



(51) International Patent Classification:
B41J 2/175 (2006.01)

(21) International Application Number:
PCT/JP2011/051681

(22) International Filing Date:
21 January 2011 (21.01.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2010-011801 22 January 2010 (22.01.2010) JP

(71) Applicant (for all designated States except US):
BROTHER KOGYO KABUSHIKI KAISHA [JP/JP];
15-1, Naeshiro-cho, Mizuho-ku, Nagoya-shi, Aichi,
4678561 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ITO, Noritsugu**
[JP/JP]; c/o Intellectual Property Dept., Brother Kogyo
Kabushiki Kaisha, 1-1-1, Kawagishi, Mizuho-ku,
Nagoya-shi, Aichi, 4678562 (JP). **HIRANO, Mikio**

[JP/JP]; c/o Intellectual Property Dept., Brother Kogyo
Kabushiki Kaisha, 1-1-1, Kawagishi, Mizuho-ku,
Nagoya-shi, Aichi, 4678562 (JP).

(74) Agents: **KOIZUMI, Shin** et al.; 6F, First Genesis Bldg.,
31-14, Yushima 2-chome, Bunkyo-ku, Tokyo, 1130034
(JP).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO,
NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE,
SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT,
TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,
ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,

[Continued on next page]

(54) Title: LIQUID CARTRIDGE

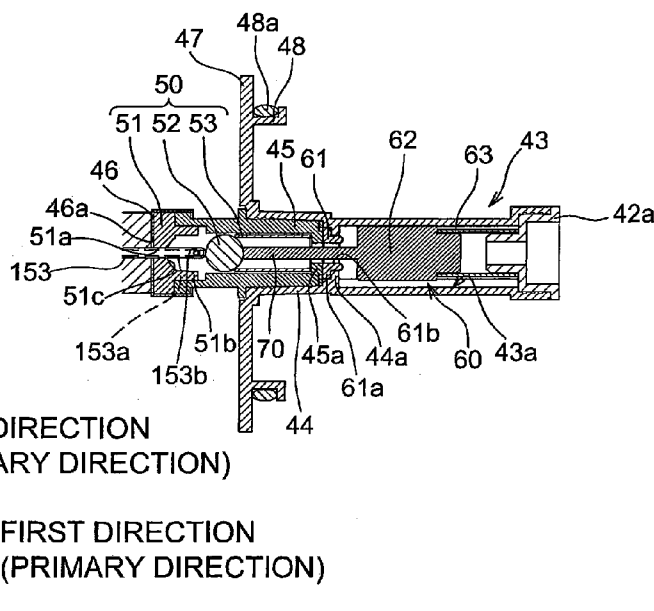


Fig.5B

(57) Abstract: A liquid cartridge includes a liquid storing portion, a liquid outlet path communicating with an interior of the liquid storing portion, a first valve configured to close an opening of the liquid outlet path, and a second valve provided in the liquid outlet path between the liquid storing portion and the first valve. The second valve includes a valve seat, a valve member configured to prevent liquid from flowing via the second valve when the valve member contacts the valve seat, and a biasing member configured to bias the valve member toward the valve seat and the sealing member.



TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, **Published:**

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,

GW, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

- 1 -

DESCRIPTION**LIQUID CARTRIDGE****Technical Field**

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

5 Background Art

[0002] A known ink cartridge, such as an ink cartridge described in JP-A-2005-238815, has an ink bag and a valve for selectively supplying ink stored in the ink bag to an outside of the ink cartridge. The valve has a spring, spring seat, and a lid. An ink supply needle (ink inlet tube) provided in an ink jet recording apparatus is inserted through the lid and contacts and moves the spring seat, such that that ink stored in the ink bag flows through the ink supply needle and is supplied to the ink jet recording apparatus.

[0003] However, the lid may be damaged by the ink supply needle, and ink may leak out of the ink cartridge via the lid when and/or after the ink supply needle is pulled out of the lid.

15 [0004] Another known ink cartridge, such as an ink cartridge described in US 7,249,831 B2, has a cylindrical ink outlet having a septum on its distal end. The septum has a slit for receiving a needle. A check valve comprising a ball and a spring are located in the ink outlet to prevent outflow of ink until the needle is inserted.

[0005] However, the septum may be damaged by the needle, and ink may leak out of the ink cartridge via the septum when and/or after the needle is pulled out of the septum.

20 [0006] Yet another known ink cartridge, such as an ink cartridge described in US 7,125,108 B2, has an ink supply port including a supply valve that is slidable by being pressed by an ink-supply needle to be opened, a sealing member provided to be fitted to surround the ink-supply needle, and a biasing member formed by a coil spring for pressing the supply valve toward the sealing member. The ink cartridge also has an ink-supply control means including a membrane valve and a spring, etc. for maintaining the pressure in the ink supply port to be a predetermined negative pressure so as to allow the ink to be supplied to a liquid ejection head.

25 [0007] However, the ink-supply control means is not suited for securely preventing ink leakage from the ink cartridge when the ink supply port is damaged.

30 Disclosure of the Invention

[0008] Therefore, a need has arisen for a liquid cartridge which overcomes these and other shortcomings of the related art. A technical advantage of the present invention is that

- 2 -

leakage of liquid is more securely reduced when a valve of a liquid cartridge is damaged.

[0009] According to an aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet path communicating with an interior of the liquid storing portion; a first valve comprising a sealing member configured to close an opening of the liquid outlet path and to contact an outer surface of a longitudinal object while being elastically deformed when the longitudinal object is inserted through the sealing member; and a second valve provided in the liquid outlet path between the liquid storing portion and the first valve, wherein the second valve comprises a valve seat; a valve member configured to prevent liquid from flowing via the second valve when the valve member contacts the valve seat; and a biasing member configured to bias the valve member toward the valve seat and the sealing member, wherein the first valve and the second valve are separate members.

[0010] With this configuration, when the longitudinal object, e.g., a hollow tube is inserted through the sealing member of the first valve, the hollow tube directly or indirectly presses the second valve member to move away from the valve seat, and the liquid stored in the liquid storing portion is allowed to flow into the hollow tube. Subsequently, when the hollow tube is pulled out of the sealing member of the first valve, the second valve member is in contact with the valve seat. Accordingly, even if the first valve is damaged, leakage of liquid is reduced when and after the hollow tube is pulled out of the first valve because the second valve member is in contact with the valve seat.

[0011] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet path communicating with an interior of the liquid storing portion; a first valve comprising a sealing member configured to close an opening of the liquid outlet path and to contact an outer surface of a longitudinal object while being elastically deformed when the longitudinal object is inserted through the sealing member; a second valve provided at the liquid outlet path between the liquid storing portion and the first valve, and configured to selectively be in an open state and a close state, wherein the second valve is configured to allow liquid to flow via the second valve when the second valve is in the open state, and the second valve is configured to prevent liquid from flowing via the second valve when the second valve is in the close state; an actuator configured to operate to switch the second valve between the open state and the close state, such that the second valve is in the open state when electric power is supplied to the actuator, and such that the second valve is in the

- 3 -

close state when electric power is not supplied to the actuator; and a contact configured to electrically connect between an external electric power supply and the actuator.

[0012] With this configuration, when connection between the contact and the external electric power supply is cut off, the electric power is not supplied to the actuator, and the second valve is in the close state. Accordingly, even if the first valve is damaged, leakage of liquid is reduced when and after the connection between the contact and the external electric power supply is cut off because the second valve is in the close state.

[0013] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet path communicating with an interior of the liquid storing portion; a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and a second valve provided at the liquid output path, comprising a valve seat positioned away from the first valve; and a valve member configured to close the second valve when the valve member contacts the valve seat, wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed..

[0014] With this configuration also, leakage of liquid is reduced.

[0015] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet path communicating with an interior of the liquid storing portion, the liquid outlet path comprising a first path portion having a first width and a second path portion having a second width greater than the first width, wherein the first path portion and the second path portion are contiguous; a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and a second valve provided at the liquid output path, comprising a valve seat provided at the liquid output path; and a valve member having a width that is greater than the first width and smaller than the second width, wherein the valve member is configured to be biased in a biasing direction toward the first valve when the second valve is closed, and wherein the valve member is configured to close the second valve when at least one contact surface of the valve member furthest in the biasing direction contacts the valve seat at a boundary between the first path portion and the second path portion, and the second width is defined at the boundary.

[0016] With this configuration also, leakage of liquid is reduced.

[0017] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid

- 4 -

outlet path communicating with an interior of the liquid storing portion, a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and a second valve provided at the liquid output path, comprising an integrally formed valve seat disposed between the first valve and the interior of the liquid storing portion; and a valve member configured to close the second valve when the valve member contacts the valve seat, wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed.

[0018] With this configuration also, leakage of liquid is reduced.

[0019] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet tube comprising at least one side wall; a liquid outlet path formed in the liquid outlet tube, partially defined by the at least one side wall, and communicating with an interior of the liquid storing portion; a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and a second valve provided at the liquid output path, comprising a valve seat that forms at least a portion of the at least one side wall; and a valve member configured to close the second valve when the valve member contacts the valve seat, wherein the valve member is configured to be biased against the valve seat toward the particular valve when the further valve is closed.

[0020] With this configuration also, leakage of liquid is reduced.

[0021] According to another aspect of the invention, there is provided a liquid cartridge comprising a liquid storing portion configured to store liquid therein; a liquid outlet path communicating with an interior of the liquid storing portion; a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and a second valve provided at the liquid output path, comprising a valve seat formed completely of an inelastic material; a valve member configured to close the second valve when the valve member contacts the valve seat, wherein the valve member is configured to be biased against the valve seat toward the particular valve when the second valve is closed.

[0022] Other objects, features, and advantages will be apparent to persons of ordinary skill in the art from the following detailed description of the invention and the accompanying drawings.

Brief Description of Drawings

[0018] For a more complete understanding of the present invention, needs satisfied thereby, and the objects, features, and advantages thereof, reference now is made to the

following description taken in connection with the accompanying drawings.

[0019] Fig. 1 is a perspective view of an ink jet printer comprising an ink cartridge according to a first embodiment of the present invention.

[0020] Fig. 2 is a schematic side view of the internal structure of the ink jet printer of Fig. 1.

[0021] Fig. 3 is a perspective view of an ink cartridge according to the first embodiment of the present invention.

[0022] Fig. 4 is a top view of the internal structure of the ink cartridge of Fig. 3.

[0023] Figs. 5A and 5B are partial horizontal cross-sectional views of the ink cartridge of Fig. 3, in which each of a first valve and a second valve is in a close state in Fig. 5A, and each the first valve and the second valve is in an open state in Fig. 5B.

[0024] Figs. 6A and 6B are partial horizontal cross-sectional views of a mounting portion and top views of the ink cartridge of Fig. 3, in which the ink cartridge is not yet mounted in the mounting portion in Fig. 6A, and the ink cartridge is mounted in the mounting portion in Fig. 6B.

[0025] Figs. 7A-7E are schematic diagrams illustrating timings at which the first and second valves become the open and close states.

[0026] Figs. 8A-8B are schematic diagrams illustrating timing at which first and second valves become open and close states in an ink cartridge according to a first modified embodiment of the present invention.

[0027] Figs. 9A and 9B are partial horizontal cross-sectional views of an ink cartridge according to a second modified embodiment of the present invention, in which each of a first valve and a second valve is in a close state in Fig. 9A, and each the first valve and the second valve is in an open state in Fig. 9B.

[0028] Figs. 10A and 10B are partial horizontal cross-sectional views of an ink cartridge according to a third modified embodiment of the present invention, in which each of a first valve and a second valve is in a close state in Fig. 10A, and each the first valve and the second valve is in an open state in Fig. 10B.

[0029] Figs. 11A and 11B are partial horizontal cross-sectional views of an ink cartridge according to a fourth modified embodiment of the present invention, in which each of a first valve and a second valve is in a close state in Fig. 11A, and each the first valve and the second valve is in an open state in Fig. 11B.

[0030] Fig. 12 is a perspective view of an ink cartridge according to a second

embodiment of the present invention.

[0031] Fig. 13 is a top view of the internal structure of the ink cartridge of Fig. 12.

[0032] Fig. 14 is a partial horizontal cross-sectional view of the ink cartridge of Fig. 12.

5 [0033] Fig. 15 is a perspective view of a second valve of the ink cartridge of Fig. 12.

[0034] Figs. 16A and 16B are vertical cross-sectional views of the second valve of Fig. 15 and an actuator, in which a path in an ink outlet tube is opened in Fig. 16A, and the path is closed in Fig. 16B.

10 [0035] Figs. 17A and 17B are partial horizontal cross-sectional views of a mounting portion and top views of the ink cartridge of Fig. 12, in which the ink cartridge is not yet mounted in the mounting portion in Fig. 17A, and the ink cartridge is mounted in the mounting portion in Fig. 17B.

[0036] Fig. 18 is a perspective view of an ink cartridge according to a third embodiment of the present invention.

15 [0037] Fig. 19 is a top view of the internal structure of the ink cartridge of Fig. 18.

[0038] Fig. 20 is a partial horizontal cross-sectional view of the ink cartridge of Fig. 18.

20 [0039] Figs. 21A and 21B are partial horizontal cross-sectional views of the ink cartridge of Fig. 18, in which a first valve is in an open state and a second valve is in a close state in Fig. 21A, and each the first valve and the second valve is in an open state in Fig. 21B.

Best Mode for Carrying Out the Invention

25 [0040] Embodiments of the present invention, and their features and advantages, may be understood by referring to Figs 1-21B, like numerals being used for like corresponding parts in the various drawings.

30 [0041] Referring to Fig. 1, an ink jet printer 1 comprising an ink cartridge 40 according to a first embodiment of the present invention comprises a housing 1a having substantially a rectangular parallelepiped shape. The housing 1a has three openings 10d, 10b, and 10c formed in one of its vertically extending outer faces. The openings 10d, 10b, and 10c are vertically aligned in this order from above. The ink jet printer 1 comprises doors 1d and 1c fitted into the openings 10d and 10c, respectively, and each of the doors 1d and 1c is configured to pivot about a horizontal axis at its lower end. When the doors 1d and 1c are pivoted to be opened and closed, the openings 10d and 10c are covered and

- 7 -

uncovered, respectively. The ink jet printer 1 comprises a sheet feed unit 1b inserted into the opening 10b. A sheet discharge portion 31 is provided at the top of the housing 1a. The door 1d is disposed facing a transporting unit 21 (See Fig. 2) in a primary direction.

[0042] Referring to Fig. 2, the interior of the housing 1a of the ink jet printer 1 is divided into three spaces A, B, and C in the vertical direction in this order from above. Four ink jet heads 2 and the transporting unit 21 are disposed in the space A, and the four ink jet heads 2 are configured to discharge inks of magenta, cyan, yellow, and black, respectively. The sheet feed unit 1b is disposed in the space B. Four ink cartridges 40 are disposed in the space C.

[0043] The sheet feed unit 1b and four ink cartridges 40 are configured to be mounted to and removed from the housing 1a in the primary direction. In this embodiment, a secondary direction is parallel with a direction in which the transporting unit 21 transports sheets P. The primary direction is a direction perpendicular to the secondary direction. Each of the primary direction and the secondary direction is a horizontal direction. The ink jet printer 1 comprises a controller 100 configured to control the sheet feed unit 1b, transporting unit 21, and ink jet heads 2.

[0044] A sheet transport path along which sheets P are transported is formed in the ink jet printer 1, extending from the sheet feed unit 1b toward the sheet discharge portion 31, as shown by the bold arrows in Fig. 2. The sheet feed unit 1b comprises a sheet feed tray 23 and a sheet feed roller 25 attached to the sheet feed tray 23 configured to store multiple sheets P. The sheet feed roller 25 is configured to feed out the topmost sheet P in the sheet feed tray 23 by being driven by a sheet feed motor (not shown) that is controlled by the controller 100. The Sheet P fed out from the sheet feed roller 25 is sent to the transporting unit 21 being guided by guides 27a and 27b and being nipped by a feed roller pair 26.

[0045] Referring to Fig. 2, the transporting unit 21 comprises two belt rollers 6 and 7, and an endless transport belt 8 wound around the belt rollers 6 and 7. The belt roller 7 is a driving roller configured to rotate in the clockwise direction in Fig. 2 when a shaft thereof is driven by a transport motor (not shown) controlled by the controller 100. The belt roller 6 is a driven roller configured to rotate in the clockwise direction in Fig. 2 along with the running of the transport belt 8 caused by the rotation of the belt roller 7.

[0046] An outer surface 8a of the transport belt 8 has been subjected to silicone processing, so as to have adhesive properties. A nip roller 4 is disposed above the belt roller 6 sandwiching the transport belt 8 therebetween on the sheet transport path. The nip roller 4

is configured to press the sheet P fed out from the sheet feed unit 1b against the outer surface 8a of the transport belt 8. The sheet pressed against the outer surface 8a is held on the outer surface 8a by the adhesive properties thereof, and is transported toward the right side in Fig. 2.

5 [0047] A separating plate 5 is disposed above the belt roller 7 sandwiching the transport belt 8 on the sheet transport path. The separating plate 5 is configured to separate the sheet P, held on the outer surface 8a of the transport belt 8, from the outer surface 8a. The sheet P that has been separated is transported being guided by guides 29a and 29b and nipped by two feed roller pairs 28, and is discharged to the discharge portion 31 from an opening 30 formed through the housing 1a. One roller of each feed roller pair 28 is driven
10 by a feed motor (not shown) controlled by the controller 100.

[0048] Each of the four ink jet heads 2 extends in the primary direction, and the four ink jet heads 2 are arrayed in the secondary direction. The four ink jet heads 3 are supported by the housing 1a by way of a frame 3. The dimension of each ink jet head 2 in the primary
15 direction is greater than the dimension of the sheet P in the primary direction. The ink jet printer 1 is a so-called line printer. The bottom surface of each ink jet head 2 has a discharge surface 2a, where multiple discharge nozzles (not shown) for discharging ink are formed. Each ink jet head 2 is connected with a flexible tube (not shown), such that the interior of the ink jet head 2 is in fluid communication with the inner path of the flexible
20 tube. Each flexible tube is connected to a mounting portion 150, such that the inner path of the flexible tube is in fluid communication with an ink supply path 154 formed in the mounting portion 150 (see Figs. 6A and 6B).

[0049] A platen 19 having substantially a rectangular parallelepiped shape is disposed within the loop of the transport belt 8. The platen 19 overlaps with the four ink jet
25 heads 2 in the vertical direction. The upper surface of the platen 19 is in contact with the inner surface of the transport belt 8 at an upper portion of the loop of the transport belt 8, and supports the transport belt 8 from the inside. Accordingly, the outer surface 8a of the transport belt 8 at the upper portion of the loop thereof faces the discharge surfaces 2a of the ink jet heads 2, and extends in parallel with the discharge surfaces 2a with a slight gap
30 formed between the discharge surfaces 2a and the outer surface 8a. The sheet transport path extends through this gap. When the sheet P held on the outer surface 8a of the transport belt 8 passes immediately below the four ink jet heads 2, ink of each color is discharged toward the upper surface of the sheet P from a corresponding one of the ink jet heads 2 under

control of the controller 100, thereby forming a desired color image on the sheet P.

[0050] Of the four ink cartridges 40, the ink cartridge 40 at the leftmost position in Fig. 2 stores black ink, and has a greater size in the secondary direction as compared to the other three ink cartridges 40. The ink cartridge 40 at the leftmost position has a greater ink capacity than the other three ink cartridges 40. The other three ink cartridges 40 have the same ink capacity, and stores magenta, cyan, and yellow inks, respectively. When the four ink cartridges 40 are mounted in the housing 1a, the interior of an ink bag 42 (described later) of each ink cartridge 40 is in fluid communication with the ink supply path 154 which is in fluid communication with the interior of a corresponding one of the ink jet heads 2, such that the ink stored in the ink bag 42 can be supplied to the ink jet head 2.

[0051] When the ink cartridge 40 is intended to be replaced, the door 1c is opened and the ink cartridge 40 is removed from the housing 1a via the opening 10c, and a new ink cartridge 40 is mounted in to the housing 1a via the opening 10c. In this embodiment, the ink cartridges 40 are configured to be individually mounted into the housing 1a, but in another embodiment, the four ink cartridges 40 may be loaded on a single cartridge tray to form an integral unit, and the unit may be mounted into the housing 1a.

