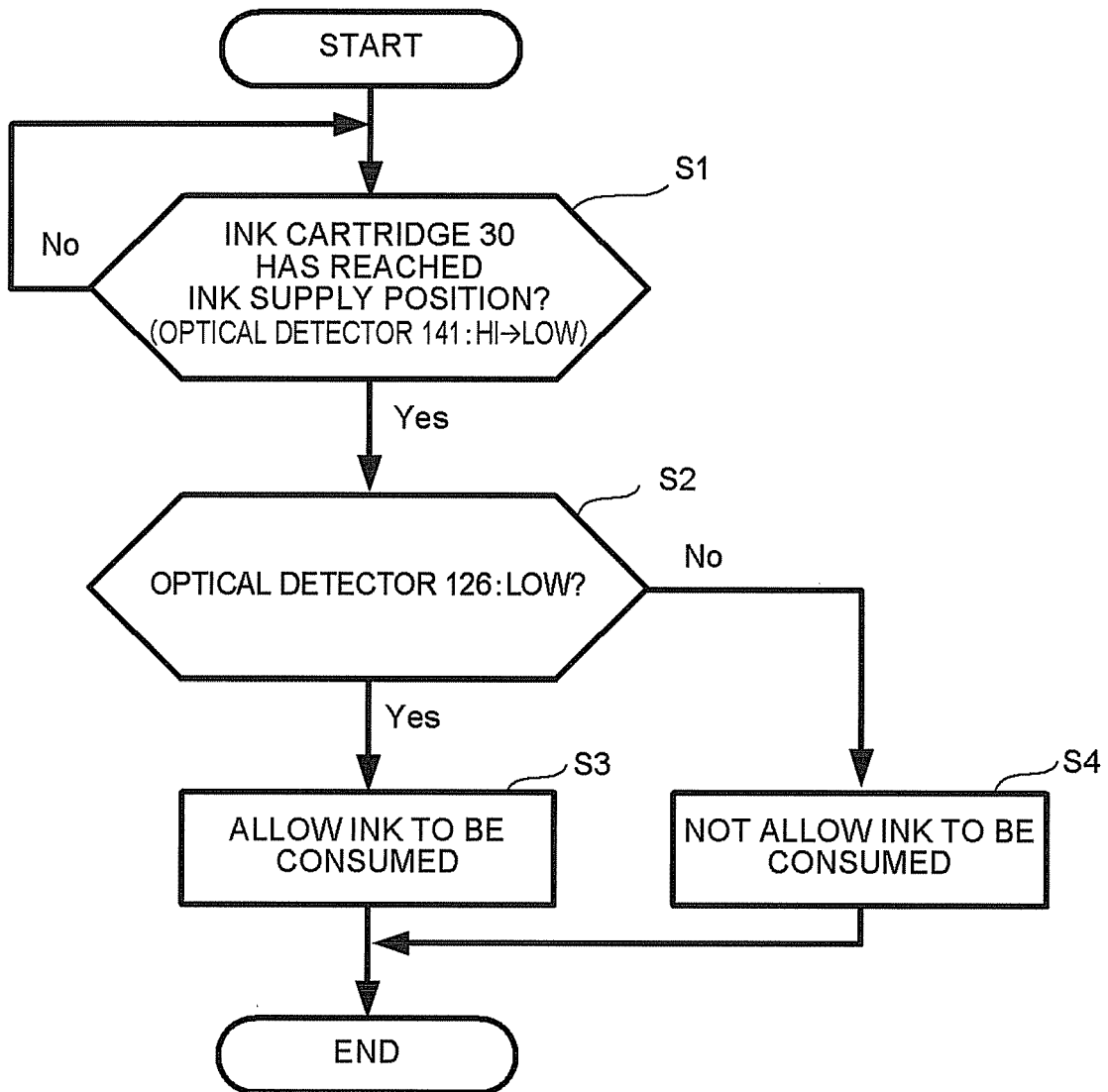


Fig.9

**Fig.10**

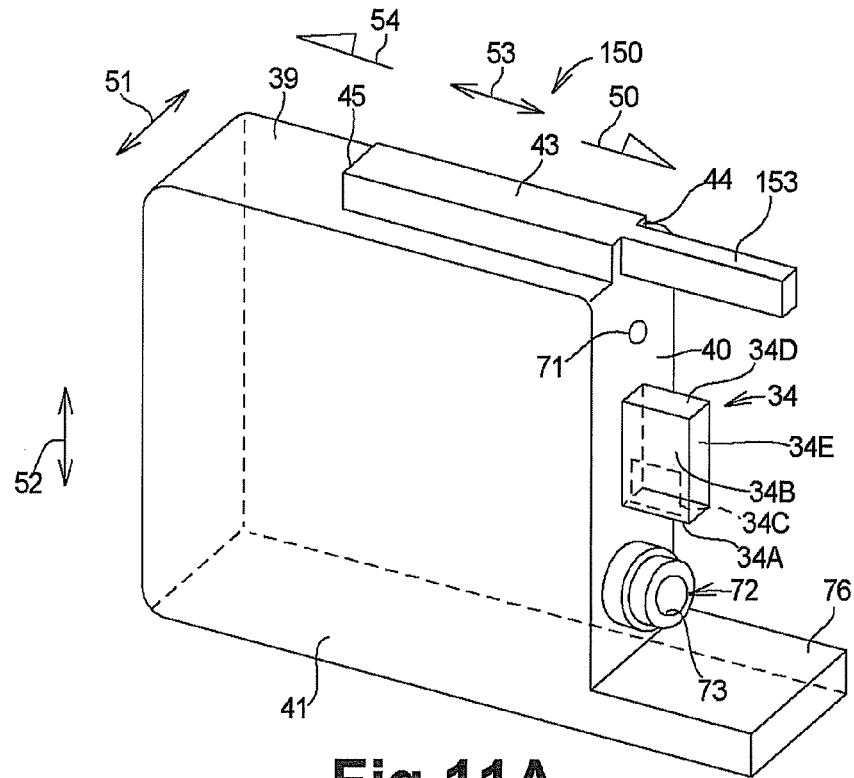


Fig.11A

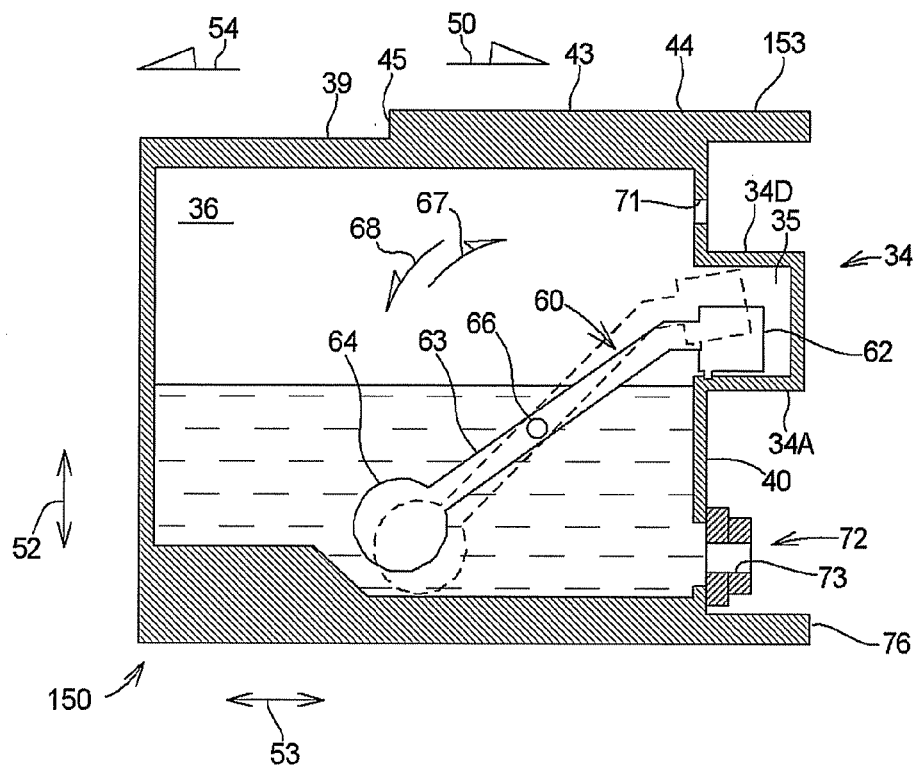


Fig.11B

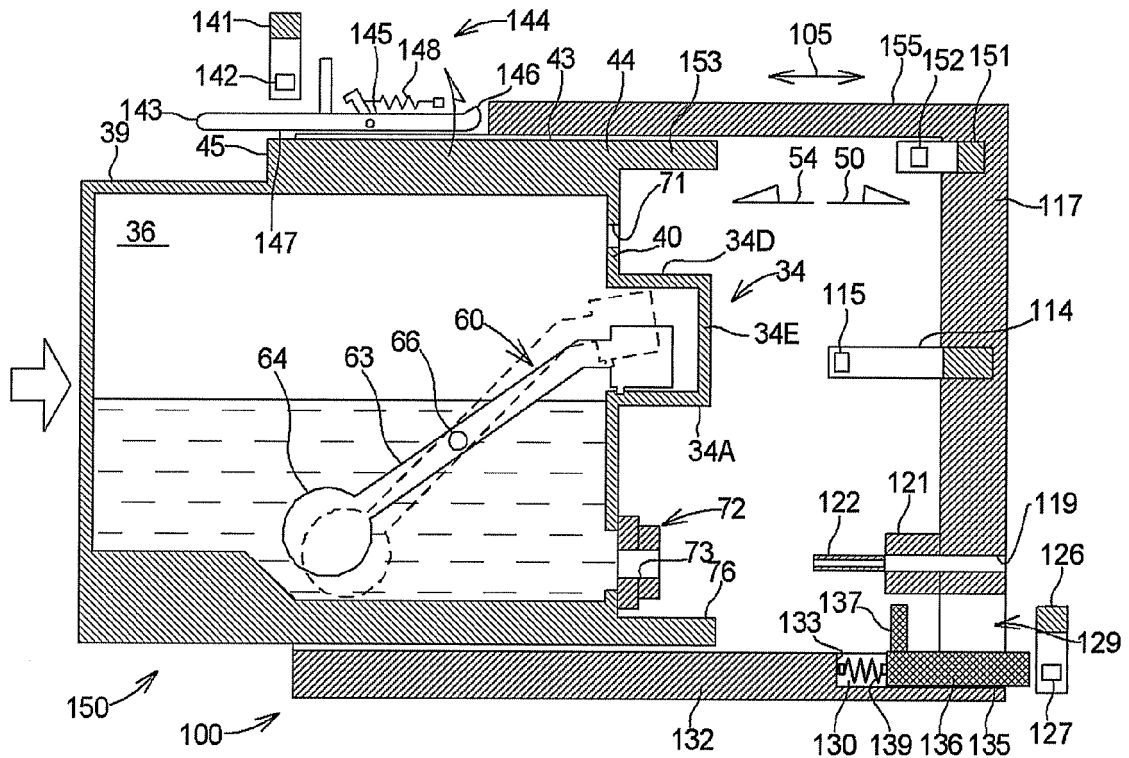


Fig.12A

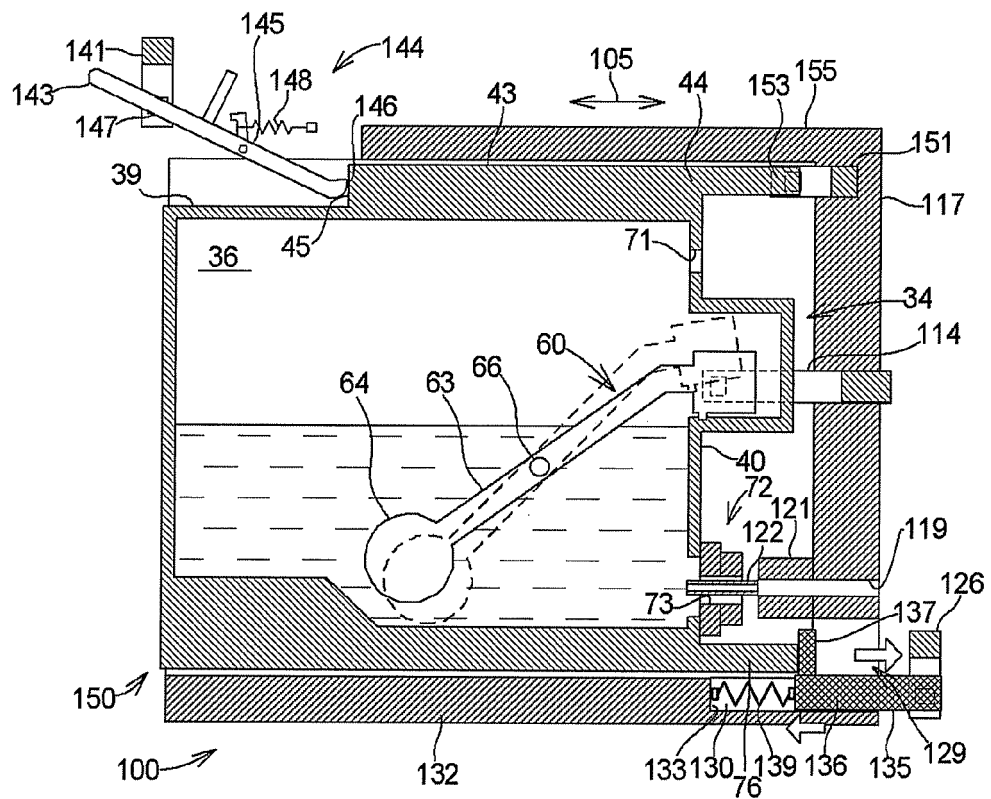


