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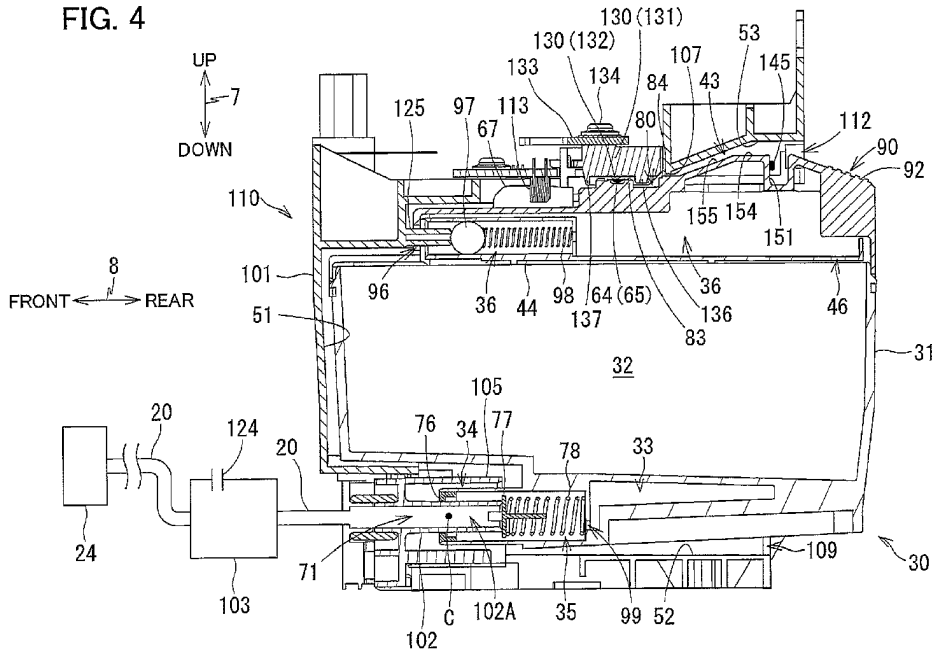
(54) SYSTEM INCLUDING LIQUID CARTRIDGE AND CARTRIDGE RECEIVING PORTION

(57) In a system, a contact unit of a cartridge receiving portion includes a contact configured to contact an electrode of a liquid cartridge. The contact unit includes first, second, third, and fourth walls. In an attached state, the first wall is positioned upstream of the electrode in an inserting direction, the second wall is positioned downstream of the electrode in the inserting direction, a lower end of each of the first through fourth walls are positioned below the contact. The electrode is positioned between the first and second walls in the inserting direction. The lower end of the first wall is positioned above the lower end of the second wall. The electrode is positioned between the third and fourth walls in a widthwise direction that is perpendicular to both of a vertical direction and the inserting direction.

FIG. 4



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Description

[0001] The present disclosure relates to a system including: a liquid cartridge storing liquid therein; a cartridge-attachment portion to which the liquid cartridge is attachable; and a consumption portion configured to consume the liquid.

[0002] One conventional system known in the art includes an inkjet recording device including a cartridge-attachment portion to which an ink cartridge can be attached and from which the ink cartridge can be detached.

[0003] Some ink cartridges is provided with electrodes and an integrated circuit (IC) storing information about the ink cartridge. In a state where the ink cartridge is attached to the cartridge-attachment portion of the inkjet recording device, the electrodes are in contact with contacts provided in the cartridge-attachment portion. Thus, the inkjet recording device becomes capable of accessing the information stored in the IC about the ink cartridge.

[0004] If the electrodes of the cartridge are attached with foreign material, such as dust, however, a contact failure might occur between the electrodes and the contacts. To avoid this problem, it is necessary to prevent the electrodes from being attached with foreign material. In order to prevent the electrodes from being attached with foreign material, it is conceivable that the electrodes are surrounded with walls in a state where the ink cartridge is attached to the cartridge-attachment portion as disclosed in Japanese Patent Application Publication No. 2017-52220.

[0005] A printer disclosed in the Japanese Patent Application Publication No. 2017-52220 includes a contact unit including contacts capable of contacting the electrodes of the ink cartridge and walls surrounding the contacts. The contact unit is configured to be vertically moved by a spring relative to the printer. With this configuration, the position of the contact unit is unstable and therefore the contacts might not contact with the electrodes. In addition, as the spring degrades with age, the distance by which the contact unit can move vertically might possibly reduce. As a result, the contacts might fail to contact the electrodes.

[0006] In view of the foregoing, it is an object of the present disclosure to provide a system capable of suppressing occurrence of contact failure between the electrodes and the contacts by suppressing adherence of foreign materials onto the electrodes.

(1) In order to attain the above and other objects, according to one aspect, the present disclosure provides a system including a liquid cartridge, a cartridge receiving portion, and a consumption portion. The liquid cartridge includes a storage chamber configured to store liquid therein. The liquid cartridge is attachable to the cartridge receiving portion in an insertion direction crossing a vertical direction. The consumption portion is configured to consume the liquid stored in the storage chamber of the liquid cartridge attached to the cartridge receiving portion. The liquid cartridge includes a main body having the storage chamber, a supply portion, and an electrode. The supply portion is positioned at a lower end portion of the main body and configured to supply the liquid stored in the storage chamber to an outside of the liquid cartridge. The electrode is provided on an upper surface of the main body at a position upstream of the supply portion in the inserting direction. The cartridge receiving portion includes a casing, a supply tube, and a contact unit. The liquid cartridge is capable of being inserted into the casing. The supply tube protrudes in a direction opposite to the inserting direction, and is connectable to the supply portion of the liquid cartridge. The supply tube allows the liquid to flow therethrough from the storage chamber of the liquid cartridge to the consumption portion. The contact unit is fixed to the casing at a position upstream of the supply tube in the insertion direction. The contact unit includes a contact that is configured to contact the electrode of the liquid cartridge from above in an attached state where the supply portion of the liquid cartridge is connected to the supply tube. The contact unit includes a first wall, a second wall, a third wall, and a fourth wall. In the attached state, the first wall is positioned upstream of the electrode in the inserting direction. In the attached state, the second wall is positioned downstream of the electrode in the inserting direction. In the attached state, a lower end of each of the first wall, second wall, third wall, and fourth wall are positioned below the contact. The electrode is positioned between the first wall and the second wall in the inserting direction. The lower end of the first wall is positioned above the lower end of the second wall. The electrode is positioned between the third wall and the fourth wall in a widthwise direction that is perpendicular to both of the vertical direction and the inserting direction.

[0007] With this configuration, the electrode is surrounded by the first wall, the second wall, the third wall, and the fourth wall from all of four directions in the state where the ink cartridge is in the attached state. Thus, the electrode is suppressed from being adhered with foreign materials.

[0008] Further, because the contact unit is fixed to the casing, a position of the contact unit can be kept stable. This can decrease such a possibility that the contact does not come into contact with the electrode.

[0009] Further, it is conceivable that in the course of insertion of the cartridge into the casing, the contact unit fixed to the casing causes such a problem that the cartridge (in particular, the electrode and a peripheral area of the cartridge) is brought into abutment contact with the first wall and the cartridge is not fully inserted into the casing. However, according to the above-identified configuration, the lower end of the first wall is higher than

the lower end of the second wall. This can decrease such a possibility that, in the course of inserting the cartridge, the cartridge comes into abutment contact with the first wall.

(2) It is preferable that the lower ends of the third wall and the fourth wall are at a position equal to a position of the lower end of the second wall in the vertical direction.

(3) It is preferable that the electrode is fixed to the main body of the liquid cartridge.

[0010] Because the electrode is fixed to the main body of the liquid cartridge, the position of the electrode relative to the main body of the liquid cartridge is kept stable. This can decrease such a possibility that the electrode does not come into contact with the contact.

(4) It is preferable that the liquid cartridge further includes an engagement portion configured to be engaged with the cartridge receiving portion in the attached state. The engagement portion is configured such that the engagement portion is engaged with the cartridge receiving portion through pivotal movement of the cartridge relative to the cartridge receiving portion about a connecting portion between the supply portion and the supply tube in a process of attachment of the liquid cartridge to the cartridge receiving portion.

[0011] With this configuration, without the cartridge and the cartridge receiving portion being not made complex in configuration, the electrode is allowed to move to the position where the electrode is in contact with the contact, in the course of insertion of the cartridge to the cartridge receiving portion. Therefore, an amount of overlapping between the engagement portion and the cartridge receiving portion when the engagement portion engages with the cartridge receiving portion can be increased.

(5) It is preferable that the engagement portion is positioned upstream of the electrode in the inserting direction.

[0012] With this configuration, a distance between the center of pivotal motion of the cartridge and the engagement portion is longer than a distance between the center of pivotal motion of the cartridge and the electrode. Accordingly, when the cartridge is pivotally moved, a distance by which the engagement portion moves is longer than a distance by which the electrode moves.

(6) It is preferable that the engagement portion has a first surface configured to be engaged with the cartridge receiving portion and a second surface positioned downstream of the first surface in the inserting direction. In the attached state, the first wall of the contact unit is positioned between the contact and the second surface of the engagement portion, and the lower end of the first wall is positioned below an upper end of the second surface of the engagement portion.

(7) It is preferable that a distance between the second wall and the electrode in the inserting direction is greater than a distance between the first wall and the electrode in the inserting direction.

[0013] When the cartridge is to be attached to the cartridge receiving portion, if the cartridge is inadvertently inserted further into the cartridge receiving portion by a distance longer than the required distance, the electrode would likely come into abutment contact with the second wall. However, because the distance between the second wall and the electrode in the inserting direction is longer than the distance between the first wall and the electrode in the inserting direction, this arrangement can decrease such a possibility that the electrode comes into abutment contact with the second wall.

(8) It is preferable that the cartridge receiving portion further includes a circuit board fixed to the casing. The contact unit is fastened to the circuit board with at least one screw.

(9) It is preferable that the main body of the liquid cartridge has a portion positioned above the supply portion and downstream of the supply portion in the inserting direction.

[0014] With this configuration, even when the cartridge drops with its upper end or its rear end facing downward, the portion of the main body of the liquid cartridge that is above the supply portion and downstream of the supply portion in the inserting direction can prevent the supply portion from directly coming into contact with the ground, for example. Accordingly, this can decrease such a possibility that the supply portion is damaged.

(10) It is preferable that the cartridge receiving portion further includes an optical sensor fixed to the casing. The liquid cartridge further includes a protrusion on the upper surface of the main body of the liquid cartridge at a position downstream of the electrode in the inserting direction. The protrusion has an irradiated surface configured to shut-off or attenuate light emitted from the optical sensor in the attached state.

[0015] With this configuration, the optical sensor is positioned downstream of the electrode in the inserting direction when the cartridge is in the attached state. Accordingly, in the course of insertion of the cartridge into the cartridge receiving portion, the electrode can be prevented from coming into contact with the optical sensor.

(11) It is preferable that the liquid cartridge is formed

with a recessed portion at a position adjacent to the electrode in the widthwise direction. The recessed portion being depressed downward from the upper surface of the main body of the liquid cartridge in the vertical direction. The cartridge receiving portion is provided with a protrusion that is configured to be received in the recessed portion in the attached state.

[0016] With this configuration, the cartridge receiving portion is equipped with the protrusion at a position corresponding to the recessed portion in the attached state. The protrusion can be used to fix the cartridge in position both in the widthwise direction and the up-down direction, for example.

(12) It is preferable that the liquid cartridge has an abutment surface at a position upstream of the electrode in the inserting direction. The abutment surface is in abutment contact with the casing from below in the attached state.

[0017] With this configuration, the abutment surface comes into contact with the casing at a position upstream of the position where the electrode contacts the contact in the inserting direction, and the supply portion is coupled to the supply tube at a position downstream of the position where the electrode contacts the contact in the inserting direction. Thus, the cartridge is fixed in position in the up-down direction. Therefore, the position of the electrode that is positioned between the abutment surface and the supply portion in the cartridge in the inserting direction can be kept stable.

[0018] According to the above-described aspect, the system is capable of suppressing a contact failure between the electrodes and the contacts from occurring by suppressing electrodes from being adhered with foreign materials.

[0019] The particular features and advantages of the disclosure as well as other objects will become apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1A is a perspective view of a multifunction peripheral according to one embodiment of the present disclosure, in which a cover of the multifunction peripheral is at a closed position;

Fig. 1B is a perspective view of the multifunction peripheral according to the embodiment, in which the cover is at an open position;

Fig. 2 is a vertical cross-sectional view schematically illustrating an internal structure of a printer portion in the multifunction peripheral according to the embodiment;

Fig. 3 is a front view of a cartridge-attachment portion in the multifunction peripheral;

Fig. 4 is a vertical cross-sectional view of an ink cartridge and a cartridge-attachment portion according to the embodiment in a state where the ink cartridge is in the attached state;

Fig. 5A is a perspective view of a contact unit provided in the cartridge-attachment portion according to the embodiment;

Fig. 5B is a cross-sectional view of the contact unit taken along a plane VB-VB in Fig. 5A in which contacts in the contact unit are in contact with electrodes of the cartridge indicated by the dashed line;

Fig. 6 is a perspective view of an ink cartridge according to the embodiment as viewed from front side thereof;

Fig. 7 is a cross-sectional view of the ink cartridge taken along a plane VII-VII in Fig. 6;

Fig. 8 is a vertical cross-sectional view of the ink cartridge and the cartridge-attachment portion, in which the ink cartridge is in a pivoted posture; and

Fig. 9 is an enlarged view of the contact unit and an area surrounding the contact unit in Fig. 4.

[0020] A multifunction peripheral 10 and an ink cartridge 30 as an example of a "system" according to one embodiment will be described with reference to the accompanying drawings, wherein like parts and components are designated by the same reference numerals to avoid duplicating description.