[0052] Referring to Figs. 3 to 5B, an ink cartridge 40 comprises a housing 41 having substantially a rectangular parallelepiped shape, the ink bag 42, as an example of an ink storing portion, disposed within the housing 41, an ink outlet tube 43 connected to the ink bag 42 at one end, a first valve 50, and a second valve 60. The ink bag 42 is configured to store ink therein.

[0053] The dimension of the housing 41a in a first direction is greater than the dimension of the housing 41 in a second direction, and the dimension of the housing 41 in the second direction is greater than the dimension of the housing in a third direction. The first direction, the second direction, and the third direction are perpendicular to each other. When the ink cartridge 40 is mounted in the mounting portion 150, the first direction is aligned with the primary direction, the second direction is aligned with the secondary direction, and the third direction is aligned with the vertical direction.

[0054] The interior of the housing 41 is divided into two chambers 41a and 41b in the first direction, with the ink bag 42 being disposed in the chamber 41a which is larger than the chamber 41b. The ink outlet tube 43 is disposed in the chamber 41b. As described above, the ink cartridge 40 for storing black ink is greater in size and ink capacity than the other three ink cartridges 40, but the difference is that the chamber 41a and ink bag 42 of the

- 10 -

ink cartridge 40 for storing black ink are merely greater than those of the other three ink cartridges 40 in the second direction. Therefore, the four ink cartridges 40 have almost the same structure, so description will be made regarding just one ink cartridge 40.

[0055] The ink bag 42 is connected to a connecting portion 42a, such that ink stored in the ink bag 42 can be supplied to the outside of the ink bag 42 through the connecting portion 42. The ink outlet tube 43 has a tube 44, e.g., a cylindrical tube 44, connected to a connecting portion 42a at a first end thereof, and a tube 45, e.g., a cylindrical tube 45, fitted into a second end (the left end in Figs. 5A and 5B) of the tube 44. The ink outlet tube 43 has an ink outlet path 43a formed therein. More specifically, a first end of the tube 45 is fitted into the tube 44, but a second end of the tube 45 is positioned outside of the tube 44. The ink outlet tube 43, i.e., the tubes 44 and 45, extends in the first direction, and therefore the ink outlet path 43a defined by the ink outlet tube 43 extends in the first direction. The ink outlet path 43a is configured to be in fluid communication with the interior of the ink bag 42 via the connecting portion 42a at a first end thereof, and to be in fluid communication with the outside of the ink cartridge 40 at a second end thereof.

[0056] A ring-shaped flange 47 is provided at the second end of the tube 44 opposite the first end of the tube 44 connected to the connecting portion 42a. The flange 47 extends from an outer surface of the second end of the tube 44 in radial directions of the tube 44. A ring-shaped protrusion 48 extends from the flange 47 toward the ink bag 42 in the first direction. An O-ring 48a is fitted around the protrusion 48. The flange 47 is one of walls defining the chamber 41b, and is a portion of the housing 41. Another portion of the housing 41 is connected to the flange 47, sandwiching the O-ring 48a with the protrusion 48. Therefore, O-ring 48a reduces chances that ink may leak around the flange 47.

[0057] The first valve 50 is disposed at the ink outlet path 43a defined by the tube 45 of the ink outlet tube 43. The first valve 50 comprises a sealing member 51 which is an elastic member positioned in the ink outlet path 43a and contacting the inner surface of the tube 45 to close an opening of the ink outlet path 43a formed at the second end of the ink outlet path 43a. The first valve 50 comprises a spherical member 52, as a first valve member, disposed in the ink outlet path 43a defined by the tube 45, and a coil spring 53, as a first biasing member, disposed in the ink outlet path 43a defined by the tube 45. Each of the diameter of the spherical member 52 and the diameter of the coil spring 53 is less than the diameter of the ink outlet path 43a defined by the tube 45. A lid 46 is attached to the second end of the tube 45, such that the sealing member 51 does not come loose from the tube 45.

An ink discharge opening 46a is formed through the lid 46.

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

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

[0060] The inner diameter of the ring-shaped protrusion 51b is slightly less than the diameter of the spherical member 52. The fluid communication between the ink outlet path 43a and the outside of the ink cartridge 40 via the opening 51a is prevented when the spherical member 52 contacts the ring-shaped protrusion 51b. The fluid communication between the ink outlet path 43a and the outside of the ink cartridge 40 via the opening 51a is also prevented when the spherical member 52 contacts the curved portion 51c. In other words, the first valve 50 is configured to prevent ink in the ink outlet path 43a from flowing via the first valve 50 when the spherical member 52 contacts the ring-shaped protrusion 51b and/or the curved portion 51c. Moreover, forming the opening 51a in the sealing member 51 allows for easier insertion of the hollow tube 153 through the sealing member 51. Additionally, a situation can be avoided wherein the sealing member 51 is shaved off by the hollow tube 153 when the hollow tube 153 is inserted into or pulled out of the sealing member 51, and debris intrudes into an inner space 153a of the hollow tube 153. Risks can

- 12 -

be reduced that such debris shaved off from the sealing member 51 intrude into the interior of the ink jet head 2.

[0061] Referring to Fig. 5B, when the hollow tube 153 is inserted into the opening 51a via the ink discharge opening 46a, the tip of the hollow tube 153 comes into contact with the spherical member 52 and the spherical member 52 moves so as to be separated from the curved portion 51c and the ring-shaped protrusion 51b. When this occurs, the state of the first valve 50 changes from a close state, in which the first valve 50 prevents ink in the ink outlet path 43a from flowing via the first valve 50, to an open state, in which the first valve 50 allows ink in the ink outlet path 43a to flow via the first valve 50. The hollow tube 153 has an opening 153b formed therethrough, and the inner space 153a of the hollow tube 153 communicates with the outside of the hollow tube 153 via the opening 153b. When the first valve 50 is in the open state, the opening 153b of the hollow tube 153 has passed through the opening 51a, so the inner space 153a of the hollow tube 153 and the ink outlet path 43a communicate with each other via the opening 153b. When the hollow tube 153 moves to be pulled out of the opening 51a, the spherical member 52 moves toward the ring-shaped protrusion 51b due to the biasing of the coil spring 53. When the spherical member 52 comes into contact with the ring-shaped protrusion 51b, the state of the first valve 50 changes from the open state to the close state. When the hollow tube 153 further moves to be pulled out of the opening 51a, the spherical member 52 comes into close contact with the curved portion 51c. Accordingly, the first valve 50 is configured to selectively be in the open state and the close state in accordance with insertion and removal of the hollow tube 153. Because the first valve 50 comprises the coil spring 53 biasing the spherical member 52 toward the sealing member 51, and the structure of the first valve 50 is simplified and leakage of ink from the first valve 50 can be prevented.

[0062] Referring to Figs. 5A and 5B, the second valve 60 is provided at the ink outlet path 43a between the ink bag 42 and the first valve 50. The second valve 60 comprises a valve seat 61, a valve member 62, as a second valve member, and a coil spring 63, as a second biasing member, disposed in the ink outlet path 43a. The tube 44 comprises a ring-shaped protrusion 44a protruding from the inner surface of the tube 44 into the ink outlet path 43a at a middle portion of the tube 44 in the first direction. The valve seat 61 is made of an elastic material such as rubber or the like, and comprises a flange 61a sandwiched between the ring-shaped protrusion 44a of the tube 44 and the platform portion 45a of the tube 45. In another embodiment, the valve seat 61 may be made of a completely inelastic

material. In still another embodiment, the valve seat 61 may be omitted, and the tube 44 may be made of a completely inelastic material. In such an embodiment, the valve member 62 may be configured to prevent ink in the ink outlet path 43a from flowing through the second valve 60 when the valve member 62 contacts the ring-shaped protrusion 44a of the tube 44. The valve seat 61 has an opening 61b formed therethrough, and the opening 61b extends in the first direction at the middle of the valve seat 61, such that the interior of the tube 44 and the interior of the tube 45 communicate with each other to form the ink outlet path 43a. More specifically, the interior of the tube 44, and the interior of the tube 45, and the opening 61b of the valve seat 61 forms the ink outlet path 43a. In other words, the valve seat 61, which has the opening 61b, forms at least a portion of at least one side wall defining the ink outlet path 43a. In the illustrated embodiments, a cross-section of the valve seat 61 has substantially a L-shape. Nevertheless, in another embodiment, the cross-section of the valve seat 61 may have other shapes. In addition, in the illustrated embodiments, the valve seat 61 is formed within the tube 44. Nevertheless, in another embodiment, the valve seat 61 may be integrally formed with one or both of the tube 44 and the tube 45. The valve member 62 and the coil spring 63 is disposed in the ink outlet path 43a defined by the tube 44, and each of the diameter of the valve member 62 and the diameter of the coil spring 63 is less than the diameter of the ink outlet path 43a defined by the tube 44.

[0063] One end of the coil spring 63 is in contact with the valve member 62 and the other end of the coil spring 63 is in contact with the connecting portion 42a. The coil spring 63 is configured to constantly bias the valve member 62 toward the valve seat 61 and the sealing member 51. The valve member 62 is configured to prevent ink in the ink outlet path 43a from flowing via the second valve 60 when the valve member 62 contacts a portion of the valve seat 61 surrounding the opening 61b, such that the portion of the valve seat 61 is elastically deformed by the biasing force of the coil spring 63. When this occurs, the valve member 62 is in a close state, and the fluid communication between the interior of the tube 44 and the interior of the tube 45 is prevented. A position at which the valve member 62 contacts the valve seat 61 defines a boundary between a first path portion, which extends from the outside of the ink cartridge 40 to the boundary, and a second path portion, which extends from the boundary to the interior of the ink bag 42. Because the coil spring 63 is configured to bias the valve member 62 toward the sealing member 51, and because the first and second valves 50 and 60, i.e., the sealing member 51, the spherical member 52, the coil

spring 53, the valve seat 61, the valve member 62, and the coil spring 63, are aligned on a single straight line in the first direction, the first and second valves 50 and 60 can be opened and closed when the hollow tube 153 is inserted into and pulled out of the sealing member 51 in the first direction/primary direction. The second valve 60 can be made with a simple structure, reducing opening/closing failure of the second valve 60. In this embodiment, the coil spring 63 is used as a biasing member, but a biasing member other than a coil spring may be used as long as the valve member 62 can be biased toward the valve seat 61.

[0064] The valve member 62 has a cylindrical shape, and is configured to slide on the inner surface of the tube 44. A first end of the valve member 62 facing the connecting portion 42a has a protruding shape protruding in the first direction at the middle thereof. The coil spring 63 is fitted around the protruding portion of the valve member 62. The valve member 62 has a width in a direction perpendicular to the first direction. The width of the valve member 62 is greater than a first width of the first path portion, e.g., an interior width of at least a portion of tube 45 as shown in Figs. 5A and 5B. Moreover, the width of the valve member 62 is less than a second width of the second path portion, e.g., an interior width of the tube 44, so that ink may flow through the tube 44 when the valve member 62 is separated from the valve seat 61. The width of valve member 62 is defined as the average width. In another embodiment, the width of the valve member 62 is defined as the width of the portion that contacts the valve seat 61. Moreover, the second width of the second path portion is defined as the average width, but in another embodiment, the second width of the second path portion is defined at the boundary between the first path portion and the second path portion.

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

- 15 -

[0066] Referring to Fig. 5B, after the hollow tube 153 is inserted through the sealing member 51 and the first valve 50 becomes the open state, the spherical member 52 comes into contact with the tip of the pressing member 70. When the hollow tube 153 is further inserted, the pressing member 70 and valve member 62 move, and the valve member 62 moves away from the valve seat 61 when the hollow tube 153 is inserted through the sealing member 51 up to a predetermined amount of distance. Accordingly, the state of the second valve 60 changes from the close state to an open state in which the second valve 60 allows ink in the ink outlet path 43a to flow via the second valve 60. When this occurs, the interior of the tube 44 and the interior of the tube 45 of the ink outlet path 43a are brought into fluid communication, such that ink stored in the ink bag 42 flows into the inner space 153a of the hollow tube 153. When the hollow tube 153 is pulled out of the sealing member 51, the valve member 62 and pressing member 70 move due to the biasing of the coil spring 63 toward the valve seat 61, and the valve member 62 comes into close contact with the valve seat 61. Accordingly, the state of the second valve 60 changes from the open state to the close state. Thus, the second valve 60 also is configured to selectively be in the open state, in which the second valve 60 allows ink in the ink outlet path 43a to flow via the second valve 60, and the close state, in which the second valve 60 prevents ink in the ink outlet path 43a from flowing via the second valve 60.

[0067] Referring to Figs. 6A and 6B, the ink jet printer 1 comprises four mounting portions 150 arrayed in the secondary direction, to which the four ink cartridges 40 are mounted, respectively. Because the mounting portions 150 have substantially the same structure, one mounting portion 150 will be described.

[0068] The mounting portion 150 has a recess 151 formed therein having a shape corresponding to the outer shape of the ink cartridge 40. The hollow tube 153 is provided at a base portion 151a defining an end of the recess 151 in the secondary direction. The ink supply path 154 is formed in the base portion 151a and in fluid communication with the inner path of the flexible tube connected to the ink jet head 2.

[0069] The hollow tube 153 extends in the primary direction, and is disposed at a position corresponding to the opening 51a when the ink cartridge 40 is mounted to the mounting portion 150. The hollow tube 153 has the inner space 153a formed therein, which is in fluid communication with the ink supply path 154, and also has the opening 153b formed therethrough near the tip thereof to allow the inner space 153a to communicate with the outside of the hollow tube 53 (See Figs. 5A and 5B). When the ink cartridge 40 is mounted

- 16 -

to mounting portion 150 and the hollow tube 153 is inserted into the sealing member 51, such that the opening 153b enters the ink outlet path 43a defined by the tube 45 past the opening 51a, the inner space 153a of the hollow tube 153 and the ink outlet path 43a are brought into fluid communicating via the opening 153b. When the ink cartridge 40 is removed from the mounting portion 150 and the hollow tube 153 is pulled out of the sealing member 51, such that the opening 153b enters the opening 51a, the fluid communicating between the inner space 153a of the hollow tube 153 and the ink outlet path 43a is blocked. Even if the inner space 153a of the hollow tube 153 communicates with the ink outlet path 43a via the opening 153b, ink stored in ink bag 42 does not flow into the inner space 153a until the second valve 60 becomes open state.

[0070] Referring to Figs. 7A-7D, how the first valve 50 and the second valve 60 work during the mounting of the ink cartridge 40 to the mounting portion is described. The dotted line S1 shown in Figs. 7A-7E is a boundary line indicating the boundary between an end of the spherical member 52, which end is most distant from the second valve 60 in the first direction (the left end of the spherical member 52 in Figs. 7A-7E), and the curved portion 51c when the spherical member 52 and the curved portion 51c are in contact. The dotted line S2 is a boundary line at which the state of the first valve 50 changes between the open state and the close state when the spherical member 52 moves. The dotted line S3 is a boundary line indicating the boundary between the valve seat 61 and the valve member 62 when the valve seat 61 is contact with the valve member 62 while being elastically deformed, and the pressing member 70 is not in contact with the spherical member 52. The dotted line S4 is a boundary line at which the state of the second valve 60 changes between the open state and the close state when the valve member 62 moves.

[0071] Referring to Fig. 7A, when the hollow tube 153 is not inserted into the ink outlet tube 43, i.e., when the ink cartridge 40 is not mounted to the mounting portion 150, only the biasing force of the coil spring 53 is applied to the spherical member 52, and the (left) end of the spherical member 52 is positioned on the boundary line S1. In other words, the first valve 50 is in the close state, and the spherical member 52 is in contact with the curved portion 51c and the ring-shaped protrusion 51b.

[0072] When the mounting of the ink cartridge 40 to the mounting portion 150 is intended, the door 1c of the ink jet printer 1 is opened, and the ink cartridge 40 is mounted to a corresponding one of the mounting portions 150 via the opening 10c. When the hollow tube 153 is inserted into the opening 51a, the tip of the hollow tube 153 comes into contact

with the spherical member 52 and the spherical member 52 moves toward the second valve 60 (to the right in Figs. 7A-7E), as shown in Fig. 7B. When the (left) end of the spherical member 52 crosses the boundary line S2, the spherical member 52 and the sealing member 51 are separated, and the state of the first valve 50 changes from the close state to the open state. Thus, the first valve 50 becomes the open state when the spherical member 52 moves beyond a distance between the boundary lines S1 and S2 from a state in which the spherical member 52 contacts the curved portion 51c. During the period when the (left) end of the spherical member 52 is positioned between the boundary lines S1 and S2, the spherical member 52 is in contact with the ring-shaped protrusion 51b, so the first valve 50 is maintained in the close state. When the state of the first valve 50 is turned into the open state, a gap is still formed between the spherical member 52 and the pressing member 70. Therefore only the biasing force of the coil spring 63 is applied to the valve member 62, such that an end of the valve member 62, which end is most distant from the connecting portion 42a in the first direction (the left end of the valve member 62 in Figs. 7A-7E) is positioned on the boundary line S3, and the second valve 60 is maintained in the close state. When the second valve 60 is in the close state, a portion of the valve seat 61 facing the valve member 62 (the right portion of the valve seat 61 in Figs. 7A-7E) is in contact with the valve member 62 while being elastically deformed due to the biasing force of the coil spring 63 (while being compressed in the biasing direction of the coil spring 63).

[0073] Referring to Fig. 7C, when the hollow tube 153 is further inserted, the spherical member 52 comes into contact with the tip of the pressing member 70, and the spherical member 52, pressing member 70, and valve member 62 move toward the connecting portion 42a (to the right in Figs. 7A-7E). When the (left) end of the valve member 62 crosses the boundary line S4, the valve member 62 and the valve seat 61 are separated, and the state of the second valve 60 changes from the close state to the open state. Thus, the second valve 60 becomes the open state when the valve member 62 moves beyond a distance between the boundary lines S3 and S4 from the boundary line S3. During the period when the (left) end of the valve member 62 is positioned between the boundary lines S3 and S4, the valve member 62 is in contact with the valve seat 61, so the second valve 60 is maintained in the close state. The distance between the boundary lines S3 and S4 is the elastically deformable range of the valve seat 61.

[0074] Referring to Fig. 7D, the hollow tube 153 is further inserted until the mounting of the ink cartridge 40 to the mounting portion 150 is completed, and the hollow

- 18 -

tube 153 is inserted up to the predetermined amount and stops when the mounting is completed. Thus, the state of each of the first and second valves 50 and 60 changes from the close state to the open state in accordance with the insertion of the hollow tube 153 into the ink outlet path 43a, such that the second valve 60 becomes the open state after the first valve 50 becomes the open state. Thus, ink stored in the mounted ink cartridge 40 flows into the inner space 153a of the hollow tube 153, and thereby ink is supplied from the ink cartridge 40 to the ink jet head 2.

[0075] Referring to Fig. 7E, how the first valve 50 and the second valve 60 work during the removal of the ink cartridge 40 from the mounting portion 150 is described.

When ink is used up, for example, the ink cartridge 40 is removed from the mounting portion 150. The spherical member 52, the valve member 62, and the pressing member 70 move together in a direction away from the connecting portion 42a (to the left in Fig. 7E) while contacting each other, due to the biasing forces of the coil springs 53 and 63, in accordance with the movement of the ink cartridges 40 being removed from the mounting portion 150 (in accordance with the movement of the hollow tube 153 being pulled out of the ink outlet tube 43). In other words, the spherical member 52, the pressing member 70, and the valve member 62 move in a direction opposite to a direction in which they move when the hollow tube 153 is inserted into the sealing member 51. When the (left) end of the valve member 62 reaches the boundary line S4, the valve member 62 comes into contact with the valve seat 61, and the state of the second valve 60 changes from the open state to the close state. When this occurs, the flow of ink from the ink bag 42 to the inner space 153a of the hollow tube 153 stops.

