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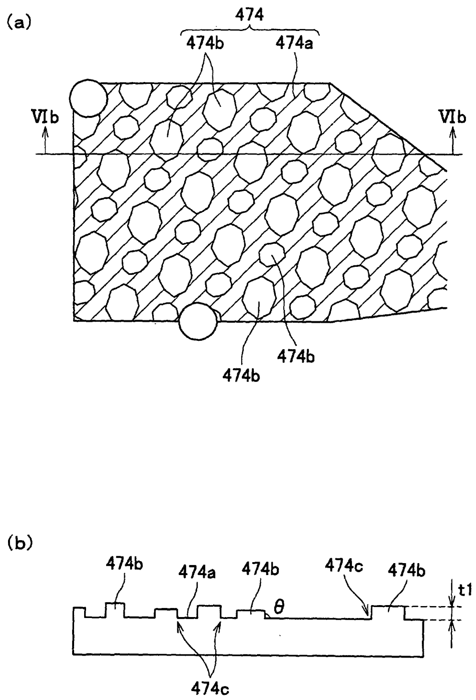
(54) Ink cartridge

(57) PROBLEM: To reduce the delay due to bubbles formed inside the ink tank until the remaining quantity of ink can be accurately detected.

MEANS FOR SOLVING: A diffusion surface (474) on which small irregularities are formed so as to generate a capillary force is provided on a portion of the surface of a sensor arm which is provided inside the ink tank where ink is stored and which moves along a set displacement path as the ink stored inside the ink tank decreases. The diffusion surface (474) consists of a base surface (474a) and a plurality of projecting parts (474b) projecting from the base surface. The base surface and projecting parts are connected at an angle so as to form corner parts (474c). Furthermore, the capillary force generating areas formed between adjacent projecting parts are linked to other capillary force generating areas.

FIG.6



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Description

[0001] The present invention relates to an ink cartridge for storing ink.

[0002] An inkjet recording apparatus that performs printing by discharging ink from a nozzle to a recording sheet is known. The inkjet recording apparatus of this type may be provided with a detachable ink cartridge. When an ink jet head attempts to discharge ink in a state in which the ink cartridge is empty, it may result not only in that printing is not performed, but also in that air may enter in the inkjet head. When air enters the inkjet head, the head in question may become unusable at the worst. In order to avoid such a result, it is necessary to always know the remaining amount of ink in the ink cartridge and control the apparatus to prohibit discharge of ink from the head when the remaining amount of ink in the ink cartridge is almost zero.

[0003] In Patent Document JP-A-2005-125738 (Fig. 1), a technique to detect the remaining amount of ink in the ink cartridge is disclosed. In other words, the ink cartridge in Patent Document JP-A-2005-125738 (Fig. 1) includes a sensor arm pivotably supported in the ink tank. The sensor arm includes a detected part at one end, and a float member at the other end. When the ink tank is full of ink, the rotation of the sensor arm due to the rise of the position of the float in the vertical direction is limited by a stopper, so that the detected part is located at a detecting position. Then, when the liquid level of the ink is lowered to a level lower than the position of the float in a state in which the rotation is limited by the stopper, the position of the float along the vertical direction is lowered in association with decrease in the remaining amount of ink, while the position of the detected part in the vertical direction rises and moves from the detecting position to a non-detecting position. Accordingly, when a detected part cannot be detected at the detecting position, running short of ink can be detected.

[0004] When carrying the ink cartridge or when transporting a printer in a state in which the ink cartridge is mounted, there may be a case in which air bubbles of ink are generated in the ink tank when the ink cartridge vibrates. When the air bubbles of ink are generated in the ink tank, there is a case in which the rotation of the sensor arm is prevented by a surface tension of the air bubbles attached on an inner wall surface of the ink tank. In such a case, there may arise such a problem that running short of ink is detected even though the remaining amount of the ink is sufficient. When the air bubbles in the ink tank disappear, the sensor arm rotates normally However, it normally takes from several hours to several tens of hours until the sensor arm is restored from a state in which the rotation of the sensor arm is hindered by the air bubbles to a state in which the air bubbles disappear to an extent in which it can rotate normally.

[0005] Accordingly, it is an object of the invention to provide an ink cartridge that can reduce a time lag until the remaining amount of ink can be detected accurately, which is caused by air bubbles generated in the ink tank.

[0006] This object is achieved by the features of claim 1. Further advantageous developments are the subject-matter of the dependent claims. According to one aspect of the ink cartridge, the air bubbles on a diffusing surface quickly disappeare in comparison with the air bubbles on a flat surface since ink which constitutes the air bubbles diffuses on the diffusing surface by a capillary force. In this arrangement, even when displacement of a displacement member is hindered by the surface tension of the bubbles attached on the inner wall surface of the ink tank, the air bubbles quickly disappeare by the diffusing surface provided on at least any one of the inner wall surface of the ink tank or a surface of the displacement member, and hence the displacement member can be displaced normally. Therefore, the time lag until the remaining amount of the ink can be detected accurately, which is caused by the air bubbles generated in the ink tank, can be reduced.

[0007] According to another aspect of the ink cartridge, preferably, the diffusing surface includes a reference surface and a plurality of projections projecting with respect to the reference surface, and a capillary force generating area formed between the projections adjacent to each other continues to other capillary force generating areas. In this arrangement, ink introduced into the capillary force generating areas can be diffused smoothly. Therefore, the time period required for the air bubbles to disappeare to an extent in which the displacement member can be displaced normally can further be reduced.

[0008] According to a further aspect preferably, the reference surface and the projections are connected at an angle which forms an angular corner. In this arrangement, the air bubbles can disappeare further reliably on the diffusing surface.

[0009] According to another further aspect, the ink cartridge may be configured in such a manner that the ink tank includes a main body, and a detection part projecting from the main body, having a width smaller than the width of the main body, and having a space that communicates with the inside of the main body formed therein, the displacement member includes a plate-shaped detected part that is displacable in the space in the detection part and the diffusing surface is formed on a surface of the detected part.

[0010] In this arrangement, since the detection part projects from the main body, it can be accessed from the outside of the ink cartridge, and since the width of the detection part is smaller than the width of the main body, the detected part of the displacement member can be detected by an inexpensive optical sensor. Although the air bubbles are apt to stay in the space in the detection part projecting from the main body and having the width smaller than that of the main body, since the diffusing surface is formed on the detected part, malfunction caused by the air bubbles can be avoided. Therefore, the time lag until the remaining amount of ink can be detected accurately, which is caused by air bubbles generated in the ink tank can effectively be reduced.

[0011] According to a further aspect, the ink cartridge may be configured in such a manner that the detection part can be provided at a position interposed between a light emitting part and a light receiving part of an optical sensor provided in an inkjet recording apparatus when the ink cartridge is mounted to the ink jet recording apparatus. In this arrangement, the detected part can be detected accurately with a simple structure.

[0012] According to a further aspect, the ink cartridge, preferably, the displacement member includes the detected part at one end and a float member being lower in relative density than the ink stored in the ink tank at the other end, and the regulating means includes a supporting mechanism for pivotably supporting the displacement member between the detecting part, and the float member so as to make the displacement member pivotable, and a regulating portion for regulating the range of pivotal movement of the displacement member.

[0013] When an end of the pivoting displacement member comes into contact with the air bubbles attached on the inner wall surface of the ink tank, a large moment force is generated in the direction of preventing the pivotal movement by a relatively small surface tension. In this arrangement, the detected part is located at the end of the displacement member. Therefore, the air bubbles attached to the detected part disappeare quickly by the diffusing surface formed on the detected part, and hence the displacement member can pivot further quickly in the normal state.

[0014] According to a further aspect, the ink cartridge may be configured in such a manner that the displacement member includes the detected part and a float member being small in relative density than the ink stored in the ink tank, and the regulating means includes a wall portion extending in the direction of displacement of the liquid level of the ink in association with decrease in the amount of the ink stored in the ink tank. In this arrangement, since an area of displacement of the displacement member is reduced in comparison with a type in which the displacement member pivots, and hence flexibility in design of the ink cartridge is increased.

(BRIEF DESCRIPTION OF THE DRAWINGS)

[0015]

(FIGURE 1) A perspective view of the ink cartridge according to a first embodiment of the present invention.

(FIGURE 2) An exploded view of the ink cartridge shown in Figure 1.

(FIGURE 3) A drawing of the ink storage element shown in Figure 2.

(FIGURE 4) A drawing of the vicinity of detection part shown in Figure 3.

(FIGURE 5) A drawing of the sensor arm shown in Figure 3.

(FIGURE 6) A drawing explaining the diffusion surface shown in Figure 5.

(FIGURE 7) A drawing explaining the method of installing the ink cartridge shown in Figure 1 in an ink jet recording device.

(FIGURE 8) A drawing explaining the method of detecting the remaining quantity of ink in the ink tank shown in Figure 5.

(FIGURE 9) A drawing illustrating the ink cartridge according to the second embodiment of the present invention.

(BEST EMBODIMENT OF THE INVENTION)

[0016] Preferred modes of embodiment of the present invention will be described below while referring to the drawings. Figure 1 is a perspective view illustrating the outer appearance of an ink cartridge 1 according to the present embodiment, and Figure 2 is an exploded perspective view of ink cartridge 1.

[0017] As shown in Figure 1 and Figure 2, the ink cartridge 1 comprises a case 200 which covers substantially all of the ink storage element 100 which stores ink, and a protector 300 which is attached to the case 200 and which protects the ink storage element 100 when the ink cartridge 1 is transported. In the present embodiment, the ink storage element 100, case 200 and protector 300 are formed from a resin material and do not contain metal materials, so they can be incinerated for waste disposal. The resin materials may include nylon, polyethylene, polypropylene, or the like.

[0018] As shown in Figure 1, the ink cartridge 1 is formed substantially as a hexahedron. Namely, it comprises substantially six surfaces, including a pair of substantially rectangular surfaces with the largest area and side surfaces position in four directions, linking said pair of surfaces. In the following description, The direction along the long edges of the pair of substantially rectangular surfaces of the hexahedron with the largest surface area will be referred to as the long direction, the direction along the short edges of those surfaces will be referred to as the short direction, and the direction linking said pair of surfaces (the direction orthogonal to the long direction and the short direction) will be referred to as the width direction. Furthermore, the pair of substantially rectangular surfaces of the hexahedron with the largest surface area will be referred to as the front surface and the back surface.

[0019] Next, referring to Figure 3, the ink storage element 100 will be described in detail. Figure 3 is a drawing, which illustrates the ink storage element 100. As shown in Figure 3, the ink storage element 100 comprises an ink tank 110 which stores ink, an ink supply part 120 which supplies the ink stored in the ink tank 110 to the outside (the ink jet recording device 1000 (see Figure 7)), an ambient air intake part 130 which takes in ambient air into the ink tank 110, and an ink dispensing part 150 which dispenses ink into the ink tank 110.

[0020] The state of the ink storage element 100 shown in Figure 3 is the orientation in which the ink cartridge 1 is installed in the ink jet recording device 1000 (see Figure 7). Namely, the ink cartridge 1 is installed in an orientation with the surfaces having the largest surface area being vertical and the long edge of the surfaces with the largest surface area being horizontal. Here, the ink supply part 120 and ambient air intake part 130 are positioned on a side surface. More specifically, the ink supply part 120 is positioned on the bottom side and the ambient air intake part 130 is positioned on the ceiling side. In the following description, the up-down direction will be defined taking the ceiling side of the ink cartridge 1 in the orientation of installation into the ink jet recording device 1000 will be defined as "up" and the bottom side as "down". Namely, the direction of displacement of the ink level accompanying the decrease of ink stored in the ink storage element 100 is the up-down direction.

[0021] The ink tank 110 has a main body part 170 and a detection part 140 which projects in the long direction from the main body part 170 between the ink supply part 120 and the ambient air intake part 130 and has a spaced formed inside it in communication with the main body part 170. Namely, the ink supply part 120, ambient air intake part 130, and detection part 140 are provided on the same wall surface of the ink storage element 100. Furthermore, inside the ink tank 110, there is arranged a sensor arm 470 capable of sliding about a pivot in the vicinity of the left bottom part of Figure 3, i.e. near the ink supply part 120, as the ink stored in the ink tank 110 decreases.

