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UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

WESTERN DIVISION

SEIKO EPSON CORPORATION, a Japan corporation; **EPSON AMERICA, INC.**, a California corporation; and **EPSON PORTLAND INC.**, an Oregon corporation,

Plaintiffs,

vs.

BURKWITZ SOLUTIONS, INC., a California corporation, **ARMEN SARGSYAN**, an individual, and **SIMON MIKAIL**, an individual,

Defendants.

CASE NO.

COMPLAINT FOR PATENT INFRINGEMENT; FEDERAL TRADEMARK INFRINGEMENT AND UNFAIR COMPETITION

DEMAND FOR JURY TRIAL

Trial Date: None Set

Plaintiffs Seiko Epson Corporation, Epson America, Inc., and Epson Portland Inc., (collectively, "Epson"), for their Complaint herein, allege as follows:

NATURE OF THE ACTION

1. This is an action for patent infringement arising under the patent laws of the United States of America, 35 U.S.C. § 1 *et. seq*., of United States Patent No. 8,794,749 ("the '749 patent"), and United States Patent No. 8,454,116 ("the '116 patent") (collectively, "the Epson Patents").

2. The patent infringing products at issue are aftermarket ink cartridges for use with Epson printers, including aftermarket ink cartridges having aftermarket circuit boards for ink cartridges (sometimes referred to as "chips") for use with Epson printers.

3. This is also an action for trademark infringement, false designation of origin, and unfair competition under the Lanham Act, 15 U.S.C. § 1051 *et. seq.* arising from Defendants' improper use of trademarks owned and used by Epson, including, but not limited to, the "252" Reg. No. 7,055,411 (the "252 Mark") trademark for filled ink cartridges for printers and photocopiers, the "502" Reg. No. 7,048,971 (the "502 Mark") trademark for filled ink bottles for printers and photocopiers, and the "wave" design trademark Reg. No. 5,402,648 (the "Wave Mark") for printer's ink, filled in bottles and filled ink cartridges, and ink bottles (collectively, with the 252 Mark and the 502 Mark, the "Epson Marks").

4. The trademark infringing products at issue are bottles of ink for use with Epson printers, ink cartridges for use with Epson printers, and packaging for the respective bottles of ink and ink cartridges, that improperly use the Epson Marks. Exemplary trademark infringing products are shown below:

Examples of Trademark infringing packaging and bottles of ink

Examples of Trademark infringing packaging for cartridges

5. Over the years, Epson has brought numerous actions in various district courts as well as the United States International Trade Commission ("ITC") for infringement of its patents related to ink cartridge technology. The ITC has issued two general exclusion orders prohibiting the importation of products that infringe certain Epson patents. The General Exclusion Order ("GEO") issued in the 337-TA-

946 ITC Investigation (the "946-GEO") includes the '749 and '116 patents asserted in this case. Epson's patent enforcement efforts have been widely publicized and reported by the aftermarket ink cartridge industry and by Epson. As a result, the aftermarket ink cartridge industry is intimately familiar with the ITC general exclusion orders and Epson's patents. The aftermarket ink cartridge industry knows that importation and sale of ink cartridges for use with Epson printers, including ink cartridges having aftermarket circuit boards, may violate the 946-GEO and infringe Epson's patents, including the '749 and '116 patents. Epson gives notice of its patents, including the '749 and '116 patents, by virtual marking of its ink cartridges pursuant to 35 U.S.C. § 287(a). Nevertheless, infringers, like Defendants here, continue to import, offer to sell, and sell ink cartridges, including ink cartridges having aftermarket circuit boards, that infringe the Epson Patents in flagrant violation of the 946-GEO and United States patent law.

6. Defendants in this case are willful infringers of the '749 and '116 patents and violators of the 946-GEO that covers those patents.

7. In addition to the importation, offer for sale, and sale of ink cartridges, including ink cartridges having aftermarket circuit boards that infringe Epson's patents, Defendants currently advertise, offer for sale, and sell a separate line of aftermarket bottles of ink and ink cartridges that independently infringe upon one or more of the Epson Marks. Defendants' use of the Epson Marks to sell replacement bottles of ink and/or ink cartridges are intended to deceive consumers and create consumer confusion and results in the dilution of Epson's reputation and trade name.

8. As a result of Defendants' trademark infringement, Epson is suffering a loss of the enormous goodwill that Epson has created in the Epson Marks and is losing lost profits from lost sales of products.

9. Epson brings this action to recover money damages, for a preliminary and permanent injunction, and for other relief as set forth herein, for both patent and trademark infringement.

RELATED ACTIONS

10. This action is related to *In the Matter of CERTAIN INK CARTRIDGES AND COMPONENTS THEREOF*, Investigation No. 337-TA-946, United States International Trade Commission ("ITC"), Washington, D.C., which was adjudicated by the ITC in a final determination (ITC Opinion, May 26, 2016) (the "ITC 946 Investigation") and in which the ITC issued a General Exclusion Order and certain Cease and Desist Orders that include the '749 and '116 patents (i.e., the aforementioned "946-GEO").

THE PARTIES

11. Plaintiff Seiko Epson Corporation ("Seiko Epson") is a corporation organized and existing under the laws of Japan. Its principal place of business is located at 3-3-5 Owa Suwa-Shi Nagano-Ken, 392-8502, Japan. Seiko Epson is the assignee of the Epson Patents.

12. Plaintiff Epson America, Inc. ("Epson America") is a corporation organized and existing under the laws of the State of California. Its principal place of business is located at 3131 Katella Avenue, Los Alamitos, California 90720. As the North American sales, marketing, and customer service affiliate of Seiko Epson, Epson America is the exclusive licensee of the Epson Patents for distributing in the United States Epson ink cartridges that embody the inventions contained in the Epson Patents, including cartridges manufactured by Epson Portland Inc.

13. Plaintiff Epson Portland Inc. ("Epson Portland") is a corporation organized and existing under the laws of the State of Oregon. Its principal place of business is located at 3950 NE Aloclek Drive, Hillsboro, Oregon 97124. Epson Portland is the exclusive licensee of the Epson Patents for manufacturing in the United States Epson ink cartridges that embody the inventions contained in the Epson Patents.

14. Plaintiffs Seiko Epson, Epson America, and Epson Portland are sometimes referred to collectively herein as "Epson" or "Plaintiffs."

15. Plaintiffs produce and sell aftermarket ink cartridges that operate with Epson ink jet printers utilizing Epson's patented technology in the United States and in this judicial district.

16. Plaintiffs also advertise and sell various ink bottles, ink cartridges and related accessories under the Epson Marks in the United States and this judicial district.

17. On information and belief, and according to the California Secretary of State, defendant Burkwitz Solutions is a corporation organized and existing under the laws of the State of California with a business address at 1317 N. San Fernando Blvd., #115, Burbank, California 91504 (which according to Google Maps is a "Pak & Ship All" commercial mail receiving agency). Based on information and belief, and according to Burkwitz Solution's filings with the California Secretary of State, defendant Armen Sargsyan is the Chief Executive Officer and a Director of Burkwitz Solutions and lists an address at 15435 Vanowan #205, Van Nuys, California 91406 (which according to Google Maps is a residential apartment). On information and belief and according to Burkwitz Solution's filings with the California Secretary of State, defendant Simon Mikail is the Chief Financial Officer, Secretary, and a Director of Burkwitz Solutions and lists an address at 23028 Peacock Court, Calabasas, California 91302 (which according to Google Maps is a residential house). On information and belief, and according to Burkwitz Solution's filings with the California Secretary of State, Burkwitz Solution's listed agent for service of process is Go Viral Enterprises, a California Registered Corporate Agent (1505). On information and belief and based on public records, Burkwitz Solutions has at least one website, inkjetsclub.com, which lists a corporate contact address at 11620 Wilshire Blvd., Los Angeles, CA 90025 (which according to Google Maps is a commercial building).

18. On information and belief, and based on public records, defendant, Armen Sargsyan is an individual who resides in California and according to Burkwitz

Solution's filings with the California Secretary of State is the Chief Executive Officer and a Director of Burkwitz Solutions, with a business address at 9035 Eton Avenue, Unit D, Canoga Park, California 91304 (which according to Google Maps is a commercial/industrial building), and a residence address at 15435 Vanowan #205, Van Nuys, California 91406 (which according to Google Maps is a residential apartment).

19. On information and belief, and based on public records, defendant, Simon Mikail is an individual who resides in California and according to Burkwitz Solution's filings with the California Secretary of State is the Chief Financial Officer, Secretary, and a Director of Burkwitz Solutions, with a business address at 9035 Eton Avenue, Unit D, Canoga Park, California 91304 (which according to Google Maps is a commercial/industrial building), and a residence address at 23028 Peacock Court, Calabasas, California 91302 (which according to Google Maps is a residential house).

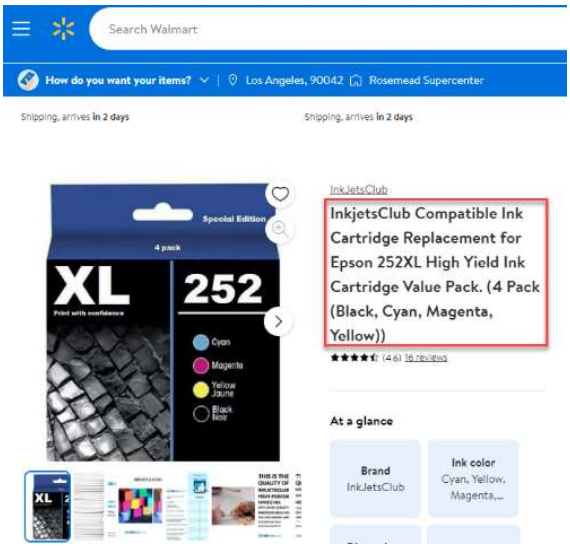
20. On information and belief, and based on public records from the United States Patent and Trademark Office, defendant Burkwitz Solutions has a U.S. Trademark registration for "INKJETSCLUB" on the supplemental register for the class of goods listed as "[i]nk jet printer ink," and lists the correspondence address as Burkwitz Solutions, 9035 Eton Avenue, Unit D, Canoga Park, California 91304, and correspondent email addresses as Support@inkjetsclub.com, and simon@gmail.com.

21. Collectively, defendant Burkwitz Solutions, defendant Armen Sargsyan, and defendant Simon Mikail are referred to herein as "Defendants."

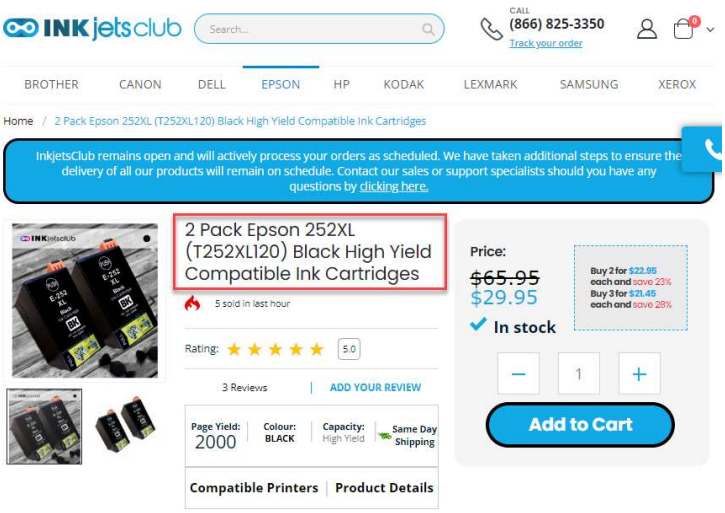
22. On information and belief, Defendants have and continue to conduct business on the Internet under various seller names, including but not limited to "inkjetsclub" through their website inkjetsclub.com, and through their listings and/or storefronts on walmart.com, amazon.com, and ebay.com. On information and belief, Defendants import, offer for sale, and sell products that infringe the Epson Patents as complained of herein, including by offering for sale and selling ink cartridges and components thereof, that infringe the Epson Patents directly through Defendants'

store fronts and listings on inkjetsclub.com, and walmart.com, amazon.com, and ebay.com. On their website inkjetsclub.com/about-us, Defendants state that they are "North America's leading online retailer for quality inkjet and toner cartridges found in all printer models," are "[h]eadquartered in Southern California," "has warehouses throughout the United States," and that their "100% compatible inkjet cartridges are manufactured from manufacturers here and throughout the world."