[0021] In the following description, up, down, front, rear, left, and right directions related to the multifunction peripheral 10 will be referred to assuming that the multifunction peripheral 10 is disposed on a horizontal plane so as to be operable, as shown in Fig. 1A. Note that this posture of the multifunction peripheral 10 illustrated in Figs. 1A and 1B will also be referred to as an "operable posture". Specifically, an up-down direction 7 of the multifunction peripheral 10 will be defined based on the operable posture of the multifunction peripheral 10. A front-rear direction 8 will be defined assuming that a surface of the multifunction peripheral 10 formed with an opening 13 is a front surface 14A of the multifunction peripheral 10 in the operable posture. A left-right direction 9 will be defined based on an assumption that the multifunction peripheral 10 in the operable posture is viewed from its front side. In the present embodiment, the up-down direction 7 is parallel to a vertical direction, and the front-rear direction 8 and the left-right direction 9 are parallel to a horizontal direction. Further, the front-rear direction 8 is perpendicular to the left-right direction 9.

<Overall Structure of Multifunction Peripheral 10>

[0022] As illustrated in Figs. 1A and 1B, the multifunction peripheral 10 has a substantially rectangular parallelepiped shape. The multifunction peripheral 10 has a lower portion at which a printer portion 11 is provided. The printer portion 11 is configured to record an image on a sheet of paper 12 (see Fig. 2) based on an inkjet recording method. The printer portion 11 includes a casing 14 whose front surface 14A is formed with the opening

13.

[0023] As illustrated in Fig. 2, within the casing 14, provided are a feed roller 23, a feed tray 15, a discharge tray 16, a conveying roller pair 25, a discharge roller pair 27, a recording portion 24, a platen 26, and a cartridge attachment portion 110 (as an example of "a cartridge receiving portion", see Fig. 1B). The multifunction peripheral 10 has various functions such as a facsimile function and a printing function.

<Feed Tray 15, Discharge Tray 16, Feed Roller 23 >

[0024] As illustrated in Figs. 1A and 1B, the feed tray 15 is configured to be inserted into and removed from the casing 14 through the opening 13 along the front-rear direction 8 by a user. The opening 13 is positioned at a center portion of the front surface 14A of the casing 14 in the left-right direction 9 (as an example of "widthwise direction"). As illustrated in Fig. 2, the feed tray 15 is configured to support a plurality of sheets 12 in a stacked state.

[0025] The discharge tray 16 is positioned above the feed tray 15. The discharge tray 16 is configured to support the sheets 12 discharged by the discharge roller pair 27.

[0026] The feed roller 23 is configured to feed each of the sheets 12 supported on the feed tray 15 toward a conveying path 17 (see Fig. 2). The feed roller 23 is configured to be driven by a feed motor (not illustrated).

<Conveying Path 17>

[0027] As illustrated in Fig. 2, the conveying path 17 is a space partially defined by an outer guide member 18 and an inner guide member 19 facing each other at a predetermined interval inside the printer portion 11. The conveying path 17 extends rearward from a rear end portion of the feed tray 15, and then, U-turns frontward while extending upward at a rear portion of the printer portion 11, and passes through a space between the recording portion 24 and the platen 26, and reaches the discharge tray 16. A part of the conveying path 17 positioned between the conveying roller pair 25 and the discharge roller pair 27 is provided at a substantially center portion of the multifunction peripheral 10 in the left-right direction 9, and extends in the front-rear direction 8. A conveying direction of the sheet 12 in the conveying path 17 is indicated by a dashed-and-dotted arrow in Fig. 2.

<Conveying Roller Pair 25>

[0028] As illustrated in Fig. 2, the conveying roller pair 25 is disposed at the conveying path 17. The conveying roller pair 25 includes a conveying roller 25A and a pinch roller 25B opposed to each other. The conveying roller 25A is configured to be driven by a conveying motor (not illustrated). The pinch roller 25B is configured to be rotated in accordance with rotation of the conveying roller 25A. When the conveying roller 25A is rotated forward in response to forward rotation of the conveying motor, the sheet 12 is conveyed in the conveying direction (i.e. frontward direction) while nipped between the conveying roller 25A and the pinch roller 25B.

<Discharge Roller Pair 27>

[0029] As illustrated in Fig. 2, the discharge roller pair 27 is disposed at the conveying path 17 at a position downstream relative to the conveying roller pair 25 in the conveying direction. The discharge roller pair 27 includes a discharge roller 27A and a spur roller 27B opposed to each other. The discharge roller 27A is configured to be driven by the conveying motor (not illustrated). The spur roller 27B is configured to be rotated in accordance with rotation of the discharge roller 27A. When the discharge roller 27A is rotated forward in response to the forward rotation of the conveying motor, the sheet 12 is conveyed in the conveying direction (i.e. frontward direction) while nipped between the discharge roller 27A and the spur roller 27B.

<Recording Portion 24 and Platen 26>

[0030] As illustrated in Fig. 2, the recording portion 24 is disposed at the conveying path 17 at a position between the conveying roller pair 25 and the discharge roller pair 27. The recording portion 24 is arranged so as to be opposed to the platen 26 in the up-down direction 7, with the conveying path 17 interposed between the recording portion 24 and the platen 26. The recording portion 24 is positioned above the conveying path 17, and the platen 26 is positioned below the conveying path 17.

[0031] The recording portion 24 includes a carriage 22 and a recording head 21 mounted on the carriage 22. The carriage 22 is reciprocally movable in the left-right direction 9 upon transmission of driving force from the drive motor (not illustrated). The recording head 21 has a lower surface at which a plurality of nozzles 29 are open. The recording head 21 is provided with a pair of oscillation elements such as piezoelectric elements so that the oscillation causes ejection of ink droplets through the nozzles 29. During a lateral movement of the carriage 22, ink droplets are selectively ejected from each nozzle 29 onto the sheet 12 supported on the platen 26 to thus form an inked image on the sheet 12.

[0032] A bundle of ink tubes 20 (One of which is shown in Fig. 4) and a flexible flat cable (not illustrated) are connected to the carriage 22. As illustrated in Fig. 4, the ink tubes 20 connect the cartridge attachment portion 110 to the recording head 21. Specifically, each of the ink tubes 20 is configured to supply ink stored in a corresponding ink cartridge 30 attached to the cartridge receiving portion 110 to the recording head 21. In the present embodiment, four ink cartridges 30 are attachable to the cartridge-attachment portion 110. Accordingly, four ink tubes 20 are provided in one-to-one correspond-

ence with the four ink cartridges 30 so that ink of four colors (black, magenta, cyan, and yellow) stored in the respective four ink cartridges 30 can flow through the corresponding ink tubes 20. The flexible flat cable is configured to electrically connect a controller (not illustrated) to the recording head 21. The controller is configured to control operation of the multi-function peripheral 10. The controller includes, for example, a CPU, a RAM, a ROM, and the like.

<Cover 87>

[0033] As illustrated in Fig. 1B, an opening 85 is formed in the front surface 14A of the casing 14 at a right end portion thereof. The cartridge-attachment portion 110 can be accommodated in a space formed rearward of the opening 85. A cover 87 is attached to the casing 14 so as to cover the opening 85. The cover 87 is configured to be pivotally movable about a pivot axis 87A (pivot center) extending in the left-right direction 9 between a closed position (a position illustrated in Fig. 1A) for closing the opening 85 and an open position (a position illustrated in Fig. 1B) for exposing the opening 85.

< Cartridge-Attachment Portion 110 >

[0034] As shown in Fig. 4, the cartridge-attachment portion 110 includes a cartridge case 101 (as an example of "a casing"), supply tubes 102, rods 125, a shaft 145, tanks 103, optical sensors 113, and contact units 130.

< Cartridge Case 101 >

[0035] The cartridge case 101 shown in Figs. 3 and 4 constitutes a casing of the cartridge-attachment portion 110. The cartridge case 101 has a box shape. An interior space 104 is formed inside the cartridge case 101. As shown in Figs. 3 and 4, the cartridge case 101 is provided with an end wall 51, a bottom wall 52, a top wall 53, and a pair of side walls. The bottom wall 52 extends forward from a bottom edge of the end wall 51. The top wall 53 extends forward from a top edge of the end wall 51 and is apart from the bottom wall 52 in the vertical direction. The pair of side walls extend forward from respective right and left edges of the end wall 51. The side wall extending from the right edge of the end wall 51 is connected to right edges of the bottom wall 52 and top wall 53, while the side wall extending from the left edge of the end wall 51 is connected to left edges of the bottom wall 52 and top wall 53. Hence, the pair of side walls connect the top wall 53 to the bottom wall 52. An opening 112 is formed in a front end of the cartridge case 101 to oppose the end wall 57 in the front-rear direction. Further, as illustrated in Fig. 1B, when the cover 87 is arranged to the open position, the opening 112 is exposed to an outside of the multifunction peripheral 10 via the opening 85 of the casing 14.

[0036] As illustrated in Fig. 3, the cartridge case 101 has three plates 104 that partition the internal space of the cartridge case 101 into four individual spaces arrayed with each other in the left-right direction 9. One of the four supply tubes 102, one of four the rods 125, one of the four protruding parts 107, one of the four tanks 103, one of the four optical sensors 113, and one of the four contact units 130 are provided in each compartment of the four internal spaces. Note that the number of compartments in the interior space partitioned by the plates 104 in the cartridge case 101 is not limited to four. The number of the plates 104 arranged in the spaces is also not limited to three.

[0037] As illustrated in Figs. 3 and 4, the bottom wall 51 is formed with guide grooves 109. The guide grooves 109 extend in the front-rear direction 8. The guide grooves 109 are formed in the four spaces in one-to-one correspondence with the four ink cartridges 30.

<Supply Tube 102>

[0038] As illustrated in Figs. 3 and 4, each supply tube 102 has a cylindrically shaped member formed of a resin. Each supply tube 102 is positioned below the end wall 51 of the cartridge case 101. The supply tube 102 protrudes farther forward than the end wall 51 of the cartridge case 101.

[0039] As illustrated in Fig. 4, the supply tube 102 has a front end (tip end) and a rear end (base end). The supply tube 102 is open at both of the front end (tip end) and the rear end (base end). The rear end of the supply tube 102 is in communication with the recording head 21 via the corresponding ink tube 20 and the corresponding tank 103.

[0040] As illustrated in Figs. 3 and 4, a guide portion 105 is provided to surround each supply tube 102. The guide portion 105 has a hollow cylindrical shape. The guide portion 105 protrudes forward farther than the end wall 51 of the cartridge case 101. The guide portion 105 is open at its protruding end. The corresponding supply tube 102 is positioned at a diametrical center of the guide portion 105.

<Rod 125>

[0041] As illustrated in Fig. 4, each rod 125 is formed on the end wall 57 of the cartridge case 101 at a position above the corresponding supply tube 102. The rod 125 protrudes forward from the end wall 57 of the cartridge case 101. The rod 125 has a cylindrical shape. In Fig. 3, the rods 125 are not illustrated.

<Shaft 145>

[0042] As illustrated in Fig. 4, the shaft 145 extends in the left-right direction 9 at a position in the vicinity of both of the top wall 53 and the opening 112 of the case 101. The shaft 145 is a bar-like member extending in the left-right direction 9. The shaft 145 is, for example, a metal

column. The shaft 145 has a left end fixed to the side wall of the cartridge case 101 on the left side, and a right end fixed to the side wall of the cartridge case 101 on the right side. The shaft 145 extends in the left-right direction 9 over all of the four interior spaces of the cartridge case 101 in which the four ink cartridges 30 can be respectively accommodated.

<Protruding Part 107>

[0043] As shown in Fig. 4, each protruding part 107 protrudes downward from the top wall 53 of the cartridge case 101. The protruding part 114 is disposed forward of the corresponding rod 125 and rearward of the shaft 145 in the front-rear direction.

<Tank 103>

[0044] As shown in Fig. 4, each tank 103 is provided rearward of the cartridge case 101. The tank 103 has a box shape and can accommodate ink internally. The tank 103 has a top portion that is open to the outside of the tank 103 through an air communication port 124. Accordingly, the interior of the tank 103 is open to the atmosphere. The interior space in the tank 103 is in communication with the interior space 102A in the corresponding supply tube 102 via the corresponding ink tube 20. With this arrangement, ink flowing out of the interior space 102A of the tube 102 is accumulated in the tank 103. The interior space of the tank 103 is also in communication with the recording head 21 via the corresponding ink tube 20. Accordingly, ink stored in the interior of the tank 103 is supplied to the recording head 21 through the corresponding ink tube 20.

[0045] Note that the cartridge-attachment portion 110 need not be provided with the tanks 103. In this case, the rear end of each supply tube 102 is arranged to communicate with the recording head 21 via the corresponding ink tube 20 without passing through the tank 103.

<Optical sensor 113>

[0046] As shown in Fig. 4, each optical sensor 113 is fixed to the top wall 53 of the cartridge case 101. The optical sensor 113 is positioned further forward than the shaft 125, and further rearward than the protruding part 107 in the front-rear direction. The optical sensor 113 includes a light-emitting part and a light-receiving part. The light-emitting part is disposed on the right or left of the light-receiving part with a gap formed therebetween. The light-emitting part is configured to emit light toward the light-receiving part in the left-right direction.

[0047] The optical sensor 113 is configured to output detection signals to the controller (not illustrated). The signals change according to whether the light-receiving part receives light emitted from the light-emitting part. For example, the optical sensor 113 outputs a low level signal to the controller when the light-receiving part does not receive light emitted from the light-emitting part (that is, when the received light is less than a prescribed intensity) and outputs a high level signal to the controller when the light-receiving part receives light emitted from the light-emitting part (that is, when the received light is greater than or equal to the prescribed intensity).

<Contact Unit 130 and Circuit Board 133>

[0048] As shown in Figs. 4, 5A and 5B, each contact unit 130 includes a case 131 and contacts 132 accommodated in the case 131.