[0022] Here, referring to Figure 5, the sensor arm 470 will be described. Figure 5 (a) is a drawing illustrating the front surface side of the sensor arm 470, while Figure 5 (b) is a drawing which illustrates the sensor arm 470 a seen from the direction of arrow Vb in Figure 5 (a). The sensor arm 470 is a member for detecting the remaining quantity of ink in the ink tank 110. Furthermore, the sensor arm 470 is comprised of a resin material (e.g. styrene resin) with a specific gravity lower than the specific gravity of the ink, and is manufactured by injection molding.

[0023] The sensor arm 470 is a sliding member which is pivotally supported inside the ink tank 110 and slides in response to the remaining quantity of ink, and which comprises an attachment part 472 with an attachment s haft 472a that is attached to a substantially C-shaped arm sandwiching part 425 (see Figure 3) provided on the main body part 170; a float part 471 positioned on the right side of the attachment part 472 in Figure 5 (a); and an arm part 473 which extends substantially vertically (upward in Figure 5 (a)) from the attachment part 472 to the float part 471 and extends further upward in sloping fashion. The volume of the float part 471 is made sufficiently larger than the volume of the arm part 473. The end of the arm part 473 constitutes the detected part 473a, which his detected by a remaining ink quantity detection sensor 1014 (see Figure 7) provided in the ink jet recording device 1000. The detected part 473a has a plate shape with a surface parallel to the surface of the paper in Figure 5 (a). When the sensor arm 470 is attached inside the ink tank 110, as shown in Figure 3, the detected part 473a of the sensor arm 470 is arranged inside the space of the detection part 140.

[0024] Namely, the sensor arm 470 has the detected part 473a at one end (the left end in Figure 5 (a)) and the float part 471 at the other end (the right end in Figure 5 (a)), and is able to slide about the attachment part 472. Here, as shown in Figure 5 (a), the length from the attachment part 472, which is the center of rotation to the detected part 473a, is longer than the length from the attachment part 472 to the end of the float part 471. The rotation of the sensor arm 470 in the clockwise direction in Figure 3 is constrained by the contact of the float part 471 with the bottom wall of ink tank 110. Furthermore, rotation in the counterclockwise direction in Figure 3 is constrained by contact of the detected part 473a with the subsequently describe stopper 142. In this way, the range of sliding of the sensor arm 470 is constrained by the bottom wall of the ink tank 110 and the subsequently described stopper 142 such that it slides within along a set sliding path.

[0025] In the arm part 473, a rib 473b that protrudes in the width direction (the left-right direction in Figure 5 (b)) is formed to maintain strength. Substantially hemispherical arm protrusion parts 473c and 473d are provided at two locations at the top and bottom of the detected part 473a (the top end and the bottom end in Figure 5 (a)). Since the arm protrusion parts 473c and 473d are formed into a hemispherical shape, the portions that contact the inner wall of the detection part 140 are only the ends of the arm protrusion parts 473c and 473d, thus making it possible to reduce the influence of the surface tension of ink.

[0026] The sensor arm 470 is comprised of a resin material with a specific gravity lower than the specific gravity of the ink. Furthermore, the volume of the float part 471 is made adequately larger than the volume of the arm part 473. More specifically, the volume ratio of the arm part 473 and the float part 471 is set such that when the float part 471 is positioned inside the ink liquid, the moment in the counterclockwise direction in Figure 5 (a) generated on the sensor arm 470 by gravity and buoyancy will be greater than the moment in the clockwise direction, and when a portion of the float part 471 is exposed from inside the liquid of the ink, the buoyancy generated on the float part 471 decreases and counterclockwise moment and clockwise moment become equal. Therefore, after a portion of the float part 471 has been exposed from inside the liquid of the ink and the liquid level of the ink drops further as the ink decreases, the float part 471 moves downward following the liquid level. When the float part 471 moves downward, the arm part 473 moves upward about the fulcrum of the attachment shaft 472a of the attachment part 472.

[0027] Furthermore, as shown in Figure 5 (a), a diffusion surface 474 provided with small irregularities is formed the surface of the sensor arm 470, more specifically, on a portion of the float part 471 and on the portion of the arm part 473 excluding the rib 473b. Here, the diffusion surface 474 will be described while referring to Figure 6. Figure 6 (a) is an enlargement of the detected part 473a, while Figure 6 (b) is a cross-section along line VIb-VIb of Figure 6. In Figure 6 (a), for explanatory purposes, recessed parts are shaded with diagonal lines. Furthermore, in Figure 6 (b), the up-down direction is depicted in enlarged fashion.

[0028] As shown in Figure 6, the diffusion surface 474 consists of a base surface 474a (the portion with diagonal lines in Figure 6 (a)) and a plurality of projecting parts 474b, which project from the base surface 474a. As shown in Figure 6 (b), the side surface of the projecting parts 474b and the base surface 474a are not joined by a smooth curve but rather are connected at an angle so as to form a corner part 474c. As a result, the corner part 474c (the connection area between the base surface 474a and the side surface of the projecting parts 474b) has a structure, which generates a strong capillary force. Here, as shown in Figure 6 (a), the shape of the plurality of projecting parts 474b when viewed from the direction orthogonal to the diffusion surface 474 is variegated rather than uniform, but is in all cases substantially circular. Furthermore, the sizes of the projecting parts 474b when viewed from the direction orthogonal to the diffusion surface 474 are also somewhat varied. Moreover, as shown in Figure 6 (b), the length from the base surface 474a to the tips of the projecting parts 474b is also not uniform but varied.

[0029] In the present embodiment, the angle θ formed by the base surface 474a and projecting parts 474b is approximately 90 degrees, the length t1 from the base surface 474a of the diffusion surface 474 to the tips of the projecting parts 474b (the height difference between the recessed and protruding parts) is 0.04 to 0.06 mm, the mean diameter of the projecting parts 474b is 0.8 mm and the area ratio of the base surface 474a and the projecting parts 474b is 0.5.

[0030] Furthermore, the length of the gaps between adjacent projecting parts 474b is sufficient to generate a capillary force on the ink when ink is present in said gaps, specifically about 0.4 mm. Therefore, the spaces between adjacent projecting parts 474b constitute capillary force generating areas. The capillary force generating area between any two projecting parts 474b is linked to other capillary force generating areas. Thus, a liquid on the diffusion surface 474 is diffused to other areas by the capillary force generated in the capillary force generating area where that liquid is located.

[0031] Returning to Figure 3, the main body part 170 comprises a frame part 180 with edge parts at the front surface side and back surface side of the main body part 170, and a film 160 welded to the front surface side and rear surface side edge parts of the frame part 180. Namely, in the present embodiment, a space for storing ink is formed inside the main body part 170 by blocking the front surface side and back surface side of the frame part 180 with film 160. Therefore, the thickness of the ink storage element 100 can be made thinner as compared to the case where the two surfaces are blocked with side walls.

[0032] The frame part 180 comprises an outer peripheral weld part 400 having a surface parallel to the width direction of the ink tank 110 and constituting vertical walls that define the inner space of the main body part 170; inner weld parts 411 through 417 which have a surface parallel to the width direction of the ink tank 110 and are arranged on the inside of the outer peripheral weld part 400; and linking parts 420, 430 and 440 that have a surface orthogonal to the width direction of the ink tank 110 and link the outer peripheral weld part 400 and inner weld parts 411 through 417. More specifically, linking part 420 links the outer peripheral weld part 400 and inner weld parts 411 at the left bottom part in Figure 3. Linking part 430 links the outer peripheral weld part 400 and inner weld parts 412 at the top part in Figure 3. Linking part 440 links the outer peripheral weld part 400 and inner weld parts 413 through 417 from the left to the right bottom part in Figure 3. Here, in Figure 3, the solid black portions of the outer peripheral weld part 400 and inner weld parts 411 through 417 are located in the same virtual plane, and a film 160 is welded by ultrasound welding to those portions. Furthermore, linking part 420 is provided with an arm sandwiching part 425 which sandwiches the attachment part 472 of the sensor arm 470.

[0033] As shown in Figure 3, at least some of the vertical walls of the inner weld parts 411 through 417 extend in a direction that slopes down or is substantially orthogonal to the long direction of the frame part 180, i.e. toward the bottom of the ink cartridge 1, and the bottom ends thereof are not connected to the outer peripheral weld part 400. Thus, even if a plurality of inner weld parts 411 through 417 is provided on the inside of the outer peripheral weld part 400, to prevent shrinkage of the film 160 when the film 160 is welded to the frame part 180, the hindrance of ink flow by the plurality of inner weld parts 411 through 417 can be reduced. Furthermore, since the inner weld parts 411 through 417 are arranged in dispersed fashion on the inside of the outer peripheral weld part 400, shrinkage of the film 160 can be reduced and hindrance of ink flow can be effectively decreased.

[0034] Next, referring to Figure 4, the structure of the detection part 140 will be described. Figure 4 (a) is a drawing illustrating the vicinity of the detection part 140 in simplified fashion; Figure 4 (b) is a cross-section of the detection part 140 along line IVb-IVb of Figure 4 (a); and Figure 4 (c) is a cross-section of the vicinity of the detection part 140 along line IVc-IVc of Figure 4 (a).

[0035] As shown in Figure 4 (a), the detection part 140 projects outward from the main body part 170 (to the left in Figure 4 (a)), and as shown in Figure 4 (b) and (c), a space is formed inside the detection part 140, in communication with the inside of the main body part 170 and extending in the up-down direction. The detected part

473a provided on one end of the sensor arm 470 is arranged in the space inside the detection part 140. The detected part 473a is displaceable in the up-down direction inside the detection part 140. Furthermore, a stopper 142, which supports the sensor arm 470 from below, and constraints the displacement of the sensor arm 470 is provided inside the detection part 140.

[0036] Here, the detection part 140 is transmissive, and is provided at a position that is sandwiched between the light emitting part 1014a and light receiving part 1014b (see Figure 7) of the transmissive remaining ink quantity detection sensor 1014 provided in the ink jet recording device 1000 when the ink cartridge 1 is installed in the ink jet recording device 1000. Furthermore, the sensor arm 470 is non-transmissive. Consequently, as discussed above, when the ink level drops due to ink decrease and the arm part 473 moves upward as the sensor arm 470 rotates, and the detected part 473a moves upward inside the detection part 140, the remaining ink quantity detection sensor 1014 is able to detect the displacement of the detected part 473a. Therefore, it is possible to detect by means of the remaining ink quantity detection sensor 1014 when the remaining quantity of ink has become low.

[0037] As shown in Figure 4 (b), the length t2 in the width direction of the detection part 140 is shorter than the length t3 in the width direction of the main body part 170. Therefore, the gap between the light emitting part 1014a and light receiving part 1014b (see Figure 7) of the remaining ink quantity detection sensor 1014 can be made relatively narrow, thus making it possible to reliably detect the detected part 473a even with an inexpensive sensor.

[0038] Returning to Figure 3, the ink supply part 120 comprises a cylindrical ink supply path 121 which communicates with the ink tank 110 and extends in the length direction, and an ink supply mechanism 122 whereof a portion is incorporated into the ink supply path 121. The ink supply mechanism 122 closes the ink flow path when the ink cartridge 1 is not installed in the ink jet recording device 1000, and opens the ink flow path when the ink cartridge is installed in the ink jet recording device 1000 and the ink extraction tube 1015 (see Figure 7) of the ink jet recording device 1000 is inserted into it. Therefore, the ink supply part 120 is able to supply ink from inside the ink tank 110 to the ink jet recording device 1000 when the ink cartridge 1 is installed in the ink j et recording device 1000.

