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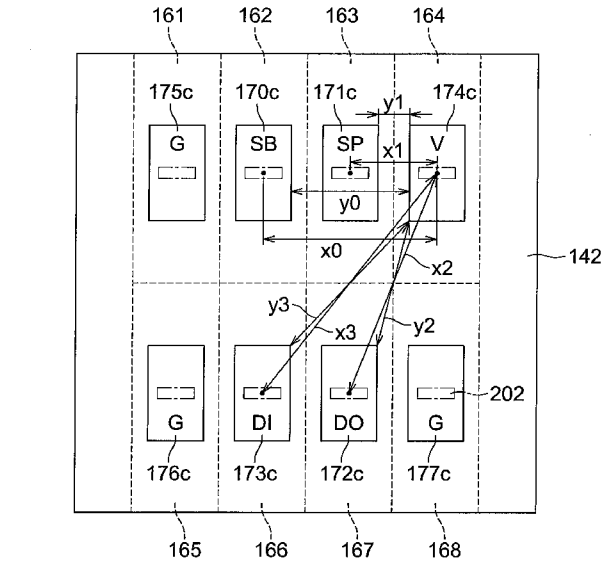
(54) Title: LIQUID CARTRIDGE AND IMAGE RECORDING DEVICE



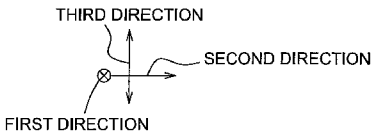


Fig.7

(57) Abstract: A liquid cartridge includes a casing, a liquid reservoir which stores more than 100 Milliliter liquid therein, a liquid flow path which places the liquid reservoir in fluid communication with an exterior, a sensor which detects a first and a second position of a movable member and configured to output a signal in relation to the first and second position of the movable member, a storage which stores data, and a substrate on which a plurality of terminals are disposed. The plurality of terminals includes a sensor terminal connected to the sensor, a data terminal connected to the storage, and a power terminal connected to at least one of the sensor and the storage. The distance between the power terminal and the data terminal is greater than a distance between the power terminal and the sensor terminal.

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DESCRIPTION

Title of Invention

LIQUID CARTRIDGE AND IMAGE RECORDING DEVICE

Technical Field

The invention relates to a liquid cartridge for storing liquid such as ink and an image recording device comprising the liquid cartridge and a main body configured to hold the liquid cartridge therein.

Background Art

An ink cartridge detachably mounted to an inkjet recording device is disclosed by Japanese laid-open patent publication No. 2007-196664. The ink cartridge includes a circuit board including a first short detection terminal, a ground terminal, a power supply terminal, a second short detection terminal, a first sensor drive terminal, a reset terminal, a clock terminal, a data terminal, and a second sensor drive terminal. The first sensor drive terminal and the second sensor drive terminal are electrically connected to the sensor which detects the remaining ink level. The data terminal is electrically connected to the memory which includes serially accessed memory cells and performs data read/write operations in sync with a clock signal. The first and second sensor terminals are arranged to the both ends of the circuit board.

Due to the advancing miniaturization of electrical equipment, a plurality of terminals has to be arranged on a comparatively narrow area of a substrate of a terminal chip disposed e.g. on a casing of a liquid cartridge. Due to the narrow arrangement of the terminals, the likelihood for short circuits between a power terminal on the terminal chip and e.g. a data terminal increases. In such a case, a need has arisen for preventing or reducing a short circuit between e.g. a power terminal and a data terminal connected to a storage, which e.g., stores data read or written from an exterior of the liquid cartridge (e.g., image recording device).

A reason for a short circuit between a plurality of terminals includes mist (e.g., ink mist) or liquid (e.g., ink) droplets. For example, the mist might be caused by ink ejected from an ink jet head of the image recording device, and adhering to the substrate on which the plurality of terminals are arranged.

In particular for high speed ink jet printers as e.g. line head ink printers using a

liquid cartridge with a large amount of liquid, a lot of ink mist might is generated by the ink jet head of the image recording device because of the high output of printed media.

It is therefore an object of the invention to improve the electrical overall robustness of a liquid cartridge for a line head printer in respect of electrical short circuits between the terminals of a substrate.

SUMMARY of Invention

Surprisingly, the inventor found that the likelihood for a short circuit is increased with the operation time of the high speed image recording device since the last insertion of the ink cartridge. In particular for high speed ink jet printers as e.g. line head ink printers, the inventors found out that the humidity within the printer casing increases with an increasing number of pages per time, because the humidity according to the rapid drying process of the various liquids (e.g. ink, water as a wetting means or ink pretreatment liquid) provided from the ink cartridge to the recording medium (e.g. paper) increases. Therefore, the risk for a short circuit at a contact terminal substrate increases with an increasing operation time.

Terminals of the substrate repeatedly sending and receiving data during and at the end of the insertion period are therefore more endangered than terminals sending and receiving data preferred during or shortly after the insertion of the cartridge into the liquid ejecting device.

In case, the distance of the terminal for the storage and the terminal for the sensor to the electric power input terminal is equal, the likelihood for damaging the storage due to a short circuit caused between the terminal for the storage and the electric power input terminal is higher than the likelihood for damaging the sensor due to a short circuit caused between the terminal for the sensor and the electric power input terminal.

Therefore, the protection of the terminals sending and receiving data repeatedly during the time of usage of the cartridge in the printer has to be improved.

In order to solve the above mentioned problem, embodiments of the present invention provide a liquid cartridge for a line head printer and an image recording device according to claims 1 to 15.

Therefore, to improve the electrical overall robustness of a liquid cartridge in respect of electrical short circuits, the invention provides a liquid cartridge for a line head printer comprising a casing comprising an outer surface and a liquid reservoir disposed in

the casing and configured to store more than 100 Milliliter liquid therein and a liquid flow path is configured to place the liquid reservoir in fluid communication with an exterior of the liquid cartridge on the outer surface of the casing and a sensor configured to detect a first and a second position of a movable member and configured to output a signal in relation to the first and second position of the movable member and a storage configured to store data and a substrate disposed on the outer surface of the casing and on which a plurality of terminals are disposed. The plurality of terminals comprises a sensor terminal connected to the sensor and a data terminal connected to the storage and a power terminal connected to at least one of the sensor and the storage. The distance between the power terminal and the data terminal is greater than a distance between the power terminal and the sensor terminal.

According to one aspect of the invention the liquid reservoir of the liquid cartridge is configured to provide liquid from the liquid reservoir to the exterior of the liquid cartridge in such an amount that at certain positions of the line head printer the humidity increases.

According to another aspect of the invention the sensor of the liquid cartridge is configured to output the signal in relation to the first and second position of the movable member during or shortly after installing the liquid cartridge into an installing portion of the line head printer and the data terminal is configured to transmit data repeatedly during the time of usage of the cartridge in the line head printer.

According to another aspect of the invention a plurality of terminals of the liquid cartridge comprise the sensor terminal and the power terminal are arranged in a first line and a plurality of terminals comprising the data terminal are arranged in a second line substantially parallel to the first line and a distance between the terminals arranged in the first line and the terminals arranged in the second line is greater than a distance between the terminals arranged in the first line.

According to another aspect of the invention the sensor terminal of the liquid cartridge is positioned adjacent to the power terminal in the first line.

According to another aspect of the invention a ground terminal of the liquid cartridge is positioned in the second line.

According to another aspect of the invention the plurality of terminals comprise the sensor terminal, the data terminal, and the power terminal arranged in a line.

According to another aspect of the invention the sensor terminal is positioned

adjacent to the power terminal.

According to another aspect of the invention a ground terminal, and the sensor terminal and the data terminal are positioned between the power terminal and the ground terminal.

According to another aspect of the invention the data stored in the storage comprises information data relating to an amount of liquid remaining in the liquid reservoir. According to another aspect of the invention the data stored in the storage of the liquid cartridge comprises information data relating to the number of sheets that have been recorded.

According to another aspect of the invention an image recording device is provided comprising a liquid cartridge as described above and a main body to which the liquid cartridge is attached, the main body comprises an installing portion into which the liquid cartridge is installed and a hollow member configured to be inserted into the liquid cartridge installed in the installing portion and a liquid discharge head configured to be in fluid communication with the hollow member and to discharge liquid received from the liquid cartridge via the hollow member and a communication section that performs communication with the liquid cartridge installed in the installing portion and a sensor signal receiving terminal configured to establish electric connections with the communication section and a data receiving terminal configured to establish electric connections with the communication section and a power supply and an electric power output terminal configured to establish electric connections with the power supply. The communication section is configured to read the data stored in the storage via the data output terminal and the data receiving terminal and is configured to receive the signal from the sensor via the sensor signal output terminal and the sensor signal receiving terminal.

According to another aspect of the invention the storage is configured to store data relating to the signal, and the communication section is further configured to determine whether a read error has occurred during reading of the data and to prohibit the recording operation when the read error has occurred.

According to another aspect of the invention the communication section writes, into the storage of the liquid cartridge, at least one of data relating to an amount of liquid discharged from the liquid discharge head during the recording operation, and data relating to the number of recording media recorded.

According to another aspect of the invention the communication section receives

the signal from the sensor during or shortly after installing the liquid cartridge into the installing portion of the main body and transmits data through the data terminal repeatedly during the time of usage of the liquid cartridge in the image recording device.

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

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

Fig. 1 is a perspective view showing an appearance of an ink jet printer according to a first embodiment of the invention;

Fig. 2 is a schematic side view showing an internal structure of the printer;

Fig. 3 is a perspective view showing a cartridge according to the first embodiment of the invention;

Fig. 4 is a schematic view showing an internal structure of the cartridge of Fig. 3;

Fig. 5A is a partial sectional view of an area designated by arrow V in Fig. 4, wherein a hollow tube of the printer is not inserted into a plug of the cartridge and a valve of the cartridge is in a closed position;

Fig. 5B is a partial section view of the area designated by arrow V in Fig. 4, wherein the hollow tube of the printer is inserted into the plug of the cartridge and the valve of the cartridge is in an open position and;

Fig. 6 is a partial sectional view taken along a line VI-VI in Fig. 5A;

Fig. 7 is a drawing showing terminals of the cartridge according to the first embodiment of the invention, and viewed in the direction of the appended arrow VII in Fig. 4;

Figs. 8A to 8C are schematic plan views showing a process of installing the cartridge to the printer;

Fig. 9 is a block diagram showing an electrical configuration of the cartridge and the printer;

Fig. 10 is a functional block diagram showing sections embodied by a controller of the printer;

Fig. 11 is a flowchart showing control executed by the controller of the printer while the cartridge is installed in the printer;

Fig. 12 is a graph showing a relationship between a position of the valve of the cartridge and an output value from a Hall device of the cartridge;

Fig. 13 is a drawing showing terminals of a cartridge according to a second embodiment of the invention;

Fig. 14 is a drawing showing terminals of a cartridge according to a third embodiment of the invention;

Fig. 15 is a drawing showing terminals of a cartridge according to a fourth embodiment of the invention;

Fig. 16 is a drawing showing terminals of a cartridge according to a fifth embodiment of the invention;

Fig. 17 is a drawing showing terminals of a cartridge according to a sixth embodiment of the invention

Fig. 18 is a drawing showing terminals of the printer according to the first embodiment of the invention, and viewed in an inserting direction of Fig. 8A; and

Fig. 19 is a partial sectional view taken along a line XIX-XIX in Fig. 18.

Description of Embodiments

Embodiments of the invention will be described with reference to the accompanying drawings.

Referring to Fig. 1, a general structure of an image recording device, e.g., a high speed ink jet printer 1, according to an embodiment of the invention will be described.

The printer 1 comprises a housing 1a having a substantially rectangular parallelepiped shape. A sheet discharge portion 31 is provided at the top of the housing 1a. 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. A sheet feed unit 1b and a cartridge unit 1c are inserted into the housing 1a through the opening 10b and the opening 10c, respectively. The printer 1 comprises a door 1d fitted into the opening 10d and configured to pivot about a horizontal axis at its lower end. When the door 1d is pivoted to be opened and closed, the opening 10d is covered and uncovered. The door 1d is disposed facing a transport unit 21 (See Fig. 2) in a primary direction of the housing 1a, e.g., in a direction perpendicular to a

direction that the vertically extending faces of the housing 1a extend.

Referring to Fig. 2, an internal structure of the printer 1 will be described.

An interior of the housing 1a is divided into sections A, B, and C in the vertical direction in this order from above. Two heads 2, e.g. line heads for high speed printing, the transport unit 21, and a controller 100 are disposed in the section A. The heads 2 are configured to discharge black ink and pretreatment liquid (hereinafter, the black ink and the pretreatment liquid are collectively referred to as liquid), respectively.

For high speed ink jet printers as e.g. line head ink printers, the humidity within the printer casing increases with an increasing number of printed pages per time, because the humidity according to the rapid drying process of the various liquids (e.g. ink and pretreatment liquid and water as a wetting means) provided from the ink cartridge to the recording medium (e.g. paper) increases. The rapid drying process is necessary for high speed ink jet printers to ensure a clean type face when dumping and stacking the printed recording media. The transport unit 21 is configured to transport sheets P. The controller 100 is configured to control operations of each component of the printer 1. The sheet feed unit 1b is disposed in the section B. The cartridge unit 1c is disposed in the section C. A sheet transport path along which sheets P are transported is formed in the interior of the printer 1 to extend from the sheet feed unit 1b toward the sheet discharge portion 31, as shown by bold arrows in Fig. 2.

The controller 100 comprises a central processing unit (CPU), a read-only memory (ROM), a random access memory (RAM) such as a nonvolatile RAM, and an interface. The ROM is configured to store programs to be executed by the CPU and various fixed data. The RAM is configured to temporarily store data, e.g., image data, necessary for the CPU to execute programs. The controller 100 is configured to transmit and receive data to and from a memory 141 (See Fig. 4) and Hall devices 71 of a cartridge 40, and transmit and receive data to and from an external device, e.g., a personal computer connected to the printer 1, via the interface.

The sheet feed unit 1b comprises a sheet feed tray 23 and a sheet feed roller 25. The sheet feed tray 23 is configured to be attached to and detached from the housing 1a in the primary direction. The sheet feed tray 23 is a box open upward and is configured to store sheets P of different sizes. 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 125 (See Fig. 9) that is controlled by the controller 100. The sheet P fed out by the sheet feed roller

25 is sent to the transport unit 21 while being guided by guides 27a and 27b and nipped by a pair of feed rollers 26.

The transport 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 of the belt roller 7 is driven by a transport motor 127 (See Fig. 9) 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.

A platen 19 having a substantially rectangular parallelepiped shape is disposed within the loop of the transport belt 8 so as to face the heads 2. An outer surface 8a of the transport belt 8 at an upper portion of the loop faces lower surfaces 2a of the heads 2, and extends in parallel with the lower surfaces 2a with a slight gap formed between the lower surfaces 2a and the outer surface 8a. The platen 19 supports an inner surface of the transport belt 8 at the upper portion of the loop. The lower surface 2a of each head 2 is a discharge surface where multiple discharge nozzles for discharging liquid are formed.

A silicone layer having a low adhesive property is formed on the outer surface 8a of the transport belt 8. The sheet P fed out from the sheet feed unit 1b toward the transport unit 21 is pressed by a pressing roller 4 against the outer surface 8a of the transport belt 8. While being held on the outer surface 8a by the adhesive property, the sheet P is transported in a secondary direction as shown by bold arrows in Fig. 2.

The secondary direction is parallel with a transport direction in which the transport unit 21 transports the 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.

When the sheet P held on the outer surface 8a of the transport belt 8 passes immediately below the heads 2, the heads 2 discharge the black ink or both of the black ink and the pretreatment liquid, as required, from the lower surfaces 2a toward the upper surface of the sheet P under control of the controller 100, thereby recording a desired image on the sheet P. A separating plate 5 is configured to separate the sheet P from the outer surface 8a of the transport belt 8. The sheet P is then separated from the outer surface 8a of the transport belt 8 by the separating plate 5 and is transported upward while being guided by guides 29a, 29b and being nipped by two pairs of discharge rollers 28. Then, the sheet P is discharged onto the sheet discharge portion 31 from an opening 30

formed at the top of the housing 1a. One roller of each discharge roller pair 28 is driven by a discharge motor 128 (See Fig. 9) controlled by the controller 100.

The pretreatment liquid has various properties, e.g., a property of improving a density of ink discharged onto the sheet P, a property of preventing the occurrence of ink blurring or strike-through (i.e., the penetration of ink through the sheet P that is being recorded), and a property of improving color reproduction and a quick dry property of ink, and a property of preventing the occurrence of wrinkles or curls on the sheet P after ink is discharged on the sheet P. For example, liquid containing a polyvalent salt, such as cationic high polymer or a magnesium salt, may be used as the pretreatment liquid.

The head 2 for discharging the pretreatment liquid is disposed upstream from the head 2 for discharging the black ink in the transport direction.

Each head 2 is a line type head elongated in the primary direction and has a substantially rectangular parallelepiped shape. The heads 2 are aligned in the secondary direction with a predetermined pitch and are supported by the housing 1a via a frame 3. A joint (not shown) is disposed at an upper surface of each head 2 for receiving a flexible tube. Multiple discharge nozzles (not shown) are formed in the lower surface 2a of each head 2. A flow path is formed inside each head 2 such that liquid supplied from a corresponding reservoir 42 of the cartridge 40, via a corresponding tube and a corresponding joint, flows to corresponding discharge nozzles.

The cartridge unit 1c comprises a tray 35, and the cartridge 40 configured to be disposed in the tray 35. The cartridge 40 comprises the reservoirs 42 (See Fig. 4) for storing, e.g. black, ink and pretreatment liquid, respectively. The liquid stored in each reservoir 42 of the cartridge 40 is supplied to the corresponding head 2 via the corresponding flexible tube and the corresponding joint.

The tray 35 is configured to be detachably attachable to the housing 1a in the primary direction in a state where the cartridge 40 is disposed in the tray 35. Accordingly, the cartridge 40 disposed in the tray 35 can be replaced with a new one in a state where the tray 35 is detached from the housing 1a.

Referring to Figs. 3 to 7, a structure of the cartridge 40 will be described.

As shown in Figs. 3 and 4, the cartridge 40 comprises a housing 41, a black ink unit 40B, a pretreatment liquid unit 40P, a memory 141, and a substrate 142.

Each of the black ink unit 40B and the pretreatment liquid unit 40P comprises the reservoir 42, an ink outlet tube 43, a plug 50, a valve 60, and a sensor unit 70. The black

ink unit 40B and the pretreatment liquid unit 40P have the same structure (See Fig. 5).