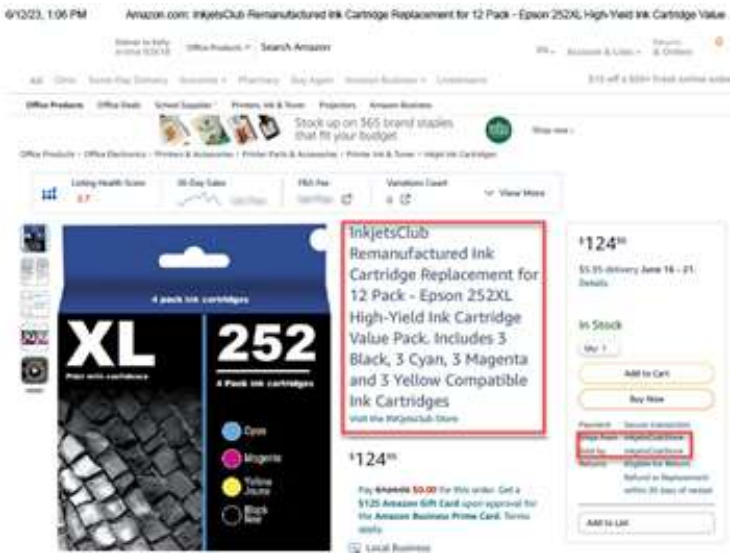
23. For example, in the annotated screen capture shown below of one of Defendants' listings on their InkjetsClub storefront on walmart.com, visited on July 31, 2024, Defendants offer for sale ink cartridges for use with Epson printers that infringe the Epson patents and describe them as: "InkjetsClub Compatible Ink Cartridge Replacement for Epson 252XL High Yield Ink Cartridge Value Pack, (4 Pack (Black, Cyan, Magenta, Yellow))."



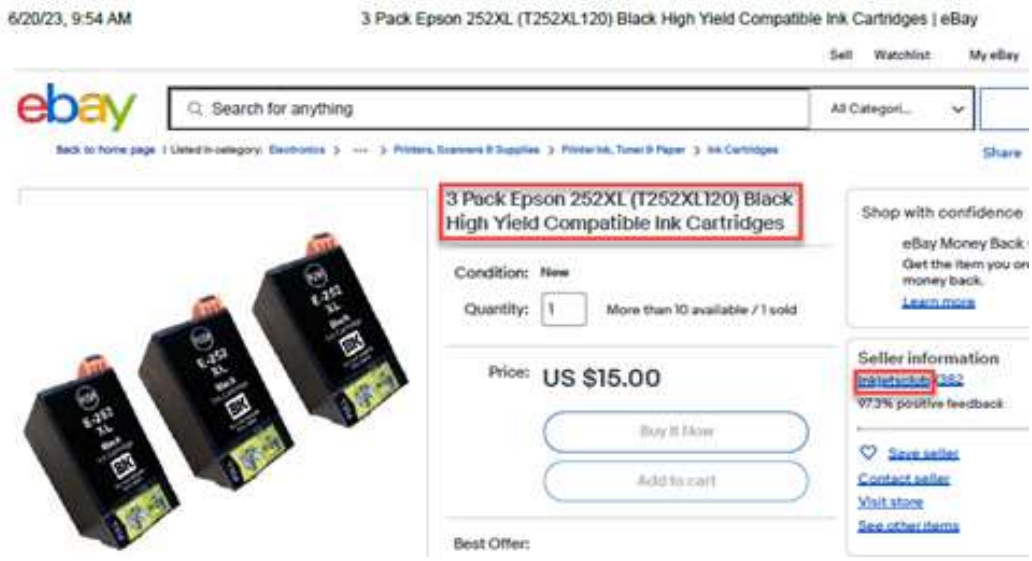
24. As another example, in the annotated screen capture below of Defendants' listing on their "InkJetsClub" storefront on their website inkjetsclub.com, visited on July 31, 2024, Defendants offered for sale ink cartridges for use with Epson printers that infringe the Epson patents and describe them as: "2 Pack Epson 252XL (T252XL120) Black High Yield Compatible Ink Cartridges."



25. As another example, in the annotated screen capture below of Defendants' listing on their "InkjetsClub" storefront on amazon.com, visited on June 12, 2023, Defendants offered for sale ink cartridges for use with Epson printers that infringe the Epson patents and describe them as: "InkjetsClub Remanufactured Ink Cartridge Replacement for 12 Pack – Epson 252 XL High-Yield Ink Cartridge Value Pack. Includes 3 Black, 3 Cyan, 3 Magenta and 3 Yellow Compatible Ink Cartridges."



26. As another example, in the annotated screen capture below of Defendants' listing on their "inkjetsclub" storefront on ebay.com, visited on June 20, 2023, Defendants offered for sale ink cartridges for use with Epson printers that infringe the Epson patents and describe them as: "3 Pack Epson 252XL (T252XL120) Black High Yield Compatible Ink Cartridges."



27. Similarly, on information and belief, through Defendants' InkJetsClub storefront and listings on its inkjetsclub.com website, Defendants advertise, offer for sale, and sell ink bottles and ink cartridges that infringe the Epson Marks. Specifically, Defendants' ink bottles exploit a nearly identical imitation of the Epson Marks on the product labels.

28. Numerous purchases of patent infringing ink cartridges and trademark infringing ink bottles and ink cartridges were made by Epson from Defendants' storefronts and listings on walmart.com, amazon.com, ebay.com, and Defendants' inkjetsclub.com website. The patent infringing ink cartridges and trademark infringing ink bottles and ink cartridges were shipped by Defendants to Epson under Defendants' seller name InkJetsClub from their shipping address 9035 Eton Avenue, Unit D, Canoga Park, California 91304.

29. On information and belief, Defendants act in concert with each other and with other entities and under fictitious business names to import, manufacture, distribute, and sell ink cartridges and circuit boards that infringe the Epson Patents and ink bottles and ink cartridges that infringe upon the Epson Marks. On information and belief, Defendants are jointly and severally responsible for the infringements of the Epson Patents and the Epson Marks as they jointly operated and continue to jointly operate and manage the infringing enterprises, including Defendants, and any related d/b/a entities, as a single enterprise by comingling resources, assets, operations, commercial activities, and they incur expenses and achieve profits jointly for the benefit of the combined enterprise, its owners and officers.

JURISDICTION AND VENUE

30. The causes of action herein for patent infringement arise under the patent laws of the United States, 35 U.S.C. § 271. This Court has subject matter jurisdiction over the claims for patent infringement pursuant to 28 U.S.C. §§ 1331, 1332, 1338(a) and 1338(b). The causes of action herein for trademark infringement arise under the Lanham Act, 15 U.S.C. § 1051 *et seq.*; 28 U.S.C. §§ 1331, 1338(a) and 1338(b); and 28 U.S.C. § 1332. This Court has jurisdiction over the claims in this complaint that arise under the laws of the State of California pursuant to 28 U.S.C. § 1367(a) because the state law claims are so related to the federal claims that they form part of the same case or controversy and derive from a common nucleus of operative facts.

31. This Court has personal jurisdiction over the Defendants at least because Defendants reside in this judicial district and have committed acts of direct and indirect patent infringement and trademark infringement in this judicial district, and have conducted systematic and continuous business within California and because they have directed their unlawful business activities towards California and have caused injury to a California resident within California.

32. Venue is proper in this district under 28 U.S.C. §§ 1391(b)(2), (b)(3), (c) and/or 1400(b) because Defendants' conduct business within this judicial district

and/or a substantial part of the events or omissions giving rise to the alleged claims occurred in this judicial district. Defendants have performed acts in this district that constitute patent and trademark infringement, and unfair competition by offering to sell and selling products in this district that infringe Epson's patents and trademarks.

FIRST CLAIM FOR RELIEF

(Patent Infringement—35 U.S.C. § 271)

INFRINGEMENT OF U.S. PATENT NO. 8,794,749

33. Epson incorporates by reference each and every allegation contained in Paragraphs 1 through 32 as though fully set forth at length here.

34. Epson owns all right, title, and interest in, including the right to sue thereon and the right to recover for infringement thereof, United States Patent No. 8,794,749 ("the '749 patent"), which was duly and legally issued to Seiko Epson by the United States Patent and Trademark Office on August 5, 2014. The '749 patent relates generally to ink cartridges for printers. Attached as **Exhibit A** to this Complaint is a true and correct copy of the '749 patent.

35. The '749 patent is valid and enforceable.

36. On information and belief after conducting a reasonable investigation, Defendants have infringed and are infringing the '749 patent, as defined by at least one claim of the patent in violation of 35 U.S.C. § 271(a) by making, using, importing, offering to sell, and selling in this judicial district and elsewhere aftermarket ink cartridges that operate with Epson ink jet printers, including but not limited to ink cartridges, including ink cartridges having aftermarket circuit boards, having model nos. T252120, T252120XL, T252220, T252320, T252420, T127220, T127320, T502120, T502220, T5402320, T502420, as well as others that are no more than colorably different from the foregoing (collectively, the "Accused '749 Ink Cartridges").

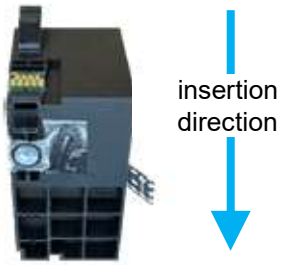
37. The specific models of Accused '749 Ink Cartridges identified above were obtained by Epson during its investigation leading to this Complaint from

Defendants' online listings on their storefronts on walmart.com, amazon.com, ebay.com, and inkjetsclub.com, as described above.

38. As a non-limiting example, set forth below is a claim chart with a description of Defendants' infringement of claim 1 of the '749 patent by the Accused '749 Ink Cartridges. The infringement is shown using a representative ink cartridge (Model No. 252120; Control No. 230448) selected from among the Accused '749 Ink Cartridges purchased from Defendants that, for infringement analysis purposes, is representative of and represents all of Defendants' ink cartridges within the Accused '749 Ink Cartridges (i.e., the represented ink cartridges), including, but not limited to, the models identified above. The claim chart below refers to this ink cartridge as "the Representative '749 Ink Cartridge." The Representative '749 Ink Cartridge was designed for use in specific Epson printers, for example, the Epson Work Force WF-7720 printer ("the Representative '749 Epson Printer"),[1] and for purposes of the analysis set forth herein, the Representative '749 Ink Cartridge was tested in the Representative '749 Epson Printer, as discussed in further detail in the claim chart below.

Claim 1 of the '749 patent	**Where found in the Accused '749 Ink Cartridges**
[1a] A printing material container adapted to be attached to a printing apparatus by being inserted into the printing apparatus in an insertion direction, the printing apparatus having a print head and a	Each of the Accused '749 Ink Cartridges is or includes a printing material container adapted to be attached to an Epson ink jet printing apparatus. Each of the Accused '749 Ink Cartridges is inserted, in an insertion direction, into an Epson ink jet printer. All Epson ink jet printers that work with the Accused '749 Ink Cartridges have a print head and a plurality of printer-side (apparatus-side) electrical contact members. These features are shown below using the Representative '749 Ink Cartridge.