[0039] The ambient air intake part 130 comprises a cylindrical ambient air communication passage 131, which communicates with the ink tank 110 and extends in the long direction, and an ambient air intake mechanism 132, which has a rod-shaped valve opening part 132a projecting outside the ambient air communication passage 131. The ambient air intake mechanism 132 closes the ambient air flow path when ink cartridge 1 is not installed in the ink jet recording device 1000, and opens the ambient air flow path when the ink cartridge is installed in the ink jet recording device 1000 and the valve opening part 132a contacts the installation surface 1013 (see Figure 7) of the ink jet recording device 1000 and pressed into the ambient air communication passage 131. Therefore, the ambient air intake part 130 is able to place the inside of the ink tank 110 in communication with the ambient air when the ink cartridge 1 is installed in the inkjet recording device 1000.

[0040] The ink dispensing part 150 comprises a dispensing cylinder part 151 provided near the bottom at the side surface opposite the side surface on which the ink supply part 120 and ambient air intake part 130 of the ink storage element 100 are provided, and extending in the long direction; and an ink dispensing cap (not illustrated) which is press-fitted into the dispensing cylinder part 151. A communication hole (not illustrated), which places the dispensing cylinder part 151 and the ink tank 110 in communication, is formed in the dispensing cylinder part 151. The ink dispensing cap is comprised of an elastic material such as butyl rubber, and is fashioned such that it cannot be easily removed once press fitted into the dispensing cylinder part 151, and so that it closes the needle entry path when a needle is inserted and withdrawn.

[0041] Here, referring to Figure 8, the method of detecting the remaining quantity of ink in the ink tank 110 will be described. Figure 8 (a) illustrates the state where there is ink remaining, while Figure 8 (b) illustrates the state with no ink remaining.

[0042] As shown in Figure 8 (a), in the state where a large amount of ink is stored in the ink tank 110 (the state where at least the ink level is positioned above the position of the float part 471 when the detected part 473a contacts the stopper 142), as discussed above, the moment in counterclockwise direction in the drawing generated on the sensor arm 470 is greater than the clockwise moment, so the float part 471 floats in the ink. Here, the detected part 473a of the sensor arm 470 is positioned at a detection position, which obstructs the space between the light emitting part 1014a and the light receiving part 1014b of the remaining ink quantity detection sensor 1014. This state is the ink-present state, and a discrimination of ink-present is made on the control board (not illustrated) of the ink jet recording device 1000.

[0043] Subsequently, when the ink in the ink tank 110 decreases and the arm part 473 is exposed from the surface of the ink, the buoyancy generated on the arm part 473 decreases. As a result, the clockwise moment generated on the sensor arm 470 becomes smaller, but there is no change of the fact that the counterclockwise moment is greater than the clockwise moment, so the sensor arm 470 stops at the position shown in Figure 8 (a). As ink decreases further and the float part 471 is exposed from the surface of the ink, the buoyancy generated on the arm part 473 decreases. As a result, the counterclockwise moment generated on the sensor arm 470 becomes smaller. When a portion of the float part 471 is exposed from inside the ink, the counterclockwise moment and the clockwise moment become equal. Subsequently, if the ink decreases further, the float part 471 moves downward following the falling level of the ink. When the ink inside the ink tank 110 is nearly gone and disappears from the bottom surface of the ink tank 110, the float part 471 of the sensor arm 470 touches the bottom surface. This downward movement of the float part 471 causes the sensor arm 470 to rotate clockwise about the attachment part 472 and causes the detected part 473a of the sensor arm 470 to be displaced upward. When the detected part 473a is displaced up to a non-detection position where it does not block the space between the light emitting part 1014a and the light receiving part 1014b of the remaining ink quantity detection sensor 1014, light passes between the light emitting part 1014a and the light receiving part 1014b. This state is the out-of-ink state, and an out-of-ink discrimination inside diameter made at the control board (not illustrated) of the ink jet recording device 1000.

[0044] Next, the case 200 will be described. The case 200, as shown in Figure 2, is comprised of a first case member 210 and a second case member 220, which sandwich the ink storage element 100 in the width direction. The first case member 210 is a member, which covers the bottom surface of the ink storage element 100 in Figure 2, while the second case member 220 is a member, which covers the top surface of the ink storage element 100 in Figure 2. The first and second case members 210 and 220 consist of a resin material and are manufactured by injection molding.

[0045] The first case member 210 and second case member 220 are formed into substantially the same shape, and have formed in them case cutout parts 211 and 221 which constitute substantially round through-holes that expose a portion of the ink supply part 120 to the outside, case cutout parts 212 and 222 which constitute substantially round through-holes that expose a portion of the ambient air intake part 130 to the outside when the case members sandwich the ink storage element 100, and case cutout parts 213 and 223 which constitute through-holes in two sides of the detection part 140 (the top and bottom sides in Figure 2) which allow insertion of the remaining ink quantity detection sensor 1014 (see Figure 7) to a position where it sandwiches the detection part 140 at side walls of the detection part 140.

[0046] Next, the outer shape of the case 200 will be described. At both side ends in the short direction of the first and second case members 210 and 220, there is formed a stepped area recessed relative to the surface of the first and second case members 210 and 220, which extends in the long direction. The first and second case members 210 and 220 are welded and the ink storage element 100 is secured to the case 200 at these stepped areas. The stepped area on the ink supply part 120 side (the right front side in Figure 2) is the first case weld part 216 and 226, and the stepped area on the ambient air intake part 130 side (the left rear side in Figure 2) is the second case weld part 217 and 227. An engagement part 226a extending in the short direction is formed on the end of the second case member 220 on the side opposite that where the case cutout part 221 of the first case weld part 226 is formed. Although this is not illustrated, the same sort of engagement part as engagement part 226a is formed also on the first case member 220. The second case weld parts 217 and 227 have engagement parts 217a and 227a formed in a recessed shape approximately at the middle in long direction of the case 200.

[0047] Protector 300 is a member which covers the surface of the ink storage element 100 where the ink supply part 120 and ambient air intake part 130 are provided, and serves to protect the ink supply part 120 and ambient air intake part 130 when the ink cartridge 1 is shipped. Furthermore, the protector 300 consists of a resin material and is manufactured by injection molding. As shown in Figure 2, a protector through-hole 310 is formed in the protector 300 at a location corresponding to the ambient air intake part 130 side (the left rear side in Figure 2), thus making it possible to protect the valve opening part 132a of the ambient air intake mechanism 132.

[0048] Next, referring to Figure 7, the installation of the ink cartridge 1 into the ink jet recording device 1000 will be described. Mounting of the ink cartridge 1 in the ink jet recording device 1000 is performed with the protector 300 having been removed from the case 200.

[0049] As shown in Figure 7, the ink jet recording device 1000 side installation part 1010, when installing ink cartridge 1, comprises an engagement rod 1011 which projects from the installation surface 1013 opposite the ink supply part 120 and ambient air intake part 130 of the ink cartridge 1 in a direction orthogonal to that surface (to the right in Figure 7) and engages with the engagement parts 217a and 227a of the case 200; and a support part 1012 which supports the first case weld parts 216 and 226 of the case 200 from below and is formed into recessed shape matching the shape of the first case weld parts 216 and 226. On the engagement rod 1011, a convex part 1011 a is formed which protrudes toward the supporting part 1012 and is formed into substantially the same shape as the engagement parts 217a and 227a.

[0050] The remaining ink quantity detection sensor 1014 is arranged on the installation surface 1013 of the installation part 1010. The remaining ink quantity detection sensor 1014 is formed substantially in a U shape, with the open end of the U shape being the light emitting part 1014a that emits light and the other end being the light receiving part 1014b, which receives light. The light emitting part 1014a and light receiving part 1014b are mounted projecting from the installation surface 1013 so as to be inserted into the through-holes formed by the case cutout parts 213 and 223 and the detection part 140 respectively. The remaining ink quantity detection sensor 1014 is configured to not output (or to output) a signal to the control board (not illustrated) provided in the ink jet recording device 1000 when the light emitted from the light emitting part 1014a is received by the light receiving part 1014b, and to output (or not output) a signal to the control board when the light emitted from the light emitting part 1014a is blocked and is not received by the light receiving part 1014b.

[0051] Furthermore, on the side corresponding to the ink supply part 120 of the installation surface 1013 (the bottom side in Figure 7 (a)), a projecting ink extraction tube 1015 is provided, while on the side of the installation surface 1013 corresponding to the ambient air intake part 130 (the top side in Figure 7 (a)), the installation surface 1013 is formed as a flat surface. An ink flow path 1013a is connected to the ink extraction tube 1015, and ink is supplied to an unillustrated emission opening through the ink flow path 1013a. Furthermore, an ambient air intake path 1013b is formed on the installation surface 1013 on the ambient air intake part 130 side, and ambient air is taken into the ink cartridge 1 (ink tank 110) through the ambient air intake path 1013b.

[0052] Moreover, on the tip side of the supporting part 1012 (the right side in Figure 7 (a), the ink cartridge 1 side end), the installation part 1010 comprises a rotating engagement member 1017, which engages with engagement parts 216a and 226a of the case 200. The engagement member 1017 comprises an engagement end 1017a that engages with the engagement parts 216a and 226a of case 200; a pivotal support part 1017b which is joined to the engagement end 1017a and pivotally supports the engagement member 1017; and a cover part 1017c that is joined to the pivotal support part 1017b and covers the surface opposite the surface of the case 200 facing the installation part 1010.

[0053] Installation of the ink cartridge 1 is carried out by inserting it such that the first case 200 weld parts 216 and 226 contact the support part 1012 and pushing so that the first case weld parts 216 and 226 slide over the support part 1012. Namely, as shown in Figure 7 (a), the ink cartridge 1 is slid in the direction of arrow E.

[0054] As shown in Figure 7 (b), when the ink cartridge 1 is pushed inward in the direction of the installation part 1010 (to the left in Figure 7 (b)), the engagement rod 1011 is depressed by the second case weld parts 217 and 227 and elastically deforms away from the support part 1012. Furthermore, the engagement end part 1017a of the engagement member 1017 comes into contact with the engagement parts 216a and 226a. Moreover, as the ink cartridge 1 is pushed in, the engagement member 1017 rotates upward (in the direction of arrow F in Figure 7 (b)).

[0055] As shown in Figure 7 (c), when the ink cartridge 1 is pushed in from the state of Figure 7 (b) (or when the user rotates the engagement member 1017 in the direction of arrow F in if 7 (b)), the protruding part 1011a of the engagement rod 1011 fits into and engages with the engagement parts 217a and 227a of the case 200, securing the ink cartridge 1. Thus, when the ink cartridge 1 has been installed in the installation part 1010, it is prevented from easily being dislodged due to printing vibrations or the like.

[0056] Furthermore, when the ink cartridge 1 is installed in the installation part 1010, the ink extraction tube 1015 is inserted into the ink supply part 120, enabling ink supply, the valve opening part 132a of the ambient air intake part 130 contacts the installation surface 1013, enabling the intake of ambient air, and the remaining ink quantity detection sensor 1014 is inserted into the through-hole formed by the case cutout parts 213 and 223 and the detection part 140, enabling detection of the remaining quantity of ink.

[0057] As indicated above, in the ink cartridge 1 of the present embodiment, a sensor arm 470 which moves along a set displacement path as the ink stored in the ink tank 110 decreases is provided inside the ink tank 110 where the ink is stored. Furthermore, a portion of the surface of the sensor arm 470 is provided with a diffusion surface 474 on which small irregularities are formed so as to generate capillary force. If bubbles adhere to the diffusion surface 474, the ink making up the bubbles is diffused by the capillary forces on the diffusion surface 474, so the bubbles disappear more rapidly as compared to bubbles adhering to a smooth surface. Therefore, with the ink cartridge 1 of the present embodiment, in cases where the ink cartridge 1 is carried or where the ink jet recording device 1000 with the ink cartridge 1 installed is transported or the like, even if ink bubbles should form inside the ink tank 110 and the surface tension of bubbles adhering to the inner wall surface of the ink tank 110 should hinder the displacement of the sensor arm 470, the bubbles will disappear quickly due to the diffusion surface 474 provided on the surface of the sensor arm 470, allowing the sensor arm 470 to move normally. Thus, the delay until the remaining quantity of ink can be accurately detected due to air bubbles formed in the ink tank 110 can be reduced.