[0049] As shown in Fig. 4, a circuit board 133 is fixed to the cartridge case 101 in proximity to the top wall 53. The circuit board 133 is positioned forward of the tubes 102 and optical sensors 113 and rearward of the protruding parts 107. The case 131 of each contact unit 130 is fixed to the bottom surface of the circuit board 133 with a screw 134. An electric circuit (not illustrated) is mounted on the circuit board 133. The electric circuit is electrically connected to the controller (not illustrated).

[0050] As shown in Figs. 5A and 5B, the case 131 of the contact unit 130 has a general rectangular parallelepiped shape. The case 131 is provided with includes a front wall 136 (as an example of "a first wall"), a rear wall 137 (as example of "a second wall"), a right wall 138 (as example of "a third wall"), and a left wall 139 (as example of "a fourth wall"). All of the front wall 136, rear wall 137, right wall 138 and left wall 139 protrude further downward than the bottom surface 131A of the case 131. The bottom end of the front wall 136 is at a vertical position higher than the vertical position of the bottom end of the rear wall 137. The front wall 136 has a rear end portion 136A on its bottom surface. The rear end portion 136A of the front wall 136 is curved. The right wall 138 and left wall 139 are aligned with each other in the left-right direction. The bottom ends of the right wall 138 and the left wall 139 are at vertical positions the same as the vertical position of the bottom end of the rear wall 137 and lower than the vertical position of the bottom end of the front wall 136. A front edge of the right wall 138 is connected to a right edge of the front wall 136 and a rear edge of the right wall 138 is connected to a right edge of the rear wall 137. A front edge of the left wall 139 is connected to a left edge of the front wall 136, and a rear edge of the left wall 139 is connected to a left edge of the rear wall 137. Note that the shape of the case 131 is not limited to the shape shown in Figs. 5A and 5B. The case 131 may have a cylindrical shape.

[0051] Four slots 135 are formed in the case 131. The slots 135 are arranged at intervals in the right-left direction. The four slots 135 provide four internal spaces in the case 131. Each slot 135 is formed in the case 131 to extend from the bottom surface 131A to the top surface 131C of the case 131. Each slot 135 also passes through the front surface 131B of the case 131. In other words, each slot 135 passes through the front wall 136. A single contact 132 is disposed in each internal space. Thus, the

contact unit 130 includes four contacts 132. Note that the number of slots 135 is not limited to four. That is, the number of contacts 132 provided in the contact unit 130 is not limited to four.

[0052] The case 131 supports the contacts 132 in the internal spaces formed by the slots 135. The contacts 132 are configured of members that are flexible and electrically conductive. Bottom ends 132A of the contacts 132 protrude further downward than the bottom surface 131A of the case 131. In other words, the bottom ends 132A are exposed outside of the case 131. The bottom ends 132A of the contacts 132 can be elastically deformed upward.

[0053] Top ends 132B of the contacts 132 (see Fig. 5B) are mounted on the circuit board 133 such that the contacts 132 are electrically connected to the electric circuit mounted also on the circuit board 133. Because the electric circuit is electrically connected to the controller, the contacts 132 are electrically connected with the controller via the electric circuit provided in the circuit board 133.

[0054] Bottom edges of all the rear wall 136, front wall 137, right wall 138, and left wall 139 are thus positioned lower than the bottom ends 132A of the contacts 132.

[0055] The front wall 136 is positioned further forward than the bottom ends 132A of the contacts 132. The rear wall 137 is positioned further rearward than the bottom ends 132A of the contacts 132.

[0056] The right wall 138 is positioned further rightward than the bottom ends 132A of the contacts 132, and the left wall 139 is positioned further leftward than the bottom ends 132A of the contacts 132.

[0057] The ink cartridge 30 (as an example of "a liquid cartridge") shown in Figs. 6 and 7 is a container that stores ink.

[0058] As illustrated in Fig. 4, one ink cartridge 30 is accommodated in one of the four compartments partitioned in the interior space 104 of the cartridge holder 101 (see Fig. 3). Thus, four ink cartridges 30 can be accommodated in the cartridge-attachment portion 110 in the present embodiment. Each of the four ink cartridges 30 corresponds to one of the ink colors cyan, magenta, yellow, and black. Ink in one of these colors is stored in the corresponding ink cartridge 30. Note that the number of ink cartridges 30 that the cartridge-attachment portion 110 can accommodate is not limited to four.

[0059] Each ink cartridge 30 can be inserted into and removed from the case 101 through the opening 85 (see Fig. 1B) of the casing 14 and the opening 112 of the case 101. As illustrated in Fig. 4, movement of the ink cartridge 30 in the front-rear direction 8 is guided by the guide groove 109 when the lower end portion of the ink cartridge 30 is inserted into the guide groove 109. The direction "rearward" for inserting the ink cartridge 30 into the cartridge-attachment portion 110 is an example of an insertion direction.

[0060] As shown in Figs. 6 and 7, each ink cartridge 30 includes a main body 31 (as an example of "main body"), a supply portion 34, a protruding part 43, an operating part 90, a projection 67, a protruding portion 83, and an IC substrate 64.

<Main body 31>

[0061] As illustrated in Fig. 6, the main body 31 has an overall flattened shape in which a left-right dimension thereof (width) is smaller than a front-rear dimension thereof (depth), and the vertical and front-rear dimensions (height and depth) are larger than the left-right dimension (width). The main body 31 has a rear wall 40, a front wall 41, upper walls 39A and 39B, a lower wall 42, a right wall 37, and a left wall 38.

[0062] An upper surface of the upper wall 39A is higher than an upper surface of the upper wall 39B. The upper wall 39A is positioned in front of the upper wall 39B. In the left-right direction 9, both left and right ends of a rear portion of the upper wall 39A are recessed. Recessed portions 45 are therefore formed on the left and right ends of the rear portion of the upper wall 39A. The recessed portions 45 are defined by front portions of the upper wall 39B and step walls 39C that connect the upper wall 39A with the front portions of the upper wall 39B in the front-rear direction 8. The upper walls 39A and 39B will be herein collectively referred to as an upper wall 39.

[0063] As illustrated in Figs. 6 and 7, the front wall 41 has an upper portion 41U and a lower portion 41L. The upper portion 41U is positioned above the lower portion 41L. The lower portion 41L is positioned further rearward than the upper portion 41U. Both the upper portion 41U and the lower portion 41L are flat surfaces. The upper portion 41U and the lower portion 41L extend in directions that intersect with each other but are not orthogonal to each other. The lower portion 41L slopes relative to the up-down direction 7, and specifically slopes rearward from top to bottom.

[0064] A lower surface of the lower wall 42 is a sloped surface that slopes relative to the front-rear direction 8 so that the front edge of the lower wall 42 is further upward than the rear edge of the lower wall 42. The front end of the lower wall 42 is connected with a lower end of the lower portion 41L of the front wall 41.

[0065] In addition to the walls described above, the main body 31 has a sub-lower wall 48 and a stepped wall 49. The sub-lower wall 48 is positioned further upward relative to the lower wall 42 and extends frontward continuously from a lower end of the rear wall 40. The stepped wall 49 serves as a wall connecting a front end of the sub-lower wall 48 and the rear end of the lower wall 42.

[0066] As illustrated in Fig. 7, the main body 31 is internally formed with a storage chamber 32, a storage chamber 33, and an air channel 36. The storage chamber 32 and the storage chamber 33 are configured to store ink therein. The storage chamber 32 and the storage chamber 33 are an example of the storage chamber. The storage chamber 32 and the storage chamber 33 are in

communication with each other via a through-hole 47. The storage chamber 32 and the storage chamber 33 are defined by the rear wall 40, the front wall 41, the lower wall 42, the right wall 37 (see Fig. 6), the left wall 38 (see Fig. 6), the sub-lower wall 48, the stepped wall 49, and an inner wall 44 formed inside the main body 31.

[0067] The air channel 36 is in communication with outside of the ink cartridge 30 through an air communication port 96 formed on an upper portion of the rear wall 40. The air channel 36 and the storage chamber 32 are in communication with each other through a through-hole 46 formed through the inner wall 44. The air channel 36 is defined by the rear wall 40, the front wall 41, the upper wall 39, the right wall 37 (see Fig. 6), the left wall 38 (see Fig. 6), and the inner wall 44.

[0068] The air channel 36 accommodates therein a valve 97 and a coil spring 98. The valve 97 is configured to move in the front-rear direction 8 to open and close the air communication port 96. The coil spring 98 is arranged so as to be able to expand and contract in the front-rear direction 8. The coil spring 98 urges the valve 97 rearward. In a state where no external force is applied to the valve 97, the valve 97 closes the air communication port 96. On the other hand, in a state where an external force is applied to the valve 97, the valve 97 opens the air communication port 96. Thus, the storage chamber 32 and the storage chamber 33 become open to the atmosphere through the air channel 36.

[0069] In the main body 31, at least the front wall 41 has translucency of such degree that allows the liquid level of ink stored in the storage chamber 32 and the storage chamber 33 to be visually recognized from an outside of the ink cartridge 30.

<Supply portion 34>

[0070] As illustrated in Figs. 6 and 7, the supply portion 34 is positioned at a lower end portion of the main body 31. The supply portion 34 protrudes rearward from the stepped wall 49. The supply portion 34 is positioned below the sub-lower wall 48. A rear end (tip end) of the supply portion 34 is positioned between the front end and a rear end of the sub-lower wall 48 in the front-rear direction 8. As described above, a part of the main body 31 is positioned above the supply portion 34, and rearward of the supply portion 34.

[0071] The supply portion 34 has a cylindrical outer shape opening at both of the front end and the rear end. An ink valve chamber 35 is formed in an interior space of the supply portion 34. A front end of the ink valve chamber 35 and a lower end of the storage chamber 33 are in communication with each other through a through-hole 99. The rear end of the supply portion 34 is plugged by a sealing member 76. The sealing member 76 is a disk-shaped member having a center portion formed with a through-hole. A rear end of the ink valve chamber 35 is therefore in communication with an outside of the ink cartridge 30 through an ink supply port 71 that is formed from the through-hole of the sealing member 76. An inner diameter of the ink supply port 71 is slightly smaller than an outer diameter of the supply tube 102 of the cartridge attachment portion 110. The sealing member 76 is made of an elastic material, such as rubber or elastomer, for example.

[0072] As illustrated in Fig. 7, the ink valve chamber 35 accommodates a valve 77 and a coil spring 78 therein. The valve 77 is configured to move in the front-rear direction 8 to open and close the ink supply port 71. The coil spring 78 urges the valve 77 rearward. In a state where no external force is applied, the valve 77 closes the ink supplying port 71 of the sealing member 76. On the other hand, in a state where an external force is applied to the valve 77, the valve 77 opens the ink supply port 71. The ink stored in the storage chambers 32 and 33 is supplied from the opened ink supplying port 71, via the ink valve chamber 35, to outside.

[0073] A spring constant of the coil spring 78 is greater than a spring constant of the coil spring 98 arranged in the air channel 36.

<Protruding portion 43>

[0074] As illustrated in Figs. 6 and 7, the protruding part 43 (an example of "an engaging portion") is provided on the upper surface of the upper wall 39A. The protruding portion 43 protrudes upward from the upper wall 39A. The protruding portion 43 extends in the front-rear direction 8. The protruding part 43 has a front-end face 151 at its front end. The front-end face 151 faces forward and serves as a lock surface 151 (as example of "a first surface"). The lock surface 151 is positioned rearward of the front end of the lower wall 42.

[0075] The protruding part 43 also includes a horizontal surface 154 that is provided rearward of the lock surface 151 and extends continuously rearward from an upper edge of the lock surface 151. The horizontal surface 154 extends in both the left-right direction 9 and the front-rear direction 8. The protruding part 43 also includes a sloped surface 155 that is rearward of the horizontal surface 154 and is continuous with the horizontal surface 154. The sloped surface 155 slopes relative to the front-rear direction 8, and specifically slopes downward toward the rear.

[0076] The protruding part 43 also includes a positioning surface 84 (as an example of "an abutment surface"). The positioning surface 84 is formed at a position rearward of the sloped surface 155, and faces upward.

[0077] The protruding part 43 also includes a side surface 82 (as example of second surface). The side surface 82 is formed at a position rearward of the positioning surface 84. The side surface 82 faces rearward. The side surface 82 is positioned at a rear end of the protruding portion 43, and faces rearward.

Operating portion 90>

[0078] As illustrated in Figs. 6 and 7, the operating por-

tion 90 is formed at a position forward of the lock surface 151 of the upper wall 39A. The operating portion 90 has an operating surface 92. The operating portion 90 is operated when the ink cartridge 30 attached to the cartridge case 101 is to be removed from the cartridge case 101.

<Projection 67>

[0079] As illustrated in Figs. 6 and 7, the projection 67 is formed on the upper surface of the upper wall 39B. The projection 67 protrudes upward from the upper wall 39B and extends in the front-rear direction 8. The projection 67 is positioned rearward of the protruding portion 43. In the embodiment, either a right surface 67A or a left surface 67B of the projection 67 serves as an irradiated surface that is configured to receive light emitted from the optical sensor 113 of the cartridge-attachment portion 110. In the embodiment, for example, the projection 67 is a plate made of resin containing a color material (black pigment) capable of blocking or absorbing light, for example. In another aspect, a material such as aluminum foil, through which light is unable to pass, may be affixed to at least the irradiated surface of the projection 67.

<Protruding portion 83 and IC substrate 64>

[0080] As illustrated in Figs. 6 and 7, a protruding portion 83 is formed at a position rearward of the protruding portion 43 on the upper surface of the upper wall 39A. The protruding portion 83 is positioned further forward of the protrusion 67 and the supply portion 34. The protruding portion 83 has a side surface 81 at a front end of the protruding portion 83. The side surface 81 faces forward. In the front-rear direction 8, the side surface 81 of the protruding portion 83 faces the side surface 82 of the protruding portion 43. A recess portion 80 is therefore defined on the upper surface of the upper wall 39A at a position between the side surface 81 and the side surface 82 in the front-rear direction 8.