[1] From a patent infringement analysis perspective, as set forth herein, the Representative '749 Epson Printer is representative of, and represents, all Epson printers that work with the Accused '749 Ink Cartridges.

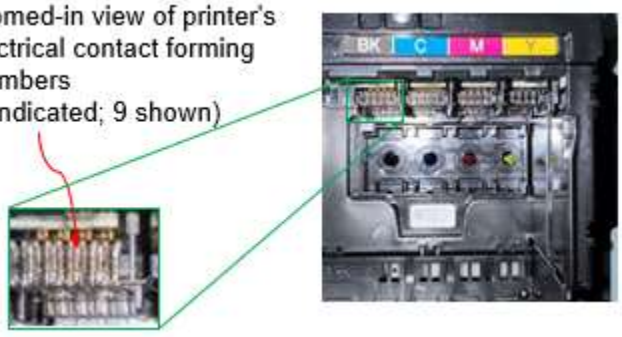
plurality of apparatus-side electrical contact members, the printing material container comprising:	The Representative ’749 Ink Cartridge is adapted to be attached to the Representative ’749 Epson Printer by being inserted in an insertion direction, as shown in the following photographs:  The Representative ’749 Ink Cartridge  The Representative ’749 Epson Printer The following photograph depicts the insertion direction (blue arrow) in which the Representative ’749 Ink Cartridge is inserted into the Representative ’749 Epson Printer:  The following photograph shows the Representative ’749

Ink Cartridge, a black-ink ink cartridge, attached in the Representative '749 Epson Printer after the cartridge has been inserted into the printer in the insertion direction (the cyan, yellow, magenta and black ink cartridges, which are genuine Epson ink cartridges used to fill the remaining slots of the cartridge holder, can also be seen):

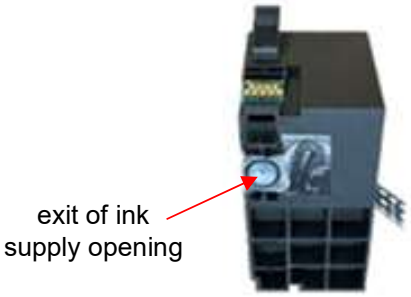
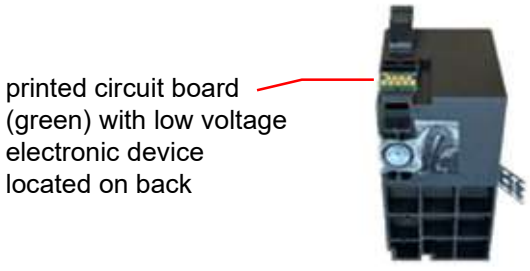
Representative '749 Ink Cartridge installed in the Representative '749 Epson Printer

The Epson ink jet printers (which includes the Representative '749 Epson Printer) that accept the Accused '749 Ink Cartridges (which includes the Representative '749 Ink Cartridge) each include a print head for printing and multiple printer-side electrical contact forming members for each ink cartridge accepted by the printer. These features are shown below for the Representative '749 Epson Printer's cartridge holder slot that accepts the Representative '749 Ink Cartridge, a black-ink ink cartridge (the printer's electrical contact members for the cyan, magenta, and yellow cartridges can also be seen in the photo):

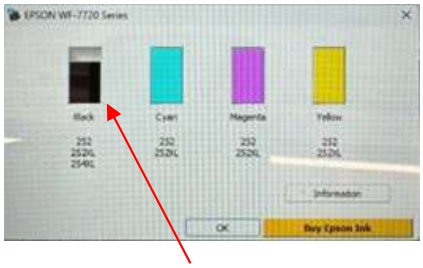
zoomed-in view of printer's electrical contact forming members (1 indicated; 9 shown)



Accordingly, the Accused '749 Ink Cartridges literally meet the preamble of claim 1 of the '749 patent.

[1b] an ink supply opening, having an exit, adapted to supply ink from the ink cartridge to the printing apparatus;	Each of the Accused '749 Ink Cartridges comprises an ink supply opening having an exit. When attached, the ink supply opening of each of the Accused '749 Ink Cartridges is adapted to supply ink from the cartridge to the Epson ink jet printer that accepts the cartridge. The following photograph depicts the exit of the ink supply opening of the Representative '749 Ink Cartridge:  Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.
[1c] a low voltage electronic device adapted to receive and function with a low voltage, the low voltage electronic device comprising a memory device;	Each of the Accused '749 Ink Cartridges comprises a low voltage electronic device that comprises a memory device adapted to receive and function with a low voltage. The low voltage electronic device is an integrated circuit ("IC") chip located on the back of a printed circuit board that is mounted on a wall of the ink cartridge, as shown below in the Representative '749 Ink Cartridge:  In addition, the presence of a low voltage electronic device (i.e., an IC chip comprising a memory device) is further confirmed through testing demonstrating that the

Epson ink jet printers that accept the Accused ’749 Ink Cartridges read the remaining ink level and other descriptive information about the ink cartridge from the ink cartridge’s memory device, and display that information on the display screen of a connected



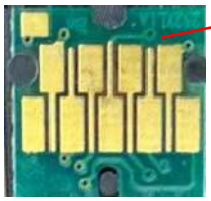
memory device shows, on the computer’s display screen, the amount of black ink remaining in the Representative ’749 Ink Cartridge

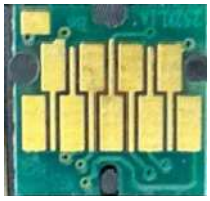
computer and on the printer’s display screen. The following photographs show the display of such information on the computer display screen

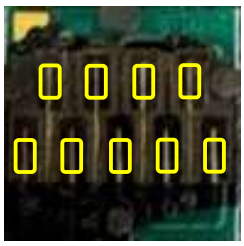
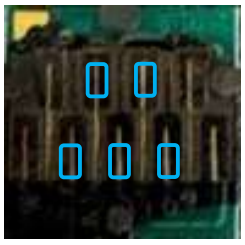
memory device shows, on the printer’s display screen, the amount of black ink remaining in the Representative ’749 Ink Cartridge

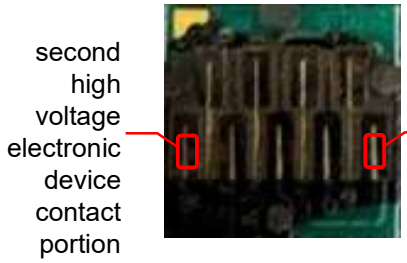
and the printer’s display screen for the Representative ’749 Ink Cartridge, containing black ink, attached to the Representative ’749 Epson Printer:

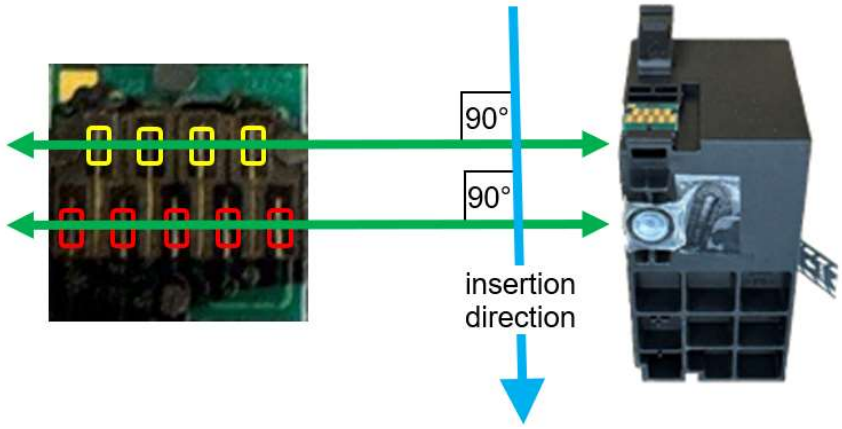
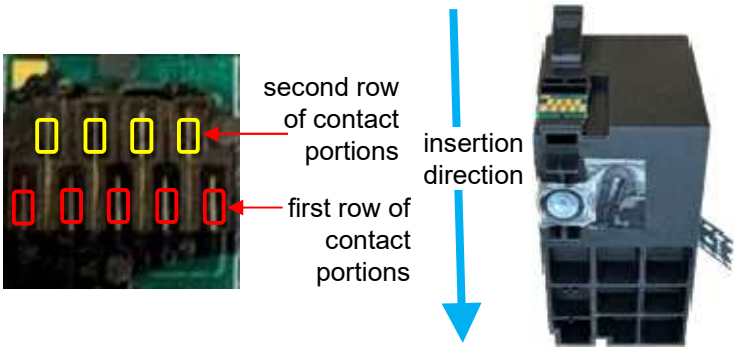
All Epson ink jet printers that accept the Accused ’749 Ink Cartridges have similar circuitry and programming in terms of the voltages and signals they apply to their contact forming members and, consequently, to the corresponding contact portions of the Accused ’749 Ink Cartridges (the contact portions are located on the gold-colored metallic terminals of the ink cartridge shown above). In particular, Epson printers apply a maximum

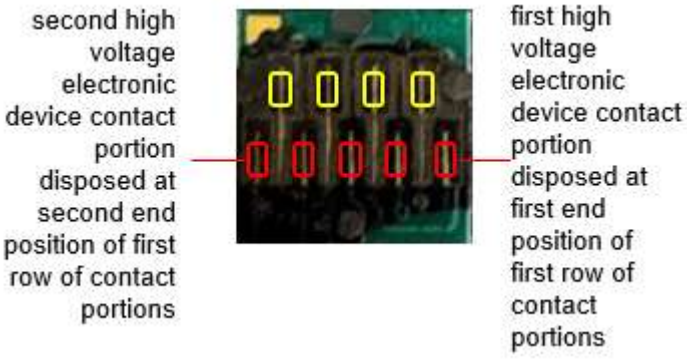
	voltage of approximately 4 volts (a low voltage as compared to the high voltage discussed in the next limitation) to certain of their contact forming members that in turn correspond to certain of the contact portions of the Accused '749 Ink Cartridges that are connected to the low voltage electronic device comprising a memory device. Consequently, the low voltage electronic device is adapted to receive and function with a low voltage. Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.
[1d] a high voltage electronic device adapted to receive and function with a high voltage, which is a higher voltage than the low voltage of the low voltage electronic device; and	Each of the Accused '749 Ink Cartridges comprises a high voltage electronic device that is adapted to receive and function with a voltage that is a higher voltage than the voltage of the low voltage electronic device. The high voltage electronic device may be, for example, a resistor, or one or more other coupled electronic components, that is/are capable of receiving and functioning with a high voltage. The high voltage electronic device is located on the back of a printed circuit board that is mounted on a wall of the ink cartridge, as shown below in the Representative '749 Ink Cartridge:  printed circuit board (green) with high voltage electronic device located on back All Epson ink jet printers that accept the Accused '749 Ink Cartridges have similar circuitry and programming in terms of the voltages and signals they apply to their contact forming members and, consequently, to the corresponding contact portions of the Accused '749 Ink Cartridges (the contact portions are located on the gold terminals of the ink cartridge shown above). In particular, Epson printers apply a voltage of approximately 42 volts (a high voltage as compared to the low voltage of approximately 4 volts applied to the low voltage electronic device discussed in the preceding limitation) to