[0076] Subsequently, the valve member 62 and pressing member 70 move until the (left) end of the valve member 62 reaches the boundary line S3. When the (left) end of the valve member 62 reaches the boundary line S3, the motion of the valve member 62 and the pressing member 70 stops. And then, only the spherical member 52 moves along with the hollow tube 153, such that the spherical member 52 and the tip of the pressing member 70 are separated from each other. When the (left) end of the spherical member 52 reaches the boundary line S2, the spherical member 52 and the ring-shaped protrusion 51b come into contact, and the state of the first valve 50 changes from the open state to the close state. Subsequently, the spherical member 52 moves until the (left) end of the spherical member 52 reaches the boundary line S1. Thus, the state of each of the first and second valves 50 and 60 changes from the open state to the close state in accordance with the movement of

the hollow tube 153 pulled out of the sealing member 51. The first valve 50 becomes the close state after the second valve 60 becomes the close state. In this way, the old ink cartridge 40 is removed from the mounting portion 105, and a new ink cartridge 40 is mounted to the mounting portion 105. The modulus of elasticity of the coil spring 63 is determined so as to be capable of applying biasing force to the valve member 62, which force exceeds the force generated when shock is applied to the valve member 62, such that no gap that would result in ink leakage will be formed in the second valve 60 due to the shock when a user handles the ink cartridge 40. Also, because the valve member 62 is constantly biased against the valve seat 61 by the coil spring 63, the second valve 60 is constantly maintained in the close state when the ink cartridge 40 is left unused (when the ink cartridge 40 is removed from the mounting portion 150).

[0077] As described above, in the ink cartridge 40 according to this embodiment, when the hollow tube 153 is inserted into the sealing member 51, the first valve 50 becomes the open state, and then the hollow tube 153 moves the spherical member 52, the pressing member 70, and the valve member 62, such that the valve member 62 moves away from the valve seat 61, which causes the second valve 60 to become the open state. When the hollow tube 153 is pulsed out of the sealing member 51, the second valve 60 becomes the close state, and then the first valve 50 becomes the close state. Accordingly, at the instant in which the hollow tube 153 is pulled out of the sealing member 51 completely, the second valve 60 has already been in the close state. Therefore, even if the first valve 50 is damaged, massive leakage of ink can be reduced when and after the hollow tube 153 is pulled out of the first valve 50 and when the first valve 50 is in the close state.

[0078] According to a first modified embodiment of the present invention, the ring-shaped protrusion 51b has a longer dimension in the first direction than in the first embodiment. Therefore, although a gap is formed between the spherical member 52 and the pressing member 70 when the first valve 50 becomes the open state in the first embodiment, the spherical member 52 comes into contact with the pressing member 70 before the first valve 50 becomes the open state, with no gap being formed between the spherical member 52 and pressing member 70 in this first modified embodiment.

[0079] Referring to Figs. 8A and 8B, in this first modified embodiment, a boundary line S2' is positioned closer to the boundary line S3 than the boundary line S2 is positioned to the boundary line S3. In this case, referring to Fig. 8A, when the hollow tube 153 is inserted into the ink outlet tube 43, and the spherical member 52 comes into contact with the

- 20 -

tip of the pressing member 70, the (left) end of the spherical member 52 has not passed over the boundary line S2', i.e., the first valve 50 is still maintained in the close state. The ring-shaped protrusion 51b has such a length that the first valve 50 becomes the open state after the spherical member 52 comes into contact with the pressing member 70 but before the second valve 60 becomes the open state. Referring to Fig. 8B, when the (left) end of the spherical member 52 reaches the boundary line S2', the (left) end of the valve member 62 is positioned between the boundary lines S3 and S4.

[0080] A distance T1, which is the distance the spherical member 52 moves from the time when the spherical member 52 comes into contact with the pressing member 70 up to the time when the first valve 50 becomes the open state, is less than a distance T2, which is a distance the valve member 62 moves from the time when the spherical member 52 comes into contact with the pressing member 70 (when the (left) end of the valve member 62 is positioned at the boundary line S3) up to the time when the (left) end of the valve member 62 reaches the boundary line S4. Accordingly, in this first modified embodiment as well, during the mounting of the ink cartridge 40 to the mounting portion 150, the second valve 60 becomes the open state after the first valve 50 becomes the open state. During the removal of the ink cartridge 40 from the mounting portion 150, the first valve 50 becomes the close state after the second valve 60 becomes the close state. Accordingly, the same advantages as with the first embodiment can be obtained.

[0081] In the above-described first modified embodiment, the ring-shaped protrusion 51b has a longer dimension in the first direction than in the first embodiment.

In another embodiment, the pressing member is made to be longer in the first direction than in the first embodiment, instead of the ring-shaped protrusion 51b having a longer dimension. In such a case, the pressing member has such a length that a distance the spherical member 52 moves from the time when the spherical member 52 comes into contact with the pressing member up to the time when the first valve 50 becomes the open state, is less than a distance the valve member 62 moves from the time when the spherical member 52 comes into contact with the pressing member up to the time when the second valve 60 becomes the open state.

[0082] Referring to Figs. 9A and 9B, according to a second modified embodiment of the present invention, a pressing member 270 is integral with the spherical member 52. Referring to Fig. 9A, the pressing member 270 comprises a ring-shaped protrusion 271 extending from the outer surface of the pressing member 270 facing the inner surface of the

coil spring 53, and the ring-shaped protrusion 271 functions as a guide for the movement of the pressing member 270 and the spherical member 52. Accordingly, referring to Fig. 9B, the pressing member 270 can move along the inner surface of the coil spring 53 in accordance with movement of the spherical member 52. Also, because the pressing member 270 is not integral with the valve member 62, the (left) end of the valve member 62 which is configured to contact the valve seat 61 can be readily manufactured, e.g., ground or polished, with high precision, thereby stabilizing the intimate contact between the valve member 62 and the valve seat 61. On the other hand, in the first embodiment described above, because the pressing member 70 is not integral with the spherical member 52 and is separated from the spherical member 52, the pressing member 70 can be readily manufactured as compared to the second modified embodiment, and therefore operates in a stable manner.

[0083] In this second modified embodiment, a gap formed between the pressing member 270 and the valve member 62 when the curved portion 51c and the spherical member 52 are in contact has the same dimension in the first direction as the gap formed between the spherical member 52 and the pressing member 70 when the curved portion 51c and the spherical member 52 are in contact in the first embodiment. Accordingly, the timings when the state of the first valve 50 changes between the open state and the close state and the state of the second valve 60 changes between the open state and the close state, are the same as in the first embodiment. Consequently, the same advantages as the first embodiment can be obtained in this second modified embodiment.

[0084] Referring to Figs. 10A and 10B, according to a third modified embodiment of the present invention, a pressing member 370 is integral with neither the spherical member 52 nor the valve member 62, i.e., the pressing member 370 is a separate from the first valve 50 and the second valve 60, and is disposed between the spherical member 52 and the valve member 62. Accordingly, the (left) end of the valve member 62 which is configured to contact the valve seat 61 can be readily manufactured, e.g., ground or polished, with high precision similarly to the second modified embodiment, thereby stabilizing the intimate contact between the valve member 62 and the valve seat 61. Additionally, the pressing member 370 is separated from the spherical member 52, so the pressing member 370 can be readily manufactured similarly to the first embodiment. Referring to Fig. 10A, the pressing member 370 comprises ring-shaped protrusions 371 and 372 extending from the outer surface of the pressing member 370 facing the inner surface of the coil spring 53, and the

ring-shaped protrusions 371 and 372 function as a guide for the movement of the pressing member 370. Thus, the pressing member 370 can move along the inner surface of the coil spring 53 in accordance of movement of the spherical member 52 and movement of the valve member 62, as shown in Fig. 10B.

5 [0085] In this third modified embodiment, the total dimension of the two gaps formed between the pressing member 370 and the spherical member 52 and between the spherical member 52 and the valve member 62 in the first direction when the curved portion 51c and the spherical member 52 are in contact is the same as the dimension of the gap formed between the spherical member 52 and the pressing member 70 in the first direction
10 when the curved portion 51c and the spherical member 52 are in contact in the first embodiment. Accordingly, the timings when the state of the first valve 50 changes between the open state and the close state and the state of the second valve 60 changes between the open state and the close state, are the same as in the first embodiment. Consequently, the same advantages as the first embodiment can be obtained in this second modified
15 embodiment.

[0086] Because the second and third modified embodiments described above are different from the first embodiment only in the structures of the pressing members 270 and 370, the dimension of the ring-shaped protrusion 51b or pressing members 270 and 370 in the first direction in the second and third modified embodiments can be greater than that in
20 the first embodiment.

[0087] Referring to Figs. 11A and 11B, according to a fourth modified embodiment of the present invention, the first valve 50 comprises a sealing member 450 which is an elastic member positioned in the ink outlet path 43a and contacting the inner surface of the tube 45 to close the opening of the ink outlet path 43a formed at the second end of the ink
25 outlet path 43a, and the first valve 50 does not comprise a spherical member and a coil spring. An opening is not formed through the sealing member 450. Accordingly, the number of parts of the first valve is reduced as compared to the first embodiment and the first through third modified embodiments. A pressing member 470 according to this fourth modified embodiment, comprises a wide-diameter portion 471 extending from the outer
30 surface of the tip of the pressing member 470. The wide-diameter portion 471 has a diameter slightly less than the inner diameter of the tube 45. Accordingly, referring to Fig. 11B, the pressing member 470 and the tip of the hollow tube 153 come into contact in a stable manner. The sealing member 450 is made of the same material as the sealing member

51 in the first embodiment.

[0088] In this fourth modified embodiment, when the hollow tube 153 is inserted into the sealing member 450 for the first time, the sealing member 450 as the first valve becomes the open state when the hollow tube 153 passes through the sealing member 450 (when the tip of the hollow tube 153 goes beyond the right end of the sealing member 450 in Figs. 11A and 11B, the hollow tube 153 penetrates through the sealing member 450, thereby elastically deforming the sealing member 450, i.e., compressing the sealing member 450 to allow hollow tube 153 to pass therethrough, without removing any portion of sealing member 450. As shown in Figs. 11A and 11B, the elastic deformation of sealing member 450 may transition the first valve to the open state). However, once the hollow tube 153 is pulled out of the sealing member 450 and then the hollow tube 153 is inserted into the sealing member 450 again, the sealing member 450 as the first valve becomes the open state when the tip of the hollow tube 153 is inserted into the sealing member 450 (when the tip of the hollow tube 153 goes beyond the left end of the sealing member 450 in Figs. 11A and 11B). More specifically, an opening is formed through the sealing member 450 when the hollow tube 153 is inserted through the sealing member 450 for the first time, whereby the sealing member 450 becomes the open state. When the hollow tube 153 is pulled out of the sealing member 450, the opening formed through the sealing member 450 is closed off by the elastic force of the sealing member 450, and thereby the sealing member 450 becomes the close state (the opening formed through the sealing member 450 is closed off by the sealing member 450 elastically reforming to seal the hole created by the penetration of hollow tube 153, thereby transitioning the first valve to the close state). When the hollow tube 153 is inserted into the sealing member 450 again, the opening of the sealing member 450 which has been closed is opened by the insertion of the tip of the hollow tube 153 therein, and thereby the sealing member 450 becomes the open state.

[0089] Referring to Fig. 11A, because a gap is formed between the sealing member 450 and the tip of the pressing member 470 in the first direction when the hollow tube 153 is not inserted into the sealing member 450, the second valve 60 becomes the open state after the sealing member 450 as the first valve becomes the open state.

[0090] When the hollow tube 153 is pulled out of the sealing member 450 from a state in which the hollow tube 153 is in the ink outlet path 43a and the valves 450 and 60 are in the open state, the second valve 60 becomes the close state first, and then the sealing member 450 becomes the close state when the hollow tube 153 is pulled out of the sealing

member 450 completely. Accordingly, in this fourth modified embodiment as well, the same advantages as in the first embodiment can be obtained.

[0091] In the fourth modified embodiment, the gap is formed between the sealing member 450 and the tip of the pressing member 470 when the hollow tube 153 is not inserted into the sealing member 450. Nevertheless, in another embodiment, there may be no gap between the sealing member 450 and the tip of the pressing member 470 when the hollow tube 153 is not inserted into the sealing member 450. In other words, the sealing member 450 and the tip of the pressing member 470 may constantly be in contact when the hollow tube 153 is not inserted into the sealing member 450. In this case, when the hollow tube 153 comes into contact with the pressing member 470, the sealing member 450 as the first valve is already in the open state, and further insertion of the hollow tube 153 from this state causes the second valve 60 to become the open state. When the hollow tube 153 is pulled out of the sealing member 450, the sealing member 450 becomes the close state after the second valve 60 becomes the close state. Accordingly, the same advantages as in the first embodiment can be obtained as well.

[0092] Moreover, in another embodiment an opening may be originally formed through the sealing member 450 for the hollow tube 153 to be inserted therein. When the hollow tube 153 is not inserted into the sealing member 450, this opening is closed by elastic force of the sealing member 450, and when the tip of the hollow tube 153 is inserted into the sealing member 450, the sealing member 450 as the first valve becomes the open state. The sealing member 450 in this case corresponds to the sealing member 450 of the fourth modified embodiment, through which the hollow tube 153 has been inserted and been pulled out at least once.

[0093] Referring to Figs. 12 to 17B, a second embodiment of the present invention will be described. Note that components which are the same as or equivalent to those in the first embodiment will be denoted with the same reference numerals and description thereof will be omitted.

[0094] Referring to Figs. 12 to 14, an ink cartridge 540 according to the second embodiment comprises a housing 541 having substantially a rectangular parallelepiped shape, an ink bag 42, an ink outlet tube 543, a first valve 50, a second valve 560, and an actuator 570.

[0095] The interior of the housing 541 is divided into two chambers 41a and 41b, similarly to the first embodiment. The ink bag 42 is disposed in the chamber 41a and the

ink outlet tube 543, the second valve 560, and the actuator 570 are disposed in the chamber 41b. The chamber 41b in this second embodiment is greater than that in the first embodiment, because an electric power input portion 591 (described later) is provided in the chamber 41b of the housing 541.

5 [0096] The ink outlet tube 543 comprises a tube 548, e.g., a cylindrical tube 548, connected to the connecting portion 42a of the ink bag 42 at a first end of the tube 548, a tube 544 connected to a second end of the tube 548 at a first end of the tube 544, and a tube 45 fitted to a second end of the tube 544, thereby forming an ink outlet path 543a therein. More specifically, a first end of the tube 45 is fitted into the tube 544, but a second end of the tube 45 is positioned outside of the tube 544. The cylindrical tube 548 is configured to elastically deform in its radial direction. The ink outlet tube 543 extends in the first direction, and therefore the ink outlet path 543a defined by the ink outlet tube 543 extends in the first direction. The ink outlet path 543a is configured to be in fluid communicating with the interior of the ink bag 42 via the connecting portion 42a at a first end thereof, and to be in fluid communication with the outside of the ink cartridge 540 at a second end thereof. The tube 544 substantially corresponds to the tube 44 of the first embodiment from which the portion where the second valve 60 is disposed is removed.

10 [0097] The housing 541 comprises a shoulder surface 541c which is positioned away from the flange 47 toward the ink bag 42. The shoulder surface 541c extends parallel with the flange 47, i.e., extends in the second direction and the third direction. The electric power input unit 591, as an example of a contact, is provided on the shoulder surface 541c. The electric power input portion 591 is positioned away from the ink discharge opening 46a in the second direction. Also, the electric power input portion 591 is electrically connected to the actuator 570, and is configured to supply electric power to the actuator 570 when the electric power input portion 591 is electrically connected to an electric power output portion 152 (described later). In a modified embodiment, the electric power input portion 591 may be disposed at any position, as long as it is not positioned directly below the ink discharge opening 46a when the ink cartridge 40 is mounted to a mounting portion 550. The electric power input portion 591 has a recess formed therein configured to receive the electric power output portion 152.

20 [0098] Because the electric power input portion 591 for transmitting electric power is provided so as not be positioned directly below the ink discharge opening 46a, ink dripping from the ink discharge opening 46a can be prevented from adhering to the electric power

- 26 -

input portion 591. This can prevent the electric power input portion 591 from short-circuiting and damaging the actuator 570. Also, because the electric power input portion 591 is provided on the shoulder surface 541c, and there is a distance between the electric power input portion 591 and the ink discharge opening 46a in the first direction, the distance
5 between the electric power input portion 591 and ink discharge opening 46a increases not only in the second direction but also greatly in the first direction. Accordingly, adhesion of ink to the electric power input portion 591 may further be reduced.

[0099] Referring to Figs. 15 to 16B, the second valve 560 comprise a rigid plate 561, a leaf spring 562 comprising a middle portion 562a, and the tube 548 is sandwiched
10 between the rigid plate 561 and the middle portion 562a of the leaf spring 562. The second valve 560 comprises a wire 563 coupled to the actuator 570 at a first end thereof and to the leaf spring 562 at a second end thereof. The rigid member 561 is disposed on a cover 571 covering the actuator 570.

[0100] The leaf spring 562 is bent following the outer shape of the cover 571. A first
15 end of the leaf spring 562 is fixed to one side face of the cover 571, and a second end of the leaf spring 562 is configured to move freely. The middle portion 562a of the leaf spring 562 faces the upper face of the cover 571 and extends substantially parallel to the rigid plate 561 and the upper face of the cover 571. A plate shaped elastic member 564 made of rubber or the like is disposed between the middle portion 562a and the tube 548. Also, an opening
20 562c is formed through a portion of the leaf spring adjacent to the second end of the leaf spring 562. The second end of the wire 563 is passed through the opening 562c, such that the wire 563 and the leaf spring 562 are coupled.

[0101] The actuator 570 comprises a solenoid fixed to a base 572, and the solenoid is configured, such that a movable core 570a is linearly advanced and retracted. The actuator
25 570 is driven such that when electric power is supplied thereto the movable core 570a is advanced and when the electric power is no longer supplied thereto the movable core 570a is retracted. Also, the actuator 570 is covered by the cover 571 fixed to the base 572. A pair of supporting portions 572a extends from the base 572 at a position facing the second end of the leaf spring 562. A pulley 565 is rotatably supported by the pair of supporting portions
30 572a. A fixing portion 570b is provided at the tip portion of the movable core 570a to which the first end of the wire 563 is fixed. The wire 563 is disposed so as to be bent over the pulley 565 and such that the second end of the leaf spring 562 moves in accordance with operations of the actuator 570.

- 27 -

[0102] When the ink cartridge 540 is removed from a mounting portion 550 (described later), the electric connection between the electric power input portion 591 and the electric power output portion 152 is cut off, and electric power is not supplied to the actuator 570. The movable core 570a is retracted from the position shown in Fig. 16A to the position shown in Fig. 16B, and the second end of the leaf spring 562 moves downwards in Figs. 16A and 16B by way of the wire 563. In other words, the second end of the leaf spring 562 moves in such a direction that the tube 548 is pressed against the rigid plate 561 by the middle portion 562a of the leaf spring 562. Accordingly, the leaf spring 562 is elastically deformed so as to press the tube 548 between the middle portion 562a and the rigid plate 561. The tube 548 is elastically deformed in its radial direction to become flat, and thereby the second valve 560 becomes a close state, in which the second valve 560 prevents ink in the ink outlet path 543a from flowing via the second valve 560. When the ink cartridge 540 is mounted to the mounting portion 550, the electric power input portion 591 and the electric power output portion 152 are electrically connected, and electric power is supplied to the actuator 570. The movable core 570a is advanced from the position shown in Fig. 16B to the position shown in Fig. 16A, and the middle portion 562a moves by the elastic force of the leaf spring 562 itself in a direction opposite to the direction to press the tube 548 against the rigid plate 561, i.e., the second end of the leaf spring 562 moves upwards in Figs. 16A and 16B. Accordingly, pressing force applied to the tube 548 between the middle portion 562a and the rigid plate 561 is released, thereby the second valve 560 becomes an open state, in which the second valve 560 allows ink in the ink outlet path 543a to flow via the second valve 560.

[0103] Thus, the second valve 560 can open and close the ink outlet path 543a without directly contacting ink in the ink outlet path 543a. This prevents the components of the second valve 560 from adhering to each other with thickened and dried ink. Disposing the wire 563 so as to be bent over the pulley 565 enables the second valve 560 and the actuator 570 to be arranged in a compact manner. Damage to the tube 548 due to opening and closing of the ink outlet path 543a by the second valve 560 is reduced because the elastic member 564 is disposed between the leaf spring 562 and the tube 548.