[0081] The IC substrate 64 is supported on an upper end of the protruding portion 83. The IC substrate 64 is attached to the protruding portion 83 with a known method, such as, bonding, meshing, and caulking in a state where the IC substrate 64 faces upward. In this manner, the IC substrate 64 is fixed to the main body 31 of the ink cartridge 30.

[0082] The IC substrate 64 includes a substrate made of silicon or glass epoxy, for example, on which an IC (not illustrated), and four electrodes 65 (see Fig. 6) are mounted. The four electrodes 65 are formed on an upper surface of the IC substrate 64. The four electrodes 65 are in one-to-one correspondence with the four contacts 132 in the cartridge-attachment portion 110. The IC substrate 64 may be a flexible substrate.

[0083] The IC is a semiconductor integrated circuit. The IC stores information related to the ink cartridge 30 in a state that the information can be read from the IC. Example of the information related to the ink cartridge 30 include data specifying a lot number, a date of manufacturing, and an ink color.

[0084] Each electrode 65 is electrically connected to the IC. Each electrode 65 extends in the front-rear direction 8. The electrodes 65 are arranged on the top surface of the IC substrate 64 to extend parallel to each other and are spaced apart from each other in the left-right direction 9. Each electrode 65 is exposed on the upper surface of the IC substrate 64 so as to be electrically accessed by the contacts 132 in the cartridge case 101.

[0085] As illustrated in Fig. 6, the recessed portions 45 described above are formed on the upper wall 39B at positions adjacent to the IC substrate 64 in the left-right direction 9.

<How ink cartridge 30 is attached to cartridge-attachment portion 110>

[0086] Next, operations for attaching the ink cartridge 30 to the cartridge case 101 of the cartridge-attachment portion 110 will be described herein.

[0087] As illustrated in Fig. 7, before the ink cartridge 30 is attached to the cartridge-attachment portion 110, the valve 77 closes the ink supplying port 71. Ink is therefore prevented from flowing from the ink valve chamber 35 to an outside of the ink cartridge 30. The valve 97 closes the air communication port 96. The storage chamber 32 and the storage chamber 33 are therefore out of communication with the atmosphere.

[0088] In order to attach the ink cartridge 30 to the cartridge attachment portion 110, the ink cartridge 30 is inserted into the cartridge case 101 (See Fig. 3) through the opening 112 (See Fig. 1B). As illustrated in Fig. 7, the upper portion 41U is positioned further forward than the lower portion 41L on the front wall 41 of the main body 31 of the ink cartridge 30. That is, the upper portion 41U is closer to the user than the lower portion 41L is to the user. Hence, the user pushes the upper portion 41U rearward to insert the ink cartridge 30 into the cartridge-attachment portion 110. As a result, a lower part of the ink cartridge 30 enters into the guide groove 109 (see Fig. 3).

[0089] As illustrated in Fig. 8, as the ink cartridge 30 is inserted further into the cartridge case 101, the supply portion 34 enters into the guide portion 105. The rod 125 also enters into the air communication port 96.

[0090] When the rear wall 40 of the ink cartridge 30 reaches a position immediately forward of the inner back wall 51 of the cartridge case 101, the supply tube 102 enters into the ink valve chamber 35 through the ink supply port 71. At this time, an outer surface of the supply tube 102 and an inner surface (surface defining the ink supply port 71) of the sealing member 76 come into contact with each other. The supply portion 34 is therefore fixed in position. The supply tube 102 inserted into the ink valve chamber 35 contacts and pushes the valve 77 forward. Through this action, the valve 77 is separated

from the sealing member 76 against a rearward urging force of the coil spring 78. As a result, the ink stored in the storage chambers 32 and 33 and the ink valve chamber 35 flows into the interior space 102A of the supply tube 102. That is, the ink stored in the storage chambers 32 and 33 and the ink valve chamber 35 is supplied through the interior space 102A of the supply tube 102, to the tank 103 and the recording head 21.

[0091] The rod 125 inserted into the air communication port 96 also contacts and pushes the valve 97 forward. Through this action, the valve 97 is separated from the air communication port 96 against a rearward urging force of the coil spring 98. As a result, the storage chamber 32 and the storage chamber 33 are opened to atmosphere through the through-hole 46, the air channel 36, and the air communication port 96.

[0092] The ink cartridge 30 is applied with the forward urging forces generated by the coil springs 78 and 98 being contracted. Magnitude of the urging force generated by each coil spring 78 and 98 is determined by both of: the spring constant of the coil spring; and a distance by which the coil spring is contracted from its natural length. The spring constant of the coil spring 98 is smaller than the spring constant of the coil spring 78. The distance, by which the coil spring 78 is contracted (that is, the distance between the valve 77 and the ink supplying port 71) is longer than the distance by which the coil spring 98 is contracted (that is, the distance between the valve 97 and the air communication port 96). Accordingly, the magnitude of the urging force generated by the coil spring 78 is greater than the magnitude of the urging force generated by the coil spring 98.

[0093] When the protruding portion 43 reaches the shaft 145, the sloped surface 155 slides on the shaft 145. Because the user pushes the upper portion 41U of the front wall 41 rearward, a torque (rotational moment) is applied to the ink cartridge 30 in the counterclockwise direction as shown in Fig. 8. However, due to the contact between the sloped surface 155 and the shaft 145, the ink cartridge 30 is pivotally moved clockwise in Fig. 8 against the torque generated. The center of the pivotal movement of the ink cartridge 30 is the center C (as an example of a connecting portion) of the ink supply opening 71, in which the supply tube 102 is inserted. The position of the center C of the pivotal movement of the ink cartridge 30 is determined depending on the shapes of the supply tube 102 and the ink supplying port 71. However, the imaginary center C of the pivotally movement of the ink cartridge 30 is the center of a contact portion, at which the outer surface of the supply tube 102 contacts the inner surface (surface defining the ink supply port 71) of the sealing member 76. The posture that the ink cartridge 30 takes while being pivotally moved, (that is, the orientation of the ink cartridge 30 shown in Fig. 8) will be referred to as a pivoted posture.

[0094] It is noted that because a lower surface of the lower wall 42 of the main body 31 is inclined relative to the front-rear direction, a space is created between the lower wall 42 and an upper surface of the guide groove 109 of the cartridge case 101. In addition, because an inner diameter of the air communication port 96 is greater than an outer diameter of the rod 125, a space is created between the rod 125 and the air communication port 96. These spaces allow the ink cartridge 30 to pivotally move in the clockwise direction.

[0095] The ink cartridge 30 in the pivoted posture is further inserted into the cartridge case 101 until the IC substrate 64 arrives at the position beneath the contacts 132 and the positioning surface 84 arrives the position beneath the protruding portion 107. More specifically, because the IC substrate has already moved downward through the pivotal movement of the ink cartridge 30 described above, the IC substrate 64 passes under the lower edge of the front wall 136 of the contact unit 130 to move rearward, before arriving directly below the contacts 132. Because the ink cartridge 30 is in the pivoted posture, a gap is formed between the electrodes 65 on the IC substrate 64 and the contacts 132 in the up-down direction 8. In other words, the electrodes 65 are apart from the contacts 132. In addition, a gap is formed in the up-down direction 7 between the protruding portion 107 and the positioning surface 84 of the ink cartridge 30 in the pivoted posture. In other words, the protruding portion 107 is apart from the positioning surface 84.

[0096] The ink cartridge 30 of the pivoted posture is further inserted rearward against the urging force of the coil spring 78, until the sloped surface 155 and the horizontal surface 154 of the protruding portion 43 reach the position rearward of the shaft 145. Because the ink cartridge 30 is in the pivoted posture, the lock surface 151 is positioned below the shaft 145.

[0097] While the user is continuously pushing rearward the upper portion 41U of the front wall 41, torque continues being applied to the ink cartridge 30 in the counterclockwise direction in Fig. 8. Accordingly, when the sloped surface 155 and the horizontal surface 154 become out of contact with the shaft 145, the force applied by the user causes the ink cartridge 30 to pivot counterclockwise in Fig. 8 about the center C against the urging force of the coil spring 98. As a result, the ink cartridge 30 changes its posture from the pivoted posture to the posture shown in Fig. 4, which will be referred to as the attached state.

[0098] In the attached state, the supply portion 34 of the ink cartridge 30 is connected with the supply tube 102 of the cartridge-attachment portion 110.

[0099] When the ink cartridge 30 shown in Fig. 8 is pivoted counterclockwise as described above, the positioning surface 84 of the ink cartridge 30 contacts the protruding part 107 of the cartridge-attachment portion 110 from below (see Fig. 4). In other words, in the attached state, the positioning surface 84 contacts the protruding part 107 from below. The contact between the positioning surface 84 and the protruding part 107 restricts the ink cartridge 30 from moving further upward. That is, the contact between the positioning surface 84

and the protruding part 107 restricts the ink cartridge 30 from further pivoting counterclockwise about the center C. Thus, the ink cartridge 30 is fixed in position in the up-down direction 7 in the inside of the cartridge case 101.

[0100] When the ink cartridge 30 is pivoted counterclockwise in Fig. 8, the protruding part 43 moves upward, and the lock surface 151 of the ink cartridge 30 changes its orientation, as a result of which the lock surface 151 faces forward and confronts the shaft 145 in the cartridge attachment portion 110 in the front-rear direction. When the user stops pushing the ink cartridge 30 rearward, the ink cartridge 30 is moved forward by the urging force of the coil spring 78. However, because the lock face 151 now faces forward and confronts the shaft 145, the lock surface 151 contacts the shaft 145 from the rear side thereof as the ink cartridge 30 moves forward (See Fig. 4). In other words, the lock surface 151 is in contact with the rear side of the shaft 145 when the ink cartridge 30 is in the attached state. In other words, in the attached state, the lock surface 151 engages with the shaft 145. The engagement between the lock surface 151 and the shaft 145 restricts the ink cartridge 30 from moving forward.

[0101] In the attached state, the projection 67 is positioned between the light emitting-part and the light receiving-part of the optical sensor 113. Consequently, the projection 67 blocks light from the light-emitting part to prevent the light from reaching the light-receiving part. In other words, when the ink cartridge 30 is in the attached state, the projection 67 is positioned in the optical path of light emitted from the light-emitting part. Accordingly, the optical sensor 113 outputs a low-level detection signal to the controller.

[0102] Further, as a result of the pivoted movement of the ink cartridge 30 counterclockwise from the state shown in Fig. 8, the electrodes 65 of the IC substrate 64 contact the corresponding contacts 132 from below, thereby elastically deforming the contacts 132 upward (see Fig. 4). Accordingly, when the ink cartridge 30 is in the attached state, the electrodes 65 are electrically connected to the contacts 132 while elastically deforming the contacts 132 upward. In the state where the four electrodes 65 are in contact with the corresponding contacts 132, and are electrically conducted with the corresponding contacts 132, a voltage Vc is applied to some of the electrodes 65, some of the electrodes 65 are electrically grounded, and power is supplied to some of the electrodes 65. Through this electrical connection between the contacts 132 and electrodes 65, the controller can access data stored in the IC of the ink cartridge 30. The accessed data is inputted into the controller.

[0103] When the ink cartridge 30 is in the attached state shown in Figs. 4 and 9, the front wall 136 of the contact unit 130 is positioned frontward of the IC substrate 64, the rear wall 137 of the contact unit 130 is positioned rearward of the IC substrate 64, and the lower ends of the front wall 136 and the rear wall 137 are lower than the electrodes 65 (upper surface of the IC substrate 64). Thus, when the ink cartridge 30 is in the attached state, the electrodes 65 are interposed between the front wall 136 and the rear wall 137 in the front-rear direction 8. The front wall 136 is interposed between the side surfaces 82 and 81 in the front-rear direction 8, and the lower end of the front wall 136 is positioned lower than the upper end of the side surface 82.

[0104] When the ink cartridge 30 is in the attached state, as illustrated in Fig. 5B, the right wall 138 of the contact unit 130 is positioned further rightward the right side of the IC substrate 64, and the left wall 139 of the contact unit 130 is positioned further leftward of the IC substrate 64, and the lower edges of the right wall 138 and the left wall 139 are positioned lower than the electrodes 65. Thus, when the ink cartridge 30 is in the attached state, the electrodes 65 are interposed between the right wall 138 and the left wall 139 such that the right wall 138 is at the right side of the electrodes 65, and the left wall 139 is at the left side of the electrodes 65.

[0105] When the ink cartridge 30 is in the attached state, as illustrated in Fig. 9, a distance L1 between the rear wall 137 and the electrodes 65 in the front-rear direction 8 is longer than a distance L2 between the front wall 136 and the electrodes 65 in the front-rear direction 8.

[0106] To detach the ink cartridge 30 from the cartridge case 101 of the cartridge-attachment portion 110, the user pushes the operating surface 92 downward. Because the operating surface 92 of the ink cartridge 30 in the attached state faces obliquely upward and forward as shown in Fig. 4, the user's operation of the operating surface 92 applies the ink cartridge 30 with an external force diagonally downward and rearward. Due to the external force, the ink cartridge 30 pivots clockwise in Fig. 4, causing the positioning surface 84 to separate away from the protruding part 107 as illustrated in Fig. 8, and causing the lock surface 151 to move to a position below the shaft 145. In other words, the posture of the ink cartridge 30 is changed to the pivoted posture. As a result, due to the urging forces of the coil springs 78 and 98, the ink cartridge 30 moves forward relative to the cartridge case 101. In this manner, the user can remove the ink cartridge 30 from the cartridge-attachment portion 110.

<Effects of the embodiment>

[0107] According to the present embodiment, when the ink cartridge 30 is in the attached state, the electrodes 65 are surrounded by all of the front wall 136, the rear wall 137, the right wall 138, and the left wall 139 from all of the four directions (i.e., front, rear, left, and right side) (see Figs. 5B and 9). Thus, the electrodes 65 are suppressed from being attached with foreign material.