	two of their contact forming members that in turn correspond to two of the contact portions of the Accused '749 Ink Cartridges that are connected to the high voltage electronic device. Consequently, the high voltage electronic device is adapted to receive and function with a high voltage. Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.
[1e] a plurality of container-side terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled between the container and the printing apparatus, the contact portions of the terminals including a plurality of low voltage electronic device contact portions electrically coupled to the low voltage electronic device, and a first high voltage electronic device contact portion and a second high voltage electronic device contact portion, each electrically coupled to the high voltage	Each of the Accused '749 Ink Cartridges comprises a plurality of container-side terminals that have contact portions. The contact portions are adapted and positioned on the cartridge so that, when the cartridge is attached to the printer, the contact portions of the cartridge's terminals contact corresponding printer-side contact forming members so that electrical communication is enabled between the cartridge and the printer. As seen with respect to limitation 1c above, the terminals of the Accused '749 Ink Cartridges are the gold-colored metallic portions on the green printed circuit board. The contact portions are located on these gold-colored metallic portions. To confirm the location and arrangement of the terminals' contact portions, the terminals were marked with black ink, the cartridge was installed in and then removed from the printer (which caused the printers' contact forming members to leave scratch marks on the terminals thereby removing a portion of the black ink that was applied and therefore indicating the location of the contact portions), and the terminals were then photographed. For example, the terminals of the Representative '749 Ink Cartridge before marking with black ink is shown on the left and after marking with black ink is shown on the right:  

electronic device, wherein:	The resulting marks left by the printer's contact forming members on the terminals show the location and arrangement of the contact portions. These are indicated below with annotated yellow boxes superimposed on the terminals to indicate the location of the contact portions  (there are a total of nine contact portions, with four contact portions in a top row and five contact portions in a bottom row): The contact portions shown above correspond to their printer-side contact forming members so that electrical communication is enabled between the ink cartridge and the printer, e.g., so the printer can read remaining ink level and other information from the memory device as described above with respect to limitation 1c. The above shown contact portions include a plurality of low voltage electronic device contact portions that are electrically coupled to the low voltage electronic device (specifically, the IC chip comprising a memory device). Each low voltage electronic device contact portion is electrically coupled by the terminal it appears on and by other circuitry to the memory device located on the back of the green printed circuit board. The following photograph of the Representative '749 Ink Cartridge  shows the low voltage electronic device contact portions (there are five such low voltage electronic device contact

	portions, as indicated by superimposed blue boxes): The contact portions of the Accused '749 Ink Cartridges' terminals also include first and second high voltage electronic device contact portions that are each electrically coupled to the high voltage electronic device discussed above with respect to limitation 1d. Each high voltage electronic device contact portion is electrically coupled by the terminal it appears on and by other circuitry to the high voltage electronic device on the back of the printed circuit board. The following photograph of the Representative '749 Ink Cartridge shows the high voltage electronic device contact portions (there are two  such high voltage electronic device contact portions, as indicated by superimposed red boxes): Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.
[1f] the contact portions are arranged in a first row of contact portions and in a second row of contact portions, the first row of contact portions and the second row of contact portions extending in a row direction which is generally orthogonal to the insertion direction,	The contact portions of each of the Accused '749 Ink Cartridges are arranged in a first row of contact portions and in a second row of contact portions that both extend in a row direction which is generally orthogonal to the insertion direction. The following photographs of the Representative '749 Ink Cartridge show the first row and second row of contact portions extending in a row direction which is generally orthogonal to the insertion direction in which the Accused '749 Ink Cartridges are inserted into Epson ink jet printers that accept the Accused '749 Ink Cartridges. The left photo shows an enlarged and annotated view of the printed circuit board shown in the right photo.

	 Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.
[1g] the first row of contact portions is disposed at a location that is further in the insertion direction than the second row of contact portions, and,	In each of the Accused '749 Ink Cartridges, the first row of contact portions is disposed at a location that is further in the insertion direction than the second row of contact portions. The following photographs of the Representative '749 Ink Cartridge show the first row of contact portions (red boxes) disposed at a location that is further in the cartridge insertion direction than the second row of contact portions (yellow boxes) (i.e., the first row is deeper in the printer than the second row).  first row of contact portions (red squares) disposed further in insertion direction (blue arrow) than second row of contact portions (yellow squares) Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.

[1h] the first row of contact portions has a first end position and a second end position at opposite ends thereof, the first high voltage electronic device contact portion is disposed at the first end position of the first row of contact portions and the second high voltage electronic device contact portion is disposed at the second end position of the first row of contact portions.	In each of the Accused '749 Ink Cartridges, the first row of contact portions has a first end position and a second end position at opposite ends thereof, the first high voltage electronic device contact portion is disposed at the first end position of the first row of contact portions, and the second high voltage electronic device contact portion is disposed at the second end position of the first row of contact portions. The following photograph of the Representative '749 Ink Cartridge shows the first and second high voltage contact portions disposed, respectively, at the first and second end positions at opposite ends of the first row of contact portions.  Accordingly, the Accused '749 Ink Cartridges literally meet this limitation of claim 1 of the '749 patent.

39. On information and belief after conducting a reasonable investigation, Defendants have and are actively, knowingly, and intentionally aiding and abetting and inducing infringement of the '749 patent in violation of 35 U.S.C. § 271(b) by non-parties, including end-users, despite Defendants' knowledge of the '749 patent.

40. On information and belief, Defendants had knowledge of the '749 patent prior to, or at least since, the filing and service of this complaint on Defendants.

41. On information and belief, defendants Armen Sargsyan and Simon Mikail, as the managers and members of defendant Burkwitz Solutions, each direct and control the infringing activities of defendant Burkwitz Solutions, and have taken

and continue to take active steps to encourage and induce defendant Burkwitz Solutions to infringe by actively running and directing the business, including but not limited to being the principal decision makers regarding the promotion, advertising, and sale of products that infringe the '749 patent on Defendants' website and other online storefronts, as discussed above. Additionally, Defendants induce end-users to infringe the '749 patent to use the infringing products, and do so with knowledge of the '749 patent or willful blindness that the induced acts constitute infringement of the '749 patent, and with knowledge that when such acts are taken constitute infringement of the '749 patent.

42. On information and belief, Defendants are contributing to the infringement of the '749 patent in violation of 35 U.S.C. § 271(c) by non-parties by offering to sell or selling within the United States or importing into the United States components of the patented inventions set forth in the '749 patent. The components constitute a material part of the inventions. Defendants know that such components are especially made or especially adapted for use in an infringement of the '749 patent. The components are not a staple article or commodity of commerce suitable for substantial noninfringing use.

43. By reason of Defendants' infringing activities, Epson has suffered, and will continue to suffer, substantial damages in an amount to be proven at trial.

44. Defendants' acts complained of herein have damaged and will continue to damage Epson irreparably. Epson has no adequate remedy at law for these wrongs and injuries. Epson is therefore entitled to a preliminary and permanent injunction restraining and enjoining Defendants and their agents, servants, and employees, and all persons acting thereunder, in concert with, or on their behalf, from infringing the claims of the '749 patent.

45. Defendants are not licensed or otherwise authorized to make, use, import, sell, or offer to sell any ink cartridge claimed in the '749 patent, and Defendants' conduct is, in every instance, without Epson's consent.

46. On information and belief, Defendants' infringement has been and continues to be willful.

SECOND CLAIM FOR RELIEF

(Patent Infringement—35 U.S.C. § 271)

INFRINGEMENT OF U.S. PATENT NO. 8,454,116

47. Epson incorporates by reference each and every allegation contained in Paragraphs 1 through 32 as though fully set forth at length here.

48. Epson owns all right, title, and interest in, including the right to sue thereon and the right to recover for infringement thereof, United States Patent No. 8,454,116 ("the '116 patent"), which was duly and legally issued to Seiko Epson by the United States Patent and Trademark Office on June 4, 2013. The '116 patent relates generally to ink supply systems for printers, including ink cartridges for printers, and circuit boards for ink cartridges. Attached as **Exhibit B** to this Complaint is a true and correct copy of the '116 patent. On April 26, 2022, certificate of correction 8,454,116 B2 was duly and legally issued to Seiko Epson by the United States Patent and Trademark Office. Attached as **Exhibit C** to this Complaint is a true and correct copy of the certificate of correction of the '116 patent. The original patent and the certificate of correction are collectively referred to herein as "the '116 patent."

49. The '116 patent is valid and enforceable.

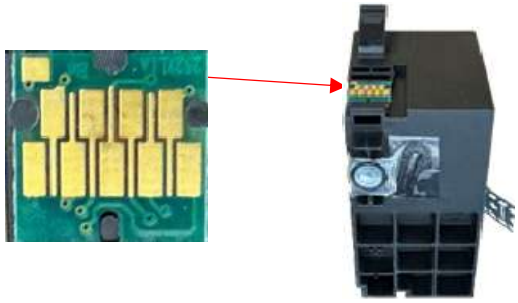
50. On information and belief after conducting a reasonable investigation, Defendants have infringed and are infringing the '116 patent, as defined by at least one claim of the patent in violation of 35 U.S.C. § 271(a) by making, using, importing, offering to sell, and selling in this judicial district and elsewhere aftermarket ink cartridges, including ink cartridges having aftermarket circuit boards, for use with Epson printers. These products include but are not limited to ink cartridges having model nos. T252120, T252120XL, T252220, T252320, T252420, T127220, T127320, T502120, T502220, T5402320, T502420, and those that are no more than

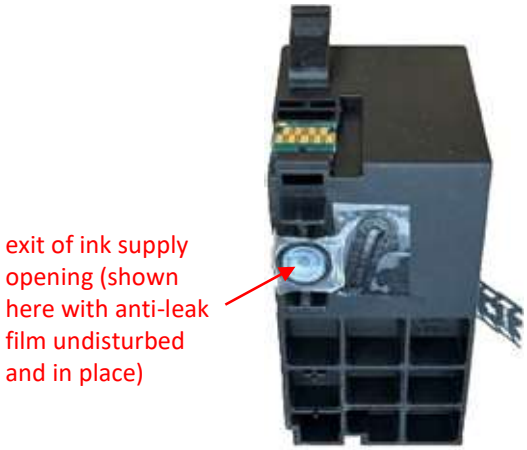
colorably different from the foregoing; (collectively, the "Accused '116 Products"). The specific models of Accused '116 Products identified above were obtained by Epson during its investigation leading to this Complaint from Defendants' online listings on their storefronts on walmart.com, amazon.com, ebay.com, and inkjetsclub.com, as described.

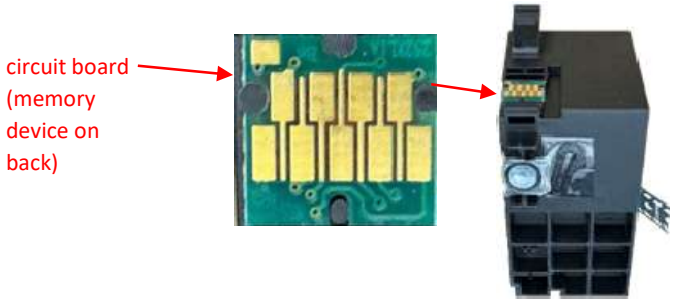
51. As a non-limiting example, set forth below is a claim chart with a description of Defendants' infringement of claim 18 of the '116 patent by the Accused '116 Products. The infringement is shown using a representative ink cartridge (Model No. 2521XL; Control No. 230448) from among the Accused '116 Products purchased from Defendants that, for infringement analysis purposes, is representative of and represents all of Defendants' products within the Accused '116 Products (i.e., the represented ink cartridges, including, but not limited to, the models identified above. The claim chart below refers to this product as "the Representative '116 Product." The Representative '116 Product was designed for use in a specific Epson printer, the Epson WorkForce WF-7720 printer ("the Representative '116 Epson Printer"),[2] and for purposes of the analysis set forth herein, the Representative '116 Product was tested in the Representative '116 Epson Printer, as discussed in further detail in the claim chart below.