[0058] Furthermore, in the ink cartridge 1 of the present embodiment, the diffusion surface 474 consists of a base surface 474a and a plurality of projecting parts 474b that project from the base surface 474a, and the capillary force generating areas formed between adjacent projecting parts 474b are linked to other capillary force generating areas. Therefore, ink that is drawn into the capillary force generating areas can be smoothly dispersed. Thus, the time needed for bubbles to disappear so that the sensor arm 470 can move normally can be further shortened.

[0059] Moreover, on the diffusion surface 474 of the ink cartridge 1 of the present embodiment, the base surface 474a and the projecting parts 474b are connected at an angle so as to form corner parts 474c. Therefore, a stronger capillary force can be generated by the corner parts 474c as compared to a share where the base surface 474a and projecting parts 474b are joined by a smooth curved surface, thus making it possible to more reliably eliminate bubbles on the diffusion surface 474.

[0060] Furthermore, in the ink cartridge 1 of the present embodiment, the ink tank 110 has a main body part 170 and a detection part 140 which projects in the long direction from the main body part 170, has a width narrower than the width of the main body part 170 and has a space formed inside it extending in the up-down direction and communicating with the main body part 170. When the sensor arm 470 is attached to the arm sandwiching part 425, displacement of the sensor arm 470 is constrained so that the plate-shaped detected part 473a moves in the space inside the detection part 140. Furthermore, a diffusion surface 474 is formed on a portion of the float part 471 of the sensor arm 470 and on the portion of the arm part 473 excluding the rib 473b. Therefore, the detection part 140 projects from the main body part 170, making the ink cartridge 1 easier to access from the outside (specifically, the ink jet recording device 1000), and the width of the detection part 140 is narrower than the width of the main body part 170, so that the detected part 473a of the sensor arm 470 can be detected with an inexpensive transmissive sensor. Although bubbles are prone to lodging in the space within the detection part 140 having a width narrower than the width of the main body part 170 and projecting from the main body part 170, since a diffusion surface 474 is formed on the detected part 473a which moves through the space inside the detection part 140, operating defects due to bubbles can be avoided. Therefore, the delay due to bubbles formed in the ink tank 110 until the remaining quantity of ink can be accurately detected can be effectively reduced.

[0061] In addition, with the ink cartridge 1 of the present embodiment, when the ink cartridge 1 is installed in the inkjet recording device 1000, the detection part 140 is arranged a position between the light emitting part 1014a and the light receiving part 1014b of the remaining ink quantity detection sensor 1014 provided in the ink jet recording device 1000. Therefore, the detected part 473a can be reliably detected with a simple mechanism.

[0062] Furthermore, in the ink cartridge 1 of the present embodiment, the sensor arm 470 has a detected part 473a on one end and a float part 471 with a specific gravity lower than that of the ink on the other end, and is slidable about an attachment part 472 located between the detected part 473a and the float part 471. The range of sliding of the sensor arm 470 is constrained such that it moves along a set displacement path by means of the arm sandwiching part 425 which pivotally supports the sensor arm 470, the bottom wall of the ink tank 110 which contacts the float part 471 when the sensor arm 470 rotates clockwise in Figure 3, and the stopper 142 which contacts the detected part 473a when the sensor arm 470 rotates counterclockwise in Figure 3. When the end of the sensor arm 470 contacts bubbles adhering to the inner wall surface of the ink tank 110, a large moment acts in a direction which hinders the sliding thereof at relatively low surface tension. In the ink cartridge 1 of the present embodiment, a diffusion surface 474 is formed on the detected part 473a provided on one end of the sensor arm 470. Therefore, bubbles adhering to the detected part 473a can be eliminated quickly, making it possible to more quickly make the sensor arm 470 slide normally.

[0063] Next, referring to Figure 9, a second embodiment of the present invention will be described. The configuration of the ink cartridge according to the second embodiment differs from the configuration of the ink cartridge 1 according to the first embodiment in that, in ink cartridge 1, the detected part 473a that is detected by the remaining ink quantity detection sensor 1014 of the ink jet recording device 1000 is arranged on one end of the sensor arm 470 which rotates with the decrease in ink inside the ink tank 110, while in the ink cartridge 500 of the present embodiment, the detected part 573 is provided on a displacement member 570 which moves in the displacement direction of the ink level as the ink inside the ink tank 510 decreases.

[0064] Figure 9 is a cross-section of the ink cartridge 500 of the present embodiment, where it is shown installed in an inkjet recording device 2000. As shown in Figure 9, the ink cartridge 500 of the present embodiment mainly comprises an ink tank 510 which stores ink, an ink supply part 520 which is arranged on one wall (bottom wall) of the ink tank 510 and supplies the ink stored in the ink tank 510 to the outside, an ink dispensing part 550 which dispenses ink inside the ink tank 510, and a cap 530 which covers the wall of the ink tank 510 where the ink supply part 520 is provided from the outside. The up-down direction of the page in Figure 9 shall be treated as the up-down direction of the ink cartridge 500, and the direction perpendicular to the page surface shall be treated as the width direction of the ink cartridge 500.

[0065] The ink tank 510 comprises a transmissive bottomed box type main body part 511 with an opening part at the top, and a cover element 515 that is welded to the main body part 511 and closes the opening part of the main body part 511, and a non-transmissive displacement member 570 is arranged therein. The displacement member 570 is formed from a material whereof the specific gravity is lower than that of the ink, and comprises a float part 571, a connection part 572 which extends vertically upward from the float part 571 in Figure 9 and extends further upward to the left, and a detected part 573 that is connected to the edge opposite of the float part 571 of connection part 572. Furthermore, the ratio of the volume of the displacement member 570 occupied by the float part 571 is set such that when the float part 571 is positioned inside the ink liquid, the buoyancy generated at the displacement member 570 is greater than the gravity, and when a portion of the float part 571 is exposed from inside the liquid of the ink (when the link level is below line A shown in Figure 9), the buoyancy generated at the displacement member 570 on the float part 571 is equal to the gravity. The width of the float part 571 is grater than the width of the space formed inside the subsequently described detection part 540, and the width of the connection part 572 and the detected part 573 is less than the width of the space formed inside the detection part 540. Furthermore, a diffusion surface 574 of the same sort as the diffusion surface 474 formed on the surface of the sensor arm 470 of the first embodiment is formed over the entire surface of the displacement member 570.

[0066] On the side surface of the main body part 511 (the left side surface in Figure 9), the detection part 540 is arranged, projecting from the main body part 511. The detection part 540 has width narrower than the width of the ink cartridge 500. Inside the detection part 540, a space is formed which extends in the up-down direction (the direction of displacement of the ink level when the ink stored in the ink tank 510 decreases) and communicates with the ink tank 510. When the ink cartridge 500 is installed in the ink jet recording device 2000, the detection part 540 is sandwiched between the light emitting part 2014a and the light receiving part 2014b of a transmissive remaining ink quantity detection sensor 2014 provided in the ink jet recording device 2000. Furthermore, a constraining wall 512 is provided extending upward on the bottom surface of the ink tank 510 near the detection part 540. More specifically, the constraining wall 512 is provided at a position opposite the space inside the detection part 540 in the ink tank 510. The displacement member 570 is arranged such that the float part 571 is positioned between the detection part 540 and the constraining wall 512 and so that the detected part 573 is positioned inside the detection part 540. Therefore, the constraining wall 512 serves to constrain the displacement path of the displacement member 570 in the up-down direction.

[0067] Furthermore, a constraining protrusion 516 is formed projecting into the ink tank 510 (downward) on the cover element 515. As shown in Figure 9, the portion of the constraining protrusion 516 near its tip is positioned in the space inside the detection part 540. In other words, the tip of the constraining protrusion 516 is arranged in the upper part of the space inside the detection part 540. Furthermore, a communication hole (not illustrated) for taking air into the ink tank 510 is formed in the cover element 515.

[0068] Therefore, when ample ink is stored inside the ink tank 510 (at least enough for the ink level to be positioned above line A shown in Figure 9), the buoyancy generated on the displacement member 570 will be greater than the gravity, so the detected part 573 will contact the tip of the constraining protrusion 516, as in the case of the displacement member 570 drawn with a dashed line. In other words, the upward displacement of the detected part 573 is constrained by the constraining protrusion 516, so that the detected part 573 does not jump out of the space inside the detection part 540. Here, the detected part 573 is located at a detection position that blocks the space between the light emitting part 2014a and the light receiving part 2014b of the remaining ink quantity detection sensor 2014 provided in the ink jet recording device 2000. This state is the ink-present state, and a discrimination of ink-present is made on the control board (not illustrated) of the inkjet recording device 2000.

[0069] Subsequently, when the ink in the ink tank 510 decreases and the ink level drops to line A, the buoyancy generated on the displacement member 570 becomes equal to the gravity. As the ink level drops further, the float part 571 moves down in the space extending vertically between the detection part 540 and the constraining wall 512, following the level drop. The detected part 573 connected to the float part 571 via the connection part 572 is also displaced downward in the space inside the detection part 540. When the remaining quantity of ink nears zero and the float part 571 contacts the bottom wall of the ink tank 510, the detected part 573 becomes positioned at a non-detection position where it does not block the space between the light emitting part 2014a and the light receiving part 2014b of the remaining ink quantity detection sensor 2014. This state is the out-of-ink state, and an out-of-ink discrimination inside diameter made at the control board (not illustrated) of the ink jet recording device 2000.

[0070] The ink supply part 520 comprises a cylindrical ink supply path 521, which communicates with the ink tank 510 and extends in the up-down direction, and an ink supply mechanism 522, which is incorporated into the ink supply path 521. The ink dispensing part 550 comprises a cylindrical dispensing cylinder part 551 which is arranged on the bottom wall of the ink tank 510, communicates with the ink tank 510 and extends in the up-down direction, and an ink dispending cap 553 which is press-fitted into the dispensing cylinder part 551. The functions of the ink supply part 520 and the ink dispensing part 550 are substantially the same as the functions of the ink supply part 120 and ink dispensing part 150 of the first embodiment, so description of these functions will be omitted.

[0071] The cap 530 is non-transmissive and is fastened to the ink tank 510 by ultrasound welding or the like. As shown in Figure 9, the cap 530 comprises a bottom wall 531 which faces the bottom wall of the ink tank 510 and touches the ends of the ink supply part 521 and dispensing cylinder part 551 projecting downward from the bottom wall of the ink tank 510 and the end of a rib 513 extending to the end of the dispensing cylinder part 551 and the ink supply path 521 from the bottom wall 531 of the ink tank 510; and side walls 535 which extend upward from the edges of the bottom wall 531 and touch a portion of the side surface of the ink supply path 521 and dispensing cylinder part 551 and the side surface of the rib 513, In the portions of the bottom wall 531 corresponding to the ink supply path 521 and dispensing cylinder part 551 there are provided openings 532 and 533. Furthermore, an annular protrusion 532a that projects downward is formed at the edge of the opening 532 corresponding to the ink supply path 521.

[0072] As indicated above, in the ink cartridge 500 of the present embodiment, just as in the ink cartridge 1 of the first embodiment, bubbles are rapidly eliminated by the diffusion surface 574 provided on the surface of the displacement member 570, allowing the displacement member 570 to move normally, thus making it possible to reduce the delay until the remaining quantity of ink can be accurately detected.

[0073] Furthermore, in the ink cartridge 500 of the present embodiment, the displacement member 570 has a detected part 573 and a float part 571 whereof the specific gravity is lower than that of the ink, and its displacement path is constrained in the up-down direction by the constraining wall 512 extending in the up-down direction, which is the direction of displacement of the ink level. Therefore, compared to the sliding type of displacement member, the degree of freedom of design of the ink cartridge 500 is greater, since the area of displacement of the displacement member 570 is smaller.

[0074] Preferred embodiments of the present invention have been described above, but the present invention is not limited to the above embodiments, and various design modification can be made within the scope described in the patent claims. For example, in the first embodiment described above, the case was described where the diffusion surface 474 was formed on a portion of the float part 471 of the sensor arm 470, which is a displacement member, and on the portion of the arm part 473 excluding the rib 473b, and in the second embodiment, the case was described where the diffusion surface 574 was formed over the entire displacement member 570, but the configuration is not limited to this. It is acceptable so long as the diffusion surface is formed on a portion of the area of the inner wall surface of the ink tank corresponding to the displacement path of the displacement member, and/or on a portion of the surface of the displacement member. However, the inside of the above-described detection parts 140 and 540 is a narrow space where bubbles are prone to lodge, so it is most desirable for the diffusion surface to be formed in the detected part 473a and 573.