As shown in Fig. 3, the housing 41 has a substantially rectangular parallelepiped shape. As shown in Fig. 4, the interior of the housing 41 is divided into two chambers 41a and 41b. The black ink unit 40B and the pretreatment liquid unit 40P are disposed in the chamber 41a. The ink outlet tubes 43 of the black ink unit 40B and the pretreatment liquid unit 40P are disposed in the chamber 41b.

Each reservoir 42 is a bag for storing liquid therein and has an opening to which one end of the ink outlet tube 43 is connected. The reservoir 42 of the black ink unit 40B is configured to store black ink therein. According to one embodiment of the invention, the liquid reservoir is configured to store more than 100 Milliliter liquid. The reservoir 42 of the pretreatment liquid unit 40P is configured to store pretreatment liquid therein. According to another embodiment of the invention, each of the liquid reservoirs 42 and 40P is configured to store more than 100 Milliliter liquid. According to another embodiment of the invention, the liquid reservoir 42 is configured to store more than 400 Milliliter and the liquid reservoir 40P is configured to store more than 250 Milliliter liquid.

The ink outlet tube 43 defines an ink outlet path 43a for discharging the liquid stored in the reservoir 42 to the head 2 (See Fig. 5A).

As shown in Fig. 4, the other end of the ink outlet tube 43 protrudes from the housing 41 of the cartridge 40. The ink outlet tube 43 has an opening 43b at a side opposite to the reservoir 42. A plug 50 made of an elastic material, e.g., rubber, is disposed in a compressed state at the other end of the ink outlet tube 43 such that the plug 51 closes the opening 43b of the ink outlet path 43a (See Fig. 5A). A cap 46 is provided at the other end of the ink outlet tube 43 and outside the plug 50. The cap 46 has an opening 46a formed substantially in its center. A surface, which is an opposite side of a surface facing the valve 60, of the plug 50 is partially exposed through the opening 46a.

As shown in Fig. 5A, the valve 60 is disposed in the ink outlet path 43a and comprises an O-ring 61 and a valve body 62.

As shown in Figs. 5A to 6, the valve body 62 is a cylindrical-shaped magnetic body having an axis extending in a second direction. When the cartridge 40 is installed in the housing 1a, a first direction is aligned with the primary direction, the second direction is aligned with the secondary direction, and a third direction is aligned with the vertical direction.

As shown in Fig. 6, the ink outlet tube 43 has a substantially cylindrical-shape.

The valve body 62 is disposed at a portion in the ink outlet tube 43. The portion of the ink outlet tube 43 comprises flat top and bottom walls and curved side walls. The portion of the ink outlet tube 43 is elongated in the first direction in cross section which extends in a direction perpendicular to the second direction. Protrusions 43p are provided at inner surfaces of the respective side walls of the ink outlet tube 43 in the first direction so as to protrude toward the inside of the ink outlet tube 43. Each protrusion 43p extends along the second direction within an area in which the valve body 62 is movable. The valve body 62 is held by the protrusions 43p and the top and bottom walls of the ink outlet tube 43 such that the valve body 62 is positioned substantially at the center of the ink outlet path 43a when viewed in cross-section. A flow path is defined by a gap between the valve body 62 and the ink outlet tube 43 at a portion where the valve body 62, the protrusions 43p and the top and bottom walls of the ink outlet tube 43 do not contact with each other.

The O-ring 61 is made of an elastic material, e.g., rubber. The O-ring 61 is fixed to a surface, facing the plug 50, of the valve body 62.

The valve 60 is pressed toward an opening 43y of a narrowed portion 43x of the ink outlet path 43 by a coil spring 63. The coil spring 63 is fixed, at its one end, to the one end of the ink outlet tube 43, and at its other end, is in contact with the other surface of the valve body 62.

As shown in Fig. 5A, the ink outlet tube 43 comprises a valve seat 43z that protrudes toward the center of the diameter of the ink outlet tube 43 from one end (which is provided near the opening 43b) of the narrowed portion 43x. When the valve 60 is in a closed position, at which the valve 60 closes the ink outlet path 43a, the O-ring 61 is in contact with the valve seat 43z to seal the opening 43y at the one end of the narrowed portion 43x of the ink outlet tube 43. Thus, fluid communication between the reservoir 42 and the outside of the reservoir 42 via the ink outlet path 43a is prevented. In this state, the O-ring 61 is elastically deformed by the biasing force of the coil spring 63.

The sensor unit 70 comprises the Hall device 71 and a magnet 72. The magnet 72 produces a magnetic field. The Hall device 71 is a magnetic sensor that detects a magnetic field of the magnet 72, converts the detected magnetic field to an electric signal, and generates the electric signal. In the embodiment, the Hall device 71 generates a signal, which indicates a voltage proportioned to the magnetic field magnitude that varies in accordance with the movement of the valve body 62.

The Hall device 71 is disposed at a position where the Hall device 71 is capable of

detecting the magnetic field produced by the magnet 72 and the valve body 62 (See Fig. 5A).

As shown in Fig. 5A, the Hall device 71 and the magnet 72 are fixed to the top wall and the bottom wall, respectively, so as to face each other in the third direction.

When the valve 60 is in the closed position, the Hall device 71 and the magnet 72 face each other while sandwiching the valve body 62 therebetween, i.e., the valve body 62 is interposed between the Hall device 71 and the magnet 72. In this state, the magnetic field produced by the magnet 72 efficiently reaches the Hall device 71 via the valve body 62. Accordingly, the Hall device 71 detects a high magnetic field magnitude and generates a signal indicating a high voltage.

While the valve 60 moves from the closed position (See Fig, 5A) to an open position (See Fig. 5B), at which the valve 60 opens the ink outlet path 43a, the magnetic field magnitude detected by the Hall device 71 becomes lower in accordance with the movement of the valve body 62 to the position where the valve body 62 does not face the Hall device 71 and the magnet 72 in the vertical direction, i.e., the valve body 62 is not positioned between the Hall device 71 and the magnet 72. Thus, the voltage indicated by a signal generated by the Hall device 71 becomes lower.

The controller 100 receives a signal generated by the Hall device 71 and determines whether the valve 60 is in the closed position or in the open position based on a voltage indicated by the signal generated by the Hall device 71.

The substrate 142 is provided at an outer surface of a downstream wall of the housing 41 of the cartridge 40 in a direction that the cartridge 40 is inserted into the section C (hereinafter, referred to as an inserting direction). The inserting direction is parallel with the first direction of the cartridge 40.

The memory 141 is provided opposite to the substrate 142. The memory 141 comprises an electrically erasable programmable ROM (EEPROM) or the like and is configured to store data relating to the cartridge 40. More specifically, the memory 141 prestores a liquid reservoir capacity (an amount of liquid stored in each reservoir 42 of a brand-new cartridge 40), sensor output values (output values Vmax and Vmin received from each Hall device 71 (See Fig. 12)), a manufacture date (year, month, and day of manufacture of a cartridge 40). The controller 100 can read those data from the memory 141 while the cartridge 40 is installed in the printer 1. In addition, while the cartridge 40 is installed in the printer 1, the controller 100 can write, in the memory 141, with various

data, e.g., a liquid usage amount (an amount of liquid that has been used in each reservoir 42, i.e., an amount of liquid that has been discharged from each head 2), the number of hollow tube insertions (the number of times the hollow tubes 153 have been inserted into the respective plugs 50), the number of recorded sheets (the number of sheets P which have been recorded by using the liquid stored in the cartridge 40), and a cumulative usage time (a total period of time during which the cartridge 40 is installed in the printer 1, which is the same as a total period of time during which the hollow tubes 153 are inserted into the respective ink outlet path 43a). The controller 100 can read those written data stored in the memory 141 while the cartridge 40 is installed in the printer 1.

As shown in Fig. 7, eight terminals 170c to 177c are provided on a surface of the substrate 142. The terminals 170c to 177c have substantially the same size and shape and are exposed at the outer surface of the cartridge 40. A shape of each of the terminals 170c to 177c is a substantially rectangle that includes two shorter sides extending in a direction parallel to the second direction and two longer sides extending in a direction parallel to the third direction. The terminals 170c to 177c are arranged in two rows.

It is assumed that each distance between centers of the terminal 174c and a respective one of the terminals 170c to 173c is x0, x1, x2, and x3 and each shortest distance between edges of the terminal 174c and a respective one of the terminals 170c to 173c is y0, y1, y2, and y3. The terminals 170c to 174c are arranged on the substrate 142 such that their positional relationship satisfies $x1 < x0 < x2 < x3$ and $y1 < y0 < y2 < y3$. xn (n = 0, 1, 2, or 3) represents a distance between centers of terminals 174c and 17nc. yn (n = 0, 1, 2, or 3) represents a shortest distance between edges of terminals 174c and 17nc.

As shown in Fig. 9, the sensor signal output terminal (SB) 170c is electrically connected with the Hall sensor 71 of the black ink unit 40B. The sensor signal output terminal (SP) 171c is electrically connected with the Hall sensor 71 of the pretreatment liquid unit 40P. The data output terminal (DO) 172c and the data input terminal (DI) 173c are electrically connected to the memory 141. The ground terminals (G) 175c, 176c, 177c are electrically connected with the memory 141, the Hall device 71 of the pretreatment liquid unit 40P, and the Hall device 71 of the black ink unit 40B, respectively.

A substrate 182 is provided on a surface of the wall that extends in a direction perpendicular to the inserting direction (the primary direction) and is one of the walls defining the section C in the housing 1a of the printer 1, as shown in Fig. 8A.

The substrate 182 has substantially the same size as the substrate 142. The substrate 182 is disposed so as to face the substrate 142 of the cartridge 40 when the cartridge 40 is installed in a predetermined position (See Fig. 8B) in the section C. A base material 201 is disposed on a surface of the substrate 182 as shown in Figs. 18 and 19. Eight terminals 170p to 177p are provided on a surface of the base material 201 such that the terminals 170p to 177p correspond to the terminals 170c to 170c, respectively.

As shown in Fig. 19, each of the terminals 170p to 177p is made of a leaf spring having a substantially C-shape in cross section, and has a first end 205, a second end 203, and a top portion 202. In each of the terminals 170p to 177p, the first end 205 is a fixed end that is fixed to the substrate 182 to establish electric connections therebetween and the second end 203 is a free end that can bend at a portion 204. The second end 203 is urged in the primary direction and in a direction that the second end 203 approaches the terminals 170c to 177c of the cartridge 40 installed in the predetermined position in the section C.

The terminals 170p to 177p are arranged in a mirror image of the terminals 170c to 177c such that the terminals 170p to 177p make contact with the terminals 170c to 177c, respectively, when the cartridge 40 is installed in the predetermined position in the section C.

Specifically, the terminals 170p to 177p are arranged such that their top portions 202 make contact with the centers of the terminals 170c to 177c, respectively, when the cartridge 40 is installed in the predetermined position in the section C.

As shown in Fig. 9, the sensor signal receiving terminal (SB) 170p, the sensor signal output terminal (SP) 171p, the data receiving terminal (DO) 172p, and the data transmitting terminal (DI) 173p are electrically connected with the controller 100. The electric power output terminal (V) 174p is electrically connected with a power supply 158. The ground terminals 175p, 176p, 177p are grounded. The power supply 158 is provided inside the housing 1a.

A process of installing the cartridge 40 into the printer 1 will be described with reference to Figs. 5A to 12, 18 and 19. The tray 35 is not illustrated in Figs. 8A to 8C for sake of simplicity. In Fig. 9, electric power supply lines are shown by thick lines and signal lines are shown by thin lines.

While the cartridge 40 is separated from the printer 1, hollow tubes 153 of the printer 1 are not inserted into the respective plugs 50 of the black ink unit 40B and the pretreatment liquid unit 40P. Therefore, the valves 60 are held at the open positions (See

Fig. 5A). In this state, electric connections between the terminals 170c to 177c and the corresponding terminals 170p to 177p are not established. Thus, the electric power is not supplied to the Hall devices 71 or the memory 141, and the controller 100 is not capable of performing signal transmission and reception with the Hall devices 71 and the memory 141.

For installation of the cartridge 40 into the printer 1, the cartridge 40 is placed in the tray 35 first (See Fig. 2) and the tray 35 is inserted into the section C of the housing 1a in the primary direction (in a direction shown by an open arrow in Fig. 8A) such that the terminals 170c to 177c of the cartridge 40 are in contact with the corresponding terminals 170p to 177p of the housing 1a as shown in Fig. 8B.

In the state shown in Fig. 8B, the centers of the terminals 170c to 177c are in contact with the top portions 202 of the corresponding terminals 170p to 177p to establish electric connections therebetween. Thus, the electric power is supplied from the power supply 158 to the Hall devices 71 and the memory 141 via the terminals 174p and 174c. Further, the controller 100 becomes capable of receiving signals from the Hall device 71 of the black ink unit 40B via the terminals 170c and 170p, receiving signals from the Hall device 71 of the pretreatment liquid unit 40P via the terminals 171c and 171p, reading data from the memory 141 via the terminals 172c and 172p, and writing data into the memory 141 via the terminals 173c and 173p.

In a process of installing the cartridge 40 into the printer 1, first, the centers of the terminals 170c to 177c contact the top portions 202 of the corresponding terminals 170p to 177p immediately before the cartridge 40 is completely installed in the printer 1. Then, until the cartridge 40 is completely installed in the printer 1, the terminals 170c to 177c press the corresponding terminals 170p to 177p to change states of the terminals 170p to 177p from a state shown in a solid line to a state shown in a dashed line as shown in Fig. 19. That is, the terminals 170p to 177p bend at their portions 204 in the primary direction and in a direction that the second ends 203 distance from the terminals 170c to 177c of the cartridge 40 installed in the predetermined position in the section C. The terminals 170c to 177c have contact portions (shown by dot and dashed lines in Fig. 7), respectively, to which the top portions 202 of the corresponding terminals 170p to 177p contact after the cartridge 40 is completely installed in the printer 1. The contact portions include the centers of the terminals 170c to 177c, respectively. The contact portions in the terminals 175c, 170c 171c, 174c arranged in the top row gradually shift upward in the vertical

direction from a position slightly below the contact portions shown in Fig. 7 and the contact portions in the terminals 176c, 173c, 172c, 177c arranged in the bottom row gradually shift downward in the vertical direction from a position slightly above the contact areas shown in Fig. 7 in a period of time from immediately before and until after the cartridge 40 is completely installed in the printer 1.

A support member 154 is provided to a wall, which extends in the direction perpendicular to the secondary direction, faces the caps 46 of the cartridge 40 when the cartridge 40 is installed in the predetermined position in the section C, and is one of the walls defining the section C of the housing 1a. The support member 154 is configured to be movable in the secondary direction with respect to the housing 1a while supporting the hollow tubes 153. The hollow tubes 153 correspond the head 2 for discharging the black ink and the head 2 for discharging the pretreatment liquid, respectively. The hollow tubes 153 are in fluid communication with the respective flexible tubes attached to the joints of the corresponding heads 2.

In the state shown in Fig. 8B, the cartridge 40 is separated from the hollow tubes 152 so that the reservoirs 42 are not in fluid communication with the corresponding flow paths of the corresponding heads 2.

The printer 1 comprises an installation detection switch 159 that is configured to detect an installation of the cartridge 40 in the predetermined position in the section C (See Fig. 9).

The installation detection switch 159 comprises a protrusion at the wall that extends in the direction perpendicular to the inserting direction and is one of the walls defining the section C of the housing 1a. The protrusion is disposed near the substrate 182, for example. Before the cartridge 40 is installed into the section C, the protrusion protrudes from the wall. When the cartridge 40 is inserted into the section C and is placed at the position shown in Fig. 8B, the protrusion retracts in the wall by the pressing of the housing 41 of the cartridge 40. The installation detection switch 159 is configured to output OFF signals when the protrusion protrudes from the wall and ON signals when the protrusion retracts in the wall.

The controller 100 determines whether the cartridge 40 has been installed in the predetermined position in the section C, based on a signal received from the installation detection switch 159 (S1 in Fig. 11. Hereinafter, S stands for a step). When the controller 100 detects that the cartridge 40 has been installed in the predetermined position

in the section C by the receipt of an ON signal from the installation detection switch 159 (S1:YES), the controller 100 records the time at which the cartridge 40 is installed in the predetermined position (the installation time) (S2) and reads, from the memory 141 of the cartridge 40, the data of the liquid reservoir capacity, the sensor output values, the manufacture date, the liquid usage amount, the number of hollow tube insertions, the number of recorded sheets, and the cumulative usage time (S3).

After S3, the controller 100 determines whether a read error has occurred (S4). When the controller 100 could not perform a reading procedure normally, the controller 100 determines that a read error has occurred (S4:YES) and notifies the error via an output device 160, e.g., a display or a speaker of the printer 1 (S5) (See Fig. 9). After S5, the controller 100 stops operations of each component of the printer 1 (S6).

The read error may occur due to damage to the memory 141 caused by a short circuit occurred between the terminal 172c the terminal 174c or due to a malfunction in communications capabilities of the controller 100 caused by a short circuit occurred between the terminal 173c and the terminal 174c.

When the controller 100 could not perform a reading procedure normally in S4, the controller 100 determines that a read error has not occurred (S4:NO). Then, the controller 100 controls a moving mechanism 155 (See Fig. 9) to move the support member 154 holding the hollow tubes 153 in the secondary direction (a direction indicated by a thick arrow in Fig. 8C).

In accordance with the movement of the hollow tubes 153 in S7, the hollow tubes 153 penetrate the substantially centers of the respective plugs 50 via the openings 46a in the primary direction as shown in Fig. 5B.

Each hollow tube 153 has an opening 153b formed therethrough at its one end. Therefore, in this state, the opening 153b is positioned in the ink outlet path 43b, so that a flow path 153a provided in the hollow tube 153 and the ink outlet path 43a are in fluid communication with each other via the opening 153b. The plug 50 is perforated with a hole by the penetration of the hollow tube 153. A portion surrounding the hole of the plug 50 intimately contacts the circumference of the hollow tube 153 by the elasticity of the plug 50. Therefore, leakage of liquid from a gap between the hole of the plug 50 and the hollow tube 153 is prevented.

Then, a tip of the hollow tube 153 contacts the valve body 62, and the valve body 62 moves together with the O-ring 61 by the further insertion of hollow tube 153 into the

ink outlet path 43a. Thus, the O-ring 61 is separated from the valve seat 43z (See Fig. 5B), and the valve 60 changes to the open position from the closed position.