[0108] In the present embodiment, the contact unit 130 is fixed to the cartridge case 101, so that a position of the contact unit 130 relative to the printer can be kept stable. This can decrease such a possibility that the contacts 132 fail to contact the electrodes 65.

[0109] According to the configuration that the contact unit 130 is fixed to the cartridge case 101, there is a possibility that in the course of insertion of the ink cartridge 30 into the cartridge case 101, the ink cartridge 30 (in particular, the electrodes 65 and the peripheral area of the electrodes 65) might come into abutment contact with the front wall 136, which will inhibit insertion of the ink cartridge 30 into the cartridge case 101. Considering this problem, according to the present embodiment, the lower end of the front wall 136 is arranged higher than the lower end of the rear wall 137. This can decrease the possibility that the ink cartridge 30 comes into abutment contact with the front wall 136 in the course of insertion of the ink cartridge 30.

[0110] According to the present embodiment, the electrodes 65 are fixed to the main body 31 of the ink cartridge 30. With this configuration, positions of the electrodes 65 relative to the main body 31 are kept stable. This can decrease such a possibility that the electrodes 65 fail to contact the contacts 132.

[0111] According to the present embodiment, by pivotally moving the ink cartridge 30 in the cartridge case 101, the lock surface 151 of the ink cartridge 30 is brought into engagement with the cartridge-attachment portion 110 as a result of which the ink cartridge 30 becomes held in the attached state. Accordingly, although the ink cartridge 30 and the cartridge attaching portion 110 have the simple configurations, the electrodes 65 can reach the position, at which the electrodes 65 contact the contacts 132, without contacting the front wall 136 in the course of attachment of the ink cartridge 30 to the cartridge attachment portion.

[0112] According to the present embodiment, the distance from the center C of the pivotal movement of the ink cartridge 30 to the lock surface 151 is longer than the distance from the center C of the pivotal movement of the ink cartridge 30 to the electrodes 65. Accordingly, a distance, by which the lock surface 151 is moved while the ink cartridge 30 is pivotally moved, is longer than a distance, by which the electrodes 65 are moved. Accordingly, an amount by which the lock surface 151 overlaps with the cartridge-attachment portion in the state where the lock surface 151 is engaged with the cartridge attachment portion 110 can be increased.

[0113] According to the present embodiment, in the state where the ink cartridge 30 is in the attached state, the front wall 136 is positioned between the side surface 82 of the protruding part 43 and the side surface 81 of the protruding portion 83 in the front-rear direction 8, and the lower end of the front wall 136 of the case 131 is positioned lower than the upper end of the side surface 82 of the protruding part 43. That is, when the ink cartridge 30 is in the attached state, electrodes 65 are surrounded by the front wall 136, rear wall 137, the right wall 138, and the left wall 139 from all of the four directions, and the front surface of the front wall 136 is covered by the side surface 82 of the protruding part 43. This ensures that the electrodes 65 are suitably suppressed from being attached with foreign material.

[0114] There is a possibility that in the course of insertion of the ink cartridge 30 into the cartridge-attachment portion 110, the ink cartridge 30 might be inserted further into the cartridge-attachment portion 110 by a distance more than the distance required, and the electrodes 65 might come into abutment contact with the rear wall 137. Considering this problem, according to the present embodiment, the distance L1 between the rear wall 137 and the electrodes 65 in the front-rear direction 8 is set longer than the distance L2 between the front wall 136 and the electrodes 65 in the front-rear direction 8. This can decrease such a possibility that the electrodes 65 come into contact with the rear wall 137.

[0115] According to the present embodiment, the part of the main body 31 is positioned above the supply portion 34, and rearward of the supply portion 34. With this configuration, even when the ink cartridge 30 drops with its upper or rear end facing downward, the part of the main body 31 can prevent the supply portion 34 from directly contacting the ground, for example. This can decrease such a possibility that the supply portion 34 is damaged.

[0116] According to the present embodiment, the optical sensor 113 is positioned behind the electrodes 65 in the state where the ink cartridge 30 is in the attached state. With this configuration, the electrodes 65 can be prevented from coming into contact with the optical sensor 113 in the course of insertion of the ink cartridge 30 to the cartridge attaching portion 110.

[0117] According to the present embodiment, the cartridge-attachment portion 110 is provided with the protruding portions 114 (see Fig. 3) each at a position corresponding to one of the recessed portions 45 of the ink cartridge 30 in the attached state. The protruding portions 114 can be each used to position the ink cartridge 30 both in the left-right direction 9 and the up-down direction 7. In the embodiment, each of the protruding portions 114 is disposed within one of the recessed portions 45 that is on the right side of the upper wall 39B (see Fig. 6).

[0118] According to present the embodiment, the ink cartridge 30 is fixed in position in the up-down direction 7 through contact between the positioning surface 84 and the protruding portion 107 of the cartridge case 101 at the position forward of the electrodes 65. Behind the electrodes 65, the supply portion 34 is coupled to the supply tube 102. With this configuration, the positions of the electrodes 65, which are disposed between the positioning surface 84 and the supplying portion 34 in the front-rear direction 8 can be kept stable.

[0119] While the description has been made in detail with reference to the embodiment thereof, it would be apparent to those skilled in the art that many modifications and variations may be made therein without departing from the scope of the disclosure.

<Modifications>

[0120] For example, the configuration of the front wall

136, the rear wall 137, the right wall 138, and the left wall 139 is not limited to that illustrated in Figs. 5A and 5B, as long as the electrodes 65 are interposed between the front wall 136 and the rear wall 137 in the front-rear direction 8 and interposed between the right wall 138 and the left wall 139 in the left-right direction 9. For example, the front end of the right wall 138 may not be connected to the right end of the front wall 136. The rear end of the right wall 138 may not be connected to the right end of the rear wall 137. The front end of the left wall 139 may not be connected to the left end of the front wall 136. The rear end of the left wall 139 may not be connected to the left end of the rear wall 137. The lower ends of the right wall 138 and the left wall 139 may not be at vertical levels identical with the lower end of the rear wall 137. The lower ends of the right wall 138 and the left wall 139 may be at vertical levels identical with the lower end of the front wall 136. The lower ends of the right wall 138 and the left wall 139 may be at vertical levels higher than the lower end of the front wall 136. The lower end of the right wall 138 and the lower end of the left wall 139 may be at vertical levels different from each other.

[0121] The IC substrate 64 may not be fixed to the main body 31 of the ink cartridge 30. For example, the IC substrate 64 may be supported by the main body 31 so as to be vertically movable relative to the main body 31. In this case, in contrast to the embodiment described above, the user can insert the ink cartridge 30 in the front-rear direction 8, without pivotally moving the ink cartridge 30 in the interior space of the cartridge case 101 of the cartridge-attachment portion 110.

[0122] The configuration of this modification will be described herein in more detail. The IC substrate 64 is arranged to be capable of moving between a first position and a second position relative to the main body 31. In a state where at least a part of the ink cartridge 30 is in the interior space of the cartridge case 101, the electrodes 65 of the IC substrate 64 in the first position are at a vertical level lower than the lower end of the front wall 136, but the electrodes 65 of the IC substrate 64 in the second position are at a vertical level higher than the lower end of the front wall 136. The IC substrate 64 is configured to be in the first position before the ink cartridge 30 is attached to the cartridge case 101. The IC substrate 64 is configured to move from the first position to the second position when the IC substrate 64 reaches a position behind the front wall 136 in the course of insertion of the ink cartridge 30 into the cartridge case 101. The ink cartridge 30 according to this modification is provided with a known mechanism including: an urging member configured to urge the IC substrate 64 to move from the first position to the second position; and a stopper configured to hold the IC substrate 64 at the first position. The cartridge case 101 is formed with a protrusion configured to contact the stopper of the ink cartridge 30. With this configuration, after the IC substrate 64 reaches the position behind the front wall 136 in the course of insertion of the ink cartridge 30 into the cartridge case 101, the protrusion of the cartridge case 101 comes into contact with the stopper, whereupon the IC substrate 64 held at the first position is released and the IC substrate 64 moves from the first position to the second position due to the urging force of the urging member.

[0123] Part of the ink cartridge 30 other than the lock surface 151 may be used to restrict the ink cartridge 30 attached to the cartridge case 101 of the cartridge-attachment portion 110 from moving forward. For example, friction between the sealing member 76 of the ink cartridge 30 and the supply tube 102 of the cartridge-attachment portion 110 may be used to restrict the ink cartridge 30 from moving. In this case, because the ink cartridge 30 need not be provided with the protruding part 43, the ink cartridge 30 can be inserted into the cartridge case 101 in the front-rear direction 8 without pivotal movement of the ink cartridge 30. However, in this modification, the ink cartridge 30 needs to be configured such that the IC substrate 64 does not come into abutment contact with the front wall 136 in the course of insertion of the ink cartridge 30 into the cartridge case 101. For example, the ink cartridge 30 may be configured such that the IC substrate 64 is vertically movable relative to the ink cartridge 30 as described above.

[0124] In the embodiment described above, as illustrated in Fig. 9, in the attached state, the distance L1 between the rear wall 137 and the electrodes 65 in the front-rear direction 8 is longer than the distance L2 between the front wall 136 and the electrodes 65 in the front-rear direction 8. However, the distance L1 may be equal to or shorter than the distance L2.

[0125] In the embodiment described above, the contact unit 130 is screwed onto the substrate 133, and fixed to the cartridge case 101. However, the contact unit 130 may be fixed to the cartridge case 101 via other manners. For example, the contact unit 130 may be directly fixed to the cartridge case 101 in other manners, such as an engaging member or a fastening member.

[0126] In the embodiment described above, the main body 31 has the part that is positioned above the supply portion 34 and rearward than the supply portion 34. However, the main body 31 may have no part that is positioned above and rearward than the supply portion 34. For example, the main body 31 may have a rectangular parallelepiped shape, and the supply portion 34 may protrude rearward from the rear wall 40 of the main body 31. In this case, the entire part of the main body 31 is positioned in front of the supply portion 34.

[0127] The cartridge-attachment portion 110 may not be equipped with the optical sensor 113. In this case, the ink cartridge 30 may not be equipped with the projection 67. The ink cartridge 30 may be provided with no recessed portions 45. The positioning surface 84 for fixing the ink cartridge 30 in position in the up-down direction 7 relative to the cartridge case 101 may not be provided behind the inclined surface 155 of the protruding portion 43. For example, a protrusion may be formed on the upper surface of the upper wall 39B. The upper surface of

the protrusion may be used in place of the positioning surface 84 to fix the ink cartridge 30 in position relative to the cartridge case 101 in the up-down direction 7.

[0128] In the above-described embodiment, ink is an example of liquid. However, example of liquid include: a pretreatment liquid that is ejected onto a recording a sheet prior to ejection of the ink during an image forming operation; and water or other liquid that is sprayed in the vicinity of the nozzles 29 of the recording head 21 for preventing the nozzles 29 from drying.

Claims

1. A system (10, 30) comprising:

a liquid cartridge (30) including a storage chamber (32, 33) configured to store liquid therein;
a cartridge receiving portion (110) to which the liquid cartridge (30) is attachable in an insertion direction (rearward) crossing a vertical direction; and
a consumption portion (21) configured to consume the liquid stored in the storage chamber (32, 33) of the liquid cartridge (30) attached to the cartridge receiving portion (110);
the liquid cartridge (30) comprising:

a main body (31) having the storage chamber (32, 33);
a supply portion (34) positioned at a lower end portion of the main body (31) and configured to supply the liquid stored in the storage chamber (32, 33) to an outside of the liquid cartridge; and
an electrode (65) provided on an upper surface of the main body (31) at a position upstream of the supply portion (34) in the inserting direction (rearward);

wherein the cartridge receiving portion (110) comprises:

a casing (101) into which the liquid cartridge (30) is capable of being inserted;
a supply tube (102) protruding in a direction opposite to the inserting direction (rearward), and connectable to the supply portion (34) of the liquid cartridge (30), the supply tube (102) allowing the liquid to flow therethrough from the storage chamber (32, 33) of the liquid cartridge (30) to the consumption portion (21); and
a contact unit (130) fixed to the casing (101) at a position upstream of the supply tube (102) in the insertion direction (rearward), the contact unit (130) including a contact (132) that is configured to contact the electrode (65) of the liquid cartridge (30) from above in an attached state where the supply portion (34) of the liquid cartridge (30) is connected to the supply tube (102), the contact unit (130) comprising: a first wall (136); a second wall (137); a third wall (138); and a fourth wall (139),
in the attached state, the first wall (136) being positioned upstream of the electrode (65) in the inserting direction (rearward),
in the attached state, the second wall (137) being positioned downstream of the electrode (65) in the inserting direction (rearward),
in the attached state, a lower end of each of the first wall, second wall, third wall, and fourth wall being positioned below the contact, the electrode (65) being positioned between the first wall and the second wall in the inserting direction (rearward), the lower end of the first wall (136) being positioned above the lower end of the second wall (137), the electrode (65) being positioned between the third wall and the fourth wall in a widthwise direction (9) that is perpendicular to both of the vertical direction and the inserting direction (rearward).

2. The system (10) according to claim 1, wherein the lower ends of the third wall (138) and the fourth wall (139) are at a position equal to a position of the lower end of the second wall (137) in the vertical direction.

3. The system according to claim 1, wherein the electrode (65) is fixed to the main body of the liquid cartridge (31).

4. The system (10) according to claim 1, wherein the liquid cartridge (30) further comprises an engagement portion (43) configured to be engaged with the cartridge receiving portion (110) in the attached state, the engagement portion (43) being configured such that the engagement portion is engaged with the cartridge receiving portion through pivotal movement of the cartridge relative to the cartridge receiving portion about a connecting portion (C) between the supply portion (34) and the supply tube (102) in a process of attachment of the liquid cartridge (30) to the cartridge receiving portion (110).

5. The system (10) according to claim 4, wherein the engagement portion (43) is positioned upstream of the electrode (65) in the inserting direction (rearward).