Fig.12B

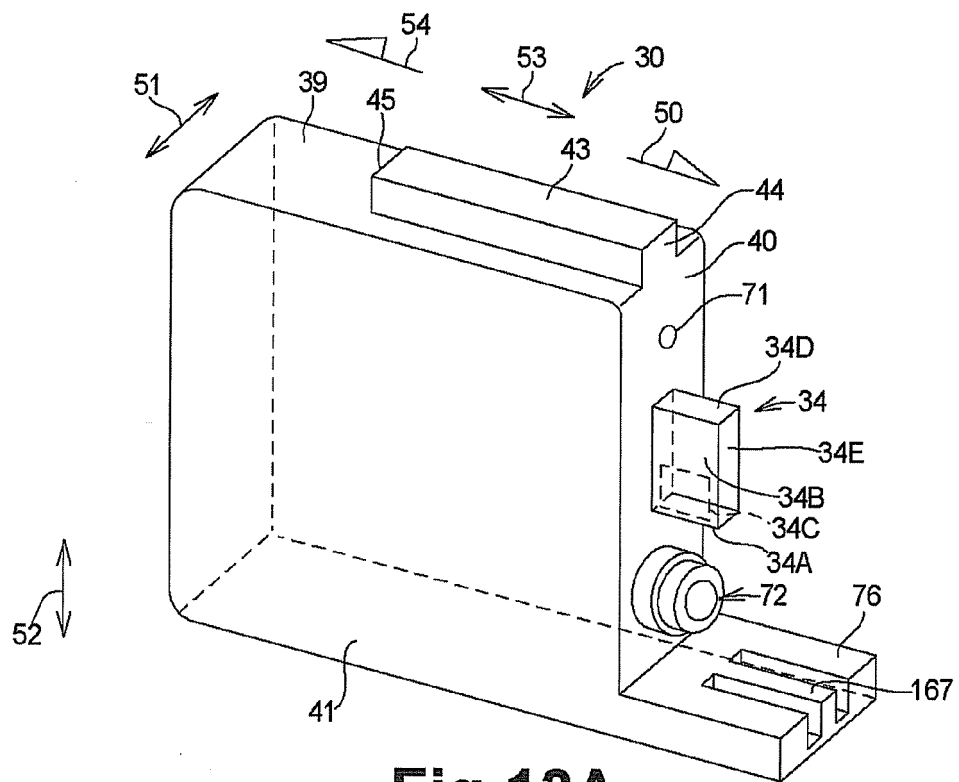


Fig.13A

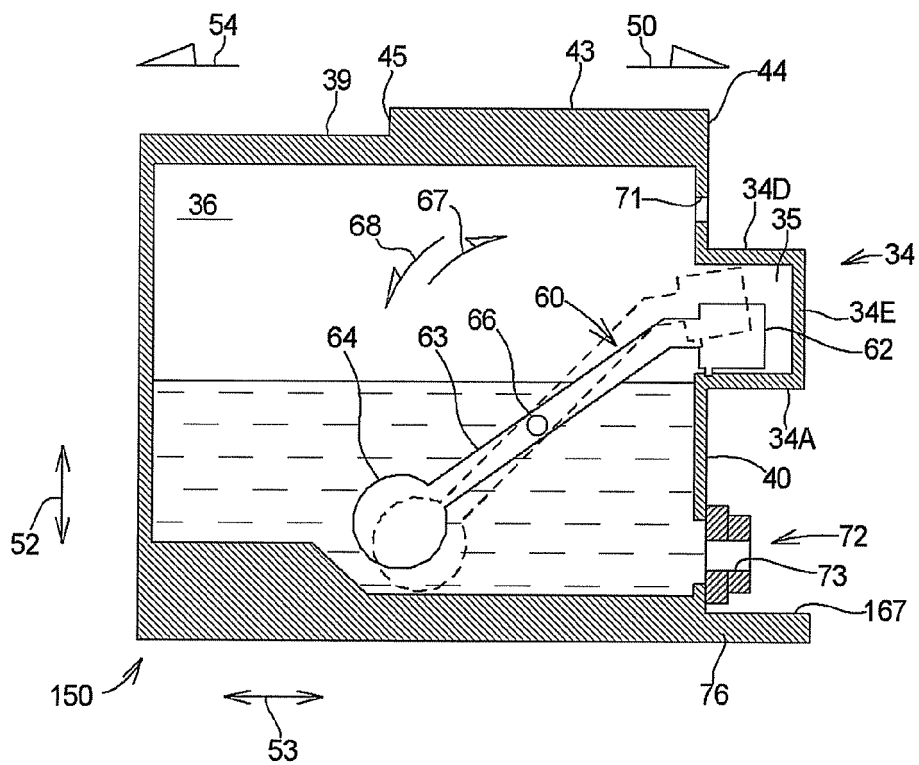


Fig.13B

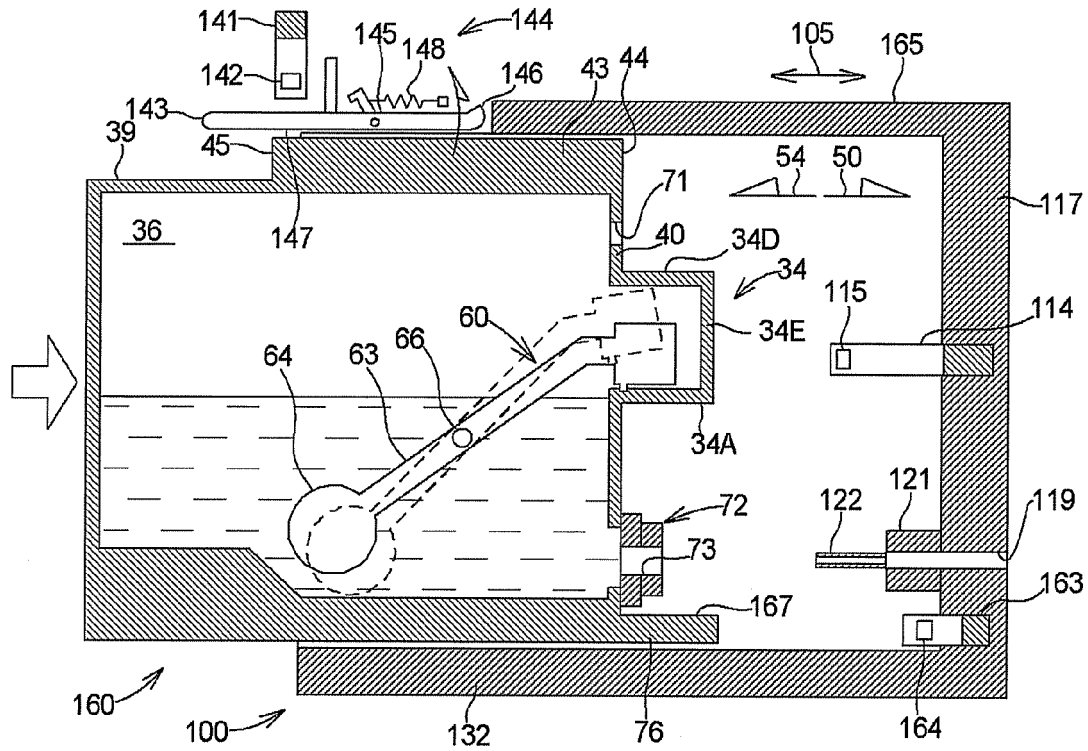


Fig.14A

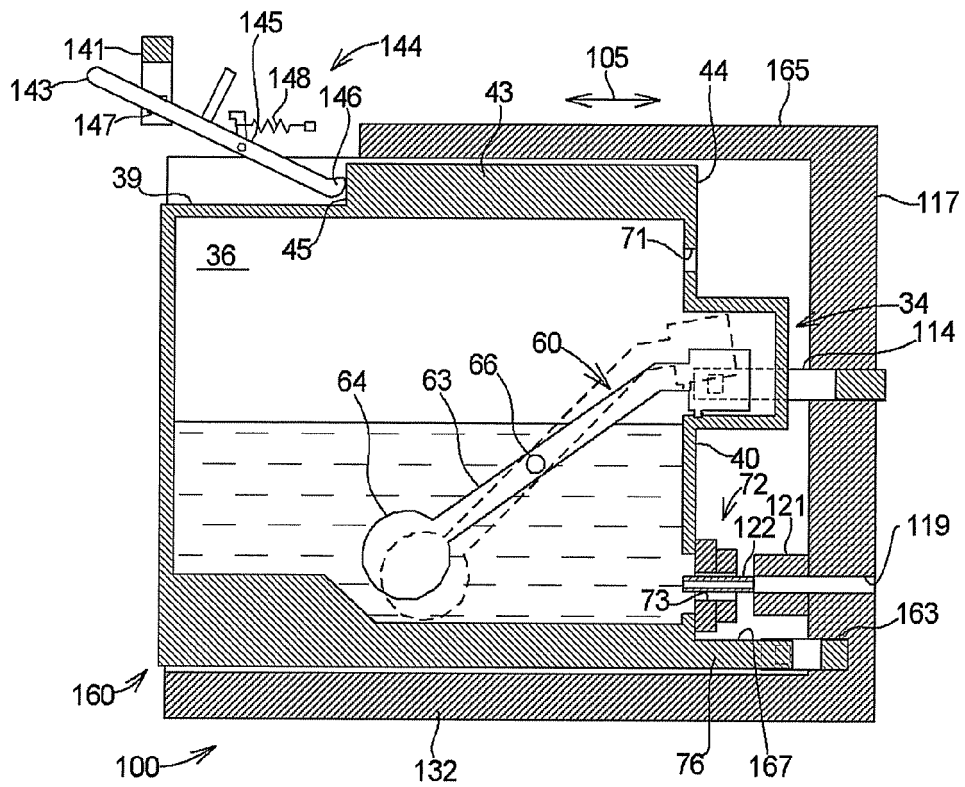


Fig.14B



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 6489