[0075] Furthermore, in the first and second embodiments described above, the case was described where the diffusion surface consisted of a base surface and a plurality of projecting parts projecting from the base surface, and the capillary force generating areas formed between adjacent projecting parts were linked to other capillary force generating areas, but the configuration is not limited hereto. For example, the diffusion surface may also consist of a base surface and a plurality of depressions depressed relative to the base surface, with the insides of the depressions constituting the capillary force generating areas. Furthermore, the diffusion surface may consists of a base surface, a plurality of projecting parts, and a plurality of depression.

[0076] Moreover, in the first and second embodiments described above, the case was described where the base surface and projecting parts of the diffusion surface were connected at an angle of approximately 90 degrees so as to form corners, but the connection angle of the base surface and projecting parts is not limited to 90 degrees. Furthermore, the base surface and projecting parts may also be connected in continuous fashion without forming corners.

[0077] Furthermore, in the above-described first embodiment, the case was described where the ink tank 110 has a main body part 170 and a detection part 140 which projects in the long direction from the main body part 170, has a width narrower than the width of the main body part 170 and has a space formed inside it extending in the up-down direction and communicating with the main body part 170, with the detected part 473a of the sensor arm 470 moving inside said space. The configuration of the detection part 140 is however not limited to this. Thus, for instance, the detection part 140 may also not project from the main body part 170, and may have the same width as the main body part 170

[0078] Furthermore, in the first and second embodiments described above, the sensor arm 470 and displacement member 570 had a specific gravity lower than the specific gravity of the ink. However, the arrangement is not limited to this, it being sufficient so long as the float part 471, 571 has a specific gravity lower than the specific gravity of the ink.

[0079] In addition, in the first and second embodiments described above, the case was described where the detection part was arranged at a position sandwiched between the light emitting part and light receiving part of the remaining ink quantity detection sensor provided in the ink jet recording device when the ink cartridge is installed in the ink jet recording device, and where the detected part was detected inside the detection part by means of a transmissive sensor. The configuration is however not limited hereto. For example, the detected pat may also be detected by means of a reflective sensor.

[0080] Moreover, in the aforementioned first embodiment, the case was described where the displacement range of the sensor arm 470, which is the displacement member, was constrained by the arm sandwiching part 425 which pivotally supports the sensor arm 470, the bottom wall of the ink tank 110 which contacts the float part 471 when the sensor arm 470 rotates toward the float part 471, and the stopper 142 which touches the detected part 473a when the sensor arm 470 rotates toward the detected part 473a, while in the second embodiment, the case was described where the displacement range of the displacement member 570 was constrained in the up-down direction by the constraining wall 512 extending in the up-down direction, which is the displacement direction of the ink level. However, the manner of displacement of the displacement member and the means constraining the displacement range of the displacement member are not limited hereto.

[0081] Furthermore, in the above-described first and second embodiments, the case was described where the detected part of the displacement member (sensor arm) blocked the space between the light emitting part and light receiving part of the remaining ink quantity detection sensor when ample ink is stored in the ink tank, and where the detected part freed the space between the light emitting part and light receiving part of the remaining ink quantity detection sensor when the ink inside the ink tank was nearly gone. The arrangement is however not limited hereto, it being also acceptable if the detected part frees the space between the light emitting part and light receiving part which there is ample ink stored inside the ink tank and blocks the space between the light emitting part and light receiving part when the ink inside the ink tank is nearly gone.

[0082] (COMPARISON TEST 1) Here, the anti-foaming properties were compared for a diffusion surface consisting of a base surface and plurality of projecting parts projecting from the base surface, as was the case with the diffusion surface formed on the surface of the displacement member in the above-described first and second embodiments; a diffusion surface consisting of a base surface and a plurality of depressions independent of each other and depressed relative to the base surface (modified example 1); a diffusion surface consisting of a base surface and a plurality of independent projecting parts and depressions (modified example 2); and a flat surface without any irregularities formed thereon (reference example 1). The height difference of the irregularities of the diffusion surface of modified example 1 (the length from the base surface to the bottom part of the depressions) was 0.04 to 0.06 mm, the mean diameter of the depressions was 0.8 mm, and the area ratio between the base surface and the depressions was 0.5. The height difference of the irregularities of the diffusion surface of modified example 2 (the length from the tips of the projecting parts to the bottom part of the depressions) was 0.04 to 0.06 mm, the mean diameter of the projecting parts and depressions was 0.8 mm, and the area ratio between the base surface and the projections and depressions was 0.5.

[0083] Ink bubbles of approximately 10 mm diameter were adhered to four samples formed with each diffusion surface and with a flat surface, and an experiment to measure the time until disappearance of the bubbles was conducted three times. The ink used was a water-soluble ink, its surface tension being approximately 30 mN/m. Furthermore, the material of the samples was styrene resin. The results of these experiments were that the mean value of the three experiments were 23 minutes for the diffusion surface of the same sort as the in the first and second embodiments, 29 seconds for the diffusion surface of modified example 1, 26 minutes for the diffusion surface of modified example 2, and 31 minutes for the flat surface of the reference example 1. Thus, it could be seen that the antifoaming properties were best in the case of a diffusion surface consisting of a base surface and a plurality of projecting parts projecting from the base surface, as in the diffusion surface of the first and second embodiments.

[0084] (COMPARISON TEST 2) Next, an experiment was conducted to investigate the behavior of the sensor arm using the ink cartridge of the first embodiment and an ink cartridge of the same form as in the first embodiment but with a sensor arm attached that had no diffusion surface formed on it, i.e. whereof the surface was flat (reference example 2). The quantity of ink stored in advance in the ink tank of each ink cartridge was such that the ink level was positioned in the middle of the long direction of the detection part.

[0085] First, the ink stored inside was forcibly foamed and to create a state where the detected part of the sensor arm was made to cling by the bubbles to the inner wall in the vicinity of the top part of the detection part (i.e. a state where the sensor arm rotated clockwise in Figure 3 and the float part came into contact with the inner wall of the ink tank). Then, the time it took the sensor arm to return from this state to the normal position (the position where the detected part is in contact with the stopper) was measured. The ink used cyan at -20°C. The results of performing this experiment twice on the ink cartridge of the first embodiment were that the mean value was 2 minutes. Furthermore, the results of performing this experiment on the ink cartridge of reference example 2 were 2 hours 10 minutes. Thus, it could be seen that the time needed for the sensor arm to go from a state where it cannot move normally due to effects of surface tension of bubbles to a state where normal displacement is possible could be substantially shortened by using a sensor arm with a diffusion surface formed thereon, such as that of the first embodiment.

(EXPLANATION OF REFERENCES)

[0086]

1, 500	Ink cartridge
110,510	Ink tank
140	Detection part
170	Main body part
470, 570	Sensor arm (displacement member)
473a, 573	Detected part
142	Stopper (constraining member)
425	Arm sandwiching part (constraining member, support mechanism)
512	Constraining wall (constraining member, wall part)
471	Float part
474, 572	Diffusion surface
474a	Base surface
474b	Projecting part
474c	Corner part
1000, 2000	Ink jet recording device
1014a, 2014	Remaining ink quantity detection sensor (transmissive optical sensor)
1014a, 2014a	Light emitting part
1014b, 2014b	Light receiving part

Claims

1. An ink cartridge comprising:

an ink tank in which ink can be stored;
a displacement member provided in the ink tank and displacable along a predetermined displacement route in association with decrease in the amount of the ink stored in the ink tank; and wherein a diffusing surface formed with fine depressions and for projections so as to generate a capillary force is provided on at least one of a part of an area corresponding to the displacement route on an inner wall surface of the ink tank and for a part of a surface of the displacement member.

2. The ink cartridge according to Claim 1, wherein the diffusing surface includes a reference surface and a plurality of projections projecting with respect to the reference surface, and a capillary force generating area formed between the projections adjacent to each other continues to other capillary force generating areas.

3. The ink cartridge according to any of the preceding claims, wherein the diffusing surface comprises a reference surface and a plurality of depressions.

4. The ink cartridge according to Claim 2, wherein the reference surface and the projections are connected at an angle which forms an angular corner.

5. The ink cartridge according to any one of Claims 1 to 4, wherein the ink tank comprises a main body, and a detection part projecting from the main body, having a width smaller than the width of the main body, and having a space that communicates with the inside of the main body formed therein,
the displacement member comprises a plate-shaped detected part that is displacable in the space in the detecting part , and the diffusing surface is formed on a surface of the detected part.

6. The ink cartridge according to Claim 5, wherein the detected part can be provided at a position interposed between a light emitting part and a light receiving part of an optical sensor provided in an inkjet recording apparatus when the ink cartridge mounted to the ink jet recording apparatus.

7. The ink cartridge according to Claim 5 or .Claim 6, wherein the displacement member comprises the detected part at one end and a float member being lower in relative density than the ink to be stored in the ink tank at the other end.

8. The ink cartridge according to any of the preceding claims, wherein the regulating means comprises a supporting mechanism for pivotably supporting the displacement member between the detecting section and the float member so as to make the displacement member pivotable and a regulating portion for regulating the range of pivotal movement of the displacement member are provided in said ink tank.

9. The ink cartridge according to claim 8, wherein the regulating means comprises a supporting mechanism for pivotably supporting the displacement member between the detecting section and the float member so as to make the displacement member pivotable and a regulating portion for regulating the range of pivotal movement of the displacement member.

10. The ink cartridge according to Claim 9, wherein the displacement member comprises the detected part and a float member being smaller in relative density than the ink to be stored in the ink tank, and the regulating means comprises a wall portion extending in the direction of displacement of the liquid level of the ink in association with decrease in the amount of the ink to be stored in the ink tank.

Amended claims in accordance with Rule 86(2) EPC.

1. An ink cartridge comprising:

an ink tank (110; 510) in which ink can be stored;
a displacement member (470; 570) provided in the ink tank (110; 510) and displacable along a predetermined displacement route in association with decrease in the amount of the ink stored in the ink tank, (110; 510) **characterized in that** a diffusing surface (474; 574) formed with a reference surface (474a) and a plurality of fine depressions and/or fine projections (474b) so as to generate a capillary force between said reference surface (474a) and said plurality of fine depressions and/or fine projections (474b), and/or between the projections (474b) adjacent to each other is provided on at least one of a part of an area corresponding to the displacement route on an inner wall surface of the ink tank (110; 510) and/or a part of a surface (474; 574) of the displacement member (470; 570).

2. The ink cartridge according to Claim 1, wherein the diffusing surface includes the reference surface (474a) and the plurality of fine projections (474b) projecting with respect to the reference surface, (474a) and a capillary force generating area formed between the projections adjacent to each other continues to other capillary force generating areas.

3. The ink cartridge according to any of the preceding claims, wherein the diffusing surface comprises the reference surface and the plurality of fine depressions.

4. The ink cartridge according to Claim 2, wherein the reference surface (474a) and the projections (474b) are connected at an angle which forms an angular corner (474c).

5. The ink cartridge according to any one of Claims 1 to 4, wherein the ink tank comprises:

a main body (170; 511), and
a detection part (140; 540) projecting from the main body (170; 511), having a width smaller than the width of the main body (170, 511), and having a space formed therein, which communicates with the inside of the main body (170; 511),
wherein the displacement member (470; 570) comprises a plate-shaped detected part (473a; 573) that is displacable in the space in the detecting part (140; 540), and the diffusing surface (474; 574) is formed on a surface of the detected part (470; 570).

6. The ink cartridge according to Claim 5, wherein the detected part (470; 570) can be provided at a position interposed between a light emitting part (1014a; 2014a) and a light receiving part (1014b; 2014b) of an optical sensor (1014; 2014) provided in an inkjet recording apparatus (1000; 2000) when the ink cartridge is mounted to the ink jet recording apparatus (1000; 2000).