When the valve 60 is in the open position, the fluid communication between the reservoir 42 and the outside of the reservoir 42 is allowed via the ink outlet path 43a. That is, as shown in Fig. 5B, when the hollow tube 153 penetrates the plug 50 and the valve 60 is in the open position, the reservoir 42 and the flow path of the head 2 are in fluid communication with each other via the ink outlet path 43a and the flow path 153a.

After S7, the controller 100 receives signals from the Hall devices 71 of the black ink unit 40B and the pretreatment liquid unit 40P (S8). After S8, the controller 100 determines whether the valves 60 of the black ink unit 40B and the pretreatment liquid unit 40P are in the open positions, i.e., the reservoirs 42 and the corresponding heads 2 are in fluid communication with each other and the liquid is allowed to flow from the reservoirs 42 to the corresponding heads 2 via the corresponding hollow tubes 153, based on the signals received in S8 and the output values Vmax and Vmin read from the memory 141 in S3 (S9). The determination in S9 is made in a manner described below.

Fig. 12 is a graph showing a relationship between a position of the valve 60 and an output value from the Hall device 71. The horizontal axis represents the position of the valve 60 in the first direction. The vertical axis represents output values from the Hall device 71. Vmax is an output value from the Hall device 71 to which a predetermined drive voltage is applied when the valve 60 is in the closed position shown in Fig. 5A. Vmin is an output value from the Hall device 71 to which the predetermined voltage is applied when the valve 60 is in the open position shown in Fig. 5B. A threshold value Vt (e.g., $Vt = (Vmax + Vmin)/2$) is obtained based on the output values Vmax and Vmin read by the controller 100 in S3. When the output value from the Hall device 71 received in S8 is smaller than or equal to the threshold value Vt, the controller 100 determines that the valve 60 is in the open position. When the output value from the Hall device 71 received in S8 is larger than the threshold value Vt, the controller 100 determines that the valve 60 is in the closed position.

When a predetermined time has elapsed while the valves 60 of the black ink unit 40B and the pretreatment liquid unit 40P are not in the open positions (S10:YES), the controller 100 notifies an error (S5) and the controller 100 stops operations of each components of the printer 1 (S6).

The open error may occur due to a breakage of the Hall device 71 of the black ink

unit 40B caused by a short circuit occurred between the terminal 170c and the terminal 174c, due to a breakage of the Hall device 71 of the pretreatment liquid unit 40P caused by a short circuit occurred between the terminal 171a and the terminal 174c, due to a malfunction in communications capabilities of the controller caused by a short circuit occurred between the terminal 173c and the terminal 174c, or due to existence of a defective condition in the plugs 50 or the valves 60 of the cartridge 40, or the hollow tubes 153 or the moving mechanism 155 of the printer 1.

When the controller 100 determines that the valves 60 of the black ink unit 40B and the pretreatment liquid unit 40P are in the open positions (S9:YES), the controller 100 writes, in the memory 144, data of a value that obtained by adding 1 (one) to the number of hollow tube insertions read in S3 (S11). Then, the controller 100 determines whether a recording command has been received from the external device (S12).

When the controller 100 determines that the recording command has been received (S12:YES), the controller 100 performs recording of a page of a sheet P by controlling the sheet feed motor 125, the transport motor 127, the discharge motor 128, and the heads 2 (S13). After S14, the controller 100 calculates a current liquid usage amount for one page of a sheet, i.e., an amount of black ink and an amount of pretreatment liquid that were discharged onto the page of the recorded sheet P during the current recording operation (S11).

After S14, the controller 100 writes, into the memory 141, data of the liquid usage amount of the black ink and the liquid usage amount of the pretreatment liquid (the total amount of liquid that has been used in each reservoir 42 since the cartridge 40 is in a brand-new condition, i.e., a value obtained by adding the current liquid usage amount for one page of the sheet P obtained in S14 to the liquid usage amount read in S3 with respect to each of the black ink and the pretreatment liquid) and data of the number of recorded sheets (the number of sheets P that have been recorded by using the cartridge 40 since the cartridge 40 is in a brand-new condition, i.e., a value obtained by adding 1 (one) to the number of recorded sheets read in S3) (S15). Therefore, as it is evident e.g. from Fig. 11, while the controller reads and writes data into and from the memory repeatedly during the whole operation, the signal of the sensor is only read in step S8 during or shortly after insertion of the cartridge.

After S12, the controller 100 determines whether a write error has occurred (S16). When the controller 100 could not perform a writing procedure normally, the controller

100 determines that a write error has occurred (S16:YES). Then, the controller 100 notifies the error (S5) and stops operations of each component of the printer 1 (S6).

The write error may occur due to damage to the memory 141 caused by a short circuit occurred between the terminal 172c the terminal 174c or due to a malfunction in communications capabilities of the controller 100 caused by a short circuit occurred between the terminal 173c and the terminal 174c.

When the controller 100 could perform a writing procedure normally, the controller 100 determines that a write error has not occurred (S16:NO), and determines whether the recording command includes data of a next page based on the image data included in the recording command received in S12 (S17).

When the recording command includes data of a next page (S17:YES), the controller 100 returns the routine to S13 and executes the processing of S13 to S16. When the recording command does not include data of a next page (S17:NO), the controller 100 returns the routine to S12 and waits until the controller 100 determines that a recording command is received.

The printer 1 comprises a lock mechanism (not shown) configured to lock the cartridge 40 in the predetermined position. When the controller 100 determines that the cartridge 40 has been installed in the predetermined position in the section C (S1:YES), the controller 100 drives the lock mechanism simultaneously with the processing of S2, for example, to lock the cartridge 40 in the predetermined position together with the tray 35.

To remove the cartridge 40 from the printer 1, a release button is pressed. When the controller 100 detects the pressing of the release button, first, the controller 100 controls the moving mechanism 155 (See Fig. 9) to move the support member 154 in a direction reverse to the direction indicated by the bold arrow (See Fig. 8C). Thus, the support member 154 moves from the position shown in Fig. 8C to the position shown in Fig. 8B. At that time, in accordance with the movement of the hollow tube 153 leftward in Fig. 5B in each of the black ink unit 40B and the pretreatment liquid unit 40P, the valve 60 also moves leftward in Fig. 5B and contacts the valve seat 43z by the urging force of the coil spring 63. Thus, the valve 60 changes from the open position to the closed position. When the output values received from the Hall device 71 exceed the threshold value Vt in each of the black ink unit 40B and the pretreatment liquid unit 40P, the controller 100 determines that the valves 60 are in closed positions and obtains the current usage time (the period between the installation time and a removal time at which the

controller 100 determines that the valves 60 are in closed positions) based on the installation time recorded in S2 and the removal time. The controller 100 writes, into the memory 141, data of a value obtained by adding the cumulative usage time read in S3 (i.e., the total period of time during which the cartridge 40 has been installed in the printer 1 since the cartridge 40 is in brand-new condition) to the obtained current usage time. After that, the hollow tube 35 is removed from the plug 50. At that time, the hole formed in the plug 50 by the hollow tube 153 becomes smaller by the elasticity of the portion surrounding the hole so as to prevent the leakage of liquid from the gap between the hole of the plug 50 and the hollow tube 153.

Then, the controller 100 drives the lock mechanism to release the cartridge 40. Therefore, the tray 35 can be removed from the section C. When the tray 35 is removed from the section C, the substrate 142 of the cartridge 40 is separated from the substrate 182 of the printer 1. Therefore, electric connections between the terminals 170c to 177c and the corresponding terminals 170p to 177p are released, and the electric power is not supplied to the Hall devices 71 and the memory 141. Accordingly, the controller 100 is not capable of performing signal transmission and reception with the Hall devices 71 and the memory 141.

The controller 100 controls to display a value obtained by reducing the liquid usage amount written into the memory 141 in S15 from the liquid reservoir capacity, on the output device 160, such as a display, of the printer 1, as an amount of liquid remaining in each reservoir 42.

The controller 100 embodies a communication section for performing communications with the cartridge 40 installed in the section C as shown in Fig. 10 and also embodies each section corresponding to the processing of Fig. 11.

A cartridge installation detecting section M1 embodies the processing of S1. A reading section M2 embodies the processing of S3. A read error determining section M3 embodies the processing of S4. A notification control section M4 embodies the processing of S5. A recording prohibiting section M5 embodies the processing of S5. A moving control section M6 embodies the processing of S7. A receiving section M7 embodies the processing of S8. A receiving error determining section M8 embodies the processing of S9 and S10. A writing section M9 embodies the processing of S11. A write error determining section M10 embodies the processing of S16. A recording control section M11 embodies the processing of S13. A fluid communication determining section

M12 embodies the processing of S9.

Referring to Figs. 13 to 17, second to sixth embodiments of the invention will be described. Printers and cartridges of the second to sixth embodiments of the invention have substantially the same structure as the printer 1 and the cartridge 40 of the first embodiment of the invention except arrangements or structures of terminals provided to the cartridges and the housings of the printers.

As compared with the cartridge 40 according to the first embodiment shown in Fig. 7, a cartridge 40 according to the second embodiment comprises terminals 170c, 171c, 172c, 173c, 174c, 175c, 177c as shown in Fig. 13, i.e., the ground terminal 176c is omitted from the cartridge 40.

As compared with the cartridge 40 according to the first embodiment shown in Fig. 7, a cartridge 40 according to the third embodiment comprises terminals 170c, 171c, 172c, 173c, 174c, 177c as shown in Fig. 14, i.e., the ground terminals 175c and 176c are omitted from the cartridge 40.

As compared with the cartridge 40 according to the first embodiment shown in Fig. 7, a cartridge 40 according to the fourth embodiment comprises terminals 170c to 177c as shown in Fig. 15. The data output terminal 172c of the cartridge 40 of the fourth embodiment has an L-shaped extended portion 172c1. The extended portion 172c1 extends from one end toward the terminal 171c, and bends and further extends toward the electric power input terminal 174c.

As compared with the cartridge 40 according to the first embodiment shown in Fig. 7, a cartridge 40 according to the fifth embodiment comprises terminals 170c, 171c, 174c, 176c, 177c and a data input/output terminal 574c as shown in Fig. 16. The data input/output terminal 574c has functions of the data output terminal 172c and the data input terminal 173c. The ground terminal 175c is omitted from the cartridge 40. The terminals 170c, 171c, 174c, 176c, 177c, 574c are arranged in two rows each of which includes three terminals. A substrate 542 of the cartridge 40 of the fifth embodiment of the invention has a width narrower than the substrate 142 of the cartridge 40 the first embodiment of the invention.

It is assumed that each distance between centers of the terminal 174c and a respective one of the terminals 170c, 171c, 574c is x0, x1, x4 and each shortest distance between edges of the terminal 174c and a respective one of the terminals 170c, 171c, 574c is y0, y1, y4. The terminals 174c, 170c, 171c, 574c are arranged on the substrate 542

such that their positional relationship satisfies x1 < x0 < x4 and y1 < y0 < y4. xn (n = 0 or 1) represents a distance between centers of terminals 174c and 17nc. yn (n = 0 or 1) represents a shortest distance between edges of terminals 174c and 17nc. y4 represents a distance between edges of the terminal 574c and the terminal 174c.

As compared with the cartridge 40 according to the first embodiment shown in Fig. 7, a cartridge 40 according to the sixth embodiment comprises the terminals 170c to 175c aligned in a row as shown in Fig. 17. The ground terminals 176c and 177c are omitted, and the cartridge 40 of the sixth embodiment comprises the ground terminal 175c only. A substrate 642 of the cartridge 40 the sixth embodiment of the invention is shorter in height and wider in width than the substrate 142 of the cartridge 40 of the first embodiment.

In each of the second to sixth embodiments of the invention, terminals and substrates provided to the housing 1a of the printer 1 are configured to correspond to the terminals and the substrates provided to the cartridge 40.

As described above, according to the first to sixth embodiments of the invention, the distance between the data output terminal 172c (the data input/output terminal 574c in the fifth embodiment) and the electric power input terminal 174c is greater than the distance between the electric power input terminal 174c and the respective one of the sensor signal output terminals 170c and 171c.

In the fourth embodiment, each distance between a specific terminal and a respective one of specific terminals is defined without consideration of the existence of the extended portion 172c1 that has no potential for contacting with any of the terminals of the housing 1a even if the cartridge 40 is displaced in the predetermined position. The extended portion 172c1 of the terminal 172c is not a main portion of a terminal according to the invention. A main portion of each terminal of the cartridge refers to a portion that has a potential for contacting a corresponding one of the terminals of the housing 1a. In the first, second, third, fifth, and sixth embodiments, the main portion refers to the entire portion of each terminals. In the fourth embodiment, the main portion refers to the entire portion of each terminals other than the terminal 172c, and refers to a portion of the terminal 172c except the extended portion 172c1.

In the first to sixth embodiments, each shortest distance between edges of a main portion of a specific terminal and a respective one of main portions of specific terminals and each distance between centers of a main portion of a specific terminal and a respective

one of main portions of specific terminals provided on each substrate 142, 542, 642 are defined as described above.

In the first to fifth embodiments, the main portions of the terminals are arranged in a matrix in the second direction and the third direction on each substrate 142, 542. The sensor signal output terminals 170c and 171c and the electric power input terminal 174c are arranged in this order in the second direction such that their main portions are adjacent to each other. The data output terminal 172c (the data input/output terminal 574c in the fifth embodiment) and the electric power input terminal 174c are arranged such that their main portions are not adjacent to each other in either the second direction or the third direction, i.e., their main portions are arranged in positions oblique to each other.

In the first to fourth embodiments, the substrate 142 has areas 161 to 168 arranged in a matrix with rows and columns in the second direction and the third direction. The substrate 542 has areas 561 to 566 arranged in a matrix with rows and column in the second direction and the third direction. The terminals of the cartridge 40 are arranged such that each terminal includes the center of the corresponding area 161 to 168. The area 164 on which the electric power input terminal 174c is disposed at its center, the area 163 on which the sensor signal output terminal 171c is disposed at its center, and the area 162 on which the electric power input terminal 174c is disposed at its center, are arranged in this order adjacent to each other in the second direction. The area 164 and the area 167 on which the data output terminal 172 is disposed at its center are arranged such that they are not located adjacent to each other in either the second direction or the third direction, i.e., they are arranged in positions oblique to each other. In the fifth embodiment, the substrate 542 has areas 561 to 566 arranged in a matrix with rows and column in the second direction and the third direction. The terminals of the cartridge 40 are arranged such that each terminal includes the center of the corresponding area 561 to 566. The area 563 on which the electric power input terminal 174c, the area 562 on which the sensor signal output terminal 171c is disposed at its center, and the area 561 on which the electric power input terminal 174c is disposed at its center, are arranged in this order adjacent to each other in the second direction. The area 563 and the area 565 on which the data input/output terminal 574c is disposed at its center are arranged such that they are not located adjacent to each other in either the second direction or the third direction, i.e., they are arranged in positions oblique to each other.

In the sixth embodiment, the main portions of the terminals are arranged in the

second direction on the substrate 642. The sensor signal output terminals 170c and 171c and the electric power input terminal 174c are arranged in this order in the second direction such that their main portions are adjacent to each other. The data output terminal 172c and the electric power input terminal 174c are arranged such that their main portions are not adjacent to each other in the second direction, i.e., other terminal is interposed between the data output terminal 172c and the electric power input terminal 174c.

The substrate 42 has areas 661 to 666 arranged in a row in the second direction. The terminals of the cartridge 40 are arranged such that each terminal includes the center of the corresponding area 661 to 666. The area 666 on which the electric power input terminal 174c is disposed at its center, the area 665 on which the data output terminal 171c is disposed at its center, and the area 664 on which the data output terminal 170c is disposed at its center, are arranged in this order adjacent to each other in the second direction. The area 666 and the area 663 on which the data output terminal 172c is disposed at its center are arranged such that they are not located adjacent to each other in the second direction, i.e. other area is interposed between the area 666 and the area 663.

In the first to sixth embodiments, the influence of a short circuit can be prevented by which the positional relationship of the terminals is specified as described above.

The memory 141 is configured to store data, which relates to signals generated by the Hall devices 71 (the output values Vmax and Vmin from the Hall devices 71) and is used for the determination of positions (the open position or the closed position) of the valves 60 (the determination of establishment of fluid communication between the heads 2 and the corresponding reservoirs 42). Accordingly, if one of the memory 141 and the Hall devices 71 is damaged due to a short circuit while the cartridge 40 is installed in the section C (before a recording control is started), the controller 100 cannot determine whether the heads 2 and the corresponding reservoirs 42 are in fluid communication with each other. Thus, the controller 100 cannot perform the recording control. As compared with the case where the Hall device 71 is damaged, if the memory 141 is damaged due to a short circuit, more inconvenience situations may occur in addition to the above problem. For example, a manufacturer may not provide timely service to a user based on the data stored in the memory 141. The manufacturer keeps track of the length of time each reservoir 42 of a cartridge 40 will provide liquid based on the cumulative usage time and the number of recorded sheets stored in the memory 141. The grasping of the cartridge conditions makes the manufacturer provide a new cartridge 40 to the user at about the time

the reservoirs become empty of liquid. However, the manufacturer cannot provide such a timely service to the user if the memory 141 is damaged.

Recycle efficiency of the cartridge 40 may be decreased in a case where the cartridge 40 is recycled based on the data stored in the memory 141. For example, it cannot be determined whether the life of each plug 50 of the cartridge 40 is within its useful time if the data of the number of hollow tube insertions stored in the memory 141 is lost. Thus, a plug 50, which is unnecessary to be replaced because its life is within the useful time, needs to be undesirably replaced with a new one.

The manufacturer may not charge a user based on the data stored in the memory 141, e.g., the liquid usage amount and/or the number of recorded sheets.

In the first to sixth embodiments, the protection of the memory 141 takes priority over the protection of the Hall devices 71 by which the positional relationship of the terminals is specified as described above. Accordingly, the influence of a short circuit, such as the inconvenience situations described above, can be prevented.

The controller 100 of the printer 1 performs the writing of the liquid usage amount and the number of recorded sheets into the memory 144 (S15) and the determination on the presence or absence of an error in the writing into the memory 141 (S16) in a period between the recording of a page of a sheet (S13) and the recording of the next page of a sheet (S13). Therefore, if the memory 141 is damaged due to a short circuit occurred between the data output terminal 172c (the data input/output terminal 574c in the fifth embodiment) and the electric power input terminal 174c during the recording of a page of a sheet, the controller 100 determines that a write error has occurred (S16:YES), notifies the error (S5) to prohibit the further recording operation, and stops operations of each components of the printer 1 (S6).