[0104] Referring to Figs. 17A and 17B, the mounting portion 550 according to this second embodiment is substantially the same as the mounting portion 150 in the first embodiment. The mounting portion 550 has a recess 551 formed therein having a shape corresponding to the outer shape of the ink cartridge 540. The hollow tube 153 is provided

at a base portion 551a defining an end of the recess 551 in the secondary direction. The ink supply path 154 is formed in the base portion 551a, and the electric power output portion 152 for outputting electric power from an electric power source (not shown) of the ink jet printer 1 is also provided at the base portion 551a.

5 [0105] The electric power output portion 152 is provided at a shoulder surface 551b formed on the base portion 551a. The electric power output portion 152 extends from the shoulder surface 551b in the primary direction, and is disposed at a position corresponding to the electric power input portion 591 when the ink cartridge 540 is mounted to the mounting portion 550.

10 [0106] The electric power output portion 152 has such a length that the tip of the electric power output portion 152 comes into contact with the end of the electric power input portion 591 defining the bottom of the recess of the electric power input portion 591 when the ink cartridge 540 is mounted to the mounting portion 550 and the hollow tube 153 is completely inserted into the ink outlet tube 543. In other word, after the first valve 50 becomes the open state, the electric power output portion 152 and the electric power input portion 591 are electrically connected, and electric power is supplied to the actuator 570. Accordingly, the second valve 560 becomes the open state after the first valve 50 becomes the open state. Thus, in this second embodiment, when the ink cartridge 540 is mounted to the mounting portion 550, the second valve 560 becomes the open state after the first valve 20 50 becomes the open state, like in the first embodiment.

[0107] When the ink cartridge 540 is removed from the mounting portion 550, such that, the hollow tube 153 moves to be pulled out of the ink outlet tube 543, the tip of the electric power output portion 152 moves away from the end the electric power input portion 591, and the supply of electric power to the actuator 570 stops. Accordingly, the second valve 560 becomes the close state before the first valve 50 becomes the close state. The hollow tube 153 further moves, the spherical member 52 and the ring-shaped protrusion 51b come into contact and the first valve 50 becomes the close state. Thus, in this second embodiment as well, at the instant in which the hollow tube 153 is pulled out of the sealing member 51 completely, the second valve 560 is already in the close state, and the first valve 25 50 becomes the close state after the second valve 560 becomes the close state. Accordingly, the same advantages as in the first embodiment can be obtained. Also, even if a user inserts a rod-shaped object in the sealing member 51 instead of a hollow needle for a lark or something, the second valve 560 does not open, so there is no or little leakage from the ink 30

- 29 -

cartridge 540. Also, because the second valve 560 operates electrically, there is no or little ink leakage from the ink cartridge 540 even if a user applies an external force to the ink cartridge 540, e.g., when a user drops the ink cartridge 540.

[0108] Referring to Figs. 18 to 21B, an ink cartridge according to a third embodiment of the present invention will be described. Note that components which are the same as or equivalent to those in the first and second embodiments will be denoted with the same reference numerals and description thereof will be omitted.

[0109] An ink cartridge 640 according to the third embodiment comprises a housing 641 having substantially a rectangular parallelepiped shape, an ink bag 642 disposed in the housing 641 configured to store ink therein, an ink outlet tube 643 communicating with the ink bag 642 at a first end thereof, a first valve 50, a second valve 660, and an actuator 670. The ink bag 642 has a protruding portion 642a at the lower left portion thereof, which protrudes to the left in Fig. 19, and the first end of the ink outlet tube 643 is connected to the protruding portion 642a.

[0110] The ink outlet tube 643 comprises a tube 644 connected to the ink bag 642 at a first end, the tube 544, and a tube 45. The tube 644 extends in the second direction and forming an ink outlet path 647a extending in the second direction. The tube 644 comprises a small-diameter portion 644a and a large-diameter portion 644b, and the inner diameter of the large-diameter portion 644b is greater than the inner diameter of the small-diameter portion 644a. A lid 646 is provided at a second end of the tube 644 opposite the first end of the tube 644 in the second direction. The tube 544 and the tube 45 extend in the first direction, and has an ink outlet path 647b formed therein which also extends in the first direction. The small-diameter portion 644a is connected to the ink bag 642, and the large-diameter portion 644b is connected to the first end of the tube 544, such that the ink outlet path 647a and an ink outlet path 647b are in fluid communication. Thus, the ink outlet tube 643 has an ink outlet path 647 formed therein, comprising the ink channels 647a and 647b communicating with each other.

[0111] The second valve 660 is disposed in the large-diameter portion 644b, and comprises a valve member 661, as a second valve member, having a cylindrical shape, and two O-rings 662 and 663 for filling the gap between the valve member 661 and the inner surface of the large-diameter portion 644b. The valve member 661 has a ring-shaped groove 661a formed in a surface of the valve member 661 facing the small-diameter portion 644a (the lower surface of the valve member 661 in Fig. 20), and a ring-shaped groove 661b

- 30 -

formed in the side surface of the valve member 661 adjacent to the second end of the tube 644 (an upper portion of the side surface of the valve member 661 in Fig. 20), with the O-rings 662 and 663 being disposed in the ring-shaped grooves 661a and 661b, respectively.

[0112] The ring-shaped groove 661a and the O-ring 662 are positioned at the surface of the valve member 661, surrounding the portion of the valve member 661 facing the path formed in the small-diameter portion 644a. When the valve member 661 is in a position (close position) where the O-ring 662 contacts the inner surface of the large-diameter portion 644b as shown in Fig. 20, the second valve 660 is in a close state, in which ink in the ink outlet path 647a is prevented from flowing via the second valve 660.

On the other hand, when the valve member 661 is in a position (open position) where the O-ring 662 is separated from the inner surface of the large-diameter portion 644b as shown in Fig. 21B, the second valve 660 is in an open state, in which ink in the ink outlet path 647a is allowed to flow via the second valve 660 and the ink outlet path 647a and ink outlet path 647b are in fluid communication. Also, regardless of whether valve member 661 is in the close position or the open position, the ring-shaped groove 661b and O-ring 663 are positioned closer to the lid 646 than the connection portion between the ink outlet path 647a and ink outlet path 647b are positioned to the lid 646. Accordingly, the connection portion between the ink outlet path 647a and ink outlet path 647b, and a space formed in the large-diameter portion 644b on the lid 646 side of the valve member 661, are not in fluid communication due to the contact between the O-ring 663 and the inner surface of the large-diameter portion 644b.

[0113] As in the case of the actuator 570 in the second embodiment, the actuator 670 comprises a solenoid configured, such that a movable core 670a is linearly advanced and retracted. The actuator 670 is electrically connected to the electric power input portion 591. The actuator 670 is fixed on the lid 646 such that the moveable core 670a can pass through an opening 646a formed through the lid 646. The actuator 670 is positioned externally from the ink outlet path 647a. Also, the tip of the moveable core 670a of the actuator 670 is coupled to the valve member 661. The actuator 670 is driven such that when electric power is supplied thereto the movable core 670a is retracted and when the electric power is not supplied thereto the movable core 670a is advanced.

[0114] When the ink cartridge 640 is removed from a mounting portion, the electric connection between the electric power input portion 591 and an electric power output portion provided in the mounting portion is cut off, and electric power is not supplied to the

actuator 670. The movable core 670a is advanced and the valve member 661 moves from the open position to the close position. Thus, the second valve 660 becomes the close state. When the ink cartridge 640 is mounted to the mounting portion, the electric power input portion 591 and the electric power output unit portion electrically connected, and electric power is supplied to the actuator 670. The movable core 670a is then retracted and the valve member 661 moves from the close position to the open position. Thus, the second valve 660 becomes the open state.

[0115] In this third embodiment, as in the second embodiment, the electric power input portion 591 is electrically connected to the electric power output portion when the ink cartridge 640 is mounted to the mounting portion and the hollow tube 153 is completely inserted into the ink outlet tube 643. More specifically, as shown in Fig. 21A, when the spherical member 52 is separated from the ring-shaped protrusion 51b due to the insertion of the hollow tube 153 into the sealing member 51, the electric power input portion 591 is not electrically connected to the electric power output portion, and power is not supplied to the actuator 670, so the valve member 661 remains in the close position. When the hollow tube 153 is completely inserted as shown in Fig. 21B, the electric power input portion 591 is electrically connected to the electric power output portion, and power is supplied to the actuator 670. Accordingly, the actuator 670 is driven and the valve member 661 moves to the open position, so the second valve 660 becomes the open state. In this third embodiment, as in the first and second embodiments, when the ink cartridge 640 is mounted to the mounting portion, the second valve 660 becomes the open state after the first valve 50 becomes the open state.

[0116] When the ink cartridge 640 is removed from the mounting portion, the electric power output portion and the electric power input portion 591 are separated and electric power supply to the actuator 670 stops, and subsequently the first valve 50 becomes the close state. In other words, the second valve 660 becomes the close state before the first valve 50 becomes the close state. Thus, in this third embodiment, in the instant in which the hollow tube 153 is pulled out of the sealing member 51 completely, the second valve 660 is already in the close state, and the first valve 50 becomes the close state after the second valve 660 becomes the close state. Accordingly, the same advantages as in the first and second embodiments can be obtained.

[0117] In the first embodiment and the first to third modified embodiments, the first valve becomes the close state after the second valve becomes the close state when the ink

cartridge is removed from the mounting portion. Nevertheless, the ring-shaped protrusion 51b can be made long in the first direction, such that the second valve becomes the closes state after the first valve becomes the close state. In this case, when the ink cartridge is mounted to the mounting portion, the first valve becomes the open state after the second valve becomes the open state. In this case as well, even if the first valve is damaged when the ink cartridge is not mounted in the mounting portion, the second valve is in the close state, so ink leakage can be reduced.

[0118] In the second and third embodiments, when the ink cartridge is mounted to the mounting portion, the electric power output portion of the mounting portion and the electric power input portion of the ink cartridge can be electrically connected with each other before the first valve becomes the open state. In this case as well, when the ink cartridge is mounted to the mounting portion, the first valve becomes the open state after the second valve becomes the open state, and when the ink cartridge is removed from the mounting portion, the second valve becomes the close state after the first valve becomes the close state. In this case as well, even if the first valve is damaged when the ink cartridge is not mounted in the mounting portion, the second valve is in the close state, so ink leakage can be reduced.

[0119] While the invention has been described in connection with various example structures and illustrative embodiments, it will be understood by those skilled in the art that other variations and modifications of the structures and embodiments described above may be made without departing from the scope of the invention. Other structures and embodiments will be apparent to those skilled in the art from a consideration of the specification or practice of the invention disclosed herein. It is intended that the specification and the described examples are illustrative with the true scope of the invention being defined by the following claims.

Industrial Applicability

[0120] The liquid cartridge of the present invention can be widely used for home and office uses.

CLAIMS

1. A liquid cartridge comprising:

a liquid storing portion configured to store liquid therein;

a liquid outlet path communicating with an interior of the liquid storing portion;

5 a first valve comprising a sealing member configured to close an opening of the liquid outlet path and to contact an outer surface of a longitudinal object while being elastically deformed when the longitudinal object is inserted through the sealing member; and

10 a second valve provided in the liquid outlet path between the liquid storing portion and the first valve, wherein the second valve comprises:

a valve seat;

a valve member configured to prevent liquid from flowing via the second valve when the valve member contacts the valve seat; and

15 a biasing member configured to bias the valve member toward the valve seat and the sealing member,

wherein the first valve and the second valve are separate members.

2. The liquid cartridge of claim 1, wherein the valve member is a second valve member, the biasing member is a second biasing member, and the first valve further comprises:

20 a first valve member configured to prevent liquid from flowing via the first valve when the first valve member contacts the sealing member, and

a first biasing member configured to bias the first valve member toward the sealing member.

25 3. The liquid cartridge of claim 1 or 2, further comprising a pressing member provided in the liquid outlet path between the first valve and the second valve, and configured to press and move the second valve member in a direction opposite to a direction in which the second biasing member biases the second valve member.

30 4. The liquid cartridge of claim 3, wherein the pressing member is integral with the second valve member.

5. The liquid cartridge of claim 3, wherein the pressing member is a separate member

- 34 -

from the first valve and the second valve.

6. The liquid cartridge of claim 2, further comprising a pressing member provided in the liquid outlet path between the first valve and the second valve, and configured to press and move the second valve member in a direction opposite to a direction in which the second biasing member biases the second valve member, wherein the pressing member is integral with the first valve member.

7. The liquid cartridge of any one of claims 1-6, wherein the sealing member and the second valve member are aligned in a direction in which the longitudinal object is inserted through the sealing member.

8. A liquid cartridge comprising:

a liquid storing portion configured to store liquid therein;

a liquid outlet path communicating with an interior of the liquid storing portion;

a first valve comprising a sealing member configured to close an opening of the liquid outlet path and to contact an outer surface of a longitudinal object while being elastically deformed when the longitudinal object is inserted through the sealing member;

a second valve provided at the liquid outlet path between the liquid storing portion and the first valve, and configured to selectively be in an open state and a close state, wherein the second valve is configured to allow liquid to flow via the second valve when the second valve is in the open state, and the second valve is configured to prevent liquid from flowing via the second valve when the second valve is in the close state;

an actuator configured to operate to switch the second valve between the open state and the close state, such that the second valve is in the open state when electric power is supplied to the actuator, and such that the second valve is in the close state when electric power is not supplied to the actuator; and

a contact configured to electrically connect between an external electric power supply and the actuator.

9. The liquid cartridge of claim 8, further comprising an liquid outlet tube defining the liquid outlet path therein, wherein at least a portion of the liquid outlet tube is configured to elastically deform in a radial direction of the at least a portion of the liquid outlet tube, and

- 35 -

the second valve is configured to apply a pressing force to the at least a portion of the liquid outlet tube such that the at least a portion of the liquid outlet tube elastically deforms in the radial direction when the second valve is in the close state and is configured not to apply the pressing force when the second valve is in the open state.

5

10. The liquid cartridge of claim 8, wherein the second valve further comprises a second valve member configured to be move between a first position where liquid is allowed to flow via the second valve and a second position where liquid is prevented from flowing via the second valve, and the actuator is coupled to the second valve member and is positioned externally from the liquid outlet path.

10

11. The liquid cartridge of any one of claims 1 to 10, wherein the first valve and the second valve are spaced away from each other.

15

12. The liquid cartridge of any one of claims 1 to 11, wherein the first valve and the second valve are aligned in a direction in which the longitudinal object is inserted through the sealing member.

13. A printer comprising:

20

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

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

14. The printer of claim 13, wherein the longitudinal object is a hollow tube configured to extract liquid stored in the liquid storing portion to the outside of the liquid cartridge.

25

15. A liquid cartridge comprising:

a liquid storing portion configured to store liquid therein;

a liquid outlet path communicating with an interior of the liquid storing portion;

a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and

30

a second valve provided at the liquid output path, comprising:

a valve seat positioned away from the first valve; and

- 36 -

a valve member configured to close the second valve when the valve member contacts the valve seat,

wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed.

5

16. A liquid cartridge comprising:

a liquid storing portion configured to store liquid therein;

a liquid outlet path communicating with an interior of the liquid storing portion, the liquid outlet path comprising a first path portion having a first width and a second path portion having a second width greater than the first width, wherein the first path portion and the second path portion are contiguous;

10

a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and

a second valve provided at the liquid output path, comprising:

15

a valve seat provided at the liquid output path; and

a valve member having a width that is greater than the first width and smaller than the second width, wherein the valve member is configured to be biased in a biasing direction toward the first valve when the second valve is closed, and

wherein the valve member is configured to close the second valve when at least one contact surface of the valve member furthest in the biasing direction contacts the valve seat at a boundary between the first path portion and the second path portion, and the second width is defined at the boundary.

20

17. A liquid cartridge comprising:

25

a liquid storing portion configured to store liquid therein;

a liquid outlet path communicating with an interior of the liquid storing portion,

a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and

a second valve provided at the liquid output path, comprising:

30

an integrally formed valve seat disposed between the first valve and the interior of the liquid storing portion; and

a valve member configured to close the second valve when the valve member contacts the valve seat,

- 37 -

wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed.

18. A liquid cartridge comprising:

5 a liquid storing portion configured to store liquid therein;

a liquid outlet tube comprising at least one side wall;

a liquid outlet path formed in the liquid outlet tube, partially defined by the at least one side wall, and communicating with an interior of the liquid storing portion;

10 a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and

a second valve provided at the liquid output path, comprising:

a valve seat that forms at least a portion of the at least one side wall; and

a valve member configured to close the second valve when the valve member contacts the valve seat,

15 wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed.

19. A liquid cartridge comprising:

a liquid storing portion configured to store liquid therein;

20 a liquid outlet path communicating with an interior of the liquid storing portion;

a first valve provided at the liquid outlet path and configured to close the liquid outlet path; and

a second valve provided at the liquid output path, comprising:

a valve seat formed completely of an inelastic material;

25 a valve member configured to close the second valve when the valve member contacts the valve seat,

wherein the valve member is configured to be biased against the valve seat toward the first valve when the second valve is closed.