7. The ink cartridge according to Claim 5 or Claim 6, wherein the displacement member (470; 570) comprises the detected part (473a; 573) at one end and a float member (471; 571) at the other end, the float member (471; 571) being lower in relative density than the ink stored in the ink tank (110; 510).

8. The ink cartridge according Claim 7, further comprises a regulating means, wherein the regulating means comprises:

a supporting mechanism (472; 472a; 425) for pivotably supporting the displacement member (470) between the detected part (473a) and the float member (471) so as to make the displacement member (470; 570) pivotable, and
a regulating portion (142, 110) for regulating the range of pivotal movement of the displacement member (470).

9. The ink cartridge according to Claim 1, wherein the displacement member (570) comprises the detected part (573) and a float member (571), the float member being smaller in relative density than the ink stored in the ink tank (510), and the ink cartridge further comprises a regulating means comprising a wall portion (512, 516) extending in the direction of displacement of the liquid level of the ink in association with decrease in the amount of the ink stored in the ink tank (510).

FIG.1

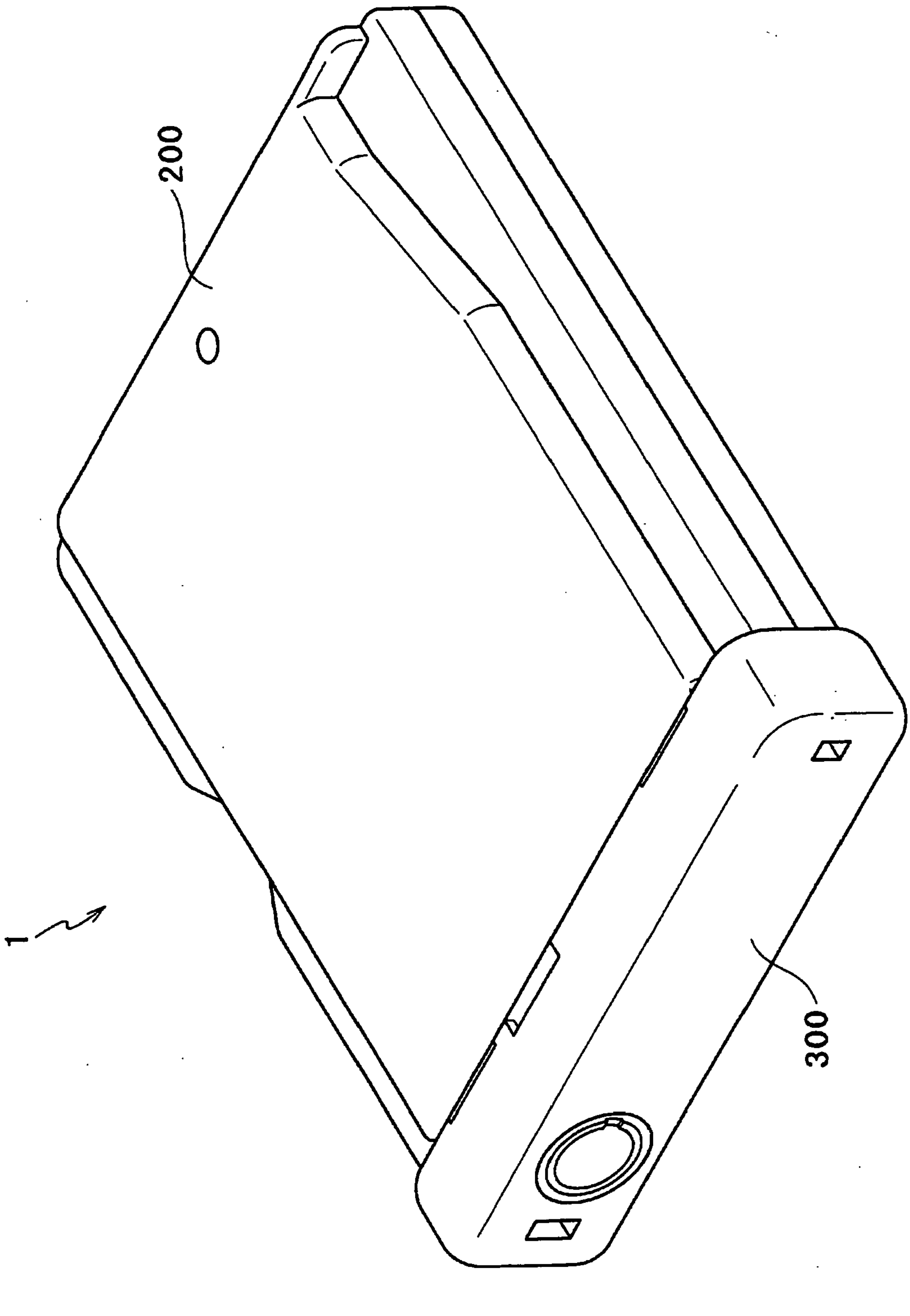


FIG.2

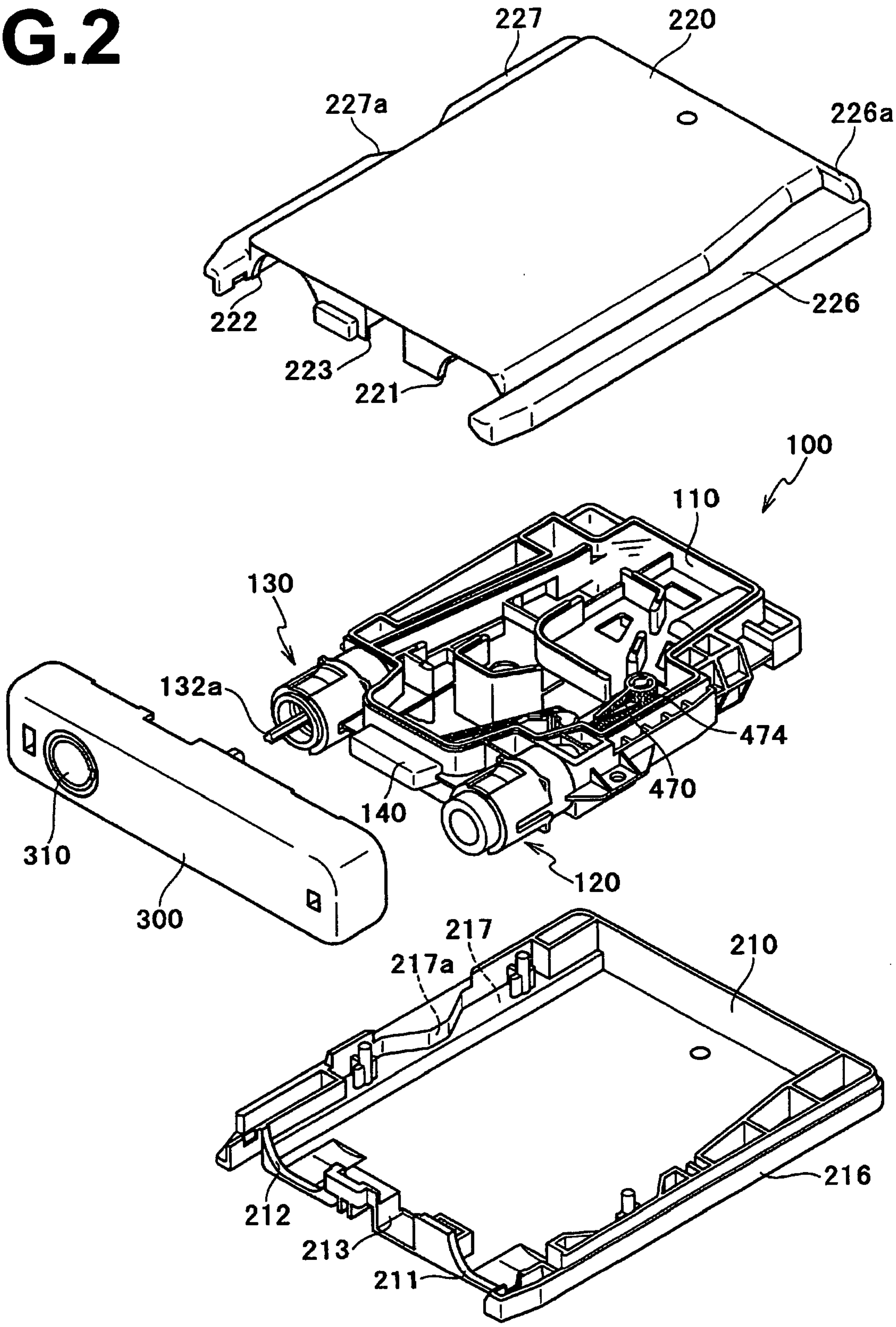
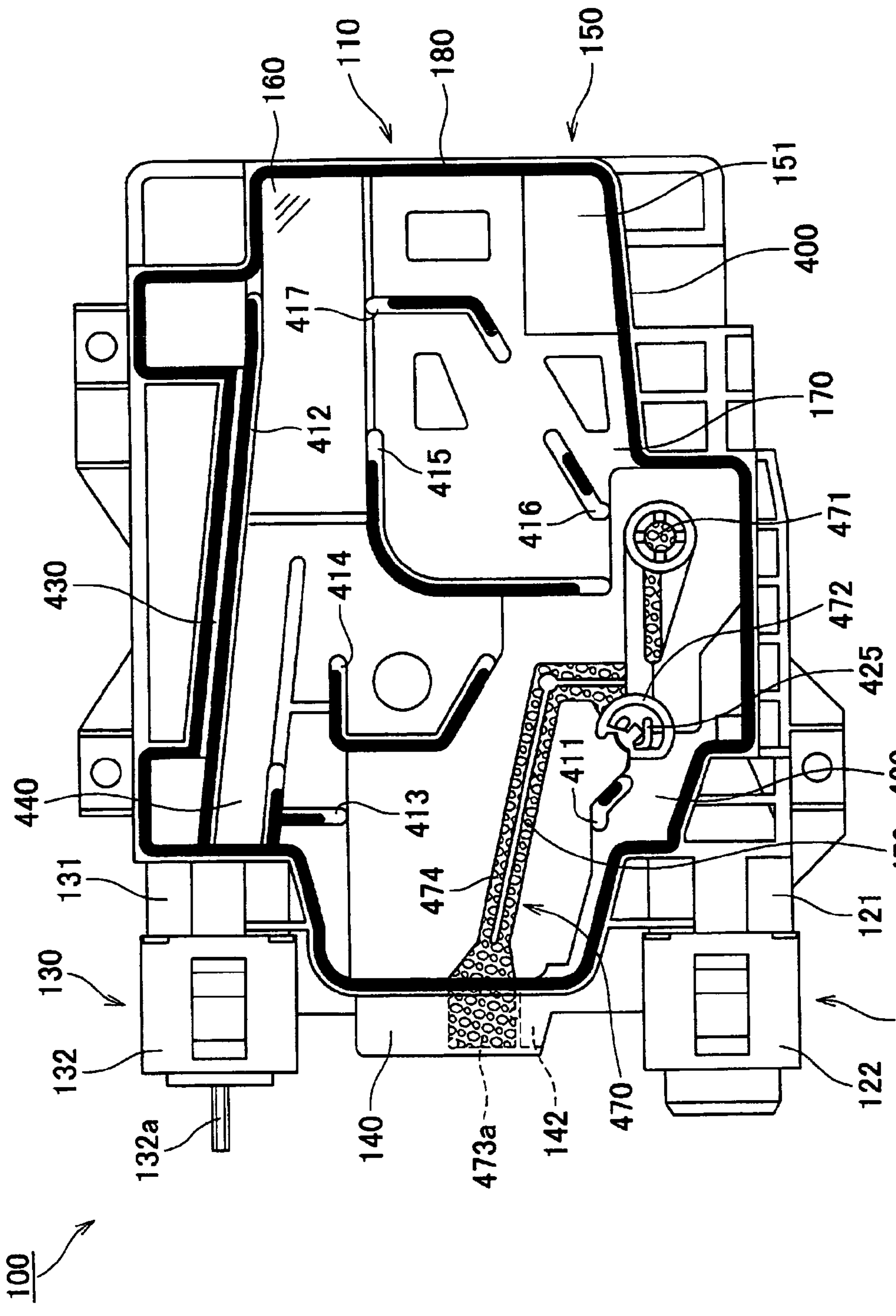