On the other hand, the controller 100 does not perform the determination on the presence or absence of an error in receipt of signals from the Hall devices 71 in a period between the recording of a page of a sheet (S13) and the recording of the next page of a sheet (S13). Therefore, if either or both of the Hall devices 71 are damaged due to a short circuit occurred between the electric power input terminal 174c and the sensor signal output terminal 170c and/or between the electric power input terminal 174c and the sensor signal output terminal 171c, the controller 100 continues to perform the recording operation.

That is, the recording operation can be continued even if either or both of the Hall

devices 71 are damaged during the execution of the recording control although the recording operation cannot be continued if the memory 141 is damaged during the execution of the recording control.

In the first to sixth embodiments, the protection of the memory 141 takes priority over the protection of the Hall devices 71 by which the positional relationship of the terminals is specified as described above. Accordingly, the influence of a short circuit on the recording operation can be prevented.

The terminals of the cartridge 40 and the terminals of the housing 1a are usually designed such that their centers contact with each other, respectively (the centers of the terminals of the cartridge 40 have contact portions, respectively). Accordingly, the influence of the short circuit caused by foreign matters adhered to the contact portion (e.g., foreign matters sandwiched between the terminal of the cartridge 40 and the terminal of the housing 1a) can be efficiently prevented by which the positional relationship is defined with reference to each distance between the centers of the contact portions of the specific terminals.

As described above, according to the first to fourth, and sixth embodiments of the invention, the distance between the data input terminal 173c and the electric power input terminal 174c is greater than the distance between the data output terminal 172c and the electric power input terminal 174c (both of the distance between the centers of the terminals and the shortest distance of the edges of the terminals).

The memory 141 may be damaged if a short circuit occurs between the data output terminal 172c and the electric power input terminal 174c. The controller 100 may be damaged if a short circuit occurs between the data input terminal 173c and the electric power input terminal 174c. Replacement of the controller 100 costs higher than replacement of the memory 141. Accordingly, the controller 100 is prevented from being damaged by which the positional relationship between the terminals is defined as described above, and the costs for replacement of the components due to the short circuit can be reduced.

In the fifth embodiment, the data input/output terminal 574c functions as both of the data output terminal and the data input terminal. Therefore, the configuration of the terminals and the wiring on the substrate can be simplified.

While the invention has been described in detail with reference to the specific embodiments thereof, it would be apparent to those skilled in the art that various changes,

arrangements and modifications may be applied therein without departing from the spirit and scope of the invention.

The terminals to be provided to the liquid cartridge may be modified as described below. The terminals may be separately provided on a plurality of substrates. The shape of the terminals may not be limited to a rectangle, but any shape, e.g., a circle, may be acceptable. The terminals may be arranged in random pitches. Although the terminals of the above-described embodiments are provided on the surface that extends in the direction perpendicular to the inserting direction of the cartridge 40, the terminals may be provided on other surface, e.g., a surface that extends in parallel to the inserting direction. The number of sensor signal output terminals to be provided may be changed along with the number of sensors to be provided. An arbitrary number of ground terminals may be provided, or otherwise, the ground terminals may be omitted. The electric power input terminal may be electrically connected with at least one of the sensor and the storage so as to supply electric power to at least one of the sensor and the storage, e.g., electric power may be supplied to the storage via the data input terminal. At least one electric power input terminal may be provided. Two or more electric power input terminals may be acceptable to be provided if the positional relationship of the electric power input terminals satisfies the distance conditions. The terminals may be arranged such that their positional relationships satisfy at least one of the distance conditions of the distance between the centers of the terminals and the shortest distance between the edges of the terminals. The arrangements or size of the terminals may be changed if their positional relationships satisfy the distance conditions. For example, in Fig. 7, the data input terminal 173c and the data output terminal 172c may be switched their positions. The sensor signal output terminal 170c and the sensor signal output terminal 171c may be switched their positions. The electric power input terminal 174c may be disposed at the left right corner, at the upper left corner, or at the lower left corner, on the substrate 142, or may be disposed at any positions other than the corners. The number of rows including the terminals and the number of terminals to be included in each row may be arbitrarily determined. The terminals may be arranged in a circle or in a random fashion.

The terminals to be provided to the housing of the printer may be modified as described below. The terminals may have the substantially same or larger size than the terminals of the liquid cartridge. The number of terminals may not be equal to the number of terminals to be provided to the liquid cartridge. The arrangement of the

terminals may not be partially correspond to that of the terminals to be provided to the liquid cartridge. For example, the terminals of the liquid cartridge may be arranged in two rows, each of which includes three terminals as shown in Fig. 14, and the terminals of the housing may be arranged in two rows, each of which includes four terminals. In this case, a few of the terminals of the housing do not contact the terminals of the liquid cartridge. Similar to this configuration, the number of terminals of the liquid cartridge may not be equal to the number of terminals of the housing and the arrangement of the terminals of the liquid cartridge may not be partially correspond to that of the terminals of the housing. In this case, also, a few of the terminals of the liquid cartridge do not contact the terminals of the housing. The terminals may be made of leaf springs (the terminals urged toward a direction that the terminals approach the terminals of the liquid cartridge by their urging forces) or may be made of other materials. The terminals of the housing and the terminals of the liquid cartridge may be designed such that the terminals of the housing contact the corresponding terminals of the liquid cartridge at portions other than their centers if their positional relationships satisfy the distance conditions with reference to the contact portions.

The structures of the liquid cartridge may be modified as described below. The sensors are not limited to the magnetic sensors such as the Hall devices 71. Sensors of different types, e.g., photosensors of reflection type or transmission type, or mechanical sensors configured to determine whether or not to contact an object to detect the presence or absence of the object, may be used instead. The sensor may be configured to directly or indirectly detect the presence or absence of the object that is to be inserted into the flow path. Although the Hall devices 71, which are configured to detect the opening or closing of the valves 60, are used as such the sensor in the above-described embodiments, for example, an installation detecting sensor, which is configured to detect the installation of the liquid cartridge in a cartridge installation portion, may be used as such the sensor when the object is inserted into the flow path and exists therein at the substantially same time of the installation of the liquid cartridge in the cartridge installation portion. For example, the installation detection switch 159 or the photosensors used in the above-described embodiments may be used as the installation detecting sensor. At least one sensor may be provided in the liquid cartridge. The liquid cartridge may store one kind of liquid only although the cartridge 40 according to the above-described embodiments stores two different kinds of liquid (i.e., the black ink and the pretreatment liquid) individually. Data

to be stored in the storage may not be limited to specific data. The storage may store data that can lead to the output values and the amount of liquid remaining in the liquid reservoir, instead of the output values and the amount of liquid remaining in the liquid reservoir themselves, as data relating to the signals generated by the sensors and the amount of liquid remaining in the liquid reservoir. The structures, e.g., shapes or arrangements, of the components of the liquid cartridge, e.g., the housing 41, the reservoirs 42, the ink outlet tubes 43, the plugs 50, the valves 60, the sensor units 70, the memory 141, and the substrate 142, may be changed as necessary, other components may be added to the liquid cartridge, or some of the components may be partially omitted from the liquid cartridge, without departing from the spirit and scope of the invention.

The controls performed in the main body of the image recording device may be modified as described below. The operations (e.g., discharging operations from the heads) of each component may be stopped without notification of an error. The timing at which signal transmission and reception becomes available between the liquid cartridge and the image recording device or the timing at which supply of electric power from the image recording device to the liquid cartridge becomes available may not be limited to the timing as described above. Those timings may be arbitrarily changed. In the above-described embodiments, the installation detection switch 159 of a mechanical sensor type is used as an installation detecting section configured to detect the installation of the liquid cartridge in the installing portion. The sensor type may not be limited to the specific embodiments, and may be a photosensor, or a switch configured to output ON signals while electric connections are established between the image recording device and the liquid cartridge. The writing of data by the writing section and the determination on the presence or absence of an error by the write error determining section may be performed also before a recording command is received from an external device. The timings at which each section implements the functions, e.g., the timing at which the reading section reads data stored in the storage of the liquid cartridge, the timing at which the writing section writes data into the storage of the liquid cartridge, the timing at which the receiving section receives signals from the sensors, the timing at which the write error determining section determines the presence or absence of a write error, the timing at which the receiving error determining section determines the presence or absence of a receiving error, and the timing at which the moving section moves the hollow members, may be arbitrarily changed without departing from the spirit and scope of the invention.

The hollow members may not have pointed tips like needles.

The liquid to be stored in the liquid cartridge may not be limited to the ink or the pretreatment liquid. The liquid may be, for example, aftertreatment liquid to be discharged onto a recording medium for improving image qualities, or cleaning liquid for cleaning the transport belt.

At least one liquid cartridge may be provided to the image recording device.

The number of heads to be provided may not be limited to two. At least one head may be provided. The image recording device may be a color inkjet printer comprising heads for discharging inks of black, magenta, cyan, and yellow.

The image recording device according to the invention may be a line-type image recording device or a serial-type image recording device. The image recording device may be applied to not only printers but also facsimile machines or copying machines, for example.

The substrate to be provided to the liquid cartridge may be an adaptor substrate detachably attachable to the liquid cartridge. The positional relationships of terminals provided on the substrate need to satisfy the distance conditions as described above. However, the positional relationships of the terminals of the liquid cartridge to which the substrate is attached may not be limited.

CLAIMS

1. A liquid cartridge (40) for a line head printer (1) comprising:

a casing (41) comprising an outer surface;

a liquid reservoir (40B, 40P) disposed in the casing (41) and configured to store more than 100 Milliliter liquid therein;

a liquid flow path configured to place the liquid reservoir (40B, 40P) in fluid communication with an exterior of the liquid cartridge on the outer surface of the casing (41);

a sensor (70) configured to detect a first and a second position of a movable member (60) and configured to output a signal in relation to the first and second position of the movable member (60);

a storage (141) configured to store data;

a substrate (142) disposed on the outer surface of the casing (41) and on which a plurality of terminals (170c – 177c) are disposed;

wherein the plurality of terminals comprises:

a sensor terminal (170c, 171c) connected to the sensor (70);

a data terminal (172c, 173c) connected to the storage (141);

a power terminal (174c) connected to at least one of the sensor (70) and the storage (141); and

wherein a distance between the power terminal (174c) and the data terminal (172c, 173c) is greater than a distance between the power terminal (174c) and the sensor terminal (170c, 171c).

2. The liquid cartridge according to claim 1, wherein the liquid reservoir (40B, 40P) is configured to provide liquid from the liquid reservoir (40B, 40P) to the exterior of the liquid cartridge (40) in such an amount that at certain positions of the line head printer (1) the humidity increases.

3. The liquid cartridge according to any one of claims 1 to 2, wherein the sensor (70) is configured to output the signal in relation to the first and second position of the movable member (60) during or shortly after installing the liquid cartridge (40) into an installing portion (35) of the line head printer and the data terminal (172c, 173c) is configured to

transmit data repeatedly during the time of usage of the liquid cartridge (40) in the line head printer (1).

4. The liquid cartridge according to any one of claims 1 to 3, wherein a plurality of terminals comprising the sensor terminal (170c, 171c) and the power terminal (174c) are arranged in a first line,

wherein a plurality of terminals comprising the data terminal (172c, 173c) are arranged in a second line substantially parallel to the first line, and

wherein a distance between the terminals arranged in the first line and the terminals arranged in the second line is greater than a distance between the terminals arranged in the first line.

5. The liquid cartridge according to claim 4, wherein the sensor terminal (170c, 171c) is positioned adjacent to the power terminal (174c) in the first line.

6. The liquid cartridge according to any of claims 4 to 5, further comprising a ground terminal (175c, 176c, 177c) positioned in the second line.

7. The liquid cartridge according to any of claims 1 to 3, wherein the plurality of terminals comprising the sensor terminal (170c, 171c), the data terminal (172c, 173c), and the power terminal (174c) are arranged in a line.

8. The liquid cartridge according to claim 7, wherein the sensor terminal (170c, 171c) is positioned adjacent to the power terminal (174c).

9. The liquid cartridge according to claim 7, further comprising a ground terminal (175c, 176c, 177c), and the sensor terminal (170c, 171c) and the data terminal (172c, 173c) are positioned between the power terminal (174c) and the ground terminal (175c, 176c, 177c).

10. The liquid cartridge according to any of claims 1 to 9, wherein the data stored in the storage (141) comprises information data relating to an amount of liquid remaining in

the liquid reservoir (40B, 40P).

11. The liquid cartridge according to any of claims 1 to 10, wherein the data comprises information data relating to the number of sheets that have been recorded.

12. An image recording device (1) comprising:

the liquid cartridge according to any one of claims 1 to 11;

a main body to which the liquid cartridge (40) is attached, the main body comprising:

an installing portion (35) into which the liquid cartridge is installed;

a hollow member (153) configured to be inserted into the liquid cartridge (40) installed in the installing portion (35);

a liquid discharge head (2) configured to be in fluid communication with the hollow member (153) and to discharge liquid received from the liquid cartridge (40) via the hollow member (153);

a communication section that performs communication with the liquid cartridge installed in the installing portion (35);

a sensor signal receiving terminal (170p) configured to establish electric connections with the communication section;

a data receiving terminal (172p) configured to establish electric connections with the communication section;

a power supply (158); and

an electric power output terminal (174p) configured to establish electric connections with the power supply (158),

wherein the communication section is configured to read the data stored in the storage (141) via the data output terminal (173p) and the data receiving terminal (172p) and is configured to receive the signal from the sensor (70) via the sensor signal output terminal (171p) and the sensor signal receiving terminal (170p).

13. The image recording device according to claim 12, wherein the storage (141) is configured to store data relating to the signal, and wherein

the communication section is further configured:

to determine whether an read error has occurred during reading of the data; and

to prohibit the recording operation when the read error has occurred.

14. An image recording device according to any of claim 12 or 13, wherein the communication section writes, into the storage (141) of the liquid cartridge (40), at least one of data relating to an amount of liquid discharged from the liquid discharge head (2) during the recording operation, and data relating to the number of recording media recorded.

15. The image recording device according to any one of claims 12 to 14, wherein the communication section receives the signal from the sensor (70) during or shortly after installing the liquid cartridge (40) into the installing portion (35) of the main body and transmits data through the data terminal (172c, 173c) repeatedly during the time of usage of the liquid cartridge (40) in the image recording device (1).

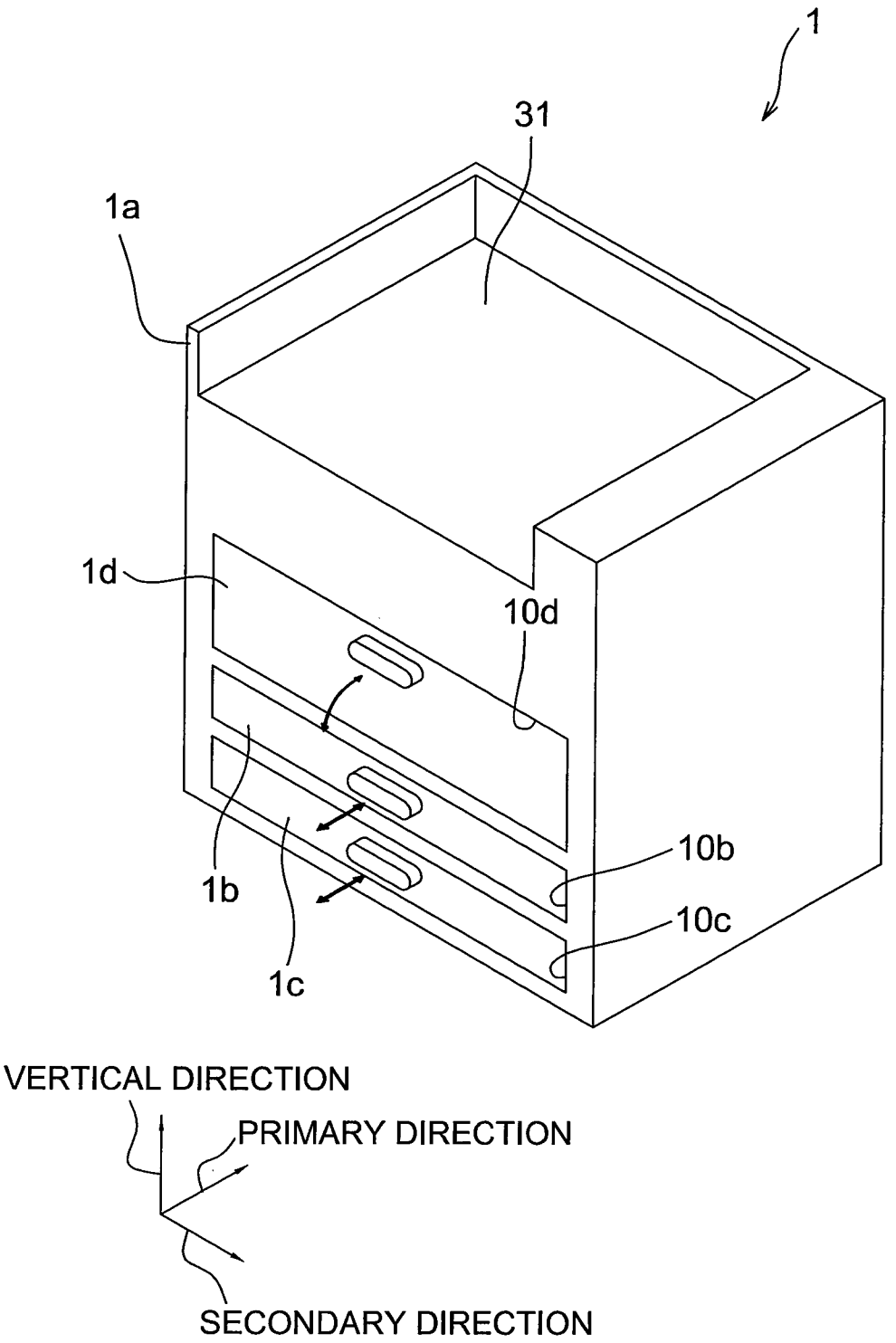
1
31
1a
1d
10d
10b
10c
1b
1c
VERTICAL DIRECTION
PRIMARY DIRECTION
SECONDARY DIRECTION