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/218649 A1 (CHOI KYUNG-CHOO L [KR]) 27 November 2003 (2003-11-27) * paragraphs [0029] - [0033]; figures 3, 5 *	1-9	INV. B41J2/175
X	EP 1 570 994 A1 (BROTHER IND LTD [JP]) 7 September 2005 (2005-09-07) * paragraph [0048]; figures 3, 7 *	1-9	
X	EP 0 955 169 A2 (CANON KK [JP]) 10 November 1999 (1999-11-10) * paragraphs [0055], [0 56], [0 63]; figures 6, 8, 11a *	1-9	
X	EP 1 241 011 A2 (SEIKO EPSON CORP [JP]) 18 September 2002 (2002-09-18) * paragraph [0098]; figure 17 *	1-9	
X	US 6 767 075 B1 (TAKADA SHINGO [JP] ET AL) 27 July 2004 (2004-07-27) * column 6, line 57 - column 7, line 3; figures 8a-8c *	1-9	
X,P	US 2009/244166 A1 (SUGAHARA HIROTO [JP]) 1 October 2009 (2009-10-01) * paragraph [0079]; figure 2 *	1-9	
X	EP 1 772 270 A2 (BROTHER IND LTD [JP]) 11 April 2007 (2007-04-11) * paragraph [0042]; figure 18 *	1	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		18 June 2010	Adam, Emmanuel
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 6489