Claim 18 of the '116 patent	Where found in the Accused '116 Products
[18a]. A circuit board mountable on a printing material container that is used in an ink jet printing apparatus, the ink jet printing apparatus having a print head and a plurality of apparatus-side contact forming members, the	A circuit board is mounted on the Representative '116 Product (model no. T2521XL; control no. 230448), which itself includes a printing material container and is used in an Epson ink jet printing apparatus (e.g., the Representative '116 Epson Printer) having a print head and a plurality of apparatus-side contact forming members.

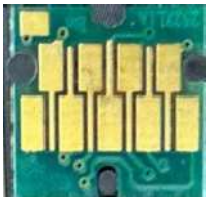
[2] From a patent infringement analysis perspective, as set forth herein, the Representative '116 Epson Printer is representative of, and represents, all Epson printers that work with the Accused '116 Products.

printing material container having a body and an ink supply opening, the ink supply opening having an exit on an exterior portion of the body and being adapted to supply ink from the printing material container to the printing apparatus, the circuit board comprising:	The Representative '116 Product has a body and an ink supply opening having an exit on an exterior portion of the body and is adapted to supply ink from the Representative '116 Product to the Representative '116 Epson Printer (the ink jet printing apparatus). The Representative '116 Product is a printing material container with a mounted circuit board. The following photos depict the circuit board (green with gold-colored metallic terminals) mounted on the Representative '116 Product containing black ink.  The Representative '116 Product is used in any of the following Epson ink jet printer (printing apparatus) models: Epson WorkForce WF-7610, WF-7710, WF-7720, WF-3620, WF-7210, WF-7620, WF-7110, WF-3640, and WF-7720 (the "Epson Ink Jet Printers"). The following photo depicts the Epson WorkForce WF-7720 ink jet printer. 

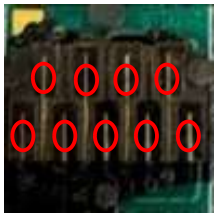
	The Epson Ink Jet Printers each include a print head for printing and multiple printer-side contact forming members. The Representative '116 Product has a body, as depicted below.  The Representative '116 Product has an ink supply opening having an exit on an exterior portion of the body. When mounted, the ink supply opening is adapted to supply ink from the printing material container (i.e., the cartridge) to the Epson Ink Jet Printers. The following photo depicts the exit of the  Representative '116 Product's ink supply opening. Accordingly, the Representative '116 Product literally meets the preamble of claim 18 of the '116 patent.

[18b] a memory device adapted to be driven by a memory driving voltage;	The circuit board mounted on the Representative '116 Product comprises a memory device that is adapted to be driven by a memory driving voltage. The following photo depicts the circuit board (green with gold-colored metallic terminals) mounted on the Representative '116 Product.  The memory device is located on the back of the circuit board and is not visible in this view. All Epson ink jet printers that accept the Representative '116 Product have similar circuitry and programming in terms of the voltages and signals they apply to their contact forming members and, consequently, to the corresponding contact portions of the Representative '116 Product (the contact portions are located on the gold-colored metallic terminals of the ink cartridge shown above). In particular, Epson printers apply a maximum voltage of approximately 4 volts (a low voltage as compared to the high voltage discussed in the next limitation) to certain of their contact forming members that in turn correspond to certain of the contact portions of the Representative '116 Product that are connected to the memory. Consequently, the memory device is adapted to be driven by a memory driving voltage. This was confirmed through testing during the ITC 946 Investigation. Accordingly, the Representative '116 Product

	literally meets this limitation of claim 18 of the '116 patent.
[18c] an electronic device adapted to receive a voltage higher than the memory driving voltage; and	The circuit board mounted on the Representative '116 Product comprises an electronic device that is adapted to receive a voltage that is a higher voltage than the voltage of the memory device. The electronic device that receives a higher voltage may be, for example, a resistor, or one or more other coupled electronic components, that is/are capable of receiving a high voltage. The electronic device is located on the back of a printed circuit board that is mounted on a wall of the Representative '116 Product shown in the above limitation. In particular, Epson printers apply a voltage of approximately 42 volts (a high voltage as compared to the low voltage of approximately 4 volts applied to the memory device discussed in the preceding limitation) to two of their contact forming members that in turn correspond to two of the contact portions of the circuit board mounted on the Representative '116 Product that are connected to the electronic device. Consequently, the electronic device is adapted to receive and function with a high voltage. This was confirmed through testing during the ITC 946 Investigation. Accordingly, the Representative '116 Product literally meets this limitation of claim 18 of the '116 patent.
[18d] a plurality of terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical	The circuit board mounted on the Representative '116 Product comprises a plurality of terminals that have contact portions. The contact portions are adapted and positioned on the cartridge so that, when the cartridge is mounted on the printer, the contact portions of

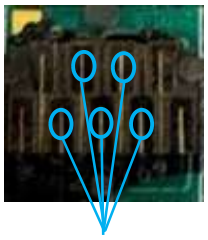
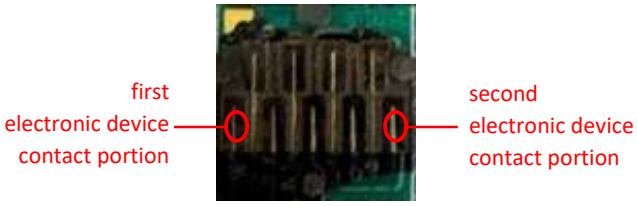
communication is enabled with the ink jet printing apparatus, the contact portions of the terminals including a plurality of memory contact portions electrically coupled to the memory device, a first electronic device contact portion electrically coupled to the electronic device, a second electronic device contact portion electrically coupled to the electronic device, and a short detection contact portion positioned and arranged to electrically contact a contact forming member that itself is electrically coupled to a short detection circuit of the printing apparatus, wherein:	the cartridge's terminals contact corresponding printer-side contact forming members so that electrical communication is enabled with the printer. As discussed at 18(a) and 18(b) *supra*, the terminals of the Representative '116 Product's  circuit board are the gold colored metallic portions on the green circuit board, reproduced in enlarged form below. To determine the precise location of the terminals' contact portions, the following steps were taken: (1) using a marker, black ink was applied to the terminals and the terminal arrangement photographed; (2) the Representative '116 Product was installed in and removed from the printer; and (3) the  terminal arrangement was photographed. The following photo shows the terminals after the application of black ink with a marker. The step of installing and removing the cartridge from the printer, causes the printer's contact forming members (discussed at 18(a), *supra*) to leave scratch marks on the terminals thereby removing a portion of the black ink that was applied with the marker. The following photo shows the terminals after the cartridge was installed and removed from the printer.

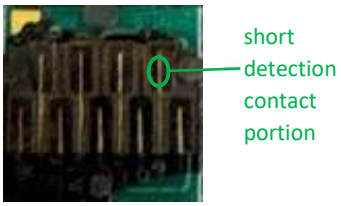
The contact portions of the circuit board's terminals are the most pronounced portions of the scratch marks (all of which contact corresponding printer-side contact forming members so that electrical communication is enabled with the printer, e.g., so that the printer can read remaining ink level and other information from the memory device as described in 18(b), *supra*). The following annotated photo shows the location of the



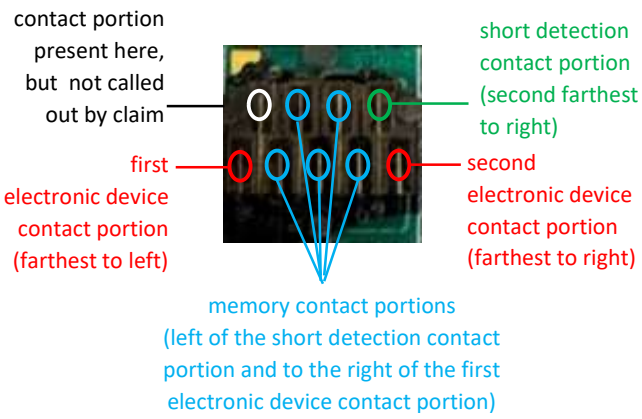
contact portions annotated by red circles.

The contact portions of the circuit board's terminals include a plurality of memory contact portions that are electrically coupled to the memory device. Each memory contact portion is electrically coupled by the terminal it appears on to a "via," which is a through-hole (through the circuit board) that electrically couples the terminal to wiring on the back of the circuit board. The wiring on the back of the circuit board electrically couples the via (and, therefore, the contact portion of the terminal) to an electrical lead of the IC chip containing the memory device mounted on the back of the circuit board. In combination, these components electrically couple the memory contact portion to the memory device.

	The following annotated photo depicts the five memory contact portions (in blue) located on the  terminals on the front of the circuit board. The contact portions of the circuit board's terminals include a first and second electronic device contact portion that are each electrically coupled to the electronic device (specifically, the resistor). Each electronic device contact portion is electrically coupled by the terminal it appears on to a via that electrically couples the terminal to wiring located on the back of the circuit board. The wiring on the back of the circuit board electrically couples the via (and, therefore, the contact portion of the terminal) to an electrical lead of the resistor mounted on the back of the circuit board. In combination, these components electrically couple the first and second electronic device contact portions to the resistor. The following annotated photo depicts the first and second electronic device contact portions (in red) located on the terminals on the front of  the circuit board. The contact portions of the circuit board's

	terminals include a short detection contact portion that is positioned and arranged to electrically contact a contact forming member of the Epson Ink Jet Printers that is itself electrically coupled to a short detection circuit of the printers. The following photo depicts the short detection contact portion (in green).  Moreover, all Epson ink jet printers that accept the Representative '116 Product have similar circuitry and programming in terms of the operation of the short detection contact portion. In particular, when the printers are operated while the short detection contact portion is electrically shorted to the second electronic device contact portion, the printers stop the receipt of the voltage higher than the memory driving voltage by the second electronic device contact portion, and display an error message to the user on the display screen of a connected computer and on the printer display screen (if the printer has a display screen). This was confirmed through testing during the ITC 946 Investigation. Accordingly, the Representative '116 Product literally meets this limitation of claim 18 of the '116 patent.
[18e] the contact portions are arranged so that, when the terminal arrangement is viewed from the vantage of the contact	The contact portions of the Representative '116 Product's circuit board are arranged so that, when the terminal arrangement is viewed from the vantage of the printer's contact forming

forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the ink cartridge oriented with the exit of the ink supply opening facing downwards, the contact portion farthest to the left is the first electronic device contact portion, the contact portion that is farthest to the right is the second electronic device contact portion, the contact portion that is second farthest to the right is the short detection contact portion, and the memory contact portions are located to the left of the short detection contact portion and to the right of the first electronic device contact portion.	members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the printer, and with the ink cartridge oriented so that the exit of the ink supply opening faces downwards, then the contact portion farthest to the left is the first electronic device contact portion, the contact portion that is farthest to the right is the second electronic device contact portion, the contact portion that is second farthest to the right is a short detection contact portion, and the memory contact portions are located to the left of the short detection contact portion and to the right of the first electronic device contact portion. The following photo depicts the terminal arrangement when it is viewed from the vantage of the printer's contact forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the printer, and with the ink cartridge oriented so that the exit of the ink supply opening faces downwards.  terminal arrangement viewed from vantage of printer's contact forming members . . . with the exit of the ink supply opening facing downwards

	The following photo depicts the arrangement of the contact portions when the terminal arrangement is viewed as described above.  Accordingly, the Representative '116 Product literally meets this limitation of claim 18 of the '116 patent.