Fig.1

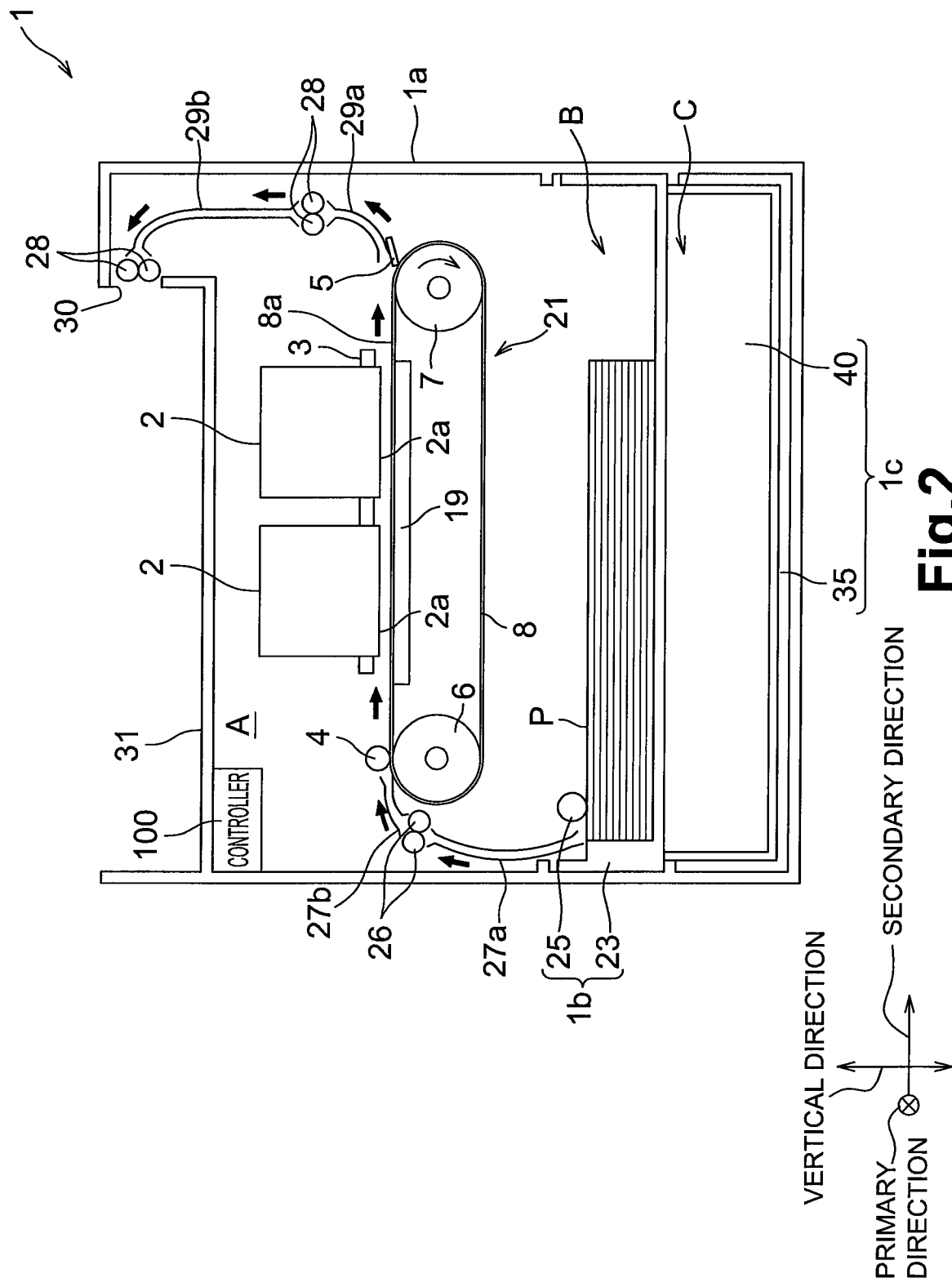
1
29b
28
29a
1a
B
C
28
30
5
8a
3
21
7
40
2
2a
19
1c
2
2a
8
35
6
P
31
A
4
CONTROLLER
100
27b
26
27a
25
23
1b
VERTICAL DIRECTION
SECONDARY DIRECTION
PRIMARY DIRECTION

Fig.2

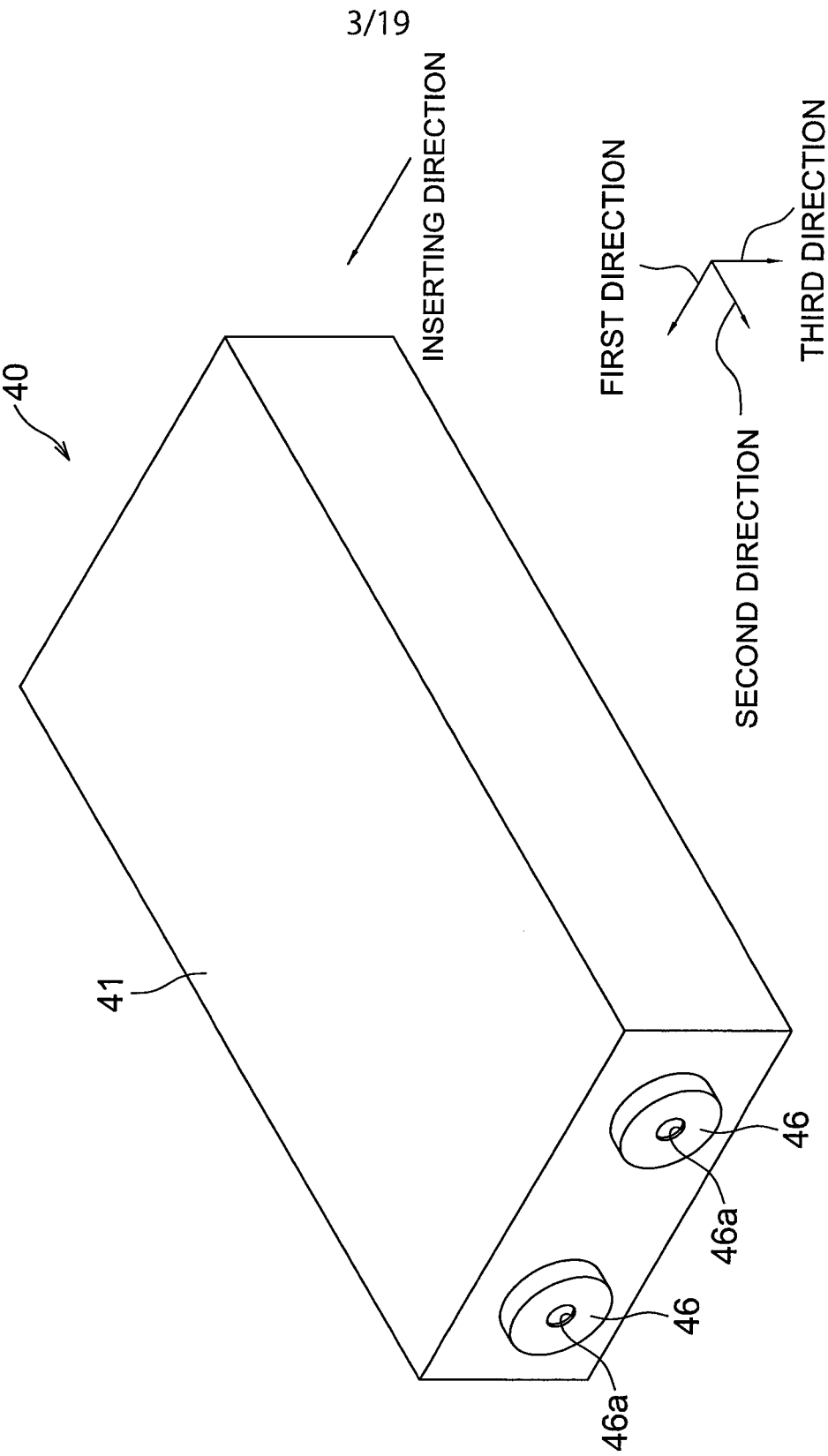
INSERTING DIRECTION
FIRST DIRECTION
THIRD DIRECTION
SECOND DIRECTION
40
41
46
46a
46
46a

Fig.3

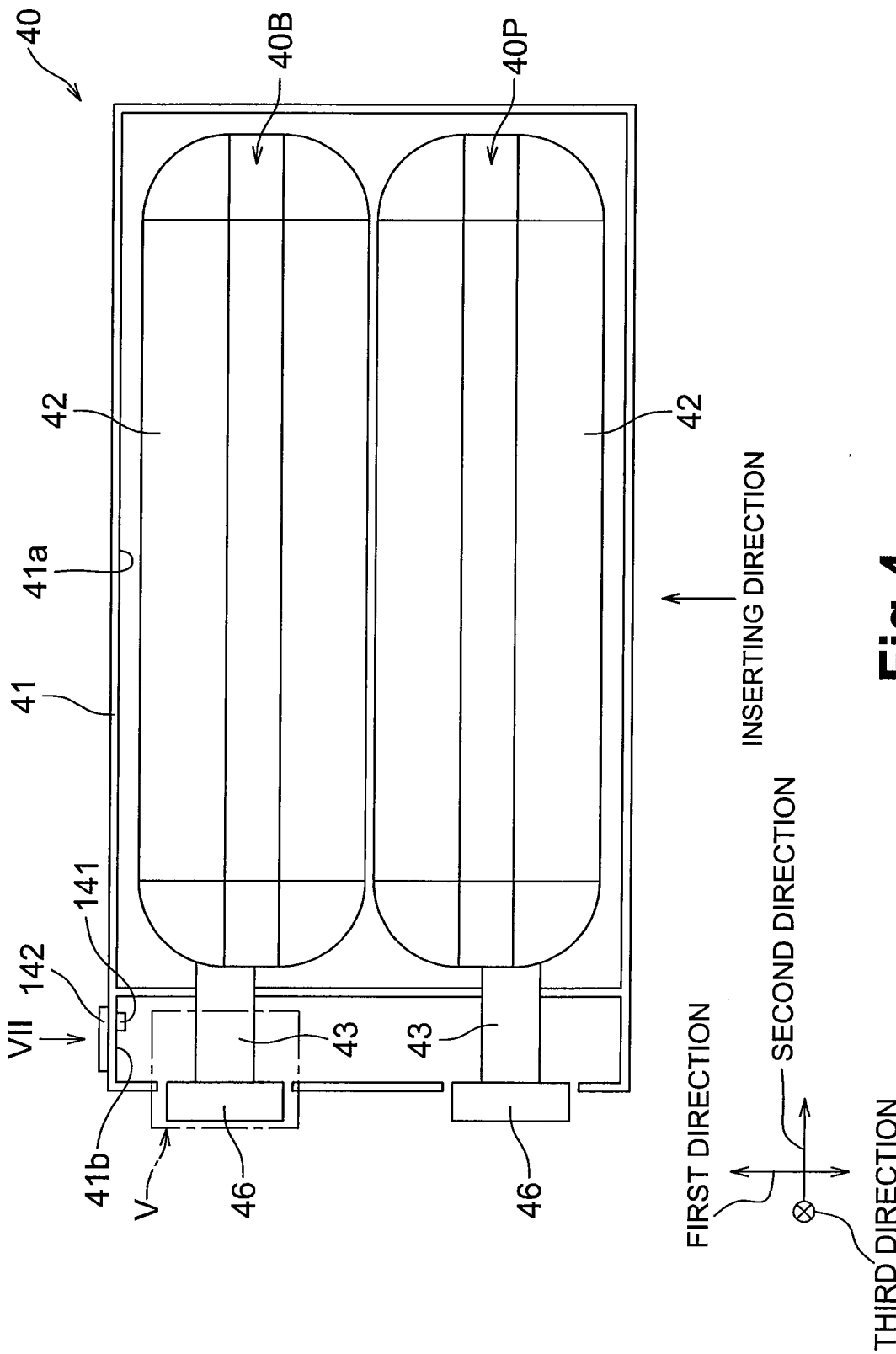
40
40B
40P
42
42
41a
41
141
142
VII
43
43
41b
V
46
46
INSERTING DIRECTION
FIRST DIRECTION
SECOND DIRECTION
THIRD DIRECTION

Fig.4

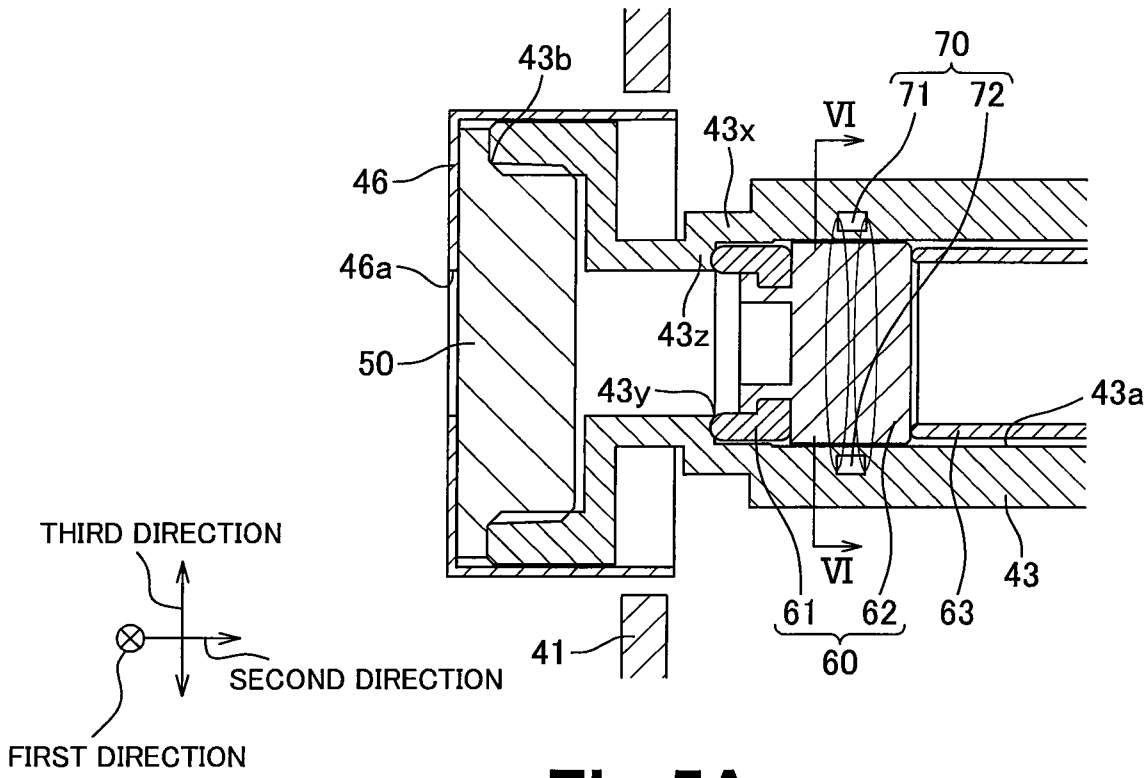
43b
70
71
72
VI
43x
46
46a
43z
50
43y
43a
VI
43
61
62
63
60
41
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.5A

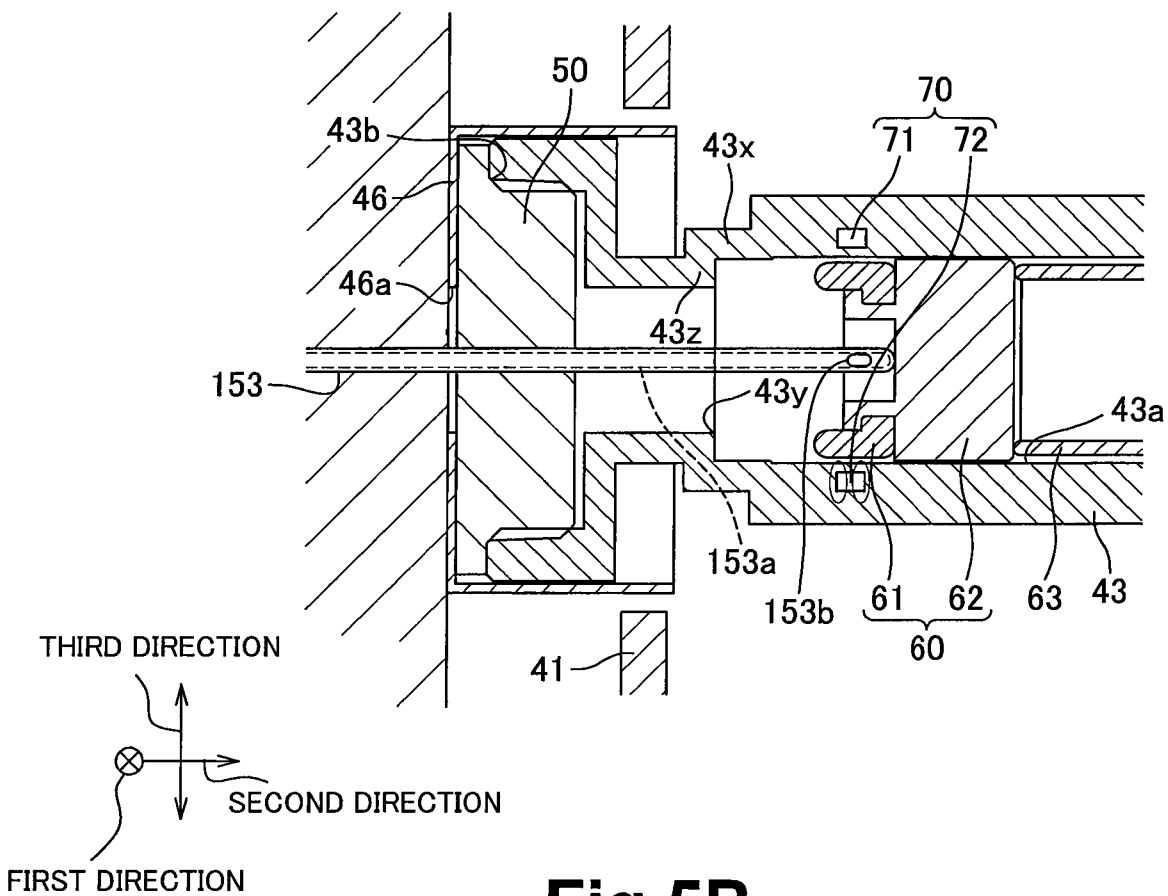
50
43b
70
71
72
43x
46
46a
43z
153
43y
43a
153a
153b
61
62
63
43
60
41
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.5B