6. The system (10) according to claim 4, wherein the engagement portion (43) has a first surface (151) configured to be engaged with the cartridge receiving

portion (110) and a second surface (82) positioned downstream of the first surface (151) in the inserting direction (rearward);
wherein in the attached state, the first wall (136) of the contact unit (130) is positioned between the contact (132) and the second surface (82) of the engagement portion, and the lower end of the first wall (136) is positioned below an upper end of the second surface (82) of the engagement portion.

7. The system (10) according to claim 1, wherein a distance (L1) between the second wall (137) and the electrode (65) in the inserting direction (rearward) is greater than a distance (L2) between the first wall (136) and the electrode (65) in the inserting direction (rearward).

8. The system (10) according to claim 1, wherein the cartridge receiving portion (110) further comprises a circuit board (133) fixed to the casing (101);
wherein the contact unit (136) is fastened to the circuit board (133) with at least one screw.

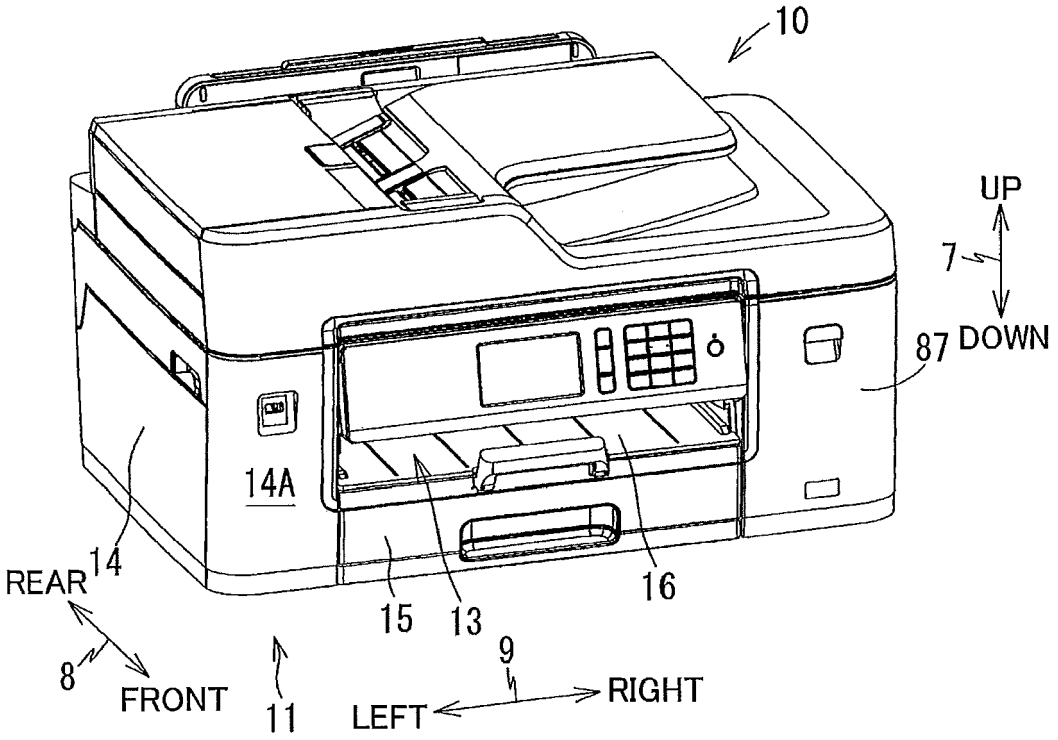
9. The system (10) according to claim 1, wherein the main body (31) of the liquid cartridge has a portion positioned above the supply portion (34) and downstream of the supply portion (34) in the inserting direction (rearward).

10. The system (10) according to claim 1, wherein the cartridge receiving portion (110) further comprises an optical sensor (113) fixed to the casing (101); and
wherein the liquid cartridge (30) further comprises a protrusion (67) on the upper surface of the main body of the liquid cartridge at a position downstream of the electrode (65) in the inserting direction (rearward), the protrusion (67) having an irradiated surface configured to shut-off or attenuate light emitted from the optical sensor (113) in the attached state.

11. The system (10) according to claim 1, wherein the liquid cartridge (30) is formed with a recessed portion (45) at a position adjacent to the electrode in the widthwise direction, the recessed portion being depressed downward from the upper surface of the main body of the liquid cartridge in the vertical direction, and
wherein the cartridge receiving portion is provided with a protrusion (114) that is configured to be received in the recessed portion in the attached state.

12. The system (10) according to claim 1, wherein the liquid cartridge (30) has an abutment surface (84) at a position upstream of the electrode (65) in the inserting direction (rearward), the abutment surface (84) being in abutment contact with the casing (101) from below in the attached state.

FIG. 1A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DOWN
87
14A
14
REAR
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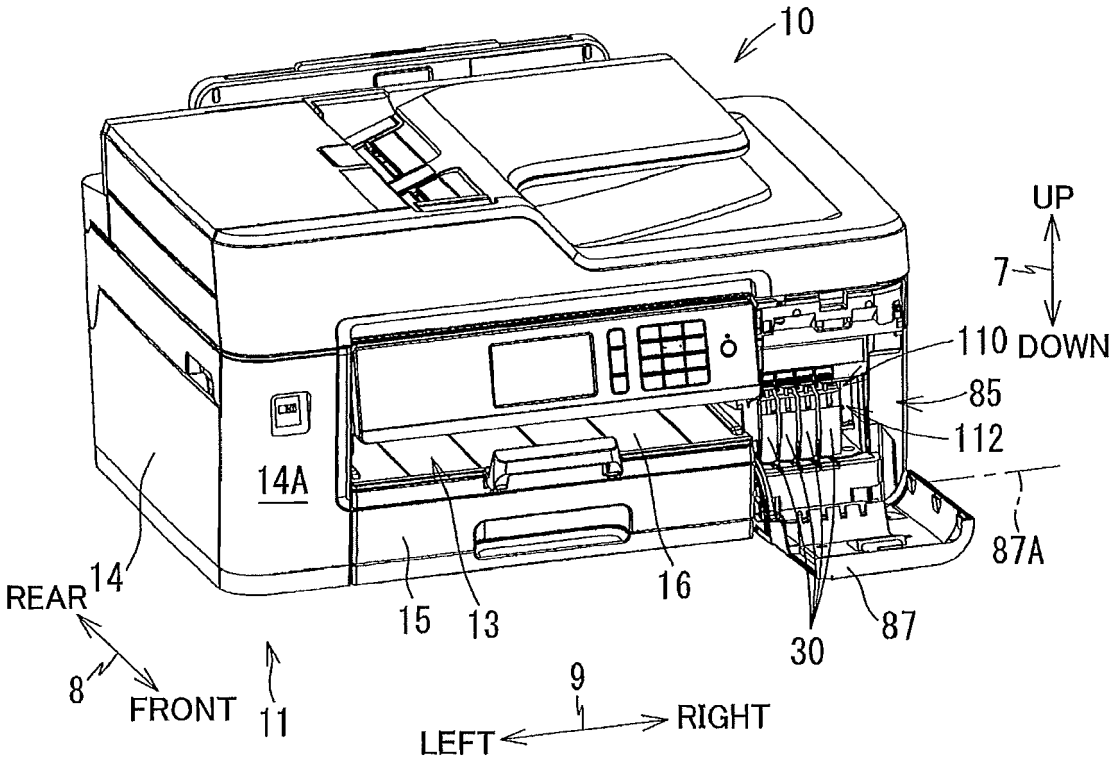
13
16
8
FRONT
11
9
LEFT
RIGHT

FIG. 1B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REAR
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13
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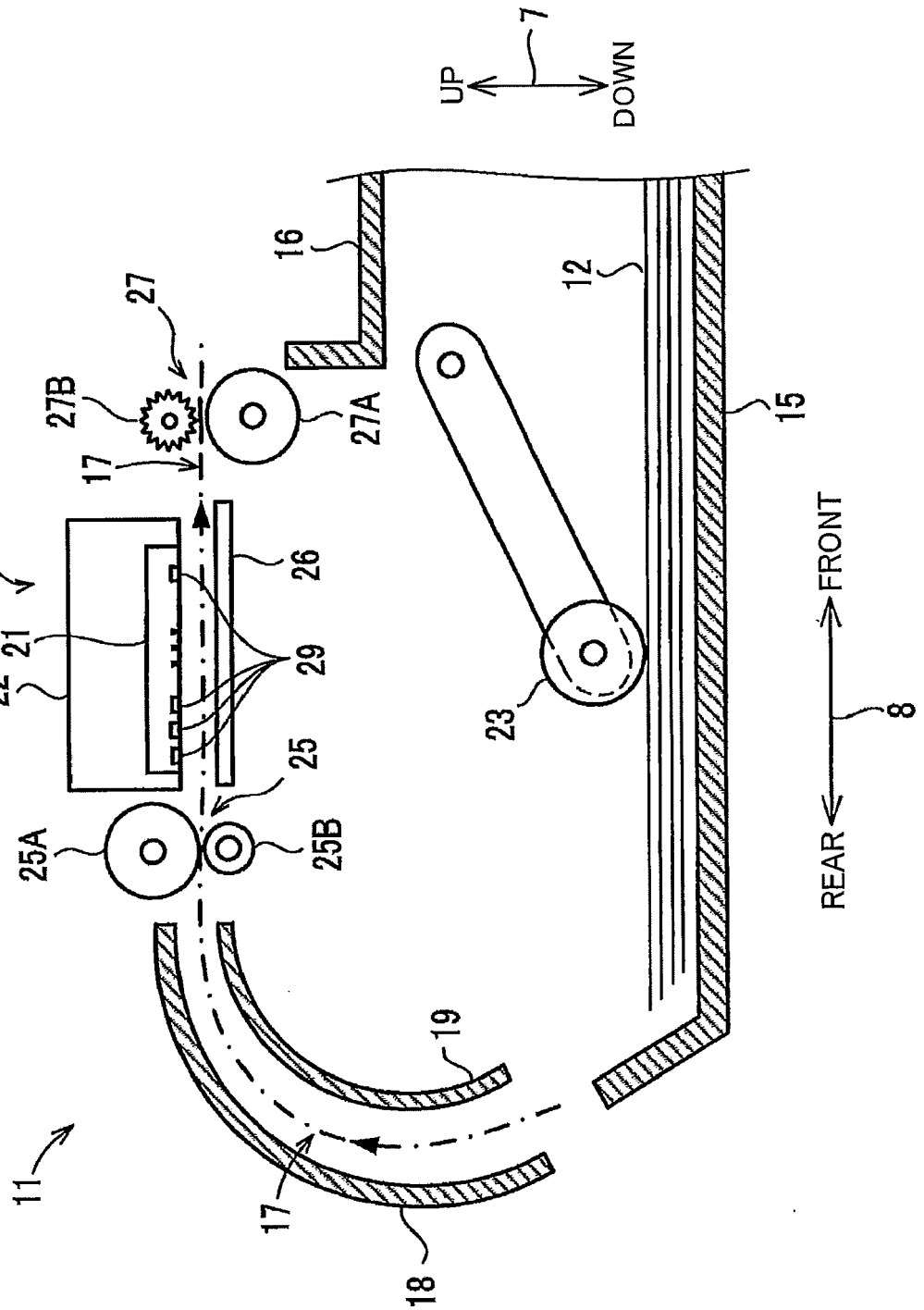
30
87
8
FRONT
11
9
LEFT
RIGHT

FIG. 2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REAR
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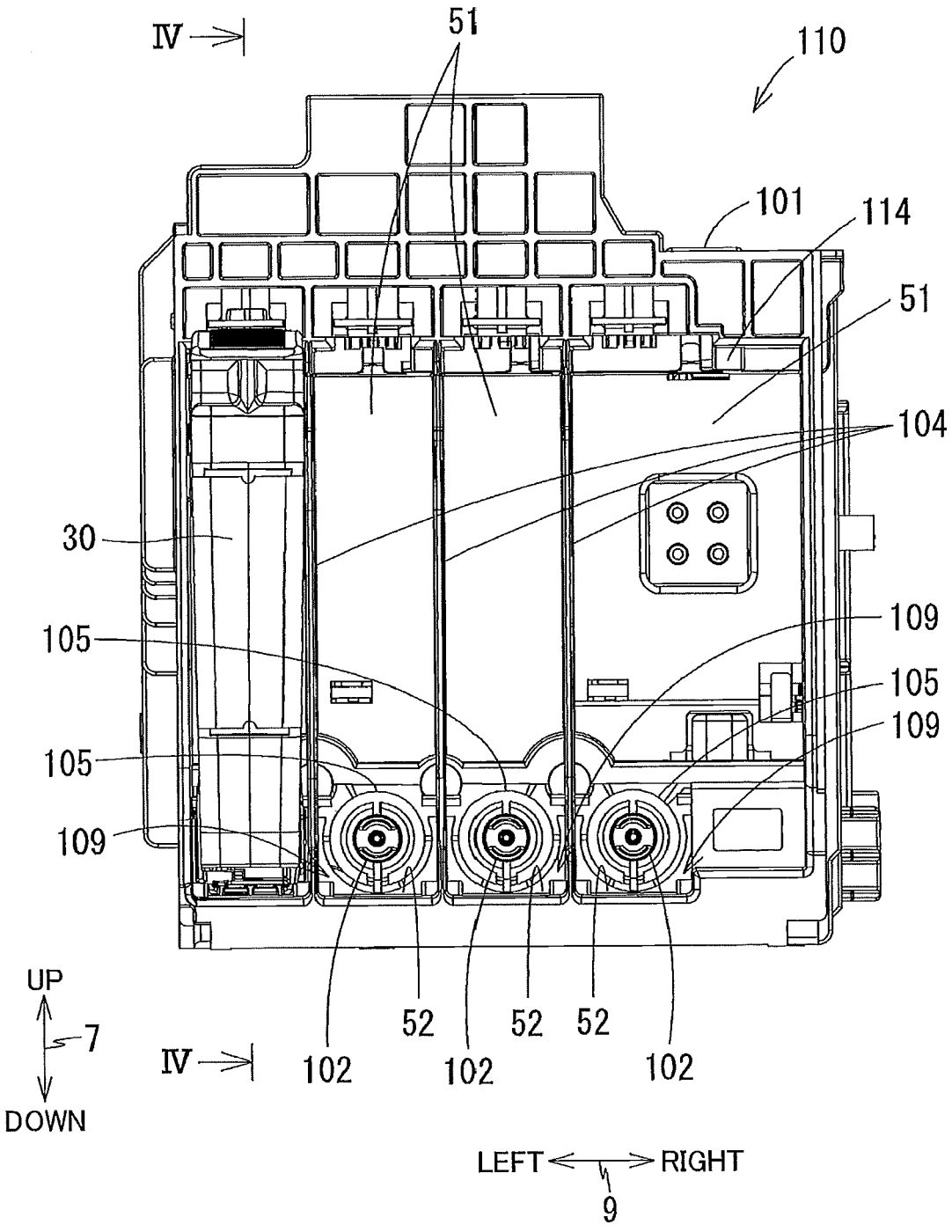
25A
25B
26
27
27A
27B
29