52. On information and belief after conducting a reasonable investigation, Defendants have and are actively, knowingly and intentionally aiding and abetting and inducing infringement of the '116 patent in violation of 35 U.S.C. § 271(b) by non-parties, including end-users, despite Defendants' knowledge of the '116 patent.

53. On information and belief, Defendants had knowledge of the '116 patent prior to, or at least since the filing and service of this complaint on Defendants.

54. On information and belief, defendants Armen Sargsyan and Simon Mikail, as the managers and members of defendant Burkwitz Solutions, each direct and control the infringing activities of defendant Burkwitz Solutions, and have taken and continue to take active steps to encourage and induce defendant Burkwitz Solutions to infringe by actively running and directing the business, including but not limited to being the principal decision makers regarding the promotion, advertising, and sale of products that infringe the '116 patent on Defendants' website and other online storefronts, as discussed above. Additionally, Defendants induce end-users to infringe the '116 patent to use the infringing products, and do so with knowledge of

the '116 patent or willful blindness that the induced acts constitute infringement of the '116 patent, and with knowledge that when such acts are taken constitute infringement of the '116 patent.

55. On information and belief, Defendants are contributing to the infringement of the '116 patent in violation of 35 U.S.C. § 271(c) by non-parties by offering to sell or selling within the United States or importing into the United States components of the patented inventions set forth in the '116 patent. The components constitute a material part of the inventions. Defendants know that such components are especially made or especially adapted for use in an infringement of the '116 patent. The components are not a staple article or commodity of commerce suitable for substantial noninfringing use.

56. By reason of Defendants' infringing activities, Epson has suffered, and will continue to suffer, substantial damages in an amount to be proven at trial.

57. Defendants' acts complained of herein have damaged and will continue to damage Epson irreparably. Epson has no adequate remedy at law for these wrongs and injuries. Epson is therefore entitled to a preliminary and permanent injunction restraining and enjoining Defendants and their agents, servants, and employees, and all persons acting thereunder, in concert with, or on their behalf, from infringing the claims of the '116 patent.

58. Defendants are not licensed or otherwise authorized to make, use, import, sell, or offer to sell any product claimed in the '116 patent, and Defendants' conduct is, in every instance, without Epson's consent.

59. On information and belief, Defendants' infringement has been and continues to be willful.

THIRD CLAIM FOR RELIEF

(Trademark Infringement, False Designation of Origin, and Unfair Competition—15 U.S.C. §§ 1114; 1125(a))

60. Epson incorporates by reference each and every allegation contained in Paragraphs 1 through 32 as though fully set forth at length here.

61. Epson is the owner of all relevant intellectual property rights in the Epson Marks. Attached as **Exhibit D, E** and **F** to this Complaint are true and correct copies of the U.S. trademark registrations for the 252 Mark, the 502 Mark, and the WAVE Mark, respectively.

62. The Epson Marks have been in continuous use since at least their date of their respective registrations.

63. Epson advertises, distributes, and sells its products to consumers under the Epson Marks.

64. Epson's federal trademark registrations for the Epson Marks are in full force and constitutes *prima facie* evidence of the validity of the Epson Marks. Epson has also acquired common law rights in the use of the Epson Marks throughout the United States.

65. Epson has invested significant time, money, and effort in advertising, promoting, and developing the Epson Marks throughout the United States and the world. As a result of such advertising and promotion, Epson has established substantial goodwill and widespread recognition in the Epson Marks, and the Epson Marks have become associated exclusively with Epson and its products both by customers and potential customers, as well as the general public at large. The Epson Marks have been, and will continue to be, known throughout the United States and the world as identifying and distinguishing Epson's products and services.

66. To create and maintain such goodwill amongst its customers, Epson has taken substantial steps to ensure that products bearing the Epson Marks are of the highest quality. As a result, the Epson Marks have become widely known and is

recognized throughout the United States and the world as a symbol of high quality products.

67. Epson is not affiliated with Defendants, and Epson has never authorized or otherwise granted Defendants permission to use the Epson Marks, in whole or in part.

68. Despite this, Defendants have used and continue to use the Epson Marks in the advertisement, offer for sale, and sale of Defendants' aftermarket bottles of ink on the Internet, including, but not limited to on walmart.com, amazon.com, ebay.com, and inkjetsclub.com, as described above.

69. The packaging for Defendants' aftermarket bottles of ink exploit a nearly identical copy of Epson's WAVE Mark as shown in the images below which on the left shows an annotated picture of Defendants' packaging for ink bottles, and on the right shows Epson's WAVE Mark.

Defendants' Infringing Packaging for Ink Bottles

Epson's Wave Mark

70. Likewise, Defendants' infringing aftermarket packaging for ink cartridges exploit Epson's 252 Mark as shown below in the annotated pictures of Defendants' infringing packaging for ink cartridges.

71. Similarly, Defendants' infringing aftermarket ink bottles and packaging for ink bottles exploit Epson's 502 Mark as shown below in the annotated pictures of Defendants' infringing ink bottles and packaging for ink bottles.

72. Defendants' use in commerce of the Epson Marks in connection with the advertising and sale of its competing aftermarket bottles of ink and ink cartridges is likely to cause, and has caused, confusion and deception amongst consumers as to the origin of Defendants' products. Defendants' conduct deceives the ordinary consumer

into believing that Defendants' aftermarket bottles of ink and ink cartridges originate from, or are affiliated, authorized, sponsored, or approved by Epson, or that Defendants and Epson are otherwise associated, which they are not.

73. Defendants' sale of bottles of ink and ink cartridges bearing the Epson Marks substantially harms consumers who ultimately purchase Defendants' aftermarket bottles of ink and ink cartridges believing them to be Epson products, or otherwise sponsored or approved by Epson. Further, Defendants' conduct likely results in consumer confusion as well as the dilution of Epson's goodwill and trade name as consumers are not receiving Epson's high-quality products as intended.

74. On information and belief, Defendants advertise and sell their bottles of ink and ink cartridges bearing the Epson Marks with the intent to deceive consumers, create consumer confusion, and divert sales of Epson products and accessories. Defendants' actions demonstrate an intentional, willful, and malicious intent to trade on the goodwill associated with the Epson Marks, thereby causing immediate, substantial, and irreparable injury to Epson. Defendants' sale of bottles of ink and ink cartridges bearing the Epson Marks results in the lessening of sales of properly advertised Epson products to the detriment of Epson.

75. Defendants acts as alleged herein constitute the use in commerce, without consent of Epson, of a reproduction, counterfeit, copy, or colorable imitation of the Epson Marks in connection with the sale, offering for sale, distribution, or advertising of goods, which use is likely to cause confusion or mistake, or to deceive consumers, and therefore infringes Epson's rights in the Epson Marks, in violation of the Lanham Act, 15 U.S.C. § 1114.

76. Further, by selling or distributing products using the Epson Marks as alleged herein, Defendants are engaging in unfair competition, and/or falsely representing sponsorship by, affiliation with, or connection to Epson and their goods and services in violation of 15 U.S.C. § 1125(a).

77. By advertising or promoting products using the Epson Marks as alleged herein, Defendants are misrepresenting the nature, characteristics, and qualities of their goods and services in violation of 15 U.S.C. § 1125(a).

78. Epson is entitled to a judgment of three times its damages and Defendants' ill-gotten profits, together with reasonable attorneys' fees, pursuant to 15 U.S.C. § 1117(a).

79. As a direct and proximate result of Defendants' actions, Epson has been, and continues to be, damaged by Defendants' activities and conduct. Defendants have profited thereby, and unless its conduct is enjoined, Epson's reputation and goodwill will continue to suffer irreparable injury that cannot adequately be calculated or compensated by money damages. Accordingly, Epson is entitled to injunctive relief pursuant to 15 U.S.C. § 1116.

PRAYER FOR RELIEF

WHEREFORE, Epson prays for judgment against Defendants as follows:

A. That the '749 and '116 patents are valid; that the '749 and '116 patents are enforceable;

B. That Defendants have infringed and are infringing the '749 and '116 patents;

C. That such infringement of the '749 and '116 patents was and is willful;

D. That Defendants and their subsidiaries, affiliates, parents, successors, assigns, officers, agents, representatives, servants, and employees, and all persons in active concert or participation with them, be preliminarily and permanently enjoined from continued infringement of the '749 and '116 patents;

E. That Defendants be ordered to pay Epson its damages caused by Defendants' infringement of the '749 and '116 patents and that such damages be trebled, together with interest thereon;

F. That this case be declared exceptional pursuant to 35 U.S.C. § 285 and that Epson be awarded its reasonable attorneys' fees, litigation expenses and expert witness fees, and costs;

G. That Defendants have infringed and are infringing the 252, 502, and WAVE Marks;

H. That Defendants' acts of trademark infringement have been knowing and willful;

I. That Defendants and their subsidiaries, affiliates, parents, successors, assigns, officers, agents, representatives, servants, and employees, and all persons in active concert or participation with them, including, but not limited to, any online platform, such as walmart.com, amazon.com, ebay.com and any website, including inkjetsclub.com, website host, website administrator, domain registrar, or internet service provider, be preliminarily and permanently enjoined from continued use, or attempts to use the 252, 502, and WAVE Marks.

J. That Defendants be ordered to pay Epson its actual damages caused by Defendants' infringement of the 252, 502, and WAVE Marks and treble said damages as provided by law pursuant to 15 U.S.C. § 1117;

K. That Defendants be ordered to recall, impound, and destroy of all goods, advertising, or other items bearing infringing markings, pursuant to 15 U.S.C. § 1118;

L. That Epson be awarded its reasonable attorneys' fees and costs incurred in bringing this action as allowed by law;

M. That Epson be awarded pre-judgment and post-judgment interest in the maximum amount allowed by law; and

N. That Epson have such other and further relief as the Court deems just and proper.

JURY TRIAL DEMAND

Pursuant to Fed. R. Civ. P. 38(b), Plaintiffs request a trial by jury of all issues so triable.

DATED: November 22, 2024

QUINN EMANUEL URQUHART & SULLIVAN, LLP

By */s/ Richard H. Doss*

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EXHIBIT A

US008794749B2

(12) **United States Patent**
Asauchi

(10) **Patent No.: US 8,794,749 B2**
(45) **Date of Patent: Aug. 5, 2014**

(54) **PRINTING MATERIAL CONTAINER, AND BOARD MOUNTED ON PRINTING MATERIAL CONTAINER**

(71) Applicant: **Seiko Epson Corporation**, Tokyo (JP)

(72) Inventor: **Noboru Asauchi**, Nagano-ken (JP)

(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/902,171**

(22) Filed: **May 24, 2013**

(65) **Prior Publication Data**

US 2013/0258009 A1 Oct. 3, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/608,658, filed on Sep. 10, 2012, now Pat. No. 8,454,116, which is a continuation of application No. 12/257,914, filed on Oct. 24, 2008, now Pat. No. 8,366,233, which is a continuation of application No. 12/040,308, filed on Feb. 29, 2008, now Pat. No. 7,484,825, which is a continuation of application No. 11/611,641, filed on Dec. 15, 2006, now Pat. No. 7,562,958.

(30) **Foreign Application Priority Data**

Dec. 26, 2005 (JP) 2005-372028
Aug. 11, 2006 (JP) 2006-220751

(51) **Int. Cl.**
B41J 2/175 (2006.01)

(52) **U.S. Cl.**
USPC **347/86**; 347/19; 347/50; 439/67; 439/924.1

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,683,481 A 7/1987 Johnson
4,739,352 A 4/1988 Gorelick et al.
5,032,855 A 7/1991 Taniguchi et al.
5,049,898 A 9/1991 Arthur et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1272081 A 11/2000
CN 1481999 A 3/2004

(Continued)

OTHER PUBLICATIONS

Allowed claims corresponding to Application No. 2002-167574.