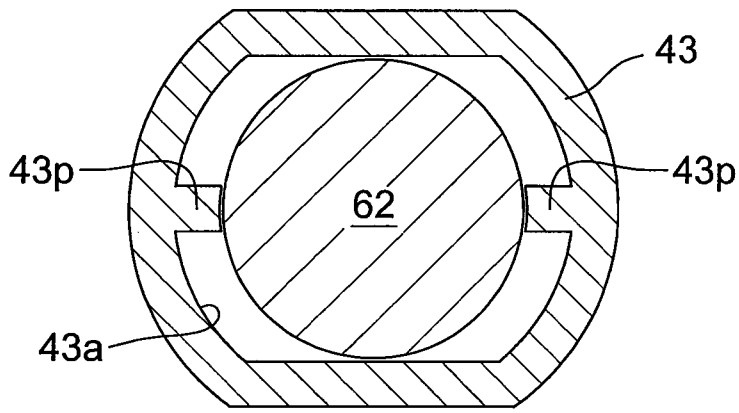

Fig.6

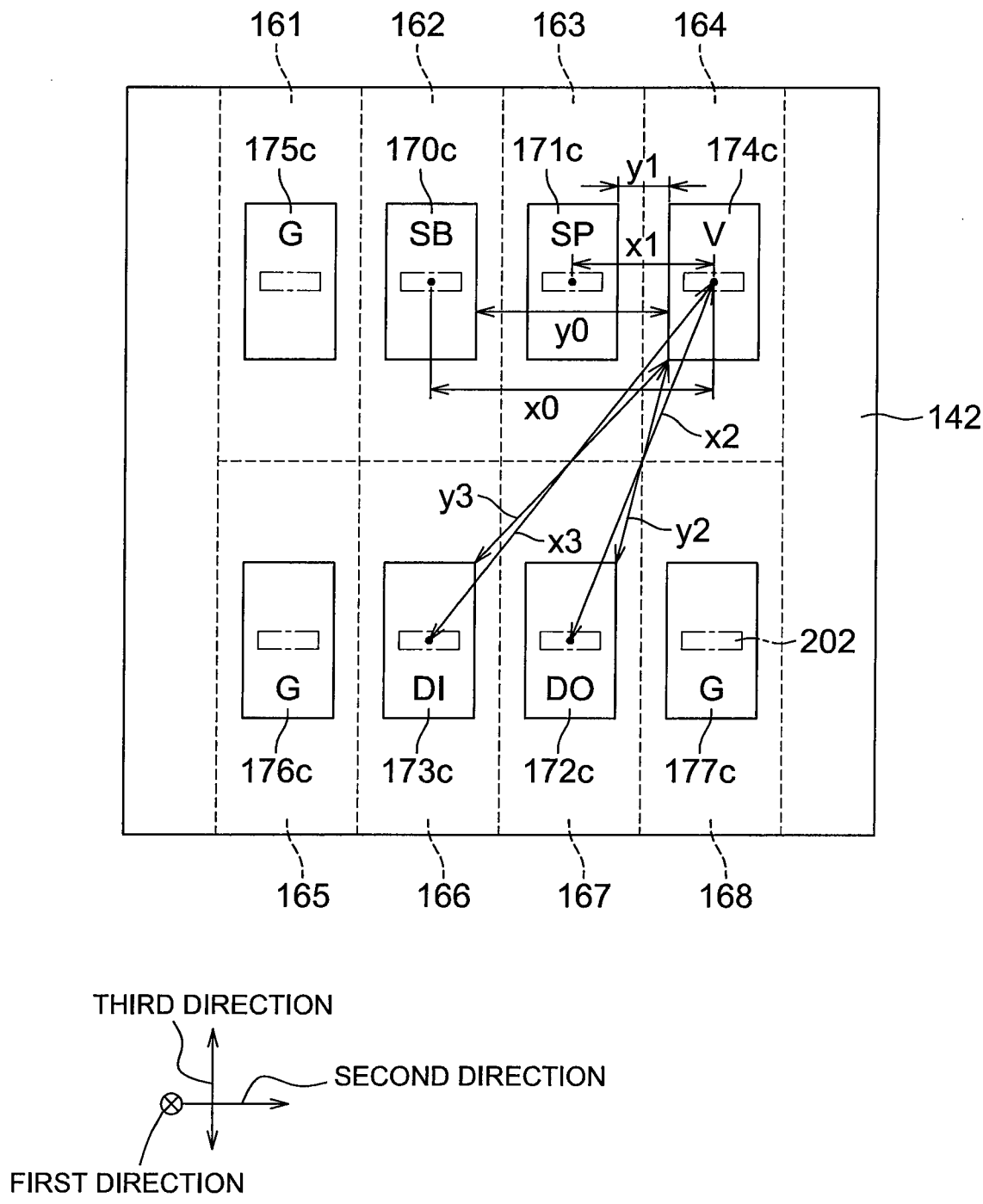
161
162
163
164
175c
170c
171c
174c
y1
G
SB
SP
x1
V
y0
x0
x2
142
y3
x3
y2
202
G
DI
DO
G
176c
173c
172c
177c
165
166
167
168
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.7

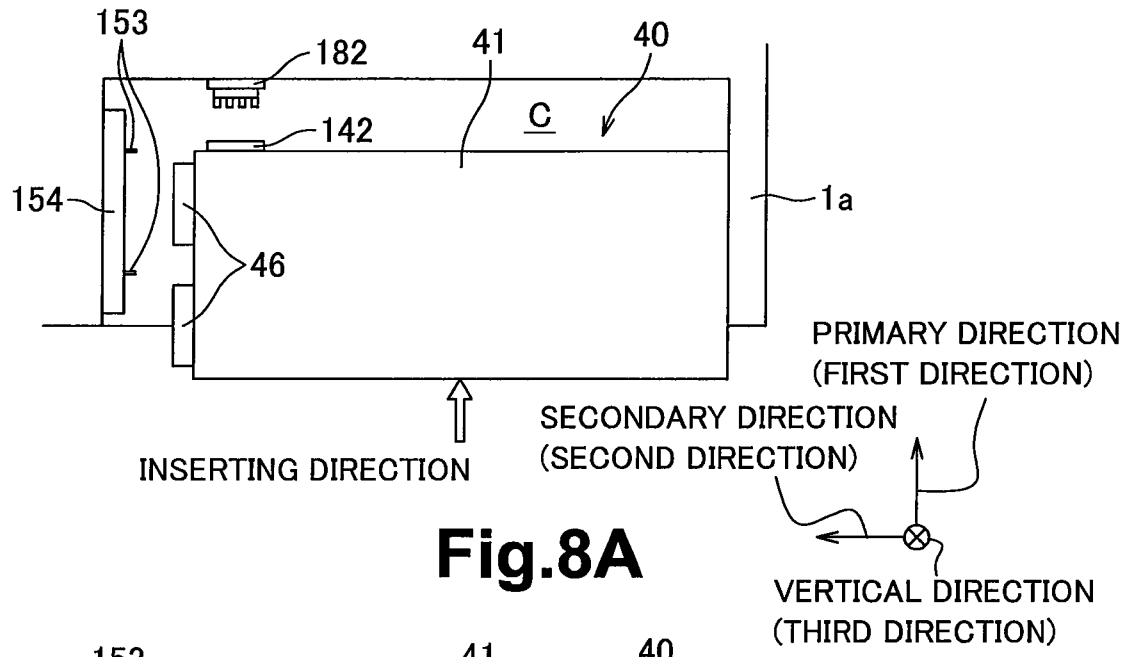

Fig.8A

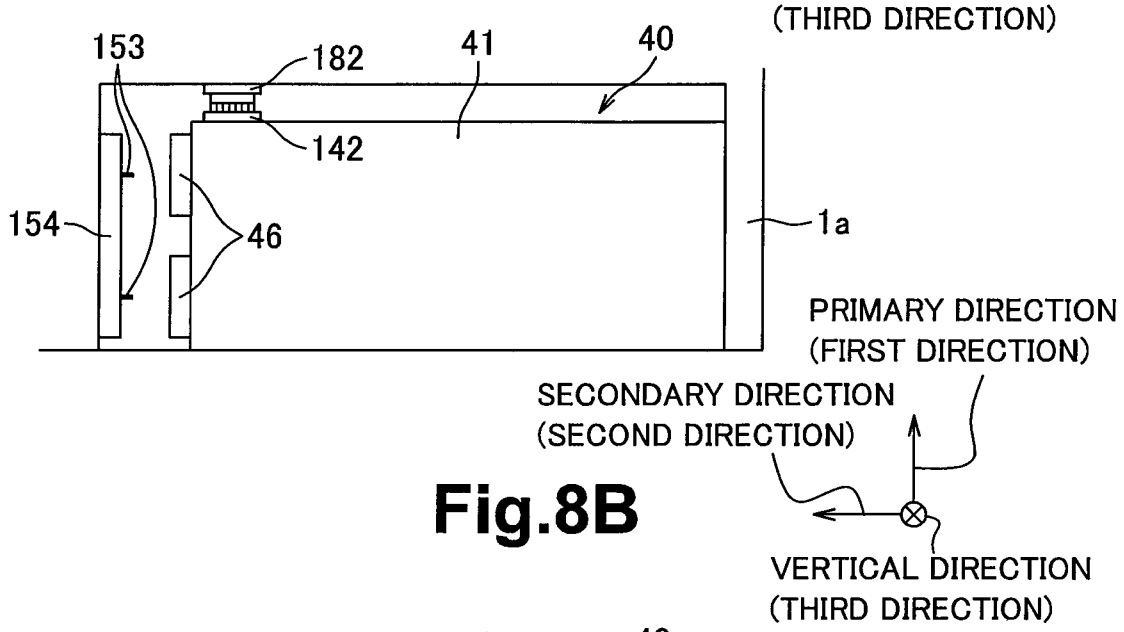

Fig.8B

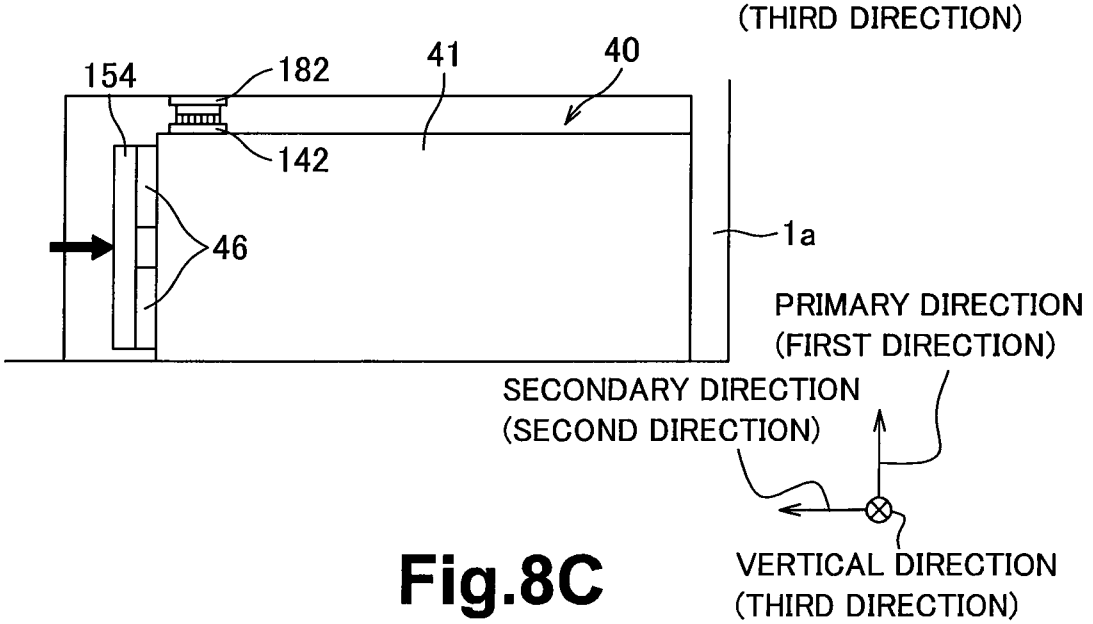

Fig.8C

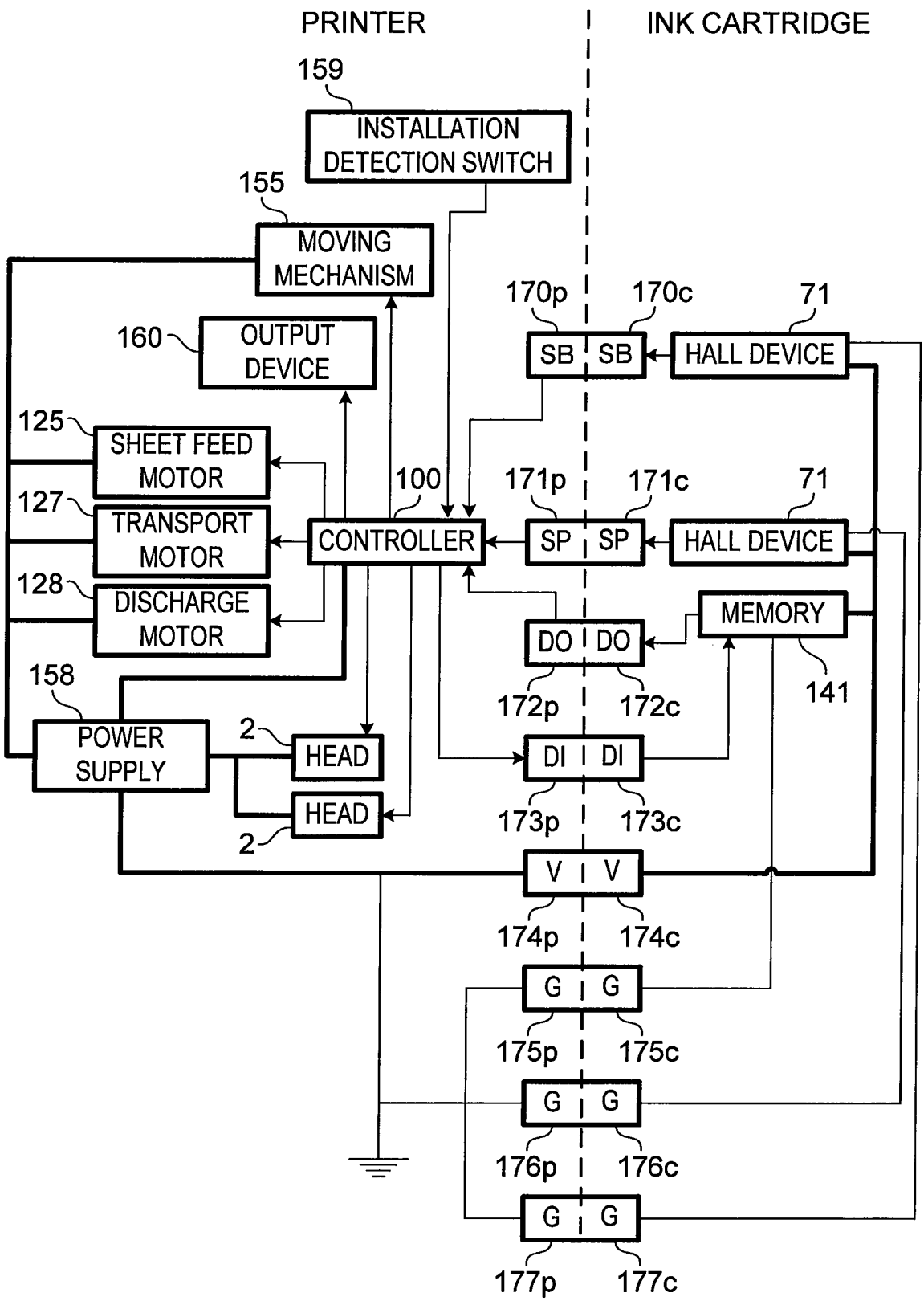
PRINTER
INK CARTRIDGE
159
INSTALLATION DETECTION SWITCH
155
MOVING MECHANISM
160
OUTPUT DEVICE
125
SHEET FEED MOTOR
127
TRANSPORT MOTOR
128
DISCHARGE MOTOR
158
POWER SUPPLY
2
HEAD
HEAD
2
100
CONTROLLER
170p
170c
71
SB
SB
HALL DEVICE
171p
171c
71
SP
SP
HALL DEVICE
MEMORY
DO
DO
141
172p
172c
DI
DI
173p
173c
V
V
174p
174c
G
G
175p
175c
G
G
176p
176c
G
G
177p
177c

Fig.9

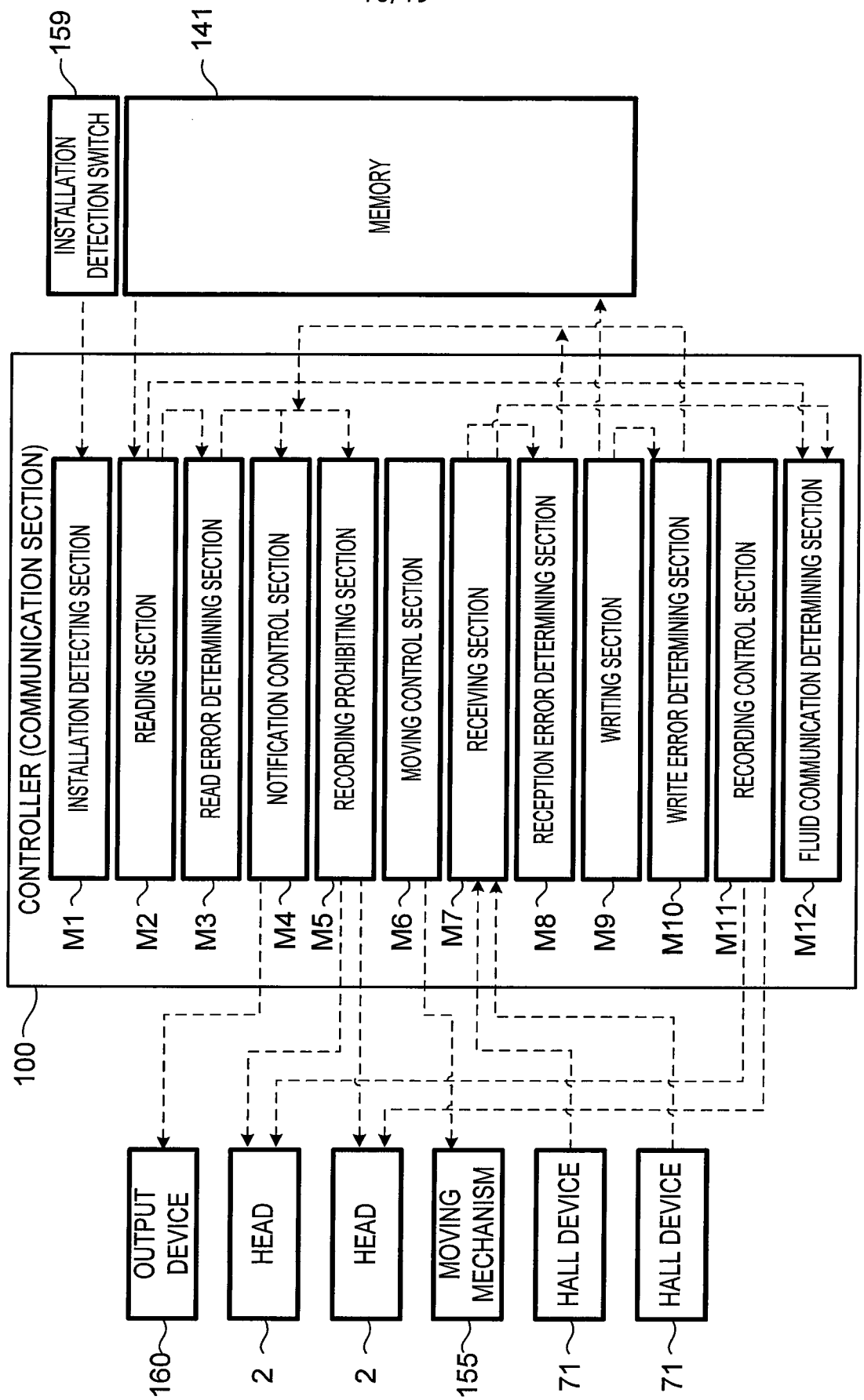
159
141
INSTALLATION DETECTION SWITCH
MEMORY
CONTROLLER (COMMUNICATION SECTION)
INSTALLATION DETECTING SECTION
READING SECTION
READ ERROR DETERMINING SECTION
NOTIFICATION CONTROL SECTION
RECORDING PROHIBITING SECTION
MOVING CONTROL SECTION
RECEIVING SECTION
RECEPTION ERROR DETERMINING SECTION
WRITING SECTION
WRITE ERROR DETERMINING SECTION
RECORDING CONTROL SECTION
FLUID COMMUNICATION DETERMINING SECTION
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M11
M12
100
OUTPUT DEVICE
HEAD
HEAD
MOVING MECHANISM
HALL DEVICE
HALL DEVICE
160
2
2
155
71
71