1/21

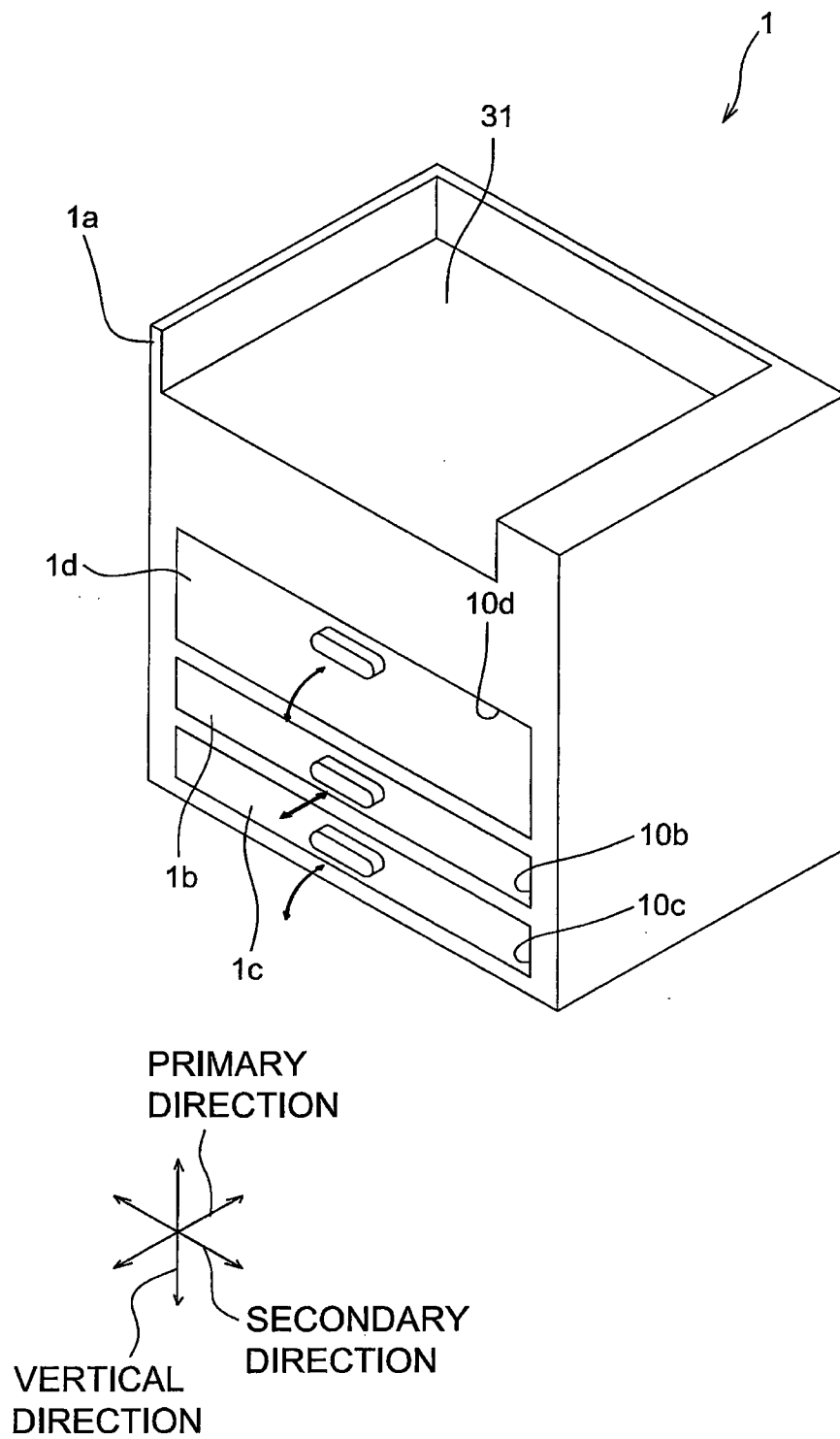
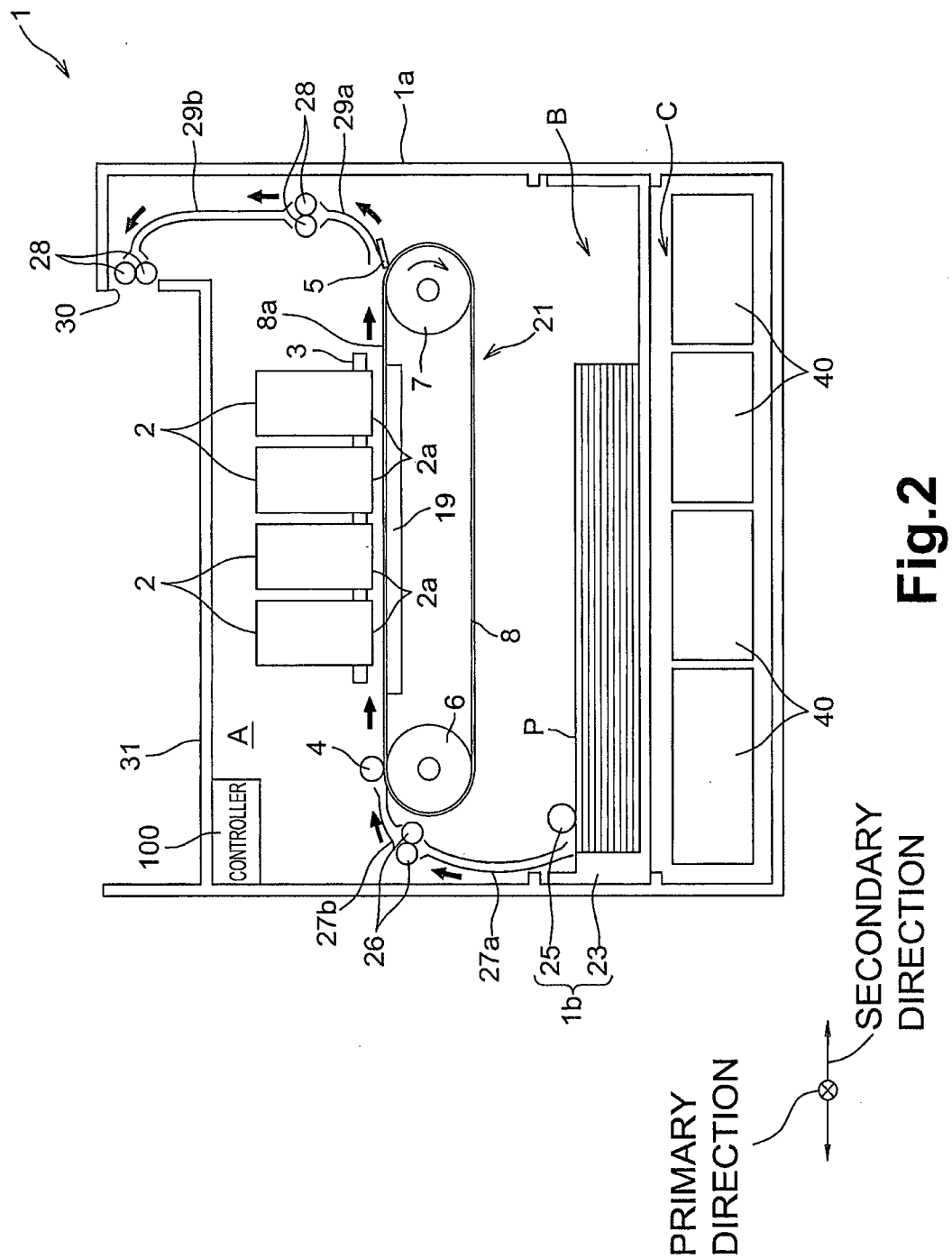