227
220
227a
226a
222
226
223
221
100
110
130
132a
474
140
470
310
120
300
217
210
217a
216
212
213
211

FIG.3


100
110
120
121
122
130
131
132
132a
140
142
150
151
160
170
180
400
411
412
413
414
415
416
417
420
425
430
440
470
471
472
473
473a
474

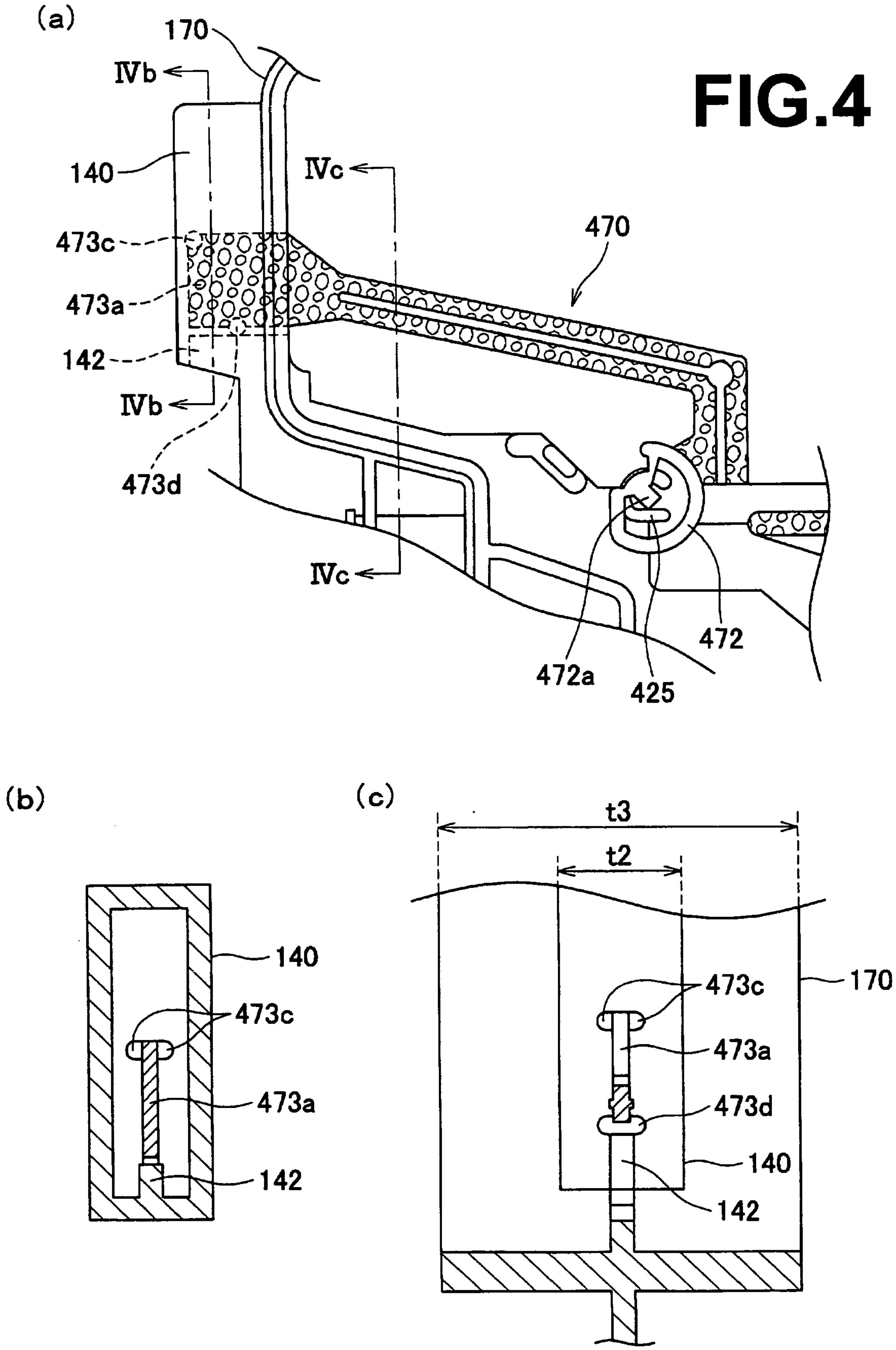

(a)
170
IVb
140
IVc
473c
473a
142
IVb
473d
470
IVc
472a
425
472
FIG.4
(b)
140
473c
473a
142
(c)
t3
t2
473c
170
473a
473d
140
142

FIG.5

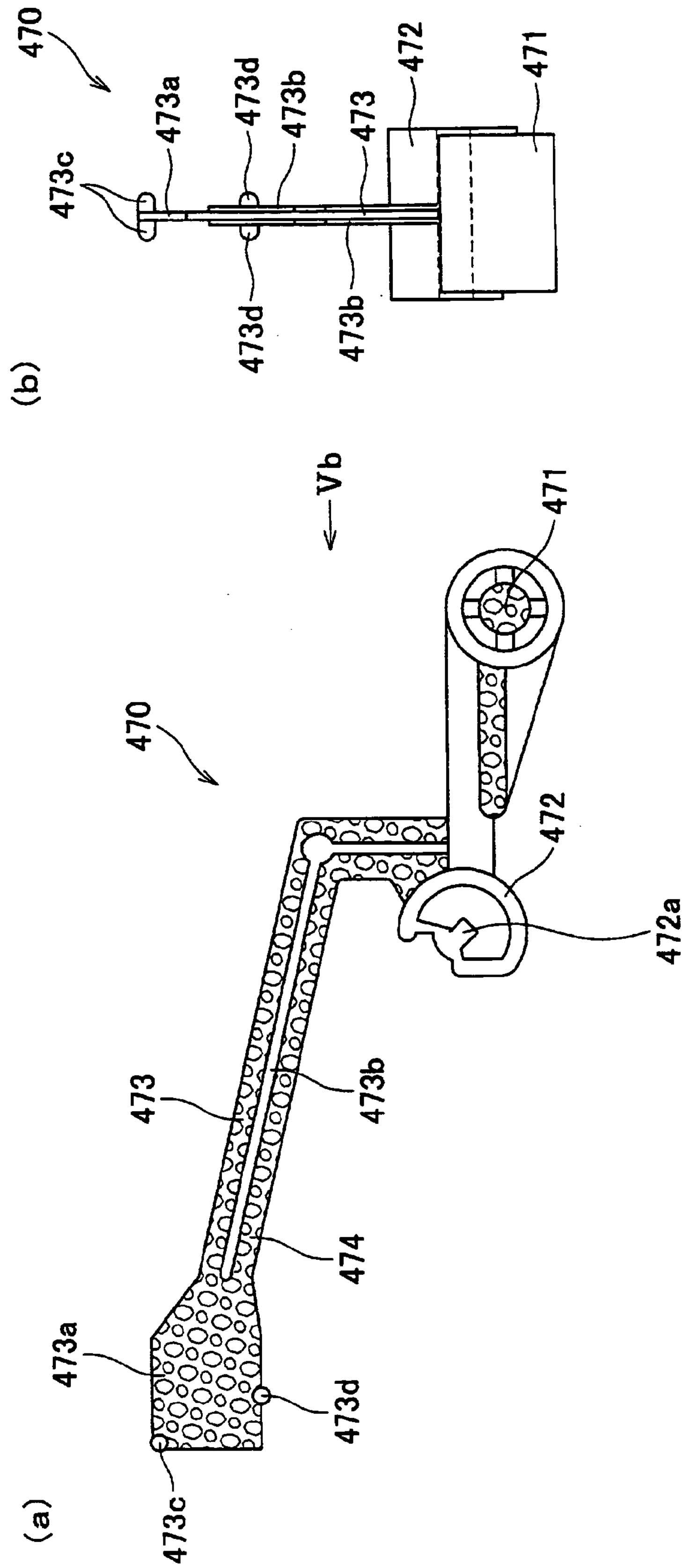
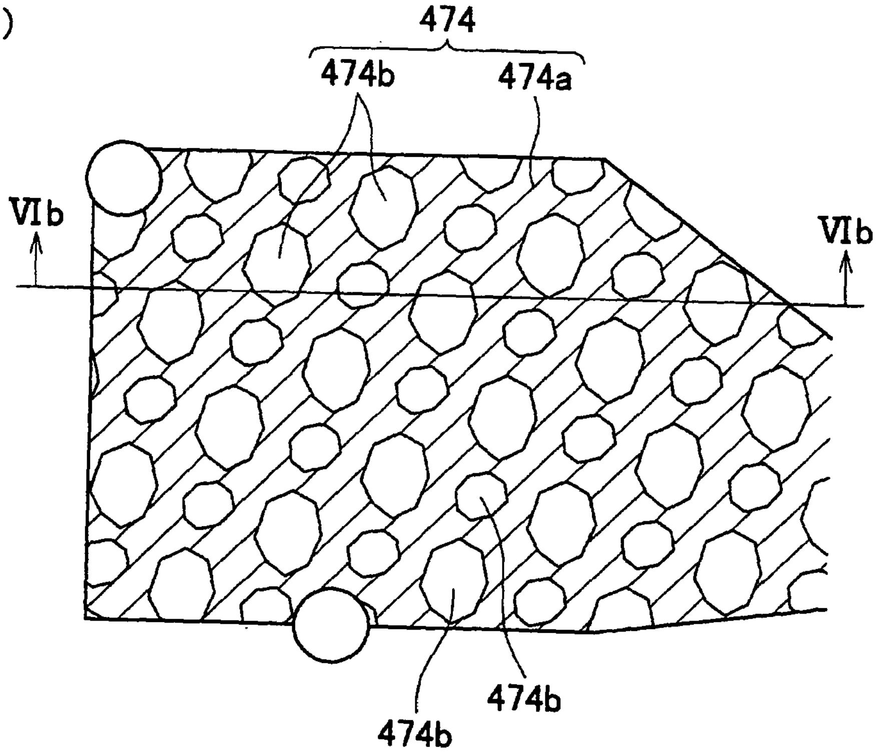
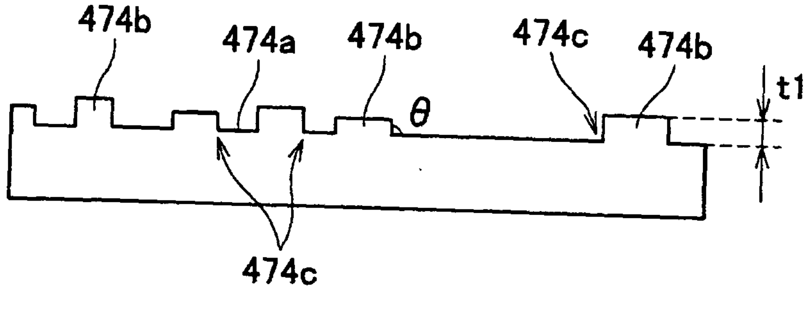


FIG.6

(a)


474
474b
474a
VIb
VIb
474b
474b

(b)