Fig.10

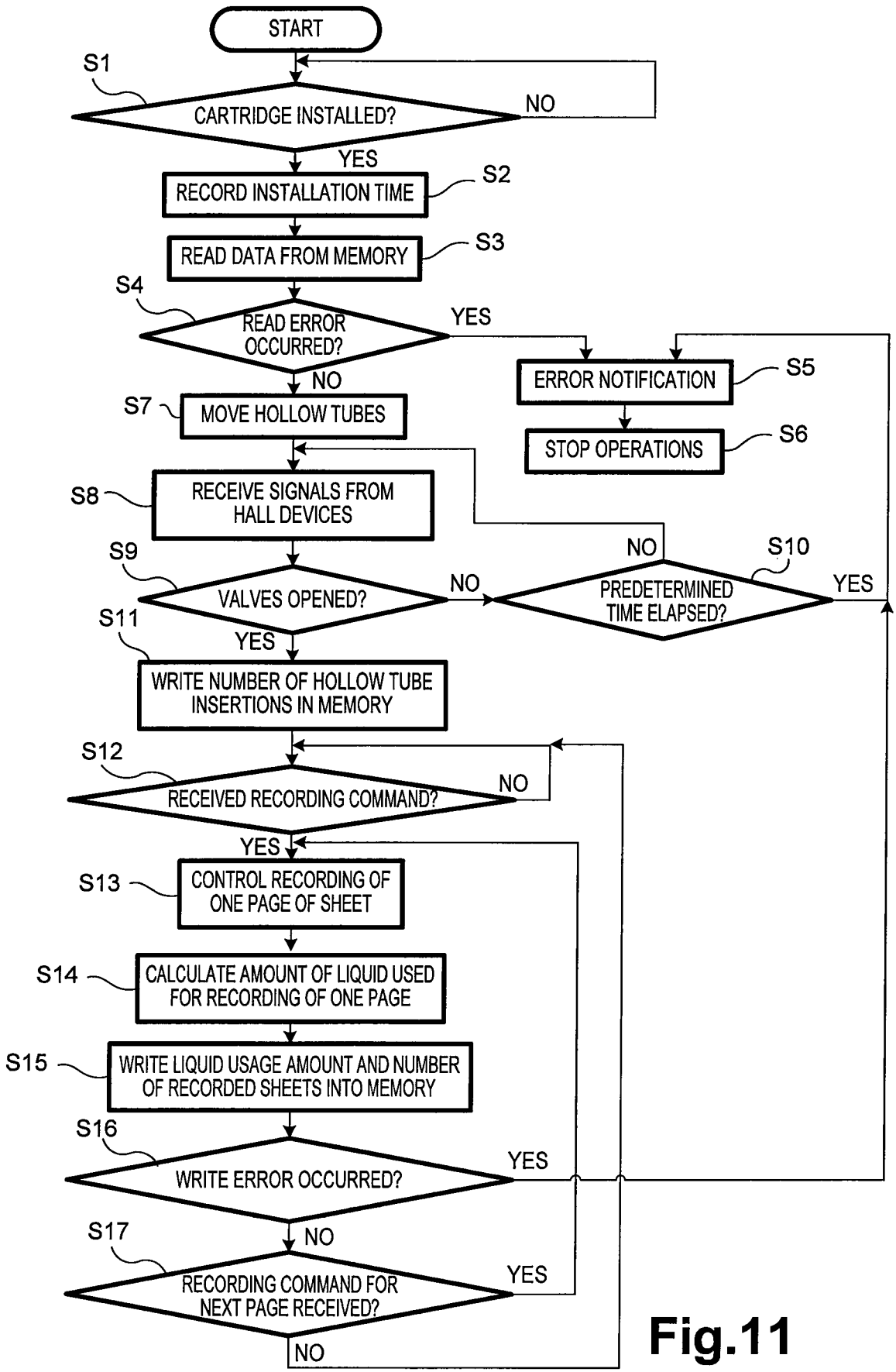
START
S1
CARTRIDGE INSTALLED?
NO
YES
RECORD INSTALLATION TIME
S2
READ DATA FROM MEMORY
S3
S4
READ ERROR OCCURRED?
YES
NO
ERROR NOTIFICATION
S5
STOP OPERATIONS
S6
S7
MOVE HOLLOW TUBES
S8
RECEIVE SIGNALS FROM HALL DEVICES
S9
VALVES OPENED?
NO
NO
S10
PREDETERMINED TIME ELAPSED?
YES
S11
YES
WRITE NUMBER OF HOLLOW TUBE INSERTIONS IN MEMORY
S12
RECEIVED RECORDING COMMAND?
NO
YES
S13
CONTROL RECORDING OF ONE PAGE OF SHEET
S14
CALCULATE AMOUNT OF LIQUID USED FOR RECORDING OF ONE PAGE
S15
WRITE LIQUID USAGE AMOUNT AND NUMBER OF RECORDED SHEETS INTO MEMORY
S16
WRITE ERROR OCCURRED?
YES
S17
NO
RECORDING COMMAND FOR NEXT PAGE RECEIVED?
YES
NO

Fig.11

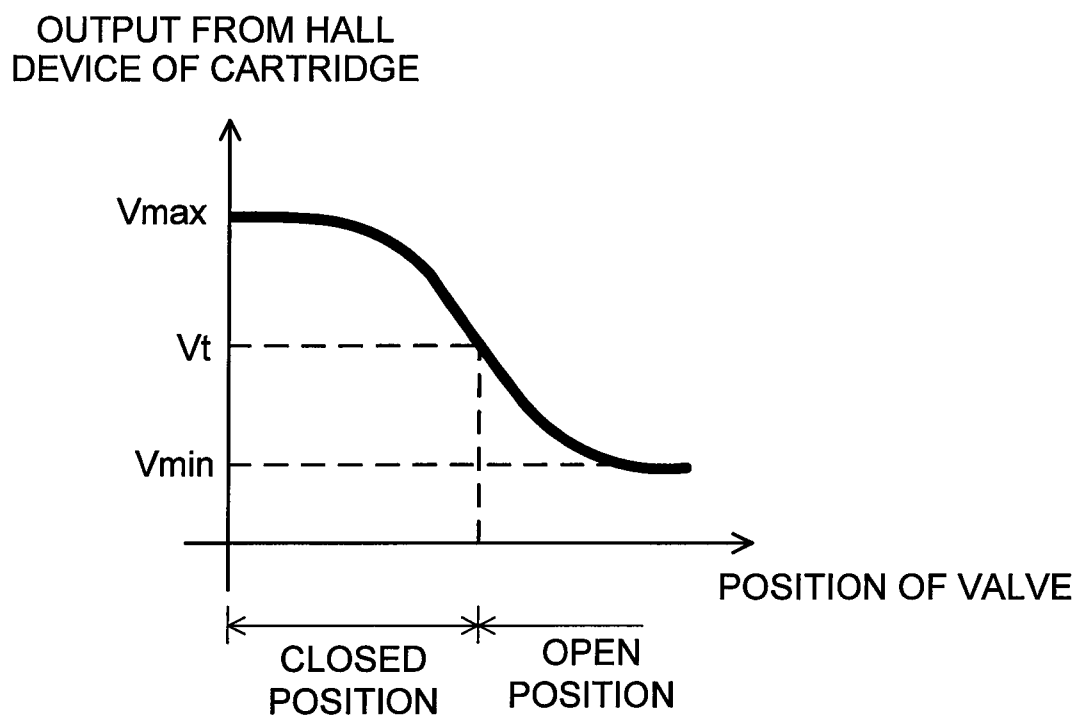
OUTPUT FROM HALL DEVICE OF CARTRIDGE
Vmax
Vt
Vmin
POSITION OF VALVE
CLOSED POSITION
OPEN POSITION

Fig.12

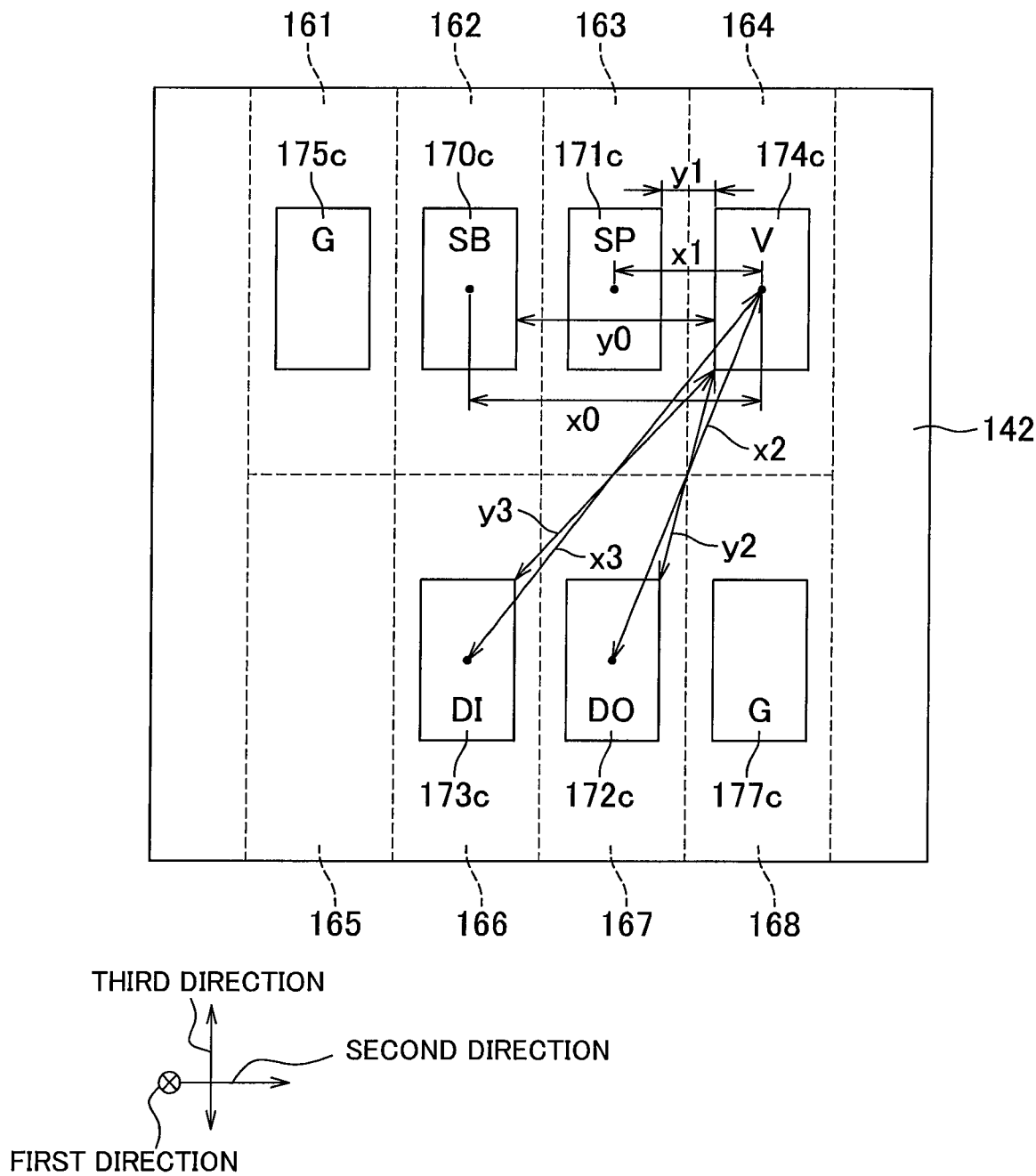
161
162
163
164
175c
170c
171c
174c
y1
G
SB
SP
V
x1
y0
x0
x2
142
y3
x3
y2
DI
DO
G
173c
172c
177c
165
166
167
168
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.13

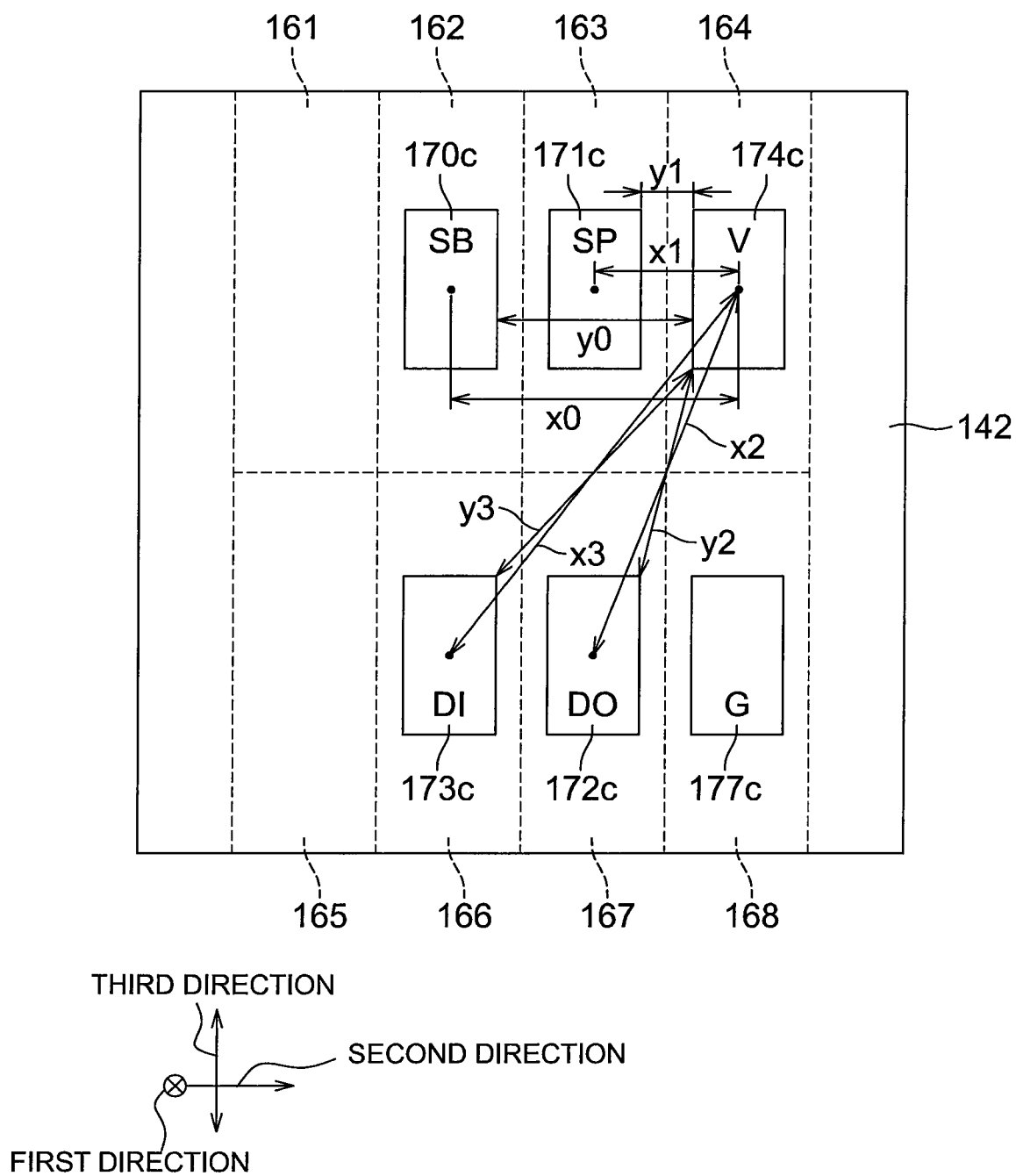
161
162
163
164
170c
171c
174c
y1
SB
SP
x1
V
y0
x0
x2
142
y3
x3
y2
DI
DO
G
173c
172c
177c
165
166
167
168
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.14