Fig.1



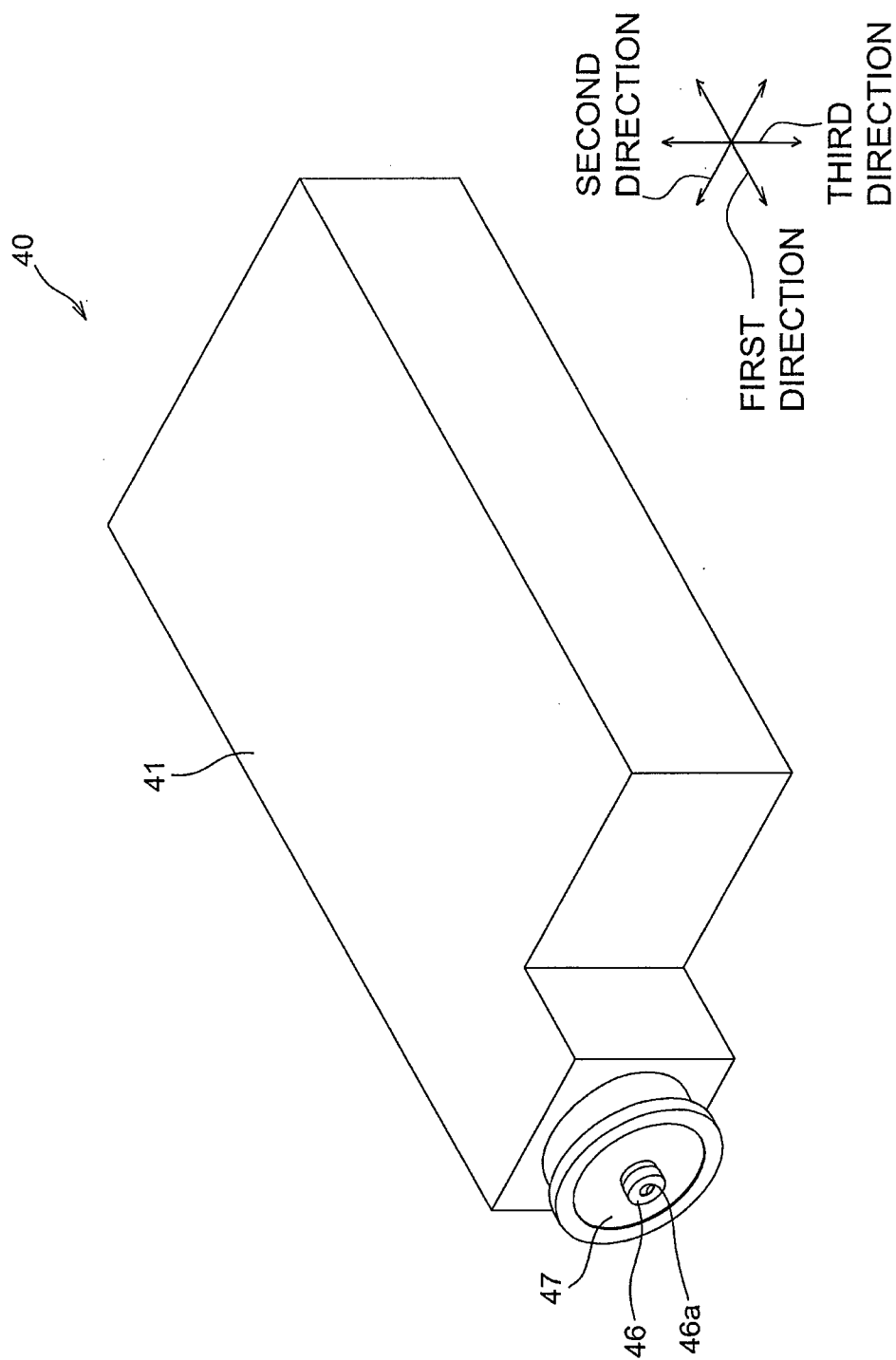


Fig.3

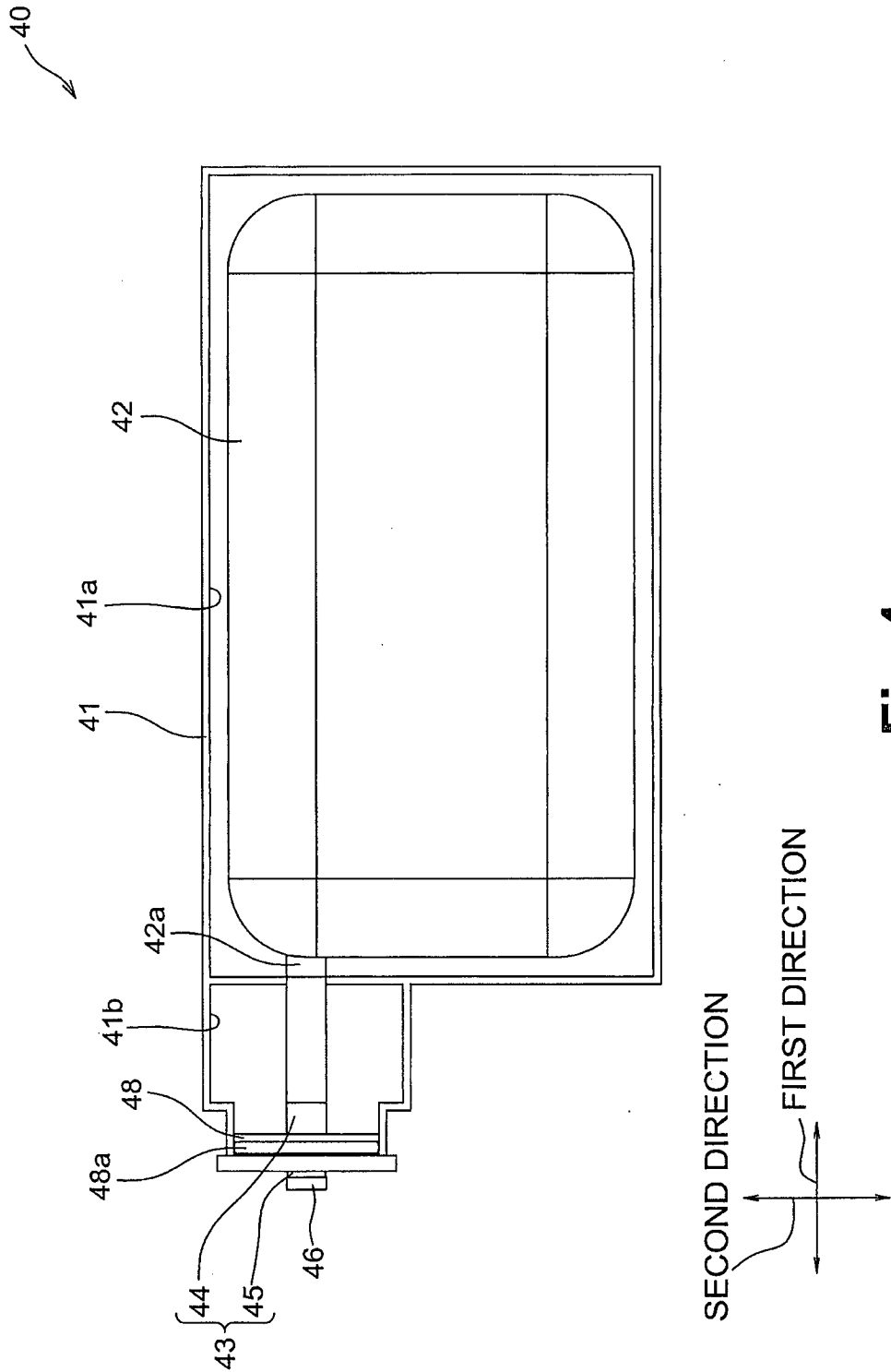


Fig. 4

5/21

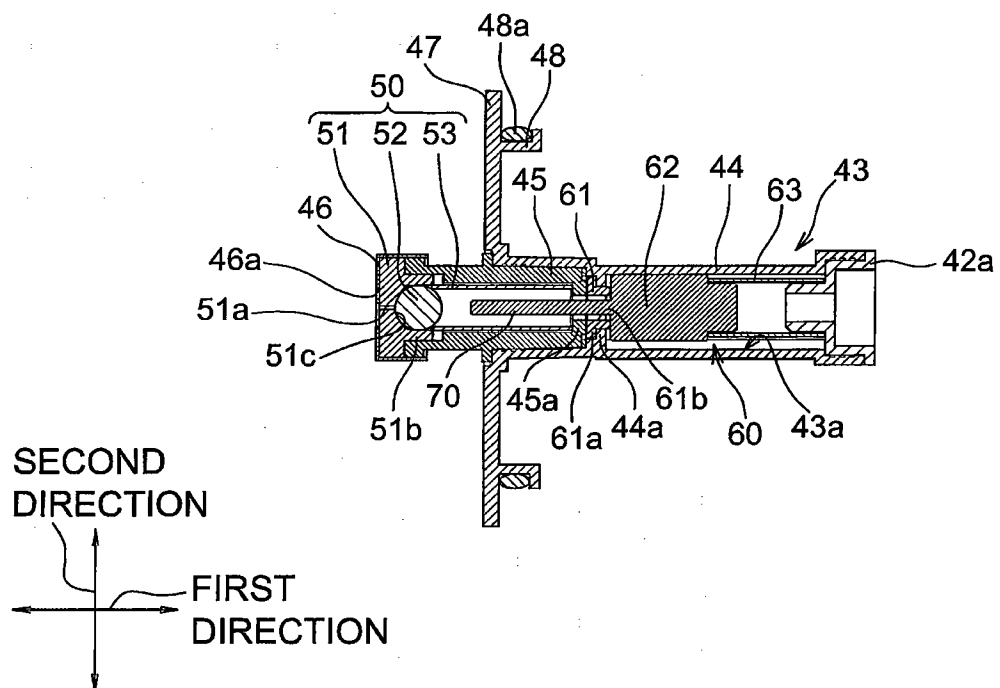


Fig.5A

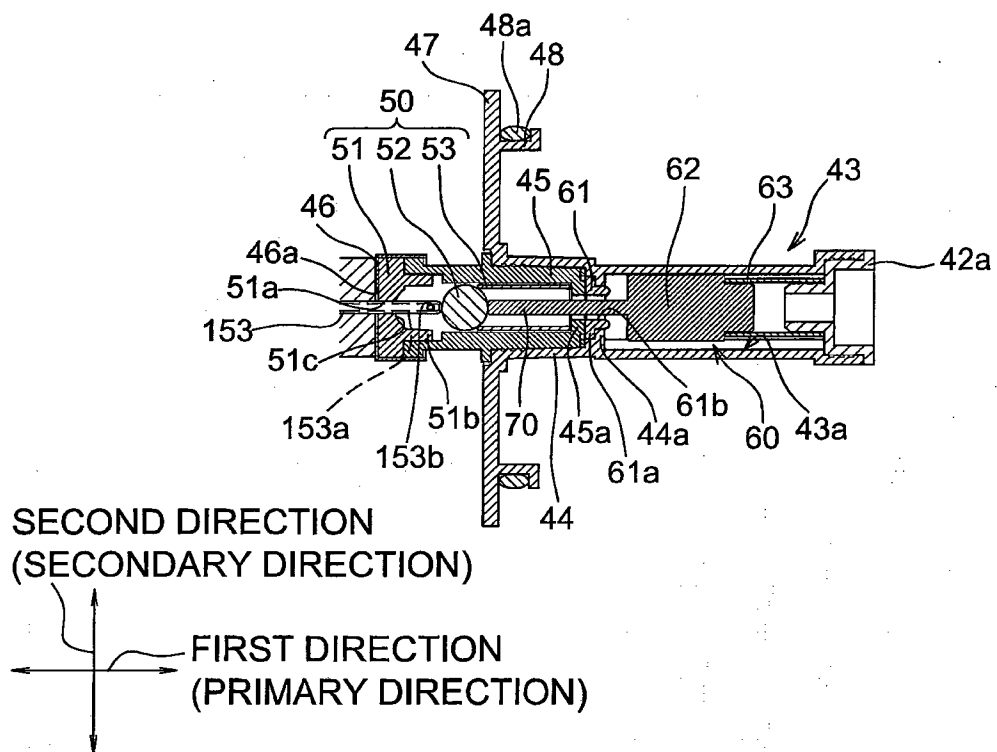


Fig.5B

6/21

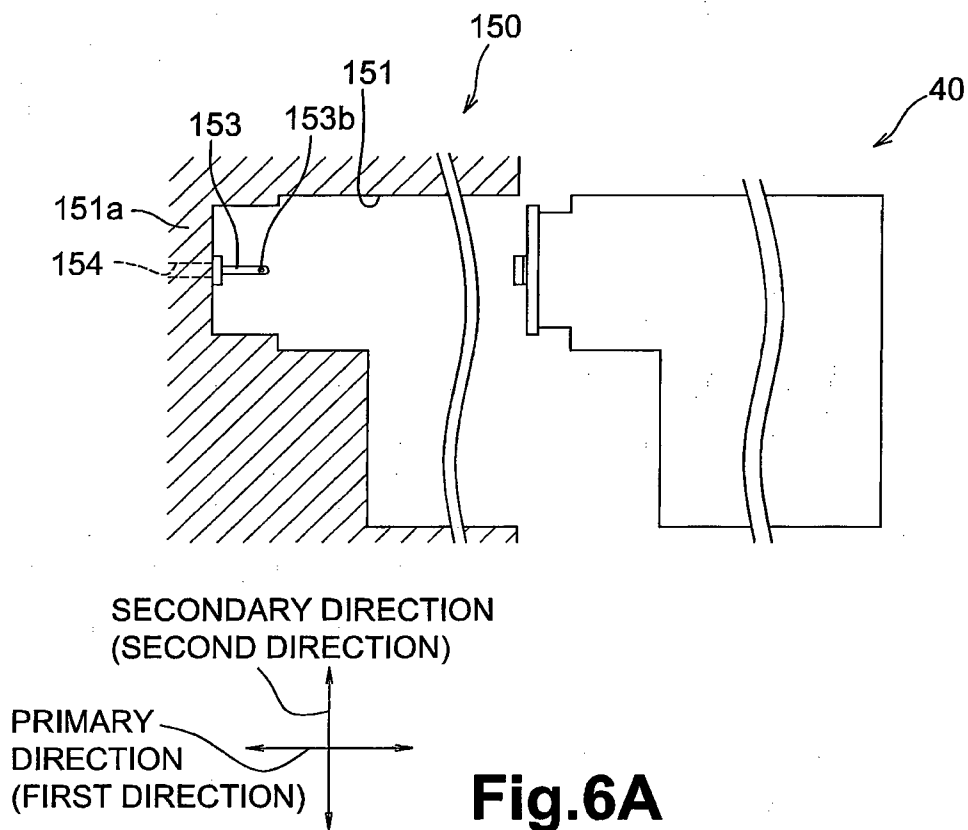


Fig.6A

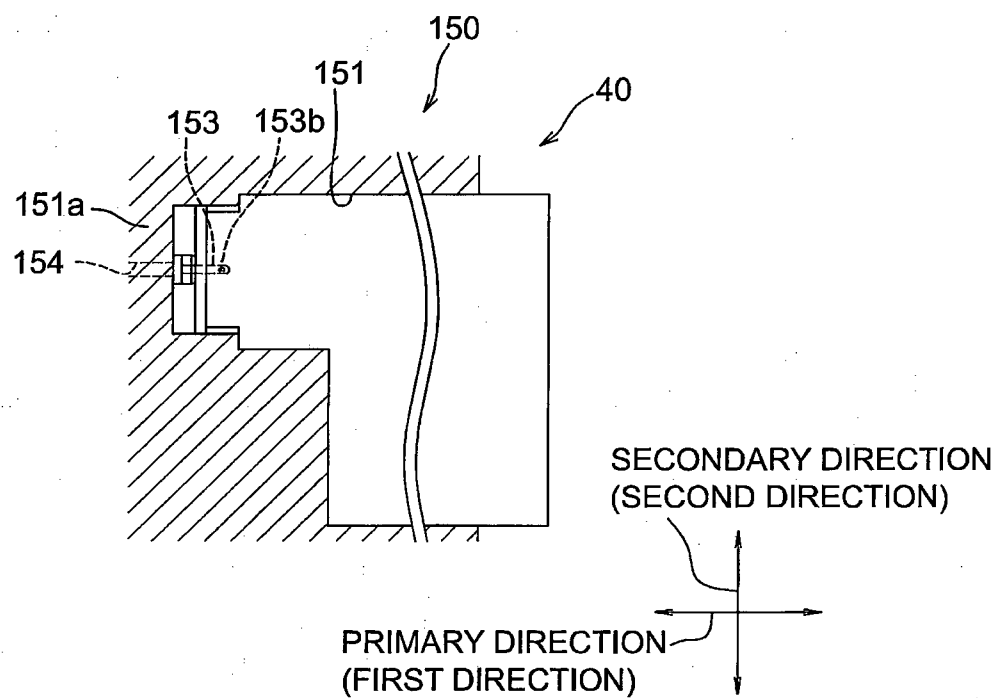


Fig.6B

7/21

Fig.7A

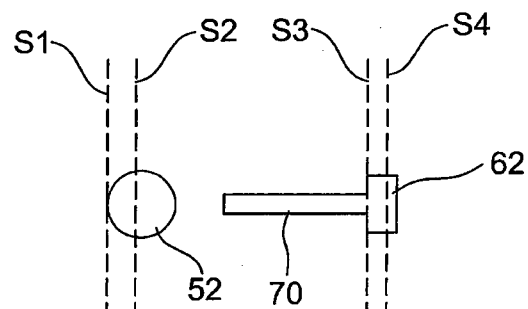


Fig.7B

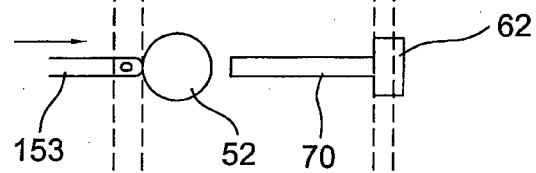


Fig.7C

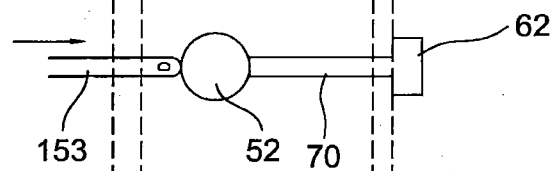


Fig.7D

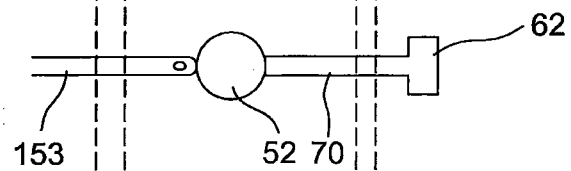
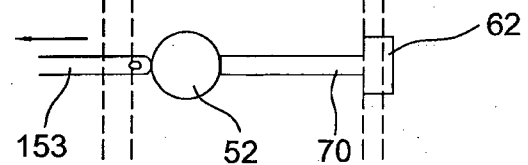


Fig.7E



8/21

Fig.8A

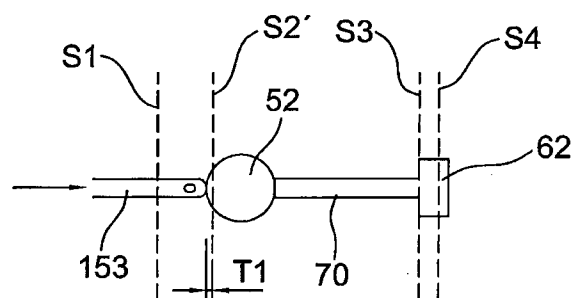
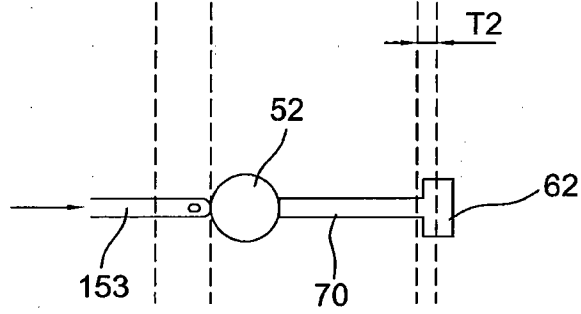