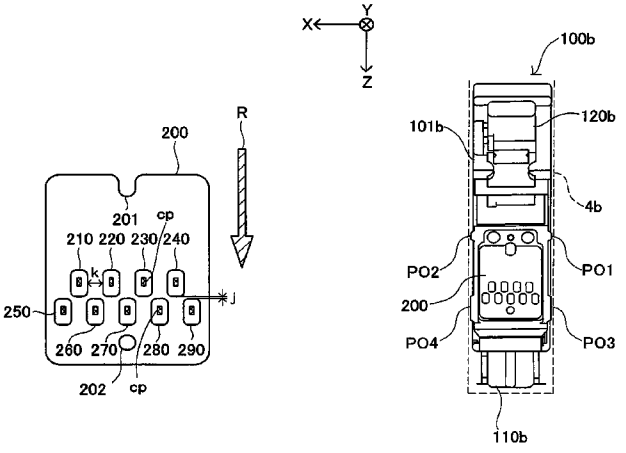
(Continued)

Primary Examiner — Michael Zarroli
(74) *Attorney, Agent, or Firm* — Stroock & Stroock & Lavan LLP

(57) **ABSTRACT**

A printing material container detachably attachable to a printing apparatus having apparatus-side terminals. The container can comprise an electrical device, a memory device and a plurality of terminals. First and second terminals can be coupled to the electrical device and a plurality of memory terminals can be coupled to the memory device. Terminal contact portions are present where the terminals contact a respective apparatus side contact forming member. A short detection contact portion can be positioned to contact a contact forming member that itself is coupled to a short detection circuit of the printing apparatus. The terminals can be arranged with the memory terminal contact portions located to the left of the second terminal contact portion and to the right of the first terminal contact portion. The contact portion that is second farthest to the right can be the third contact portion.

62 Claims, 22 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,278,584	A	1/1994	Keefe et al.
5,565,786	A	10/1996	Balousek
5,610,635	A	3/1997	Murray et al.
5,646,660	A	7/1997	Murray
5,699,091	A	12/1997	Bullock et al.
5,710,582	A	1/1998	Hawkins et al.
5,751,311	A	5/1998	Drake
5,788,388	A	8/1998	Cowger et al.
5,940,095	A	8/1999	Parish et al.
6,039,428	A	3/2000	Juve
6,086,193	A	7/2000	Shimada et al.
6,130,695	A	10/2000	Childers et al.
6,155,664	A	12/2000	Cook
6,155,678	A	12/2000	Komplin et al.
6,161,915	A	12/2000	Bolash et al.
6,164,743	A	12/2000	Hmelar et al.
6,260,942	B1	7/2001	Ahne et al.
6,280,017	B1	8/2001	Miyauchi
6,550,902	B2	4/2003	Shinada et al.
6,585,359	B1	7/2003	Gasvoda et al.
6,749,287	B2	6/2004	Osada et al.
7,008,053	B2	3/2006	Hashii et al.
7,175,244	B2	2/2007	Usui et al.
7,201,463	B2	4/2007	Kosugi et al.
7,219,985	B2	5/2007	Shinada et al.
7,237,864	B2	7/2007	Sarmast et al.
7,306,308	B2	12/2007	Tsukada et al.
2002/0003551	A1	1/2002	Beck et al.
2002/0024559	A1	2/2002	Murray et al.
2002/0135623	A1	9/2002	Tsukada et al.
2002/0167574	A1	11/2002	Shinada et al.
2002/0171700	A1	11/2002	Shinada et al.
2002/0180823	A1	12/2002	Shinada et al.
2003/0043216	A1	3/2003	Usui et al.
2003/0054003	A1	3/2003	Leung et al.
2003/0058296	A1	3/2003	Shinada et al.
2003/0079655	A1	5/2003	Takahashi et al.
2003/0085969	A1	5/2003	Shinada et al.
2003/0137568	A1	7/2003	Shinada et al.
2004/0155913	A1	8/2004	Kosugi et al.
2004/0183848	A1	9/2004	Hasseler
2005/0057622	A1	3/2005	Kimura et al.
2005/0146576	A1	7/2005	Shinada et al.
2005/0146579	A1	7/2005	Sasaki et al.
2005/0195255	A1	9/2005	Shinada et al.
2005/0219303	A1	10/2005	Matsumoto et al.
2005/0237349	A1	10/2005	Nishihara
2005/0270315	A1	12/2005	Yamamoto
2006/0007253	A1	1/2006	Kosugi
2006/0033790	A1	2/2006	Shinada et al.
2006/0119677	A1	6/2006	Shinada et al.
2006/0203050	A1	9/2006	Shinada et al.
2006/0250426	A1	11/2006	Wanibe et al.
2006/0250446	A1	11/2006	Wanibe et al.
2007/0149044	A1	6/2007	Asauchi
2008/0158318	A1	7/2008	Asauchi
2008/0259135	A1	10/2008	Asauchi et al.

FOREIGN PATENT DOCUMENTS

CN	1532064	A	9/2004
DE	102006060705	A1	6/2007
EP	0412459	A2	2/1991
EP	0593282	A2	4/1994
EP	0789322	A2	8/1997
EP	0805028	A2	11/1997
EP	0812693	A1	12/1997
EP	0873873	A2	10/1998
EP	0882595	A2	12/1998
EP	0997297	A1	5/2000
EP	1013426	A2	6/2000
EP	1155864	A1	11/2001
EP	1219437	A2	7/2002
EP	1279503	A2	1/2003
EP	1281523	A2	2/2003
EP	1300245	A1	4/2003
EP	1314565	A2	5/2003
EP	1462262	A1	9/2004
EP	1188567	A2	3/2005
EP	1514690	A1	3/2005
EP	1097043	B1	11/2005
EP	1598198	A2	11/2005
EP	1792733	A1	6/2007
EP	1800872	A1	6/2007
EP	2080622	A1	7/2009
EP	2080622	B1	2/2011
GB	2369801	A	6/2002
GB	2424623	A	10/2006
GB	2446311	A	8/2008
GB	2447150	A	9/2008
JP	62-184856	A	8/1987
JP	02-009645	A	1/1990
JP	02-279344	A	11/1990
JP	03-211060	A	9/1991
JP	05-246032	A	9/1993
JP	06-320818	A	11/1994
JP	07-052411	A	2/1995
JP	07-060954	A	3/1995
JP	07-309018	A	11/1995
JP	08-090871	A	4/1996
JP	08-221158	A	8/1996
JP	09-174827	A	7/1997
JP	10-006535	A	1/1998
JP	10-086357	A	4/1998
JP	11-312554	A	11/1999
JP	11-320857	A	11/1999
JP	2000-006413	A	1/2000
JP	2000-198190	A	7/2000
JP	2001-147146	A	6/2001
JP	2002-079655	A	3/2002
JP	2002-154222	A	5/2002
JP	2002-513340	A	5/2002
JP	2002-198627	A	7/2002
JP	2003-054003	A	2/2003
JP	2003-103796	A	4/2003
JP	2003-152297	A	5/2003
JP	2004-050573	A	2/2004
JP	2004-261970	A	9/2004
JP	2004-310312	A	11/2004
JP	2005-161764	A	6/2005
JP	2005-246664	A	9/2005
JP	2005-343037	A	12/2005
JP	2005-372028	A	12/2005
JP	2006-100398	A	4/2006
JP	2007-196664	A	8/2007
TW	310363		7/1997
TW	200520981		7/2005
TW	200526423	A	8/2005
WO	98/04414	A1	2/1998
WO	98/55318	A1	12/1998
WO	98/55324	A1	12/1998
WO	02/04215	A1	1/2002
WO	2005/000591	A1	1/2005
WO	2006/025578	A1	3/2006
WO	2006104258	A1	10/2006

OTHER PUBLICATIONS

Allowed claims corresponding to Application No. 2002-171700.
Allowed claims corresponding to Application No. 2002-180823.
Allowed claims corresponding to Application No. 2003-058296.
Allowed claims corresponding to Application No. 2006-033790.
Allowed claims corresponding to Application No. 2006-119677.
Allowed claims corresponding to US Application No. 2006-0033790 filed Oct. 19, 2005.
Allowed claims corresponding to US Application No. 2006-0119677 filed Jan. 30, 2006.
U.S. Appl. No. 11/572,880, filed Jun. 25, 2008.
Allowed claims of U.S. Appl. No. 11/611,641 (published as US-2007/149944-A1) filed Dec. 15, 2006.
Allowed claims of U.S. Appl. No. 12/040,308 (published as US-2008/158318-A1) filed Feb. 29, 2008.