474b
474a
474b
474c
474b
θ
t1
474c

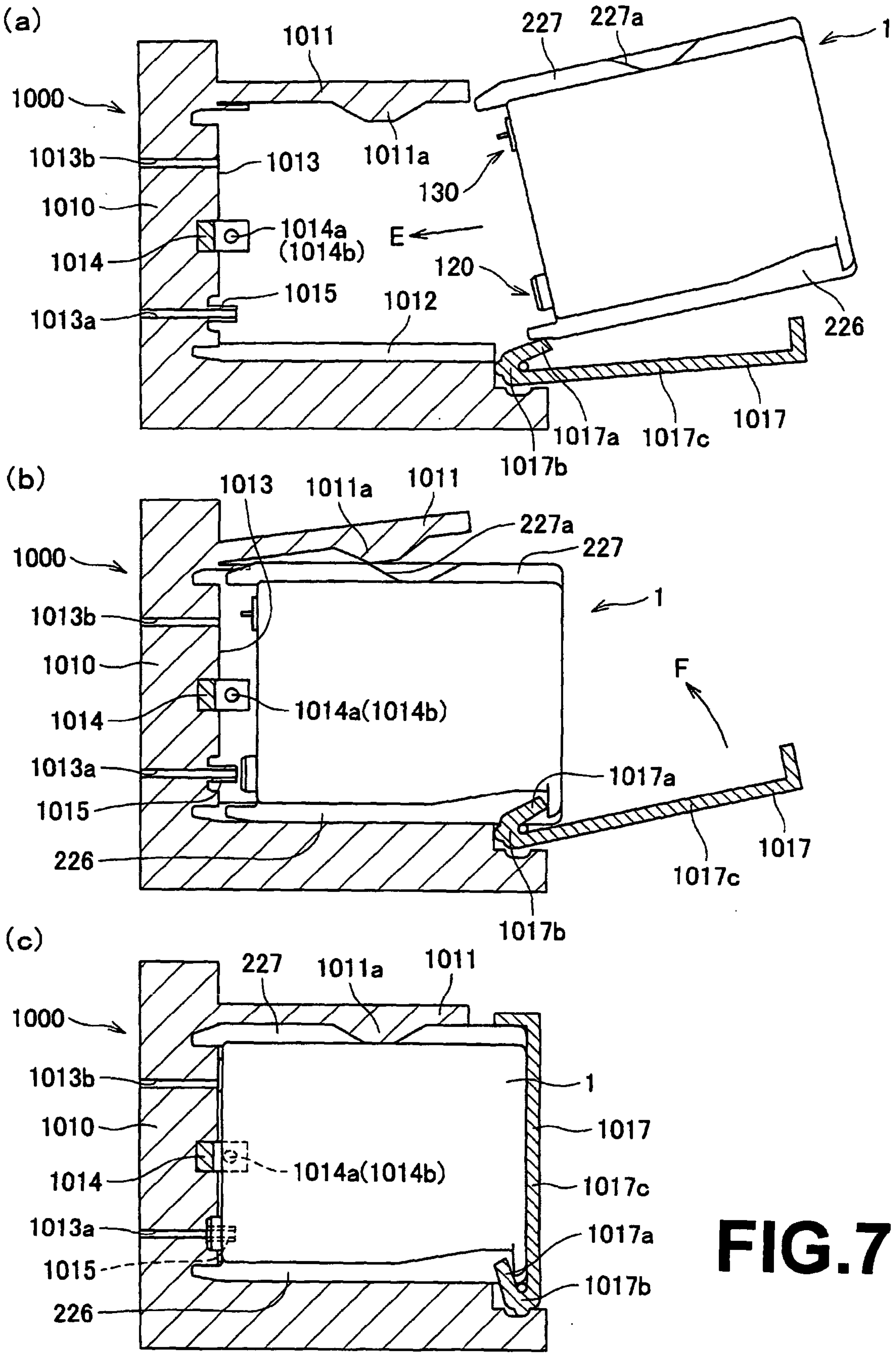

(a)
1000
1013b
1010
1014
1013a
1011
1013
1011a
1014a
(1014b)
1015
1012
E
227
227a
1
130
120
226
1017a
1017c
1017
1017b
(b)
1000
1013b
1010
1014
1013a
1015
226
1013
1011a
1011
227a
227
1
1014a(1014b)
F
1017a
1017
1017c
1017b
(c)
1000
1013b
1010
1014
1013a
1015
226
227
1011a
1011
1
1017
1014a(1014b)
1017c
1017a
1017b

FIG.7

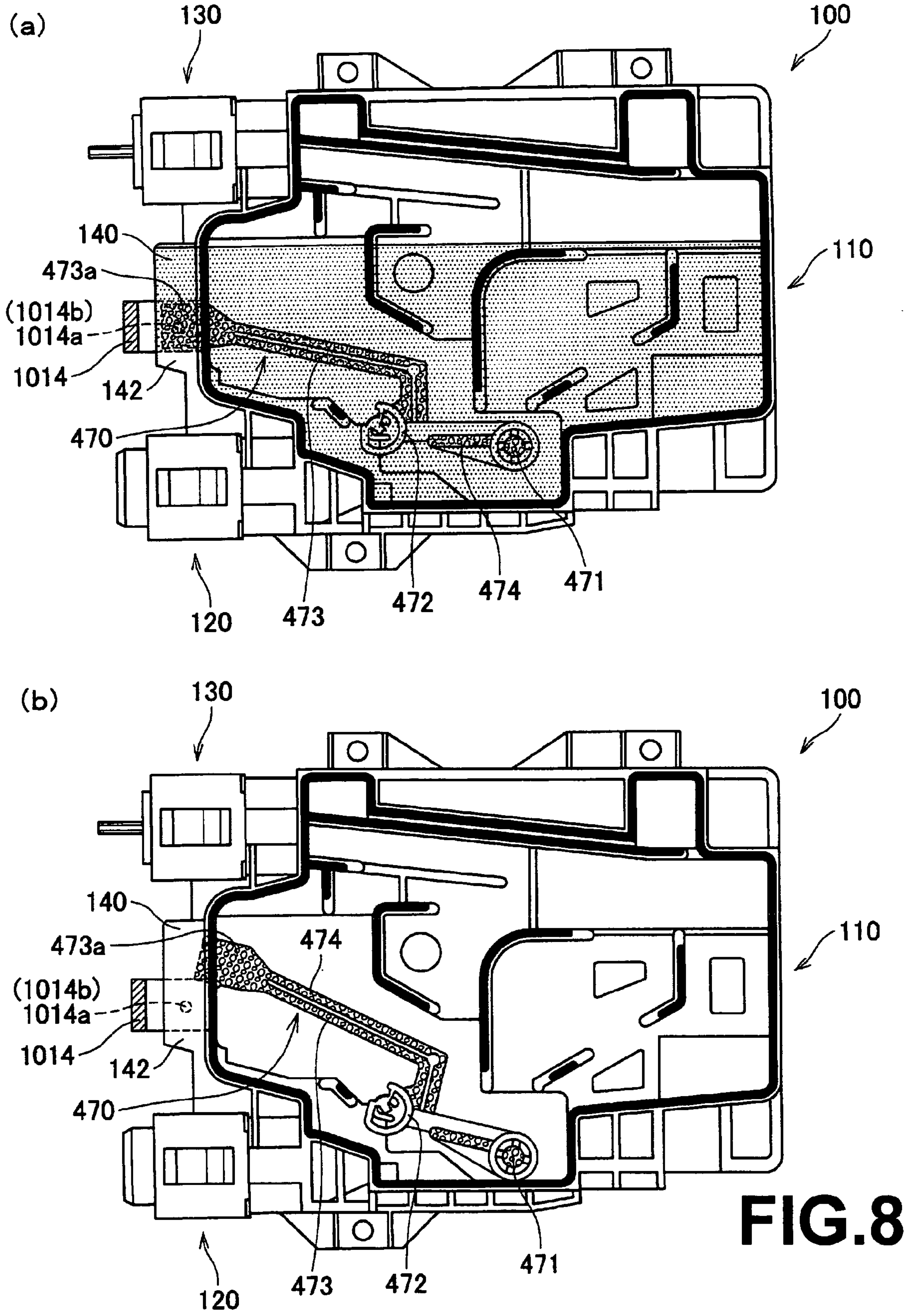
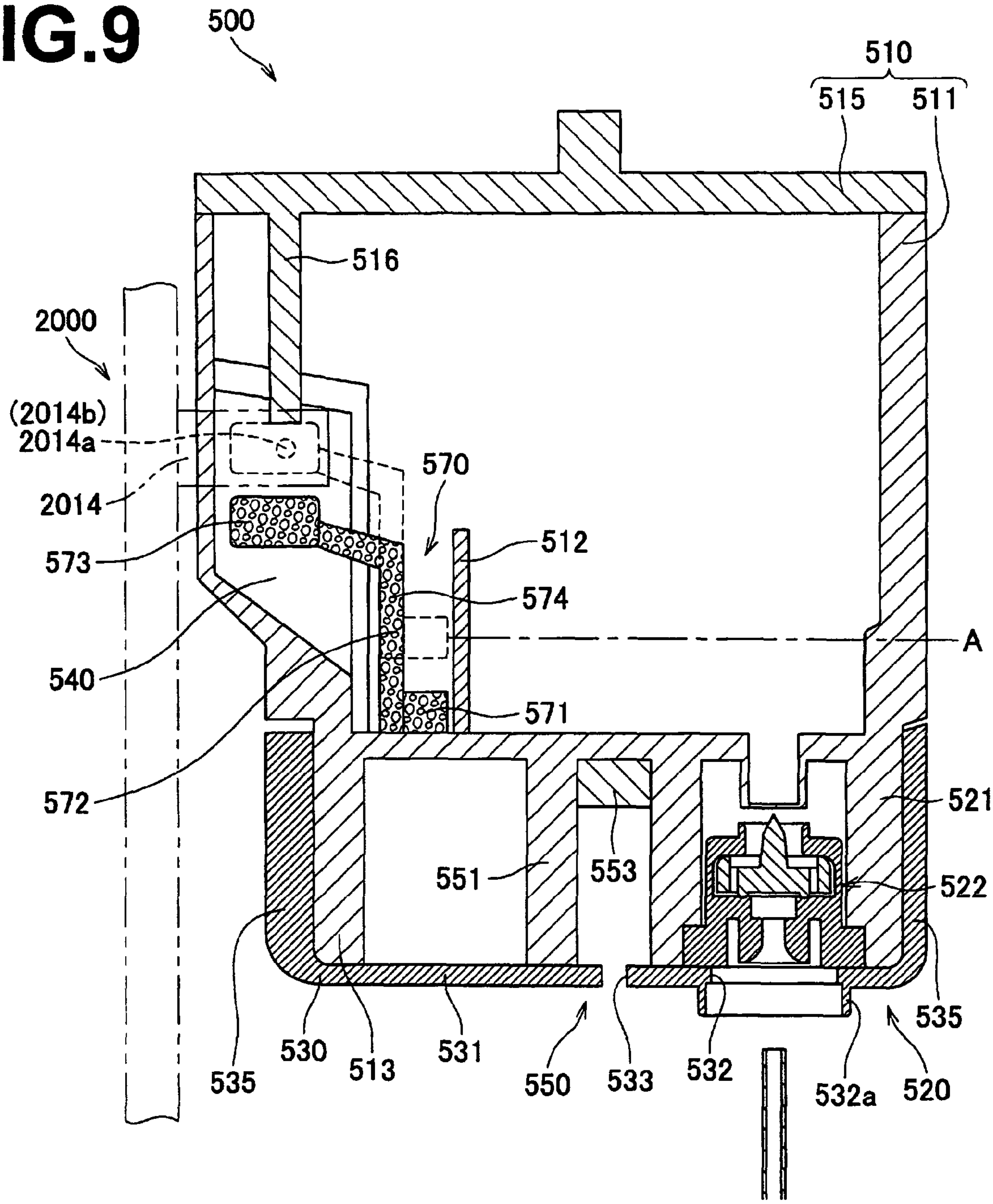

(a)
130
100
140
473a
(1014b)
1014a
1014
142
470
110
120
473
472
474
471
(b)
130
100
140
473a
474
(1014b)
1014a
1014
142
470
110
120
473
472
471

FIG.8

FIG.9


500
510
515
511
516
2000
(2014b)
2014a
2014
570
573
512
574
A
540
571
572
521
551
553
522
535
530
513
531
550
533
532
532a
520
535

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 2967

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 520 706 A (BROTHER KOGYO KABUSHIKI KAISHA) 6 April 2005 (2005-04-06) * abstract; figures * -----	1-10	INV. B41J2/175
X	EP 1 097 814 A (SEIKO EPSON CORPORATION) 9 May 2001 (2001-05-09) * paragraph [0053]; figure 12A * -----	1	
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			B41J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 September 2006	Urbaniec, Tomasz

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