Fig.8B



9/21

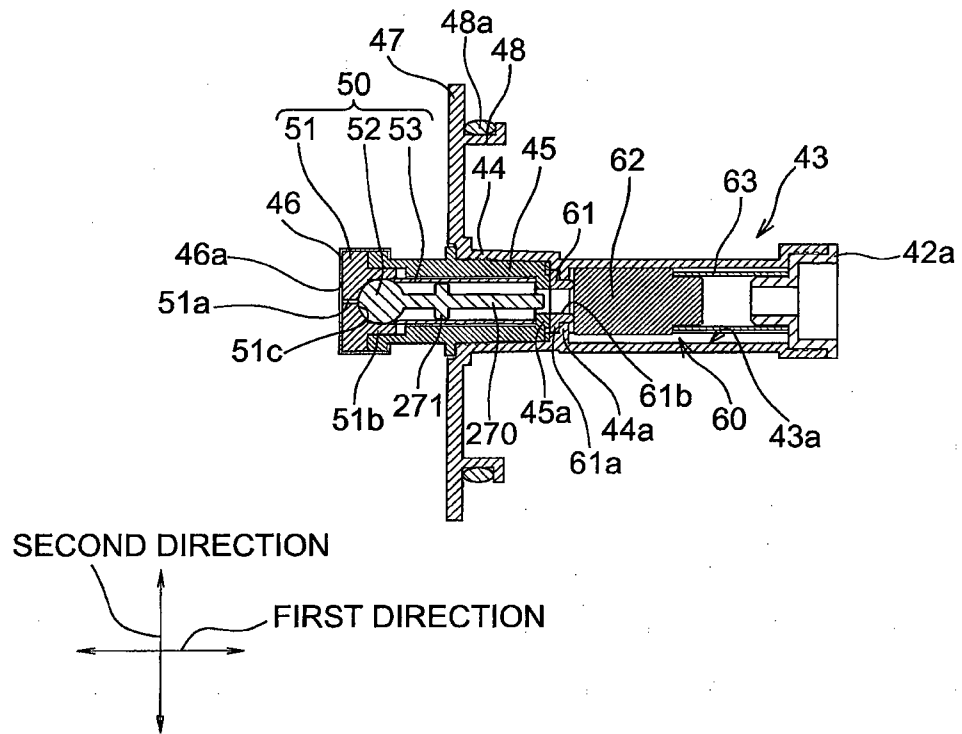


Fig.9A

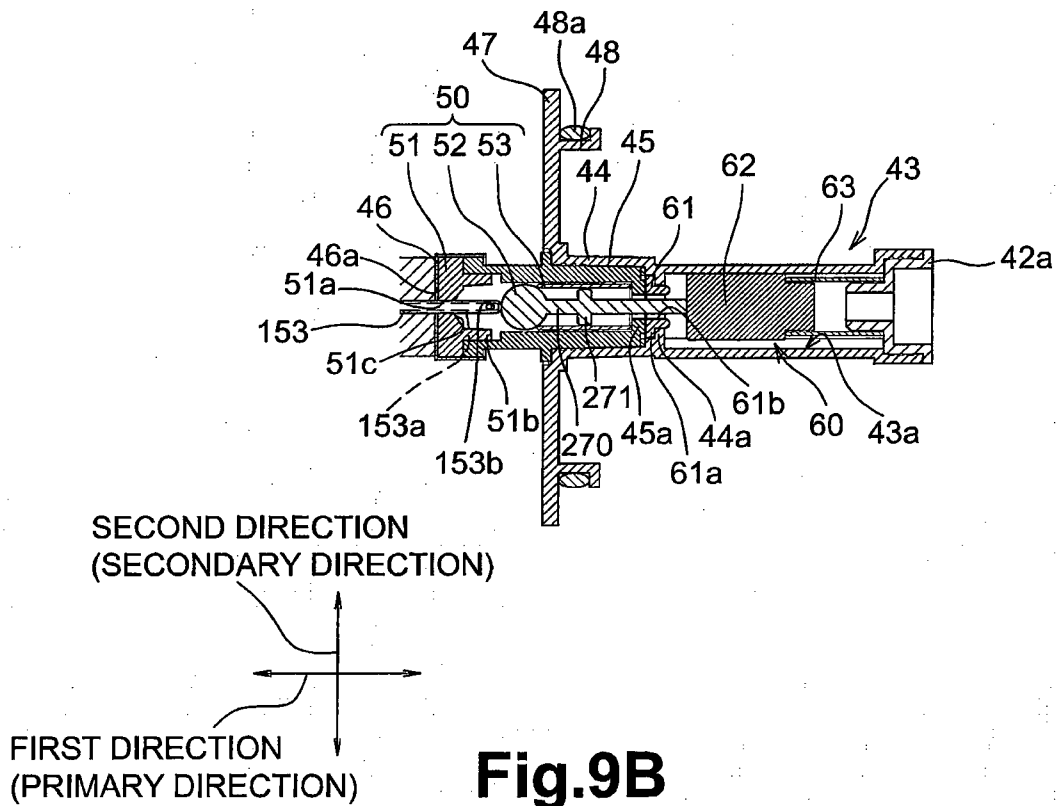


Fig.9B

10/21

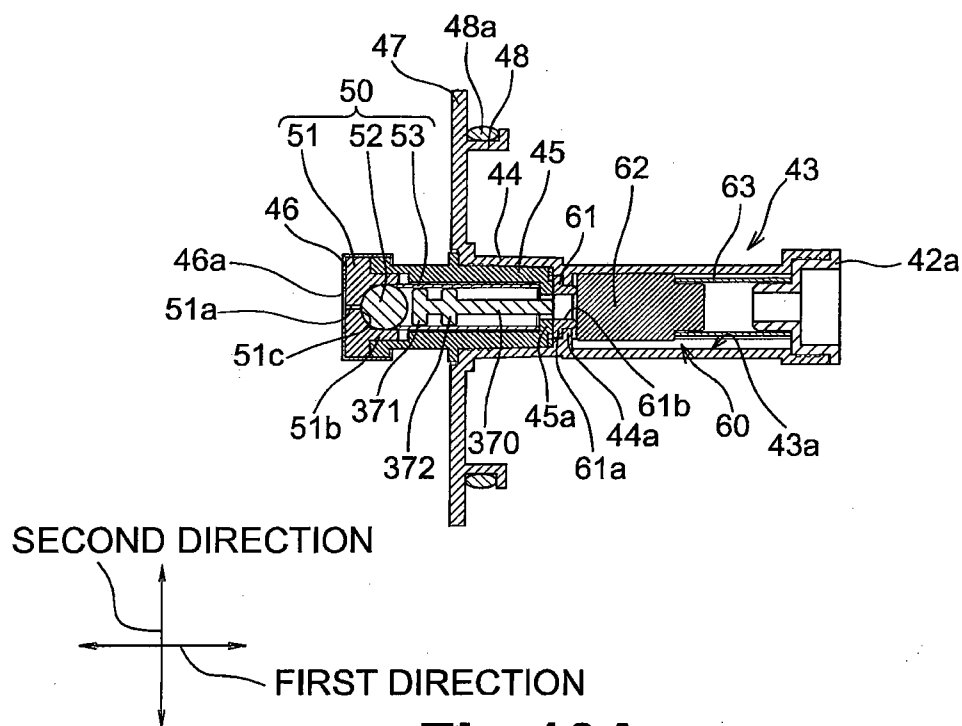


Fig.10A

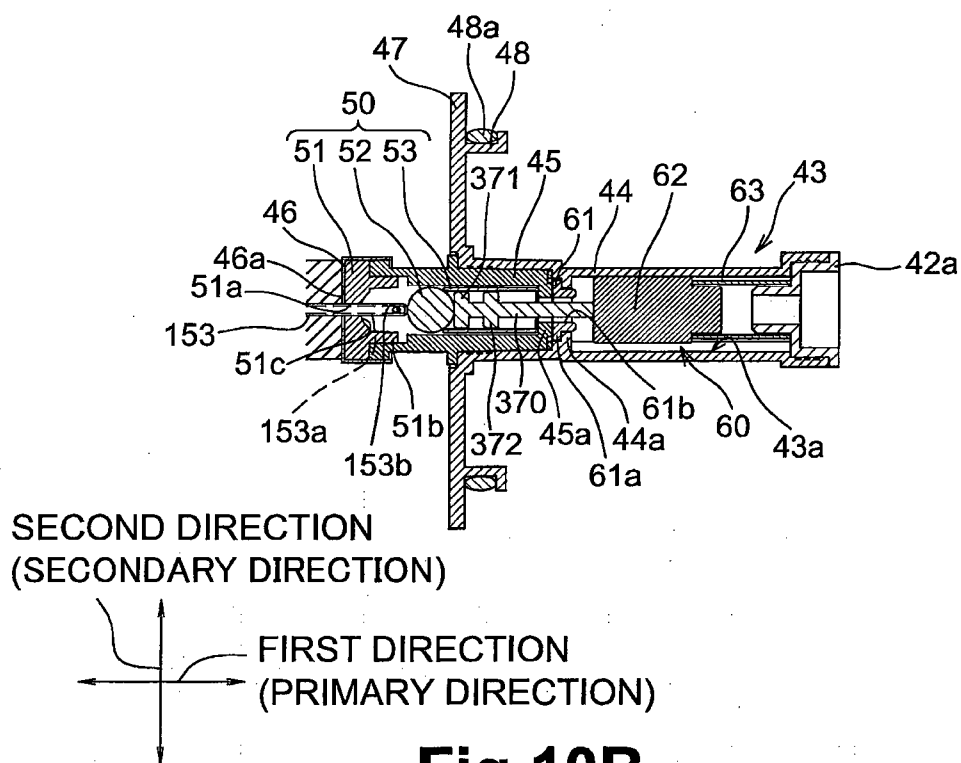


Fig.10B

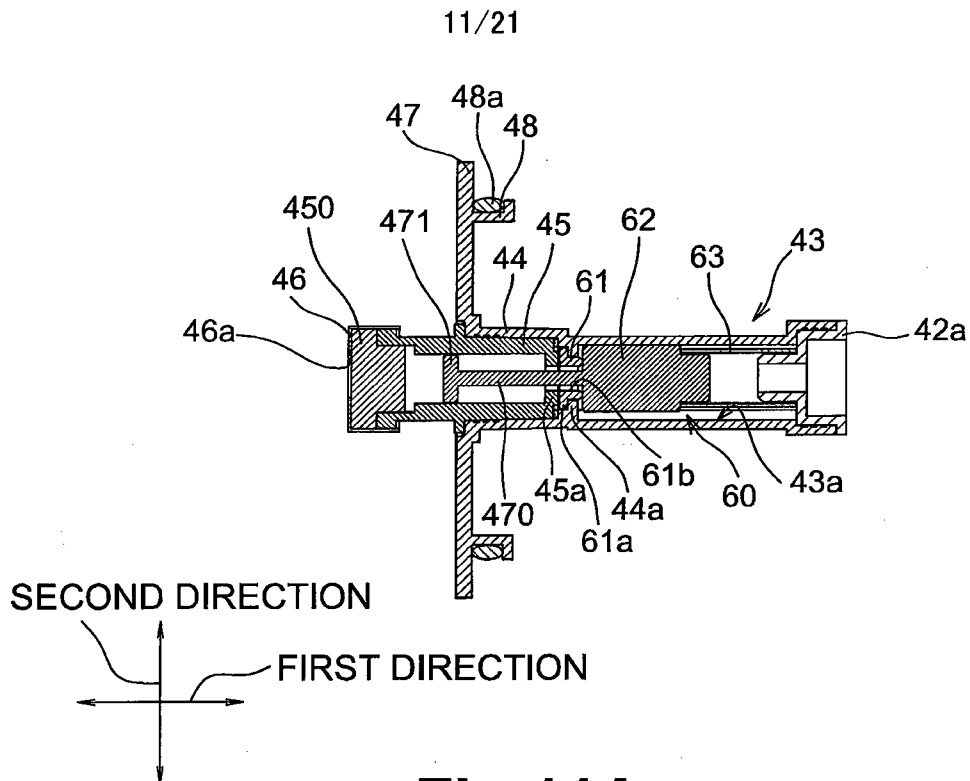


Fig.11A

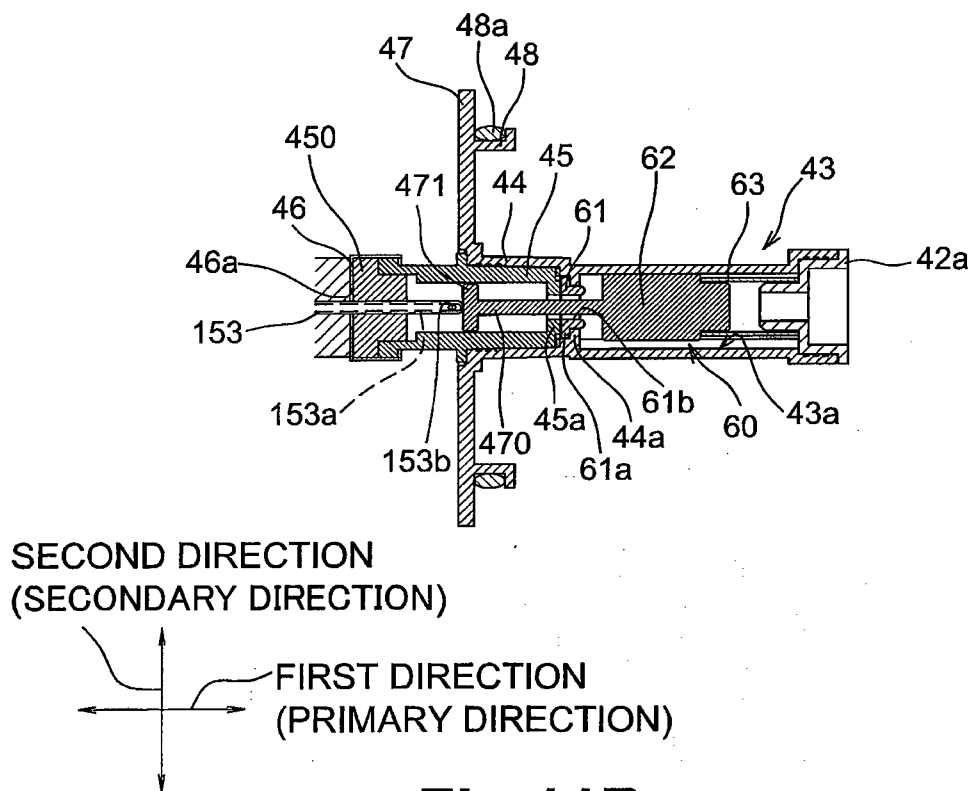


Fig.11B

12/21

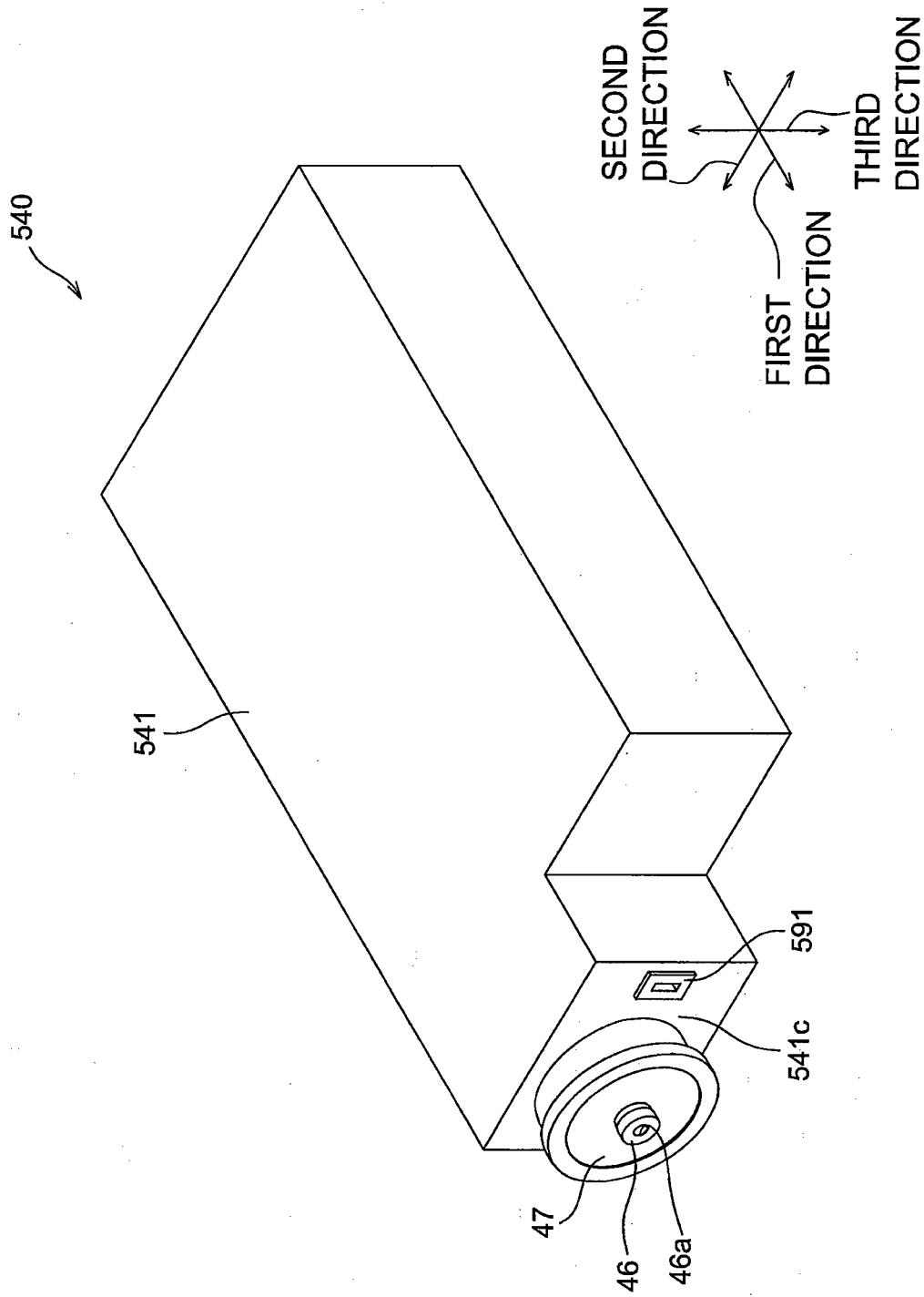


Fig. 12

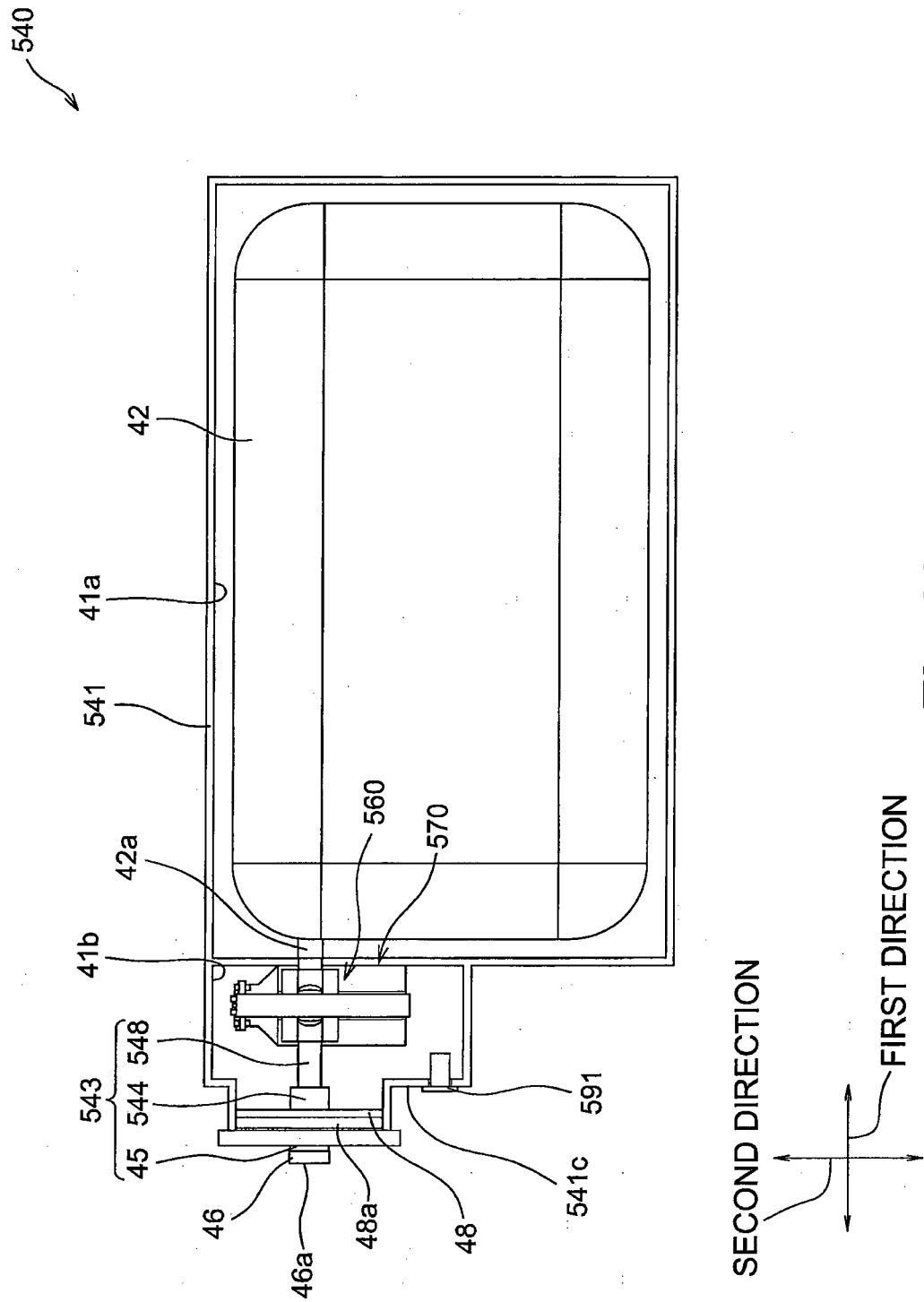


Fig.13

14/21

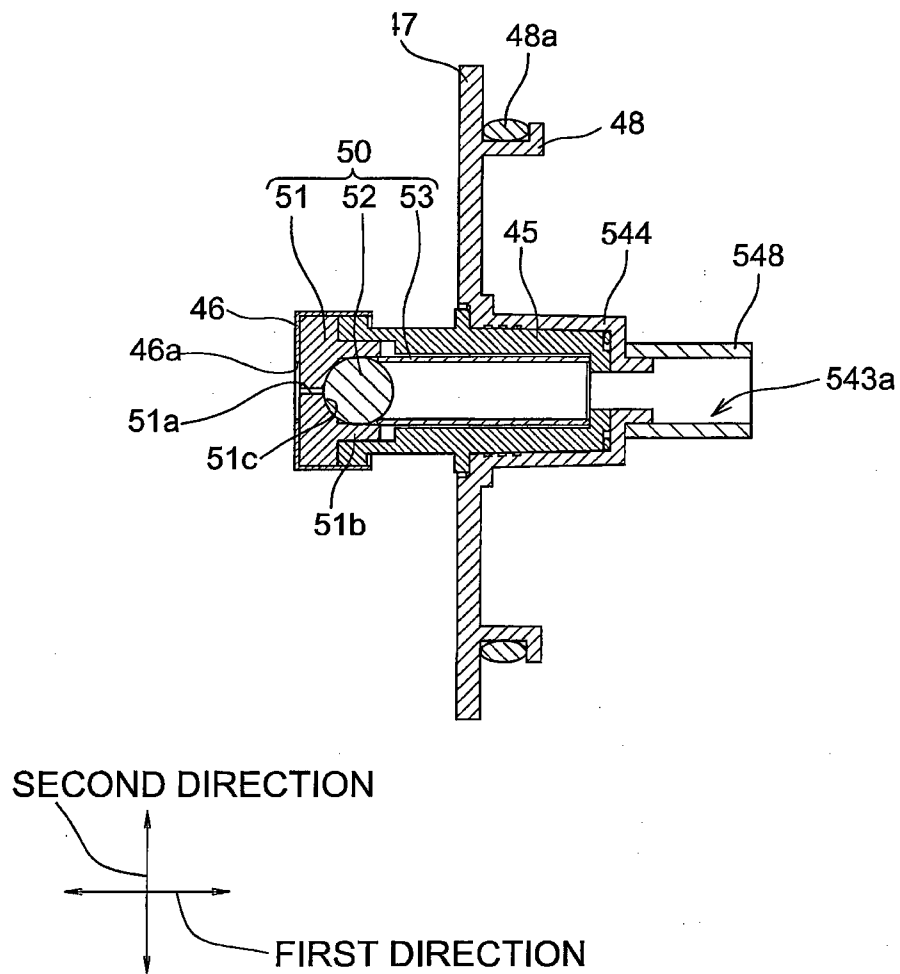


Fig.14

15/21

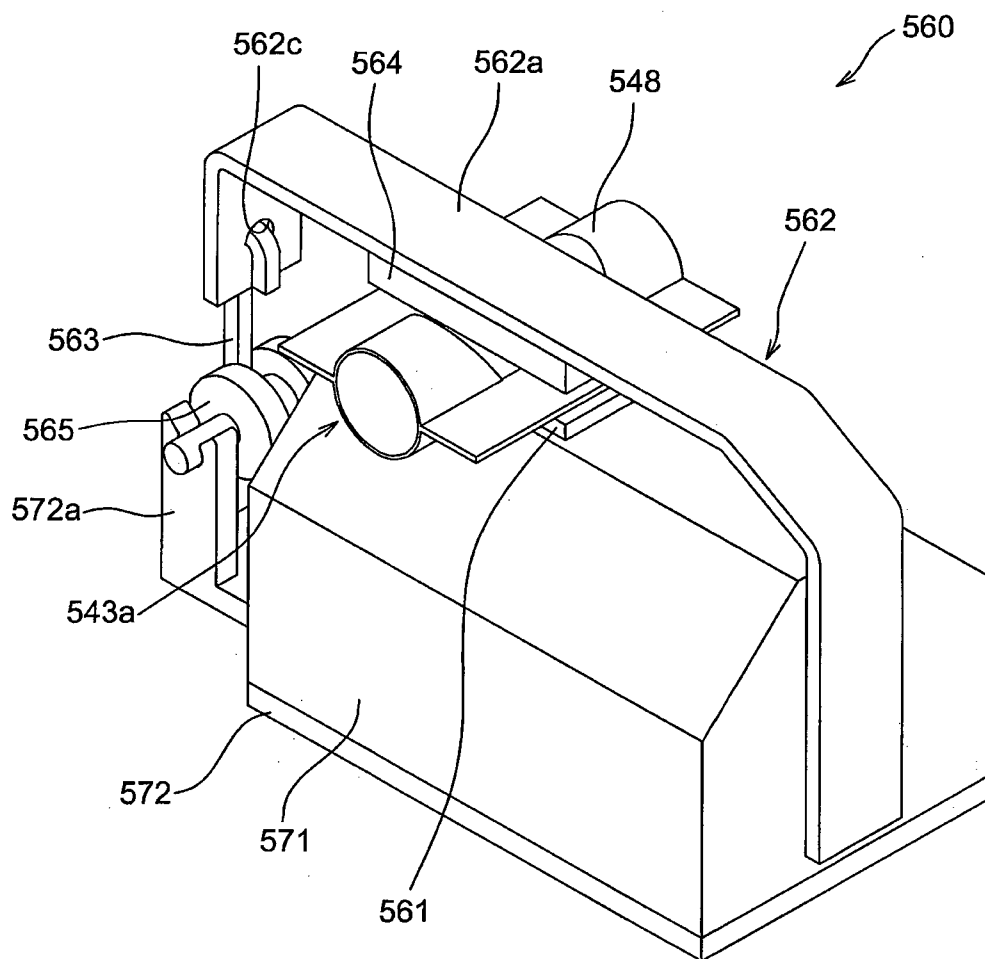


Fig.15

16/21

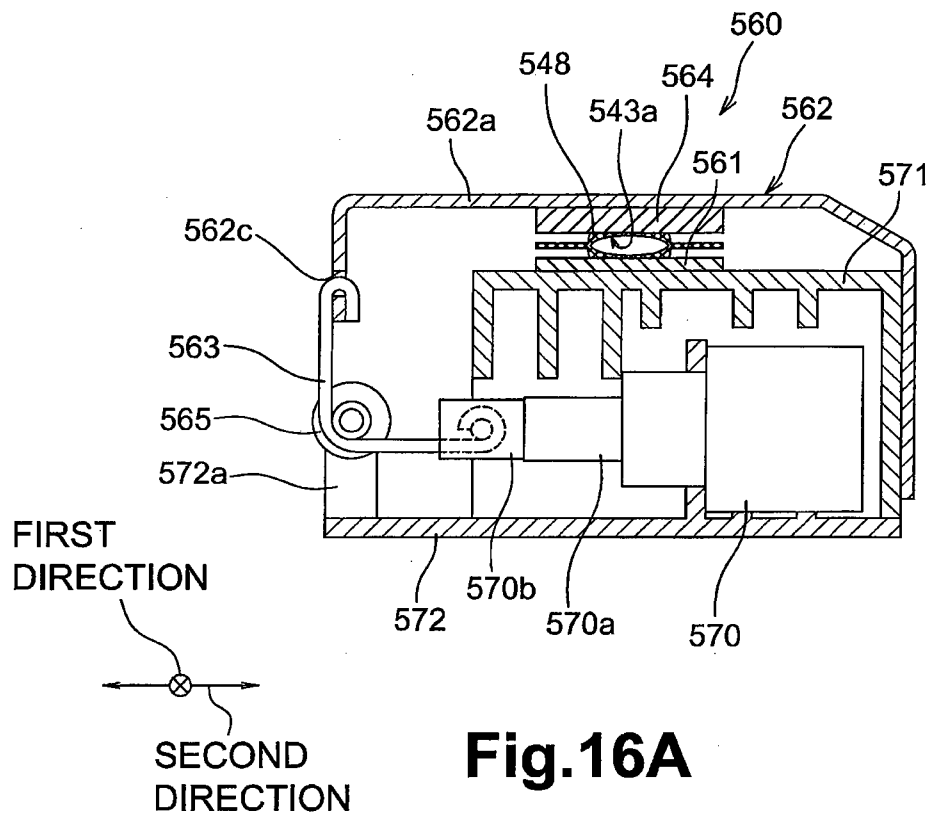


Fig.16A

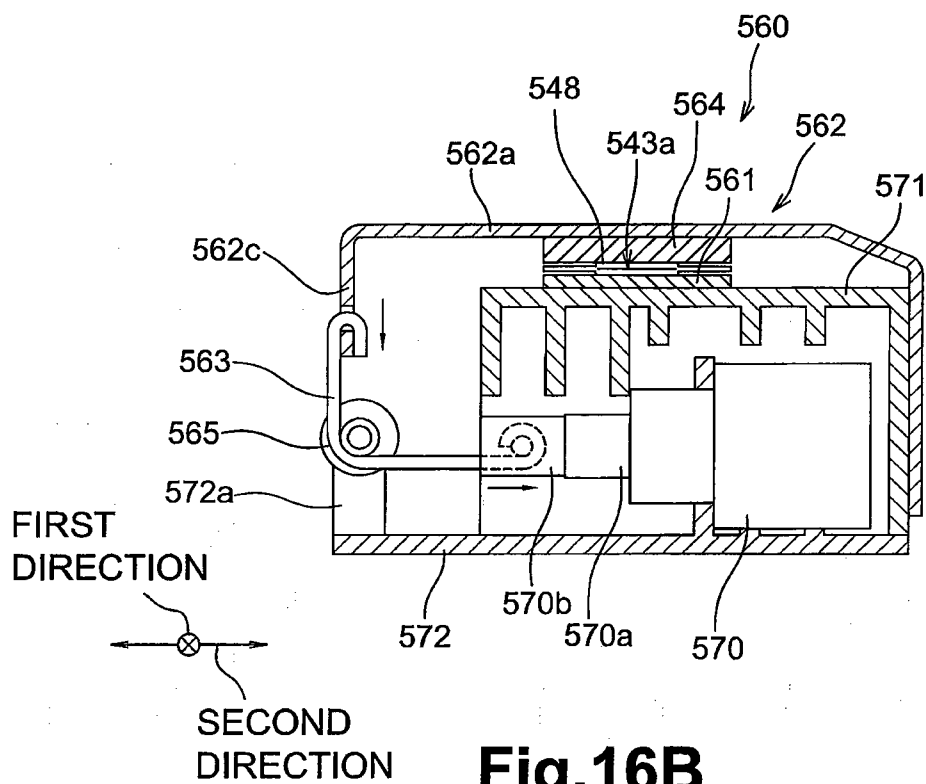


Fig.16B

17/21

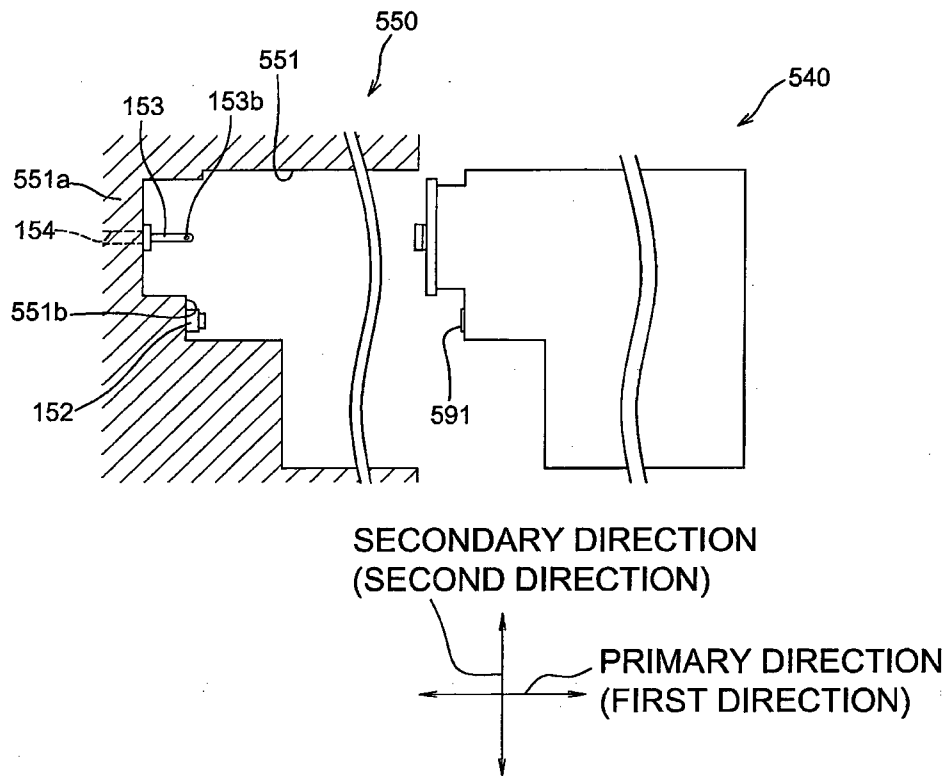


Fig.17A

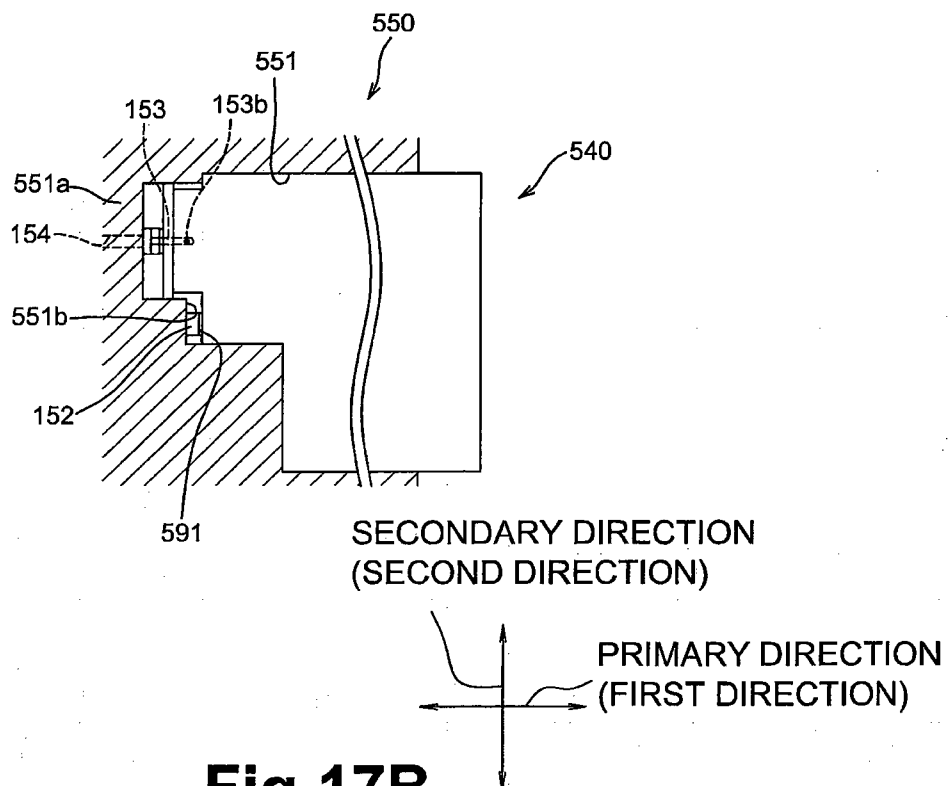


Fig.17B

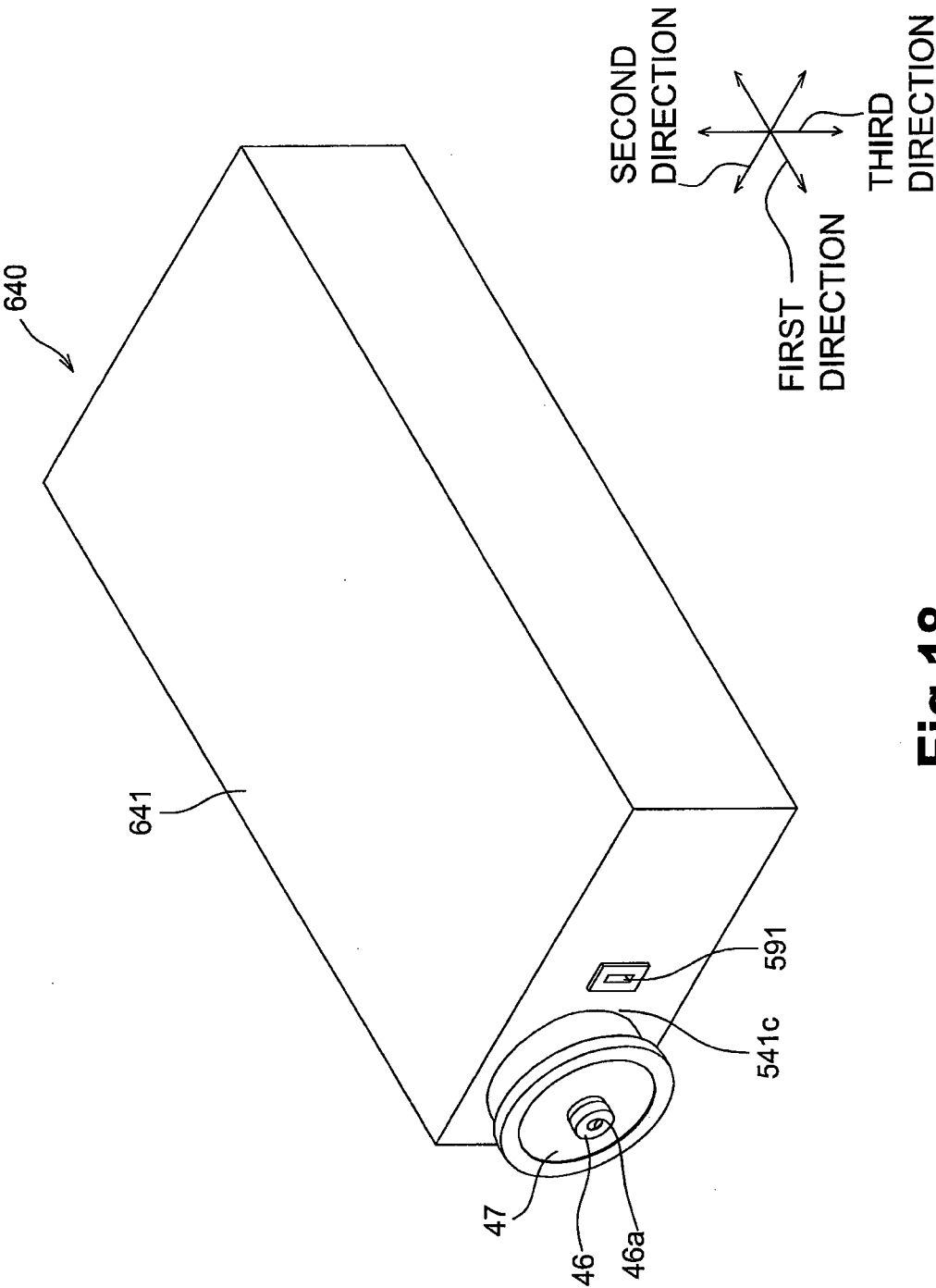


Fig. 18

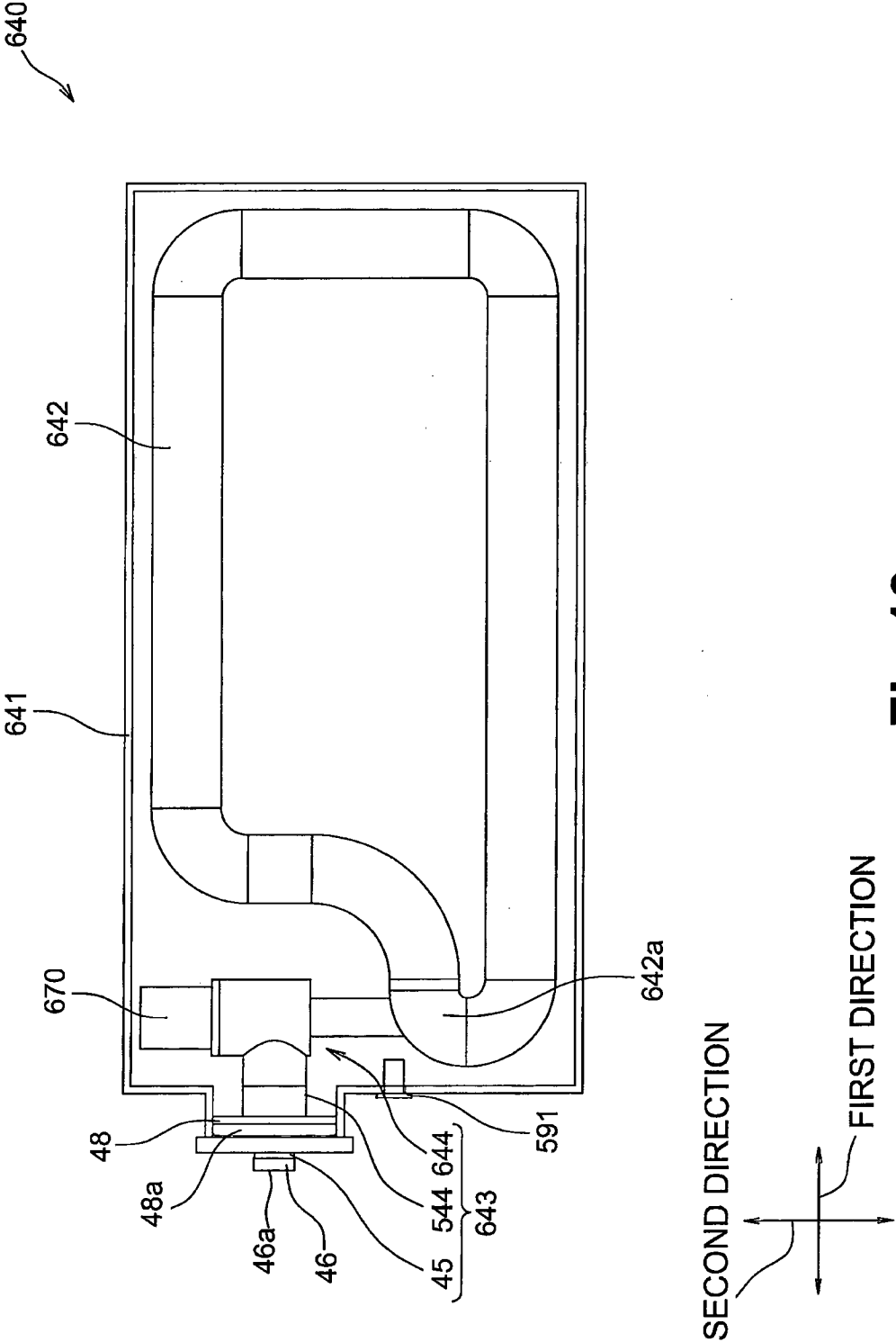


Fig. 19

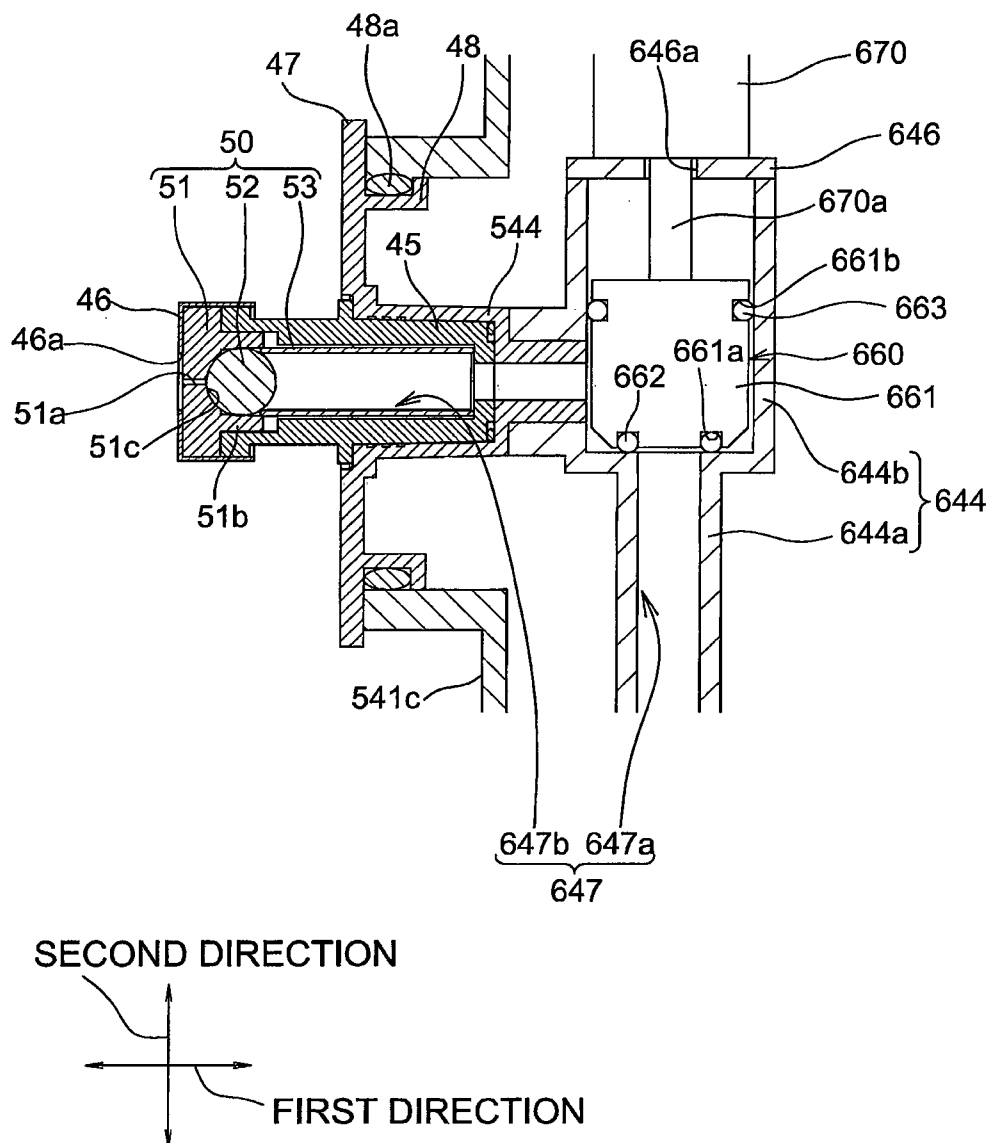


Fig.20

21/21

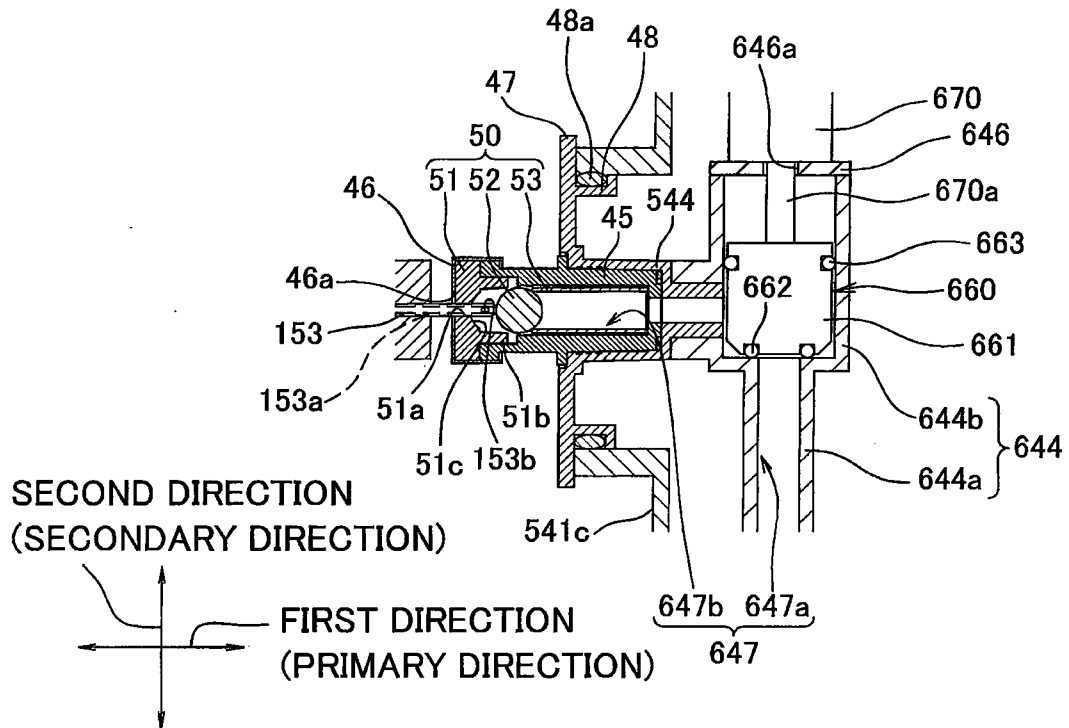


Fig.21A

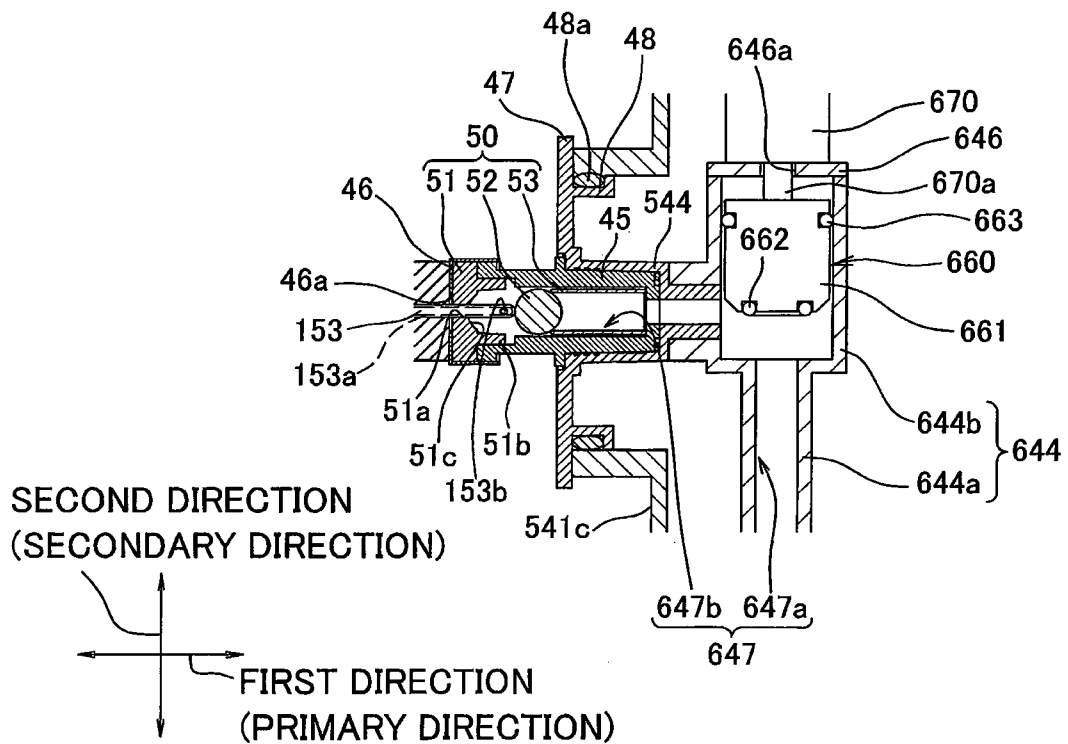


Fig.21B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/051681

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. B41J2/175 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. B41J2/175

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2011
 Registered utility model specifications of Japan 1996-2011
 Published registered utility model applications of Japan 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2005-77275 A (BABCOCK-HITACHI K.K.) 2005.03.24, Paragraphs [0011], [0015]-[0023], Fig.2, No family	15, 19 1-14, 16-18
A	EP 1584476 A1 (PRINT-RITE UNICORN IMAGE PRODUCTS Co.LTD.) 2004.07.29, Paragraphs [0004]-[0005], Fig.14-15, & CN 002614901 Y & WO 2004/062931 A1 & JP 2006-513060 A1	1-19