(56) **References Cited**

OTHER PUBLICATIONS

U.S. Appl. No. 12/257,827, filed Oct. 24, 2008.
Allowed claims corresponding to Publication No. US-2002-0167574-A1 published Nov. 14, 2002.
Allowed claims corresponding to Publication No. US-2002-0171700-A1 published Nov. 21, 2002.
Allowed claims corresponding to Application No. US-2002-0180823-A1 published Dec. 5, 2002.
Allowed claims corresponding to Application No. US-2003-0058296-A1 published Mar. 27, 2003.
Response to Appeal dated Oct. 1, 2012 for European Patent No. 1800872 B1.
Statement of grounds for appeal for EP 1800872 B1 dated Apr. 10, 2012 and English translation.
Affidavit of Daniel Sulser regarding analysis of "T0714" Epson ink cartrige and "Epson Stylus D78" and photos from Sep. 2006 and English translation.
Article on Epson Stylus D120 dated Dec. 14, 2007 and English translation.
Article on Epson Stylus D78 and D88 plus dated Aug. 21, 2006 and English translation.
Photo of Epson cartridge dated Apr. 10, 2012.
Affidavit of Joachim Kretschmer regarding analysis of "T071x" Epson ink cartrige and "Epson Stylus D78" dated Apr. 10, 2012 and English translation.
The Hard Copy Supplies Journal dated Apr. 1998.
"Dallas Semiconductor, DS1220AB/AD, 16K Nonvolatile SRAM", cited in Japanese Patent Document No. 4144637.
Notice of Opposition for EP2080622 dated Dec. 7, 2011.
Opposition Form for EP2080622 filed Nov. 28, 2011.
Grounds of Opposition for EP2080622 dated Nov. 23, 2011 and English translation.
Decision of Appeal for Invalidation 2011-800028 received Nov. 25, 2011 and English translation.
Office Action issued on Oct. 23, 2012 in Taiwan Patent Application No. 099126391 and its English translation.
U.S. Appl. No. 12/257,827.
Office Action in U.S. Appl. No. 11/572,880 dated Dec. 7, 2010.
European Patent Office—Extended European Search Report Pursuant to Rule 62 EPC dated Mar. 8, 2010.
"Rebuttal to Corrected Claims", in Japanese Patent Document No. 4144637, Trial Examiner-In-Chief, Patent Office Trial (original Japanese and English), dated Jul. 11, 2011.
"Rebuttal to the Reply Brief", in Japanese Patent Document No. 4144637, Trial Examiner-In-Chief, Patent Office Trial (original Japanese and English), dated Jul. 11, 2011.
"Opinion Brief", in Japanese Patent Document No. 4144637, Trial Examiner-In-Chief, Patent Office Trial (original Japanese and English), dated Jul. 11, 2011.
"Notice of Examination", in Japanese Patent Document No. 4144637, Notification Examiner-In-Chief, Patent Office, (original Japanese and English), dated Aug. 22, 2011.
"Notice of Reasons for Rejection (of Amendments)", in Japanese Patent Document No. 4144637, (original Japanese and English), dated Aug. 26, 2011.
Allowed claims of U.S. Appl. No. 11/611,641 (published as US-2007/0149044-A1).
Allowed claims of U.S. Appl. No. 12/040,308 (published as US-2008/0158318-A1).
U.S. Appl. No. 12/257,914.
Opponent's Comments to the Patent Proprietors Rejoinder in the Opposition Proceedings of EP1800872B1.
U.S. Appl. No. 11/572,880.
Statement of Defense and Counterclaim dated Dec. 29, 2010 in Dutch Case No. 378291/re EP1800872B and English translation.
Response to Complaint dated Sep. 17, 2010 in German Action re Utility Model DE 20 2006 020730 U1 and English translation.
Defendant's Brief dated Dec. 17, 2010 in Japanese Patent Rights Infringement Demand for Injury Case 2010 (Wa) No. 7482 (3-20101217) and English translation.
Response to Complaint dated Sep. 17, 2010 in German Action re EP1800872B and English translation.
Defendant's Second Preparatory Brief dated Feb. 16, 2011; 2010 (Wa) No. 7482 Patent Rights Infringement Demand for Injunction Case for JP4144637B and English translation.
European Patent Application EP10184458.7 Search Report dated Dec. 27, 2010.
Spanish Patent Application No. P200603218 Search Report and Written Opinion dated Sep. 21, 2009 and English translation.
Malaysian Patent Application No. PI20091706 Office Action dated Dec. 31, 2010.
International Preliminary Report on Patentability and Written Opinion dated Jul. 1, 2008 in PCT/JP2006/325448 dated May 8, 2007.
Summons to Oral Proceeding and Notification in JP4144637B dated Feb. 22, 2011 and English translation.
Opponents Comments to the Patent Proprietor's Rejoinder in the Opposition Proceedings of EP1800872B1 dated Jan. 27, 2011.
Defendant's Deed of Appearance and Reply (English language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275 dated Feb. 9, 2011.
Defendant's Deed of Appearance and Reply (Italian language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275 dated Feb. 9, 2011.
Notice of Opposition filed against EP1800872B1, Annexes of the Notice of Opposition, and an English translation thereof dated Apr. 26, 2010.
Notification of Reason for Rejection of Correction From Proceedings regarding JP Patent No. 4144637, dated Mar. 1, 2011 and English translation.
Statement of Grounds for Appeal for EP1800872B1 dated Apr. 10, 2012 and English translation.
Canon Colour Bubble Jet Printer BJC-7000 User Manual dated 1997 and English translation.
Defendant's Demand for Judgment to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 29, 2010 and English translation.
Defendant's second preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 30, 2010 and English translation.
Defendant's third preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 30, 2010 and English translation.
Defendant's first preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Jun. 7, 2010 and the English translation.
Petition to Tokyo District Court, Civil Affairs Div. 29-C in connection with "2010 (wa) No. 7482 Patent Infringement Injunction" dated Feb. 26, 20010, and the English translation.
English translation of Response to Appeal dated Oct. 1, 2012 for European Patent No. 1800872B1.
Interlocutory decision in opposition proceedings for EP-B-1800872 dated Nov. 29, 2011 and English translation.
"Written Statement", in Japanese Patent Document No. 4144637, (original Japanese and English), dated Aug. 26, 2011.
Combined Search and Examination Report for U.K. Patent Application No. GB0819699.0 dated Feb. 27, 2009.
Accelerated Graphic Port Interface Specification dated Jul. 31, 1996, pp. 89-96.
Search and Examination Report issued on Mar. 12, 2010 in counterpart U.K. Patent Application No. GB0922617.6 by the Intellectual Property Office of the United Kingdom.
English Translation of Taiwanese Search Report issued Apr. 22, 2010 in a related Taiwanese Patent Application No. 096150637.
Written Submission by Pelican Hardcopy Production AG in Opposition Proceedings of EP1800872, dated Aug. 31, 2011 and English translation.
Search Report from U.K. Patent Application No. GB0804416.6 dated Mar. 30, 2013.
Australian Search and Examination Report dated May 8, 2007 and letter from Singapore Patent Office forwarding same dated Jun. 4, 2007 for Singapore Patent Application No. 200608798-5.

(56) **References Cited**

OTHER PUBLICATIONS

Examination Report for New Zealand Patent Application No. 552094 dated Dec. 19, 2006.
Extended European Search Report for European Patent Application No. 06256540.3 dated May 4, 2007.
International Search Report for International Patent Application No. PCT/JP2005/016205 dated Nov. 22, 2005 and English translation.
Expert Report of Professor Joachim Heinzl dated May 1, 2013.
Notice of Experiments dated Apr. 17, 2013 including Annex 1 and Annex 2 to Schedule A.
Search Report for U.K. Patent Application No. GB0625839.6 dated Apr. 20, 2007.

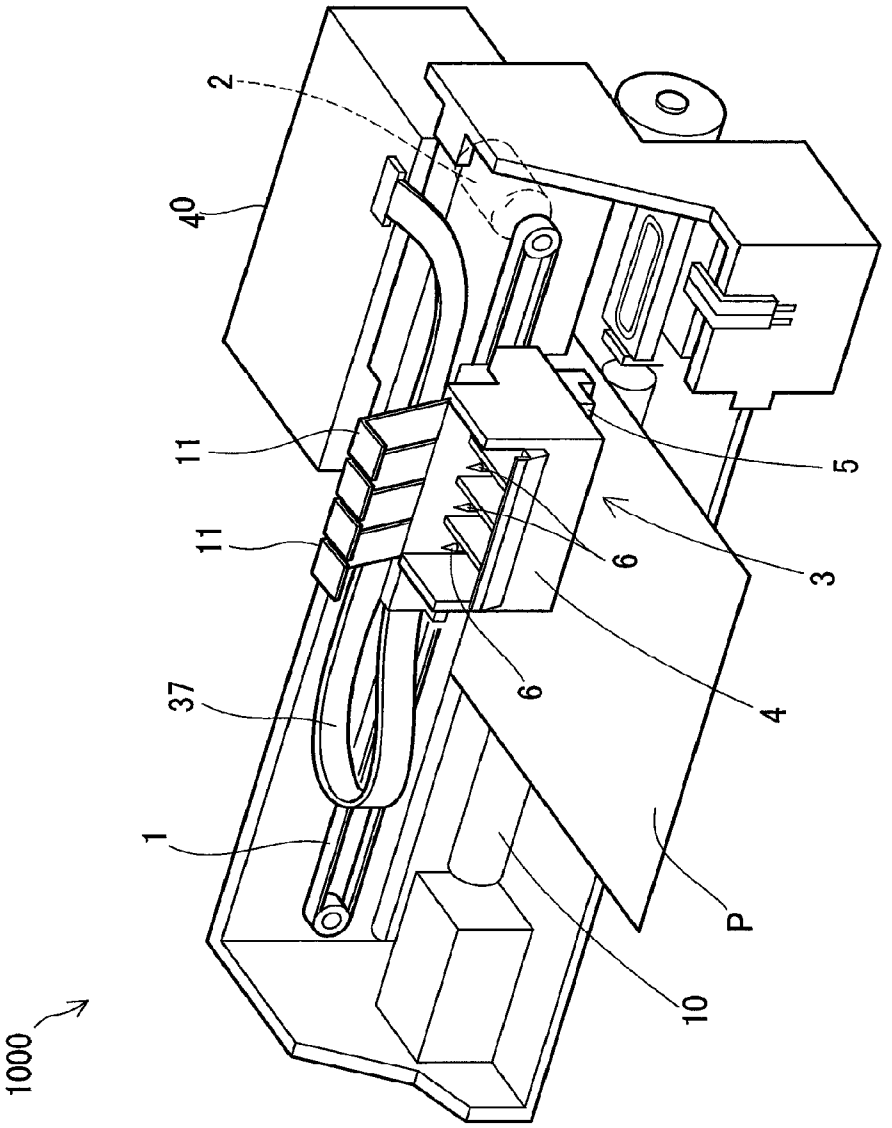


Fig.1

Fig.2

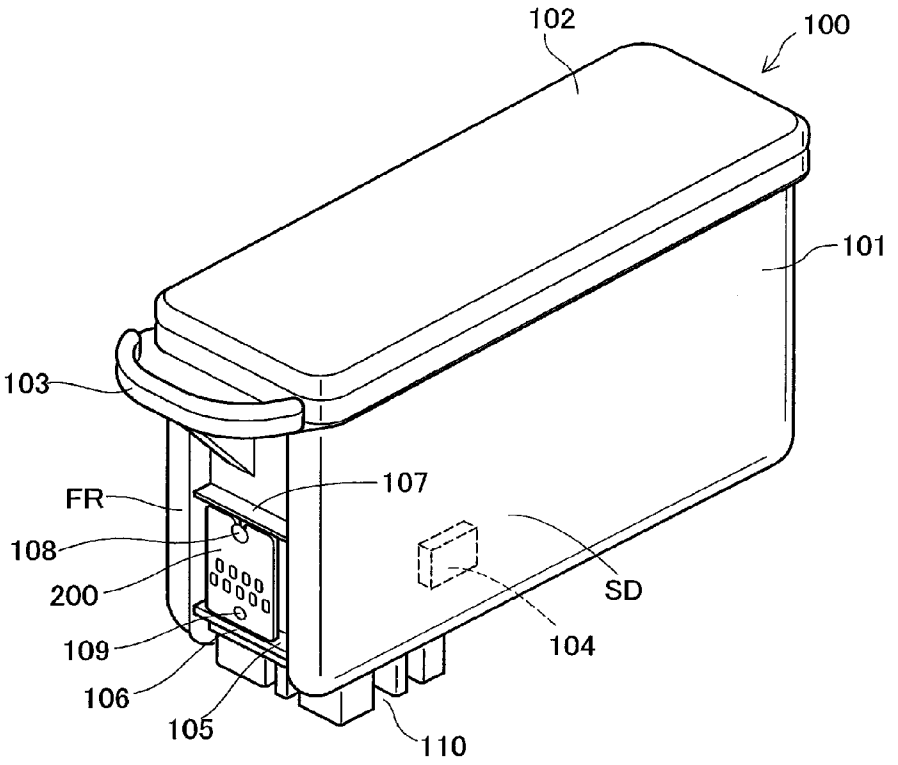


Fig.3A

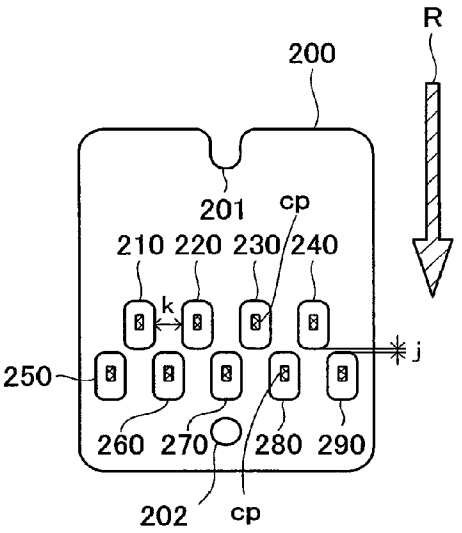


Fig.3B

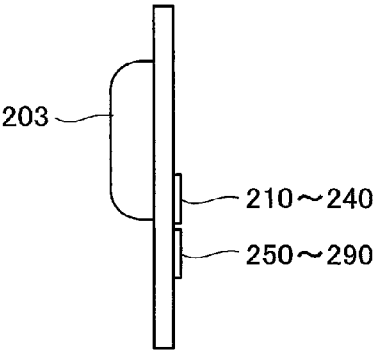