FIG. 3


IV
51
110
101
114
51
104
30
105
109
105
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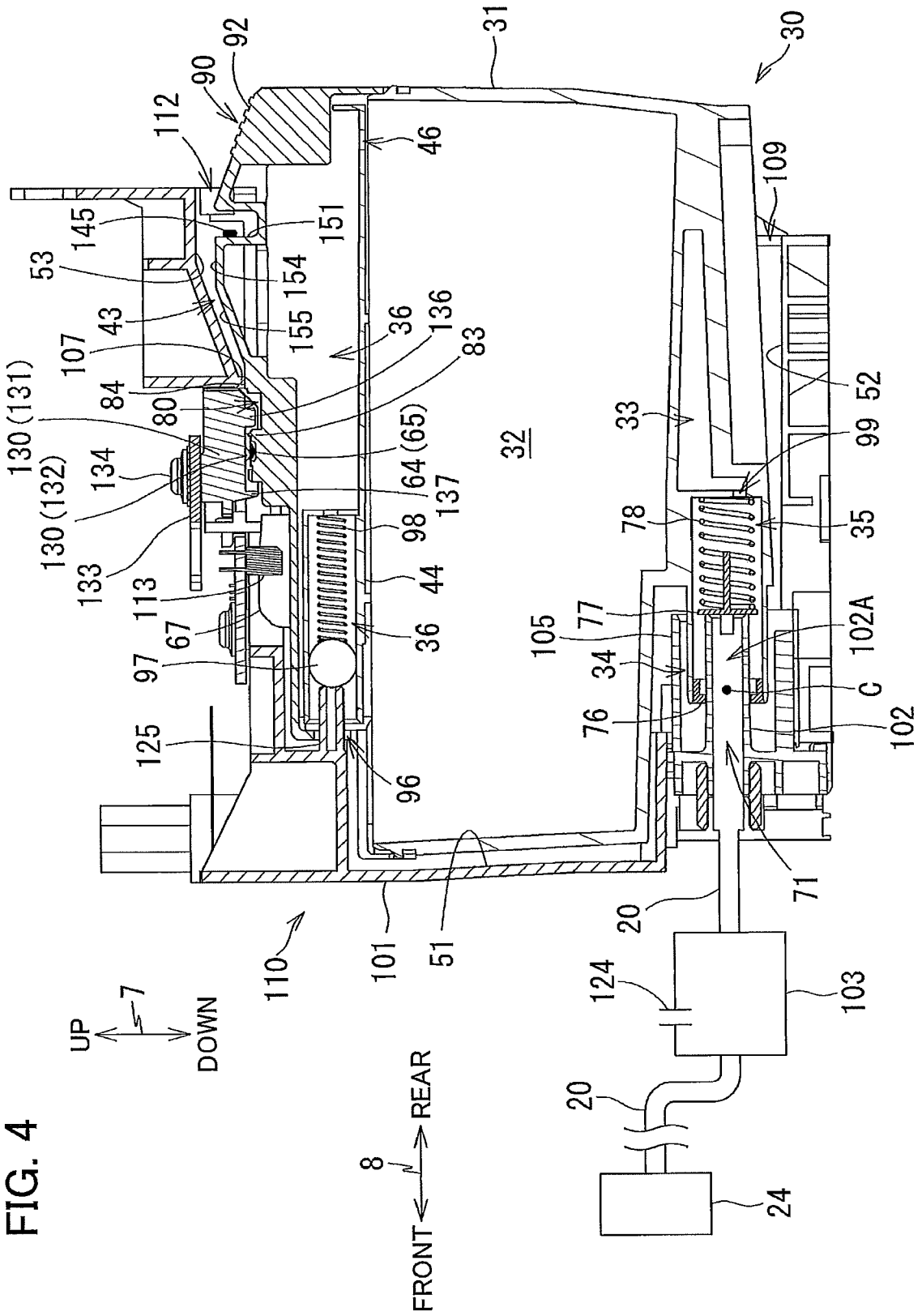
UP
7
DOWN
IV
52
52
52
102
102
102
LEFT
RIGHT
9

FIG. 4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30
92
90
112
46
109
145
151
53
154
155
43
36
136
107
83
84
80
52
130 (131)
64 (65)
33
99
130 (132)
134
137
32
78
35
133
98
113
44
105
77
102A
67
36
34
97
C
76
102
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124
103
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24
UP
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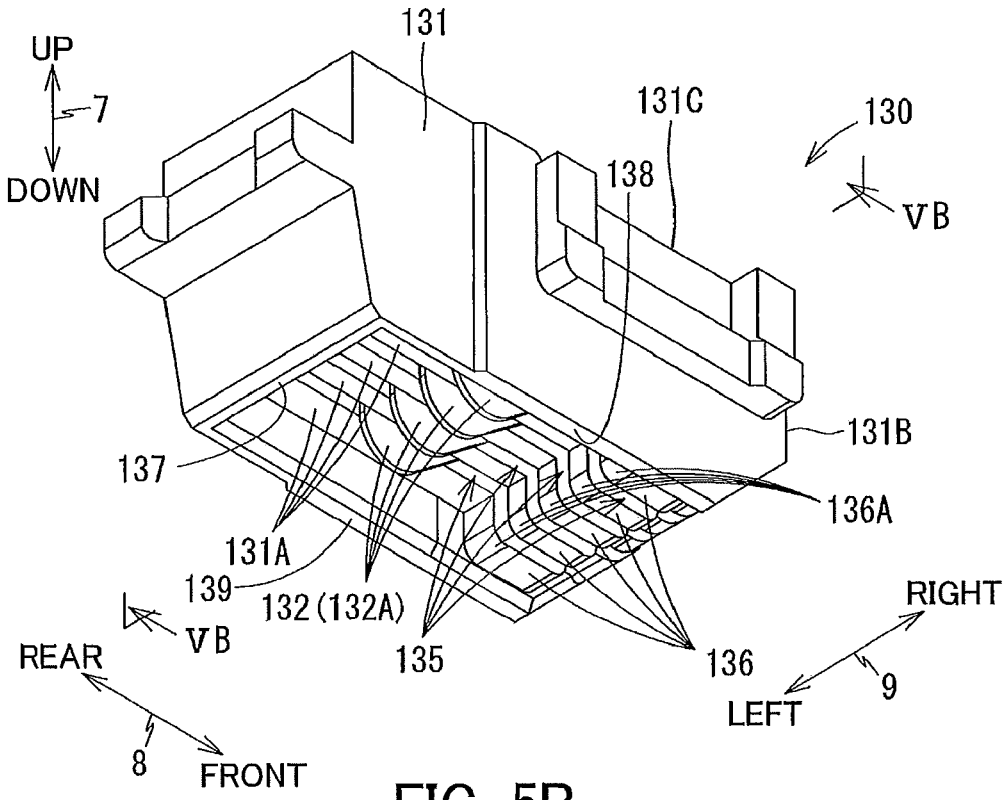
8
REAR
FRONT

FIG. 5A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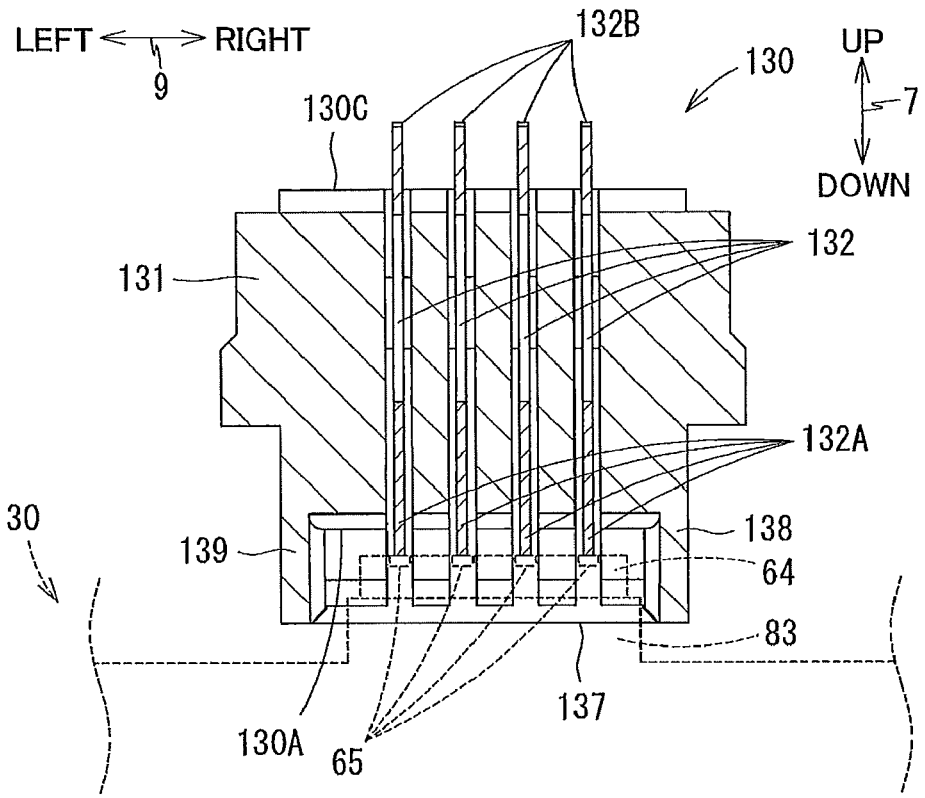
DOWN
131C
130
138
VB
131B
137
136A
131A
139
132 (132A)
VB
135
136
RIGHT
REAR
9
LEFT
8
FRONT

FIG. 5B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132B
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130C
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131
132A
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138
139
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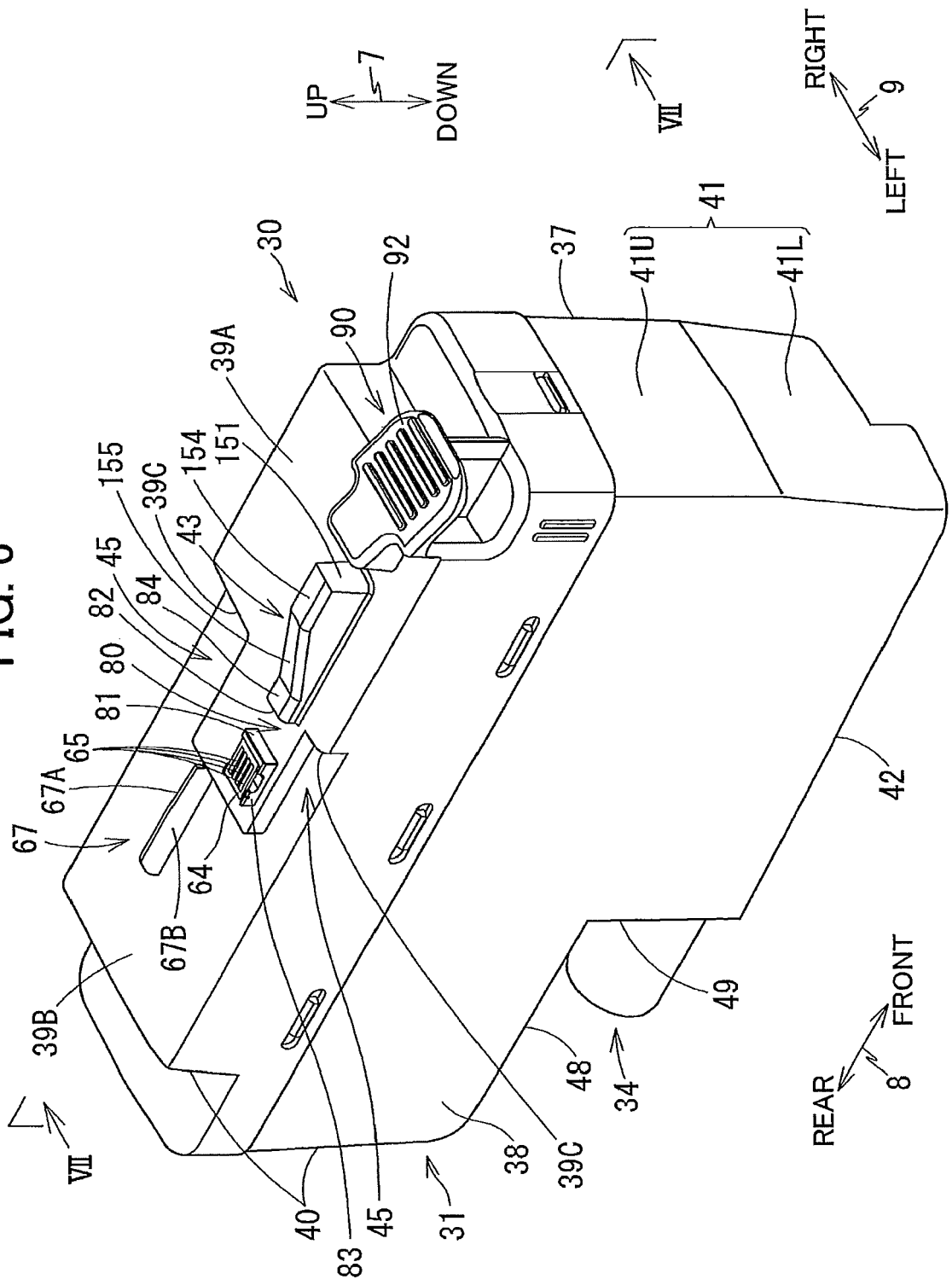
83
137
130A
65