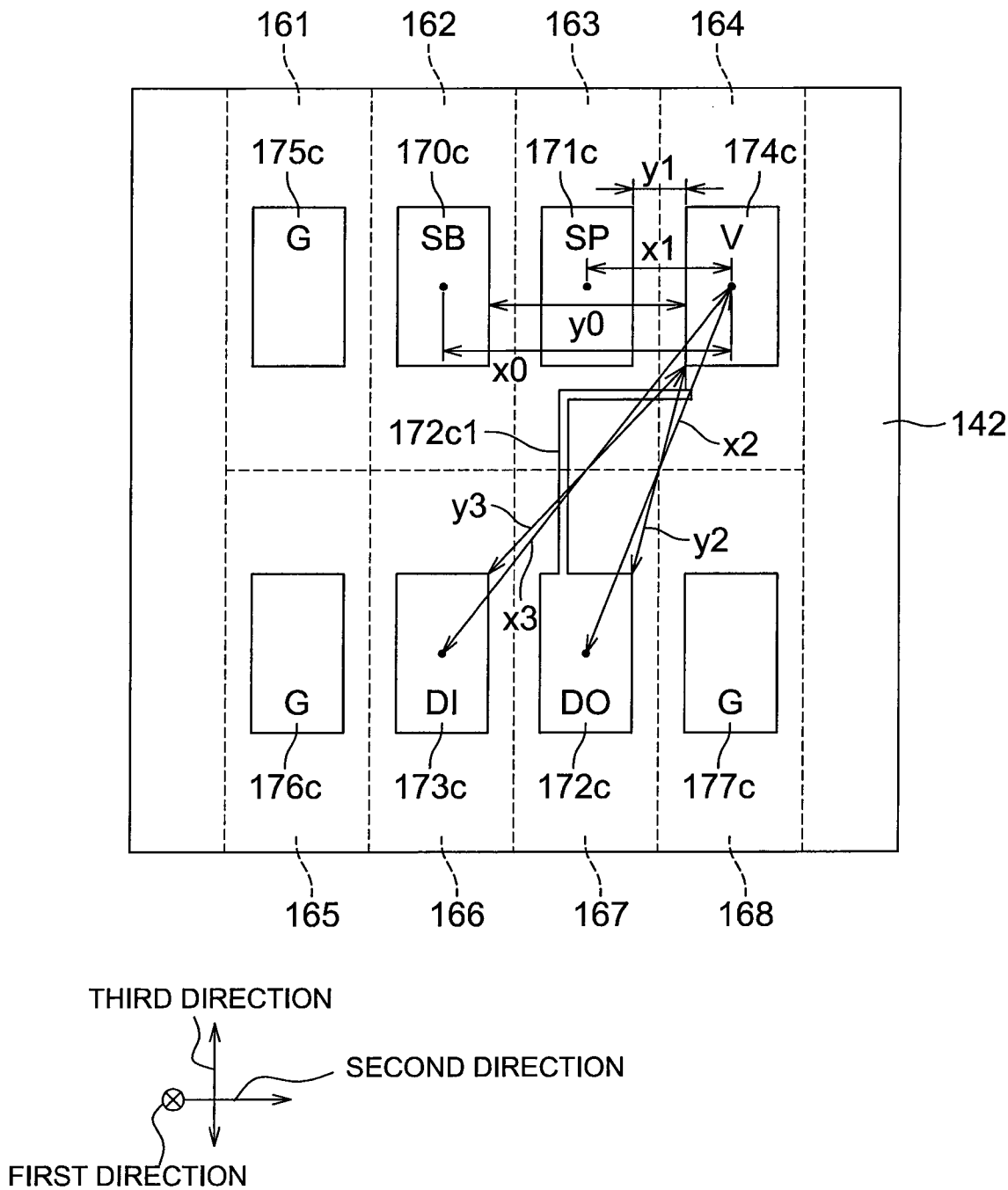
161
162
163
164
175c
170c
171c
174c
y1
G
SB
SP
x1
V
y0
x0
172c1
x2
142
y3
y2
x3
G
DI
DO
G
176c
173c
172c
177c
165
166
167
168
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.15

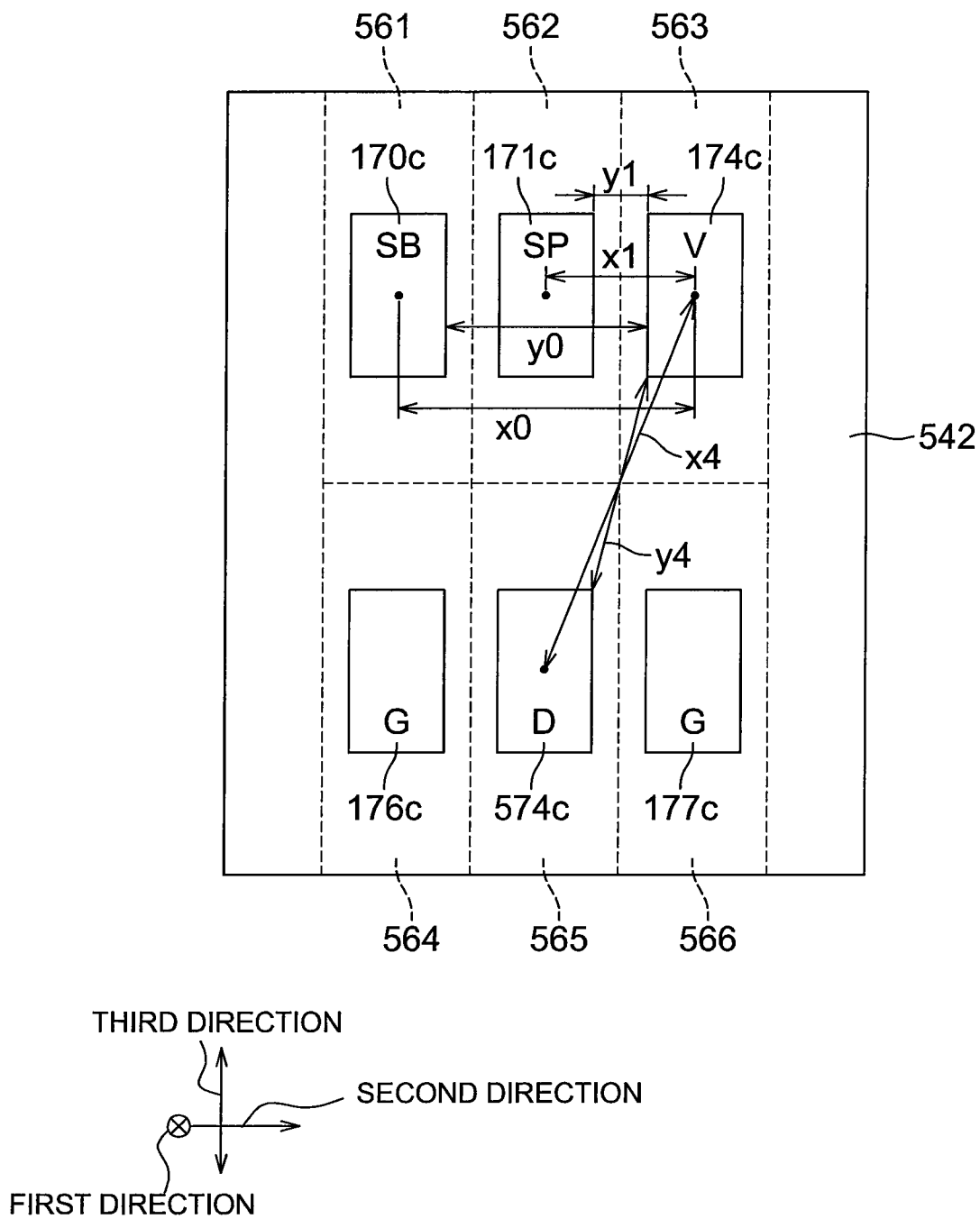
561
562
563
170c
171c
174c
y1
SB
SP
x1
V
y0
x0
x4
542
y4
G
D
G
176c
574c
177c
564
565
566
THIRD DIRECTION
SECOND DIRECTION
FIRST DIRECTION

Fig.16

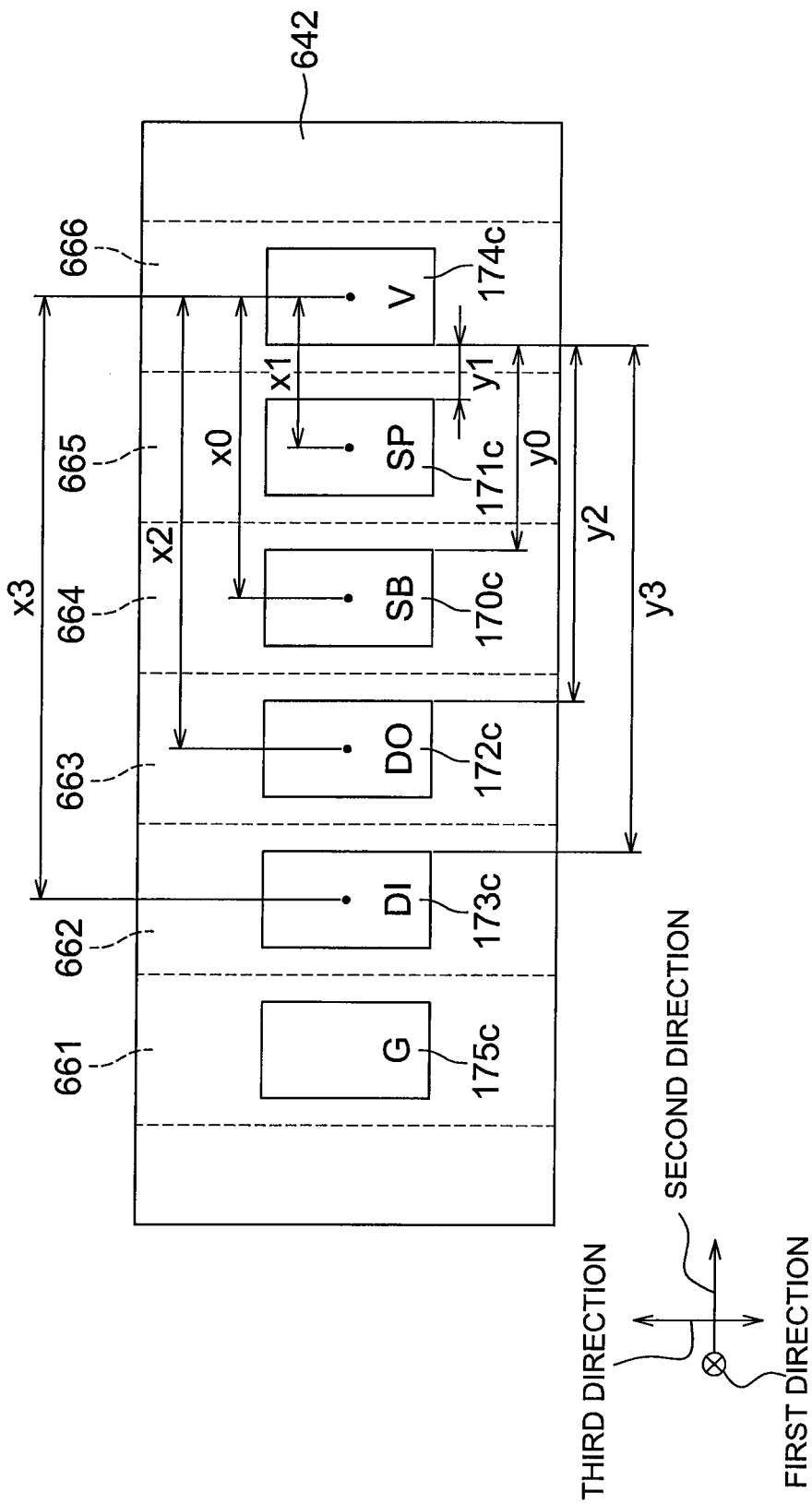
642
666
665
664
663
662
661
V
SP
SB
DO
DI
G
174c
171c
170c
172c
173c
175c
x0
x1
x2
x3
y0
y1
y2
y3
SECOND DIRECTION
THIRD DIRECTION
FIRST DIRECTION

Fig.17

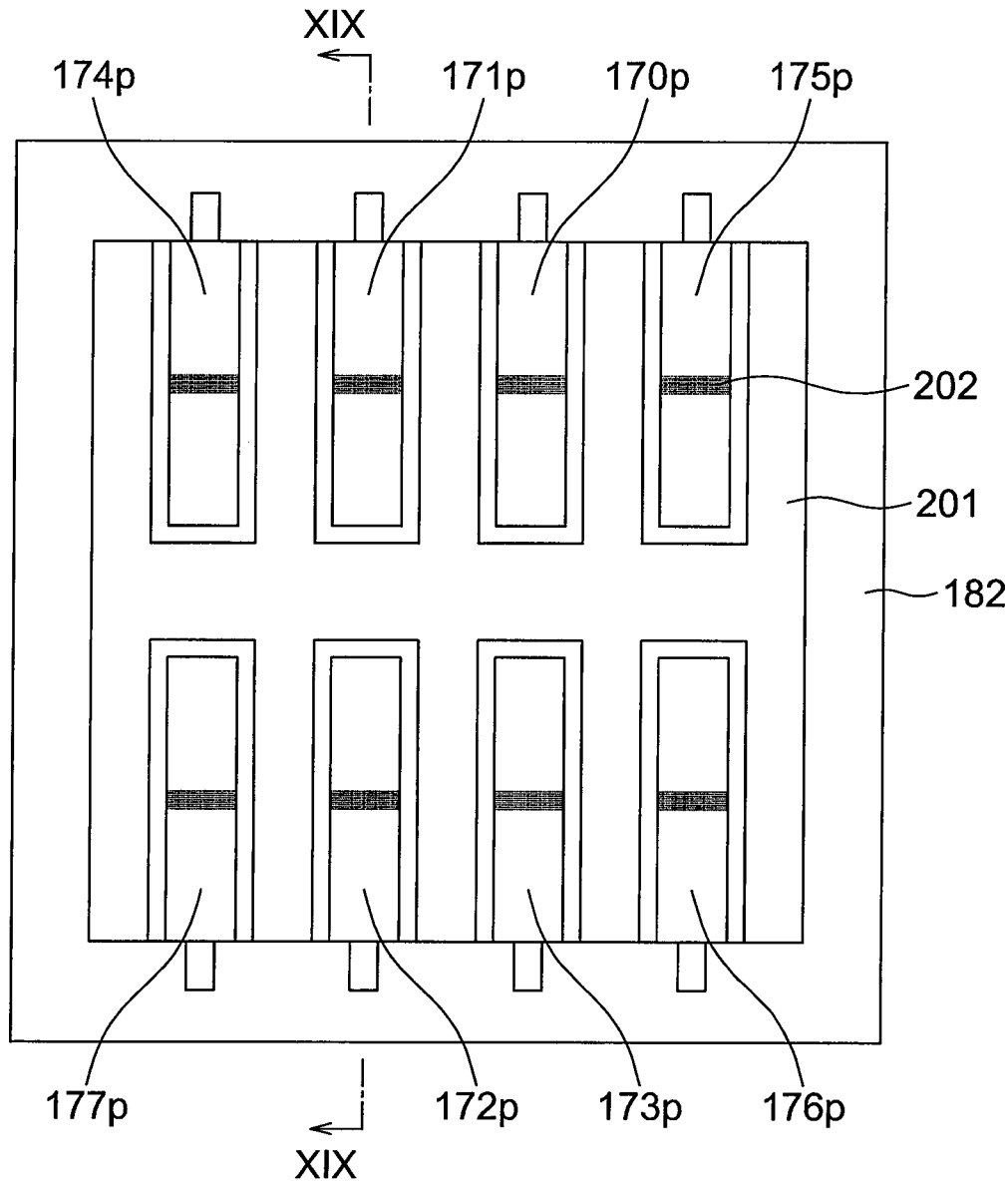

Fig.18

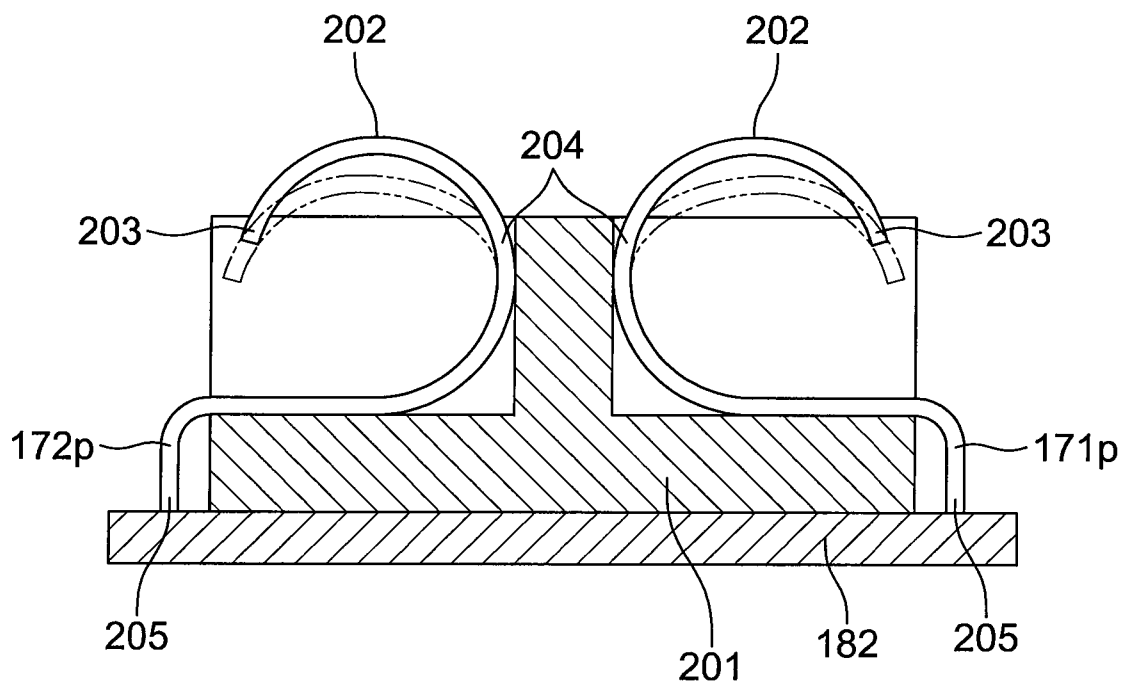

Fig.19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/067819

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.
A	US 2010/0091070 A1 (SEIKO EPSON CORP.) 2010.04.15, Whole Document & JP 2010-111116 A & CN 101716854 A	1－15
A	US 2008/0211838 A1 (SEIKO EPSON CORP.) 2008.09.04, Whole Document & JP 2008-49696 A & EP 1884363 A1 & CN 101112822 A & KR 10-2008-0011102 A	1－15
A	US 2010/0257305 A1 (SEIKO EPSON CORP.) 2010.10.07, Whole Document & JP 2010-257446 A & US 2010/0254202 A1 & EP 2237161 A1 & EP 2237163 A1 & CN 101859235 A & CN 101898455 A	1－15
A	EP 2202078 A1 (CANON KABUSHIKI KAISHA)	1－15

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"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	Date of mailing of the international search report
22.08.2011	30.08.2011

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/067819

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	2010.06.30, Whole Document & JP 2010-162867 A & US 2010/0155417 A1 & KR 10-2010-0071923 A & CN 101746149 A	
A	JP 2000-094706 A (CANON KABUSHIKI KAISHA) 2000.04.04, Whole Document (No Family)	1－15