A	JP 2007-90730 A (BROTHER KOGYO K.K.) 2007.04.12, Fig.19, Fig.27 (a)-(c), No family	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

20.04.2011

Date of mailing of the international search report

10.05.2011

Name and mailing address of the ISA/JP

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan

Authorized officer

SATOMURA, Toshimitsu

Telephone No. +81-3-3581-1101 Ext. 3261

2P

9314

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/051681

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 08-118671 A (CANON INK.) 1996.05.14, Paragraph [0049], No family	8
A	JP 2008-213338 A (RICOH K.K.) 2008.09.18, claim 6, Fig.11, No family	8
A	JP 2001-199084 A1 (SEIKO EPSON INK.) 2001.07.24, claims 1, 8, 12, 14, Paragraphs [0049]-[0062], Fig.6 No family	8-10
A	JP 2009-34891 A (OLYMPUS K.K.) 2009.02.19, Paragraphs [0023]-[0030], Fig.1, Fig.4-5, No family	9
A	JP 11-254701 A (CANON INK.) 1999.09.21, Fig.6, No family	9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/051681

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1-19 share the following technical feature:

A liquid cartridge comprising: a liquid storing portion, a liquid outlet path, a first valve provided at the liquid outlet path configured to close the liquid outlet path, and a second valve provided in the path between the liquid storing portion and the first valve.

Since Fig. 14, 15 in EP 1584476 A1 discloses the above feature and no further common technical feature can not be regarded as "Special Technical Feature" under the meaning of the 2nd sentence of PCT regulation 13.2, claims 1-19 are not so linked as to form a single general inventive concept.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.