FIG. 6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VII
RIGHT
9
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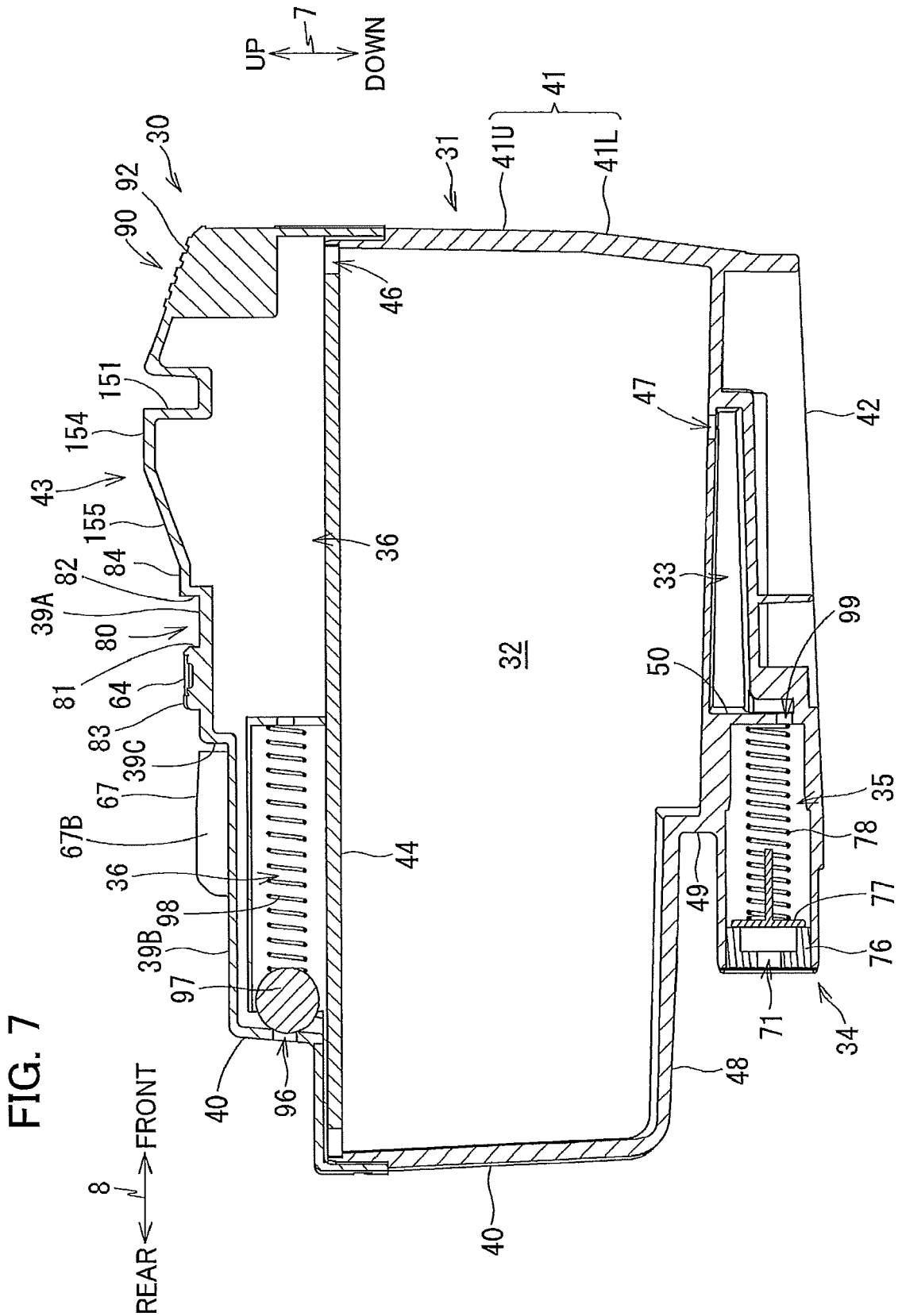
41U
41L
37
30
92
90
39A
151
154
155
39C
43
45
82
84
80
81
65
67A
67
64
67B
39B
VII
REAR
8
FRONT
42
49
48
34
38
39C
40
83
45
31

FIG. 7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DOWN
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31
41
41U
41L
90
92
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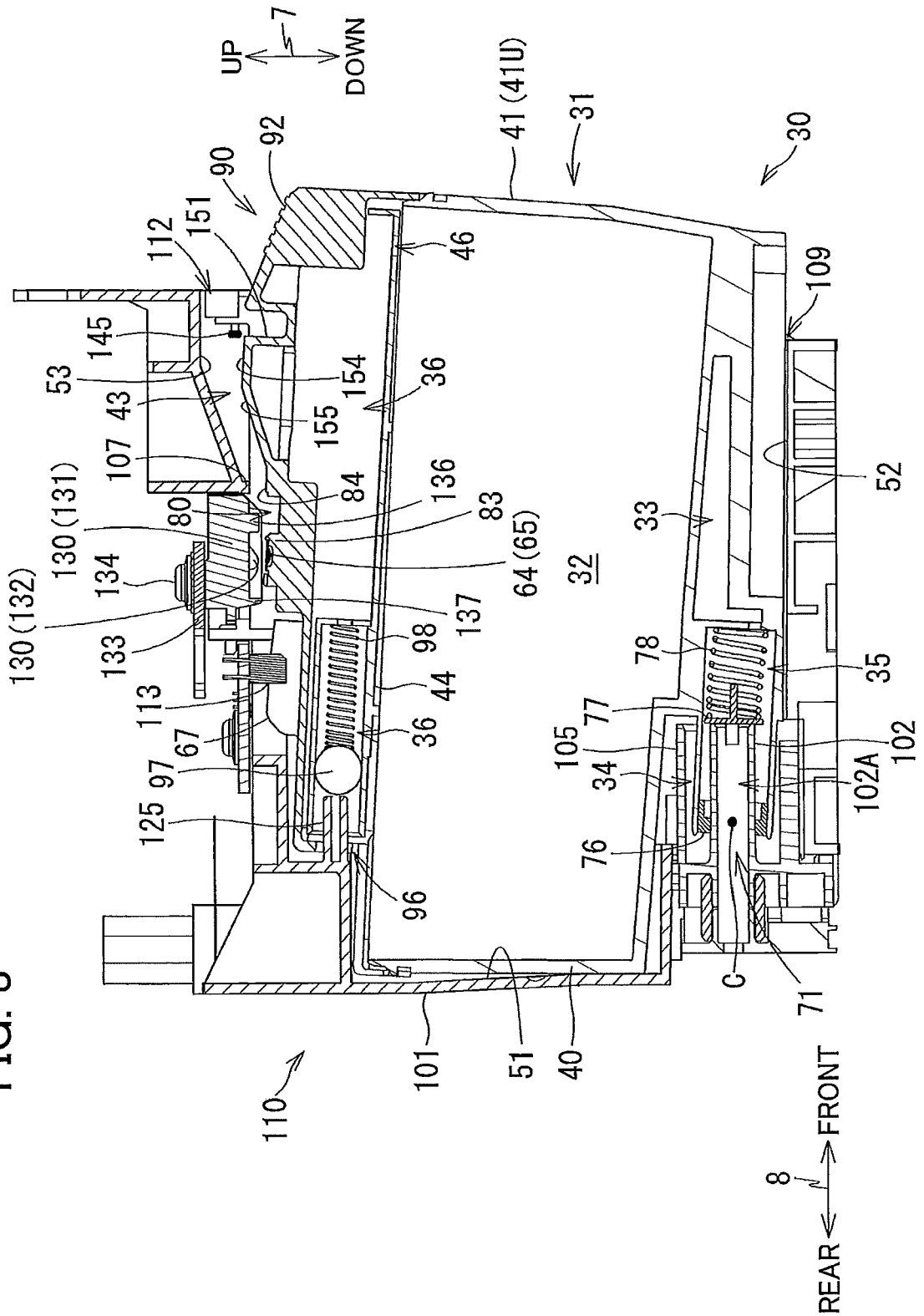
151
154
43
155
84
82
39A
80
81
64
83
39C
67
67B
36
98
39B
97
40
96
44
36
32
47
42
33
99
50
35
78
49
77
76
71
34
48
40
8
FRONT
REAR

FIG. 8


UP
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41 (41U)
31
30
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112
151
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109
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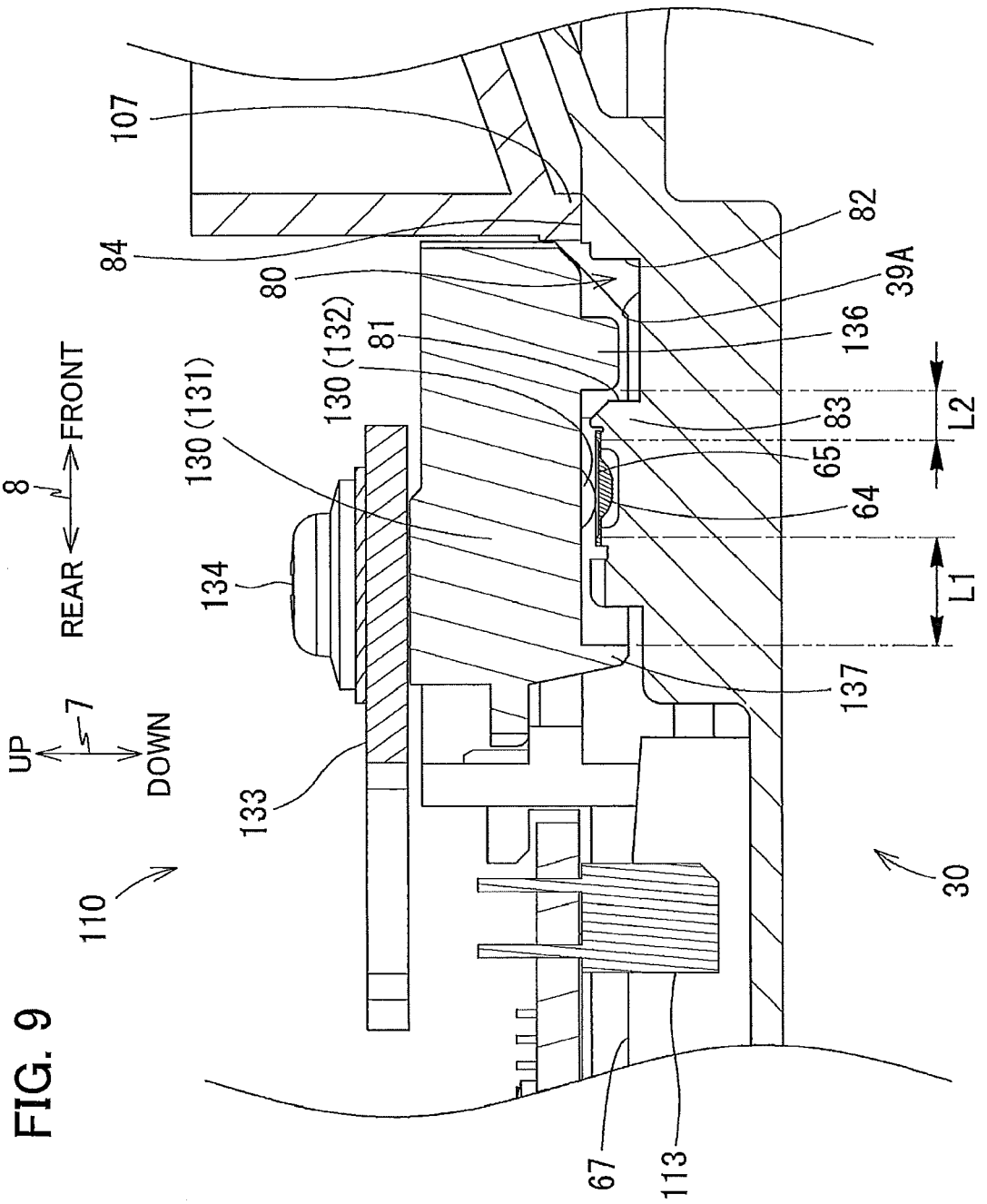
155
107
84
136
52
130 (131)
80
83
33
130 (132)
134
64 (65)
32
137
133
98
78
35
113
44
105
77
67
36
102
97
34
102A
125
76
96
C
71
101
51
40
110
8
FRONT
REAR

FIG. 9


107
84
80
82
39A
81
130 (132)
136
130 (131)
83
L2
65
64
FRONT
8
REAR
134
L1
UP
7
DOWN
137
133
110
30
67
113

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EUROPEAN SEARCH REPORT

Application Number
EP 18 21 4135

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X Y	EP 3 112 167 A1 (BROTHER IND LTD [JP]) 4 January 2017 (2017-01-04) * paragraphs [0045] - [0057], [0062] - [0073], [0080] - [0083], [0136] - [0138]; figures 1-12 *	1-9,11, 12 10	INV. B41J2/175 B41J29/13 B41J13/00
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X	US 9 821 557 B2 (SEIKO EPSON CORP [JP]) 21 November 2017 (2017-11-21) * column 21/22, lines 15-67/1-65; figures 1-19 *	1-9	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 April 2019	Bitane, Rehab

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