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 0 412 459 A2 (CANON KK [JP]) 13 February 1991 (1991-02-13) * figure 19a * * figure 21 * * figures 30a, 30b * -----	1	
X	US 2007/279464 A1 (HARAZIM EUGEN [DE]) 6 December 2007 (2007-12-06) * paragraph [0074]; figures 5a-5d * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search The Hague		Date of completion of the search 18 June 2010	Examiner Adam, Emmanuel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03/82 (P04C01)

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

EP 10 15 6489

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

18-06-2010

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2003218649	A1	27-11-2003	KR 20030091373 A	03-12-2003
EP 1570994	A1	07-09-2005	AT 365108 T	15-07-2007
			AT 405429 T	15-09-2008
			AT 454270 T	15-01-2010
			CN 1663801 A	07-09-2005
			DE 202005021209 U1	21-06-2007
			DE 202005021768 U1	12-11-2009
			DE 202005021805 U1	04-03-2010
			DE 602005001410 T2	07-02-2008
			DK 1826009 T3	26-04-2010
			EP 1780026 A2	02-05-2007
			EP 1826009 A2	29-08-2007
			EP 2177364 A2	21-04-2010
			ES 2287825 T3	16-12-2007
			ES 2312147 T3	16-02-2009
			ES 2339058 T3	14-05-2010
			US 2005195225 A1	08-09-2005
EP 0955169	A2	10-11-1999	NONE	
EP 1241011	A2	18-09-2002	AT 337918 T	15-09-2006
			CN 1375400 A	23-10-2002
			DE 60214264 T2	12-07-2007
			ES 2271134 T3	16-04-2007
			JP 2002273911 A	25-09-2002
			KR 20020073446 A	26-09-2002
			PT 1241011 E	29-12-2006
			US 2002140759 A1	03-10-2002
US 6767075	B1	27-07-2004	CN 1344208 A	10-04-2002
			DE 60035868 T2	06-03-2008
			EP 1177904 A1	06-02-2002
			WO 0054974 A1	21-09-2000
			JP 2000263806 A	26-09-2000
US 2009244166	A1	01-10-2009	JP 2009241320 A	22-10-2009
EP 1772270	A2	11-04-2007	DE 602006000459 T2	08-01-2009
			WO 2007037536 A1	05-04-2007
			US 2007070146 A1	29-03-2007
EP 0412459	A2	13-02-1991	AT 361838 T	15-06-2007
			AT 173677 T	15-12-1998
			AT 187126 T	15-12-1999
			AT 227649 T	15-11-2002

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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

EP 10 15 6489

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

18-06-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0412459	A2	AT 213999 T	15-03-2002
		AT 311985 T	15-12-2005
		AU 648985 B2	12-05-1994
		CA 2022756 A1	06-02-1991
		CN 1491798 A	28-04-2004
		CN 1051011 A	01-05-1991
		CN 1141241 A	29-01-1997
		DE 9018060 U1	15-09-1994
		DE 69032780 D1	07-01-1999
		DE 69032780 T2	02-06-1999
		DE 69033377 D1	05-01-2000
		DE 69033377 T2	29-06-2000
		DE 69033928 D1	11-04-2002
		DE 69033928 T2	18-07-2002
		DE 69034019 D1	19-12-2002
		DE 69034019 T2	09-10-2003
		DE 69034212 T2	13-07-2006
		DE 69034240 T2	10-01-2008
		DK 0997296 T3	03-04-2006
		EP 1234675 A2	28-08-2002
		EP 0610965 A1	17-08-1994
		EP 0729836 A1	04-09-1996
		EP 0872347 A1	21-10-1998
		EP 0997296 A1	03-05-2000
		ES 2124212 T3	01-02-1999
		ES 2185722 T3	01-05-2003
		ES 2252908 T3	16-05-2006
		HK 1047910 A1	14-09-2007
		HK 1011647 A1	01-09-2000
		HK 1011655 A1	24-03-2000
		KR 960000542 Y1	17-01-1996
		SG 54174 A1	16-11-1998
		SG 85110 A1	19-12-2001
US 2007279464	A1	06-12-2007	DE 102006036716 B3
			EP 1862314 A2

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2007196647 A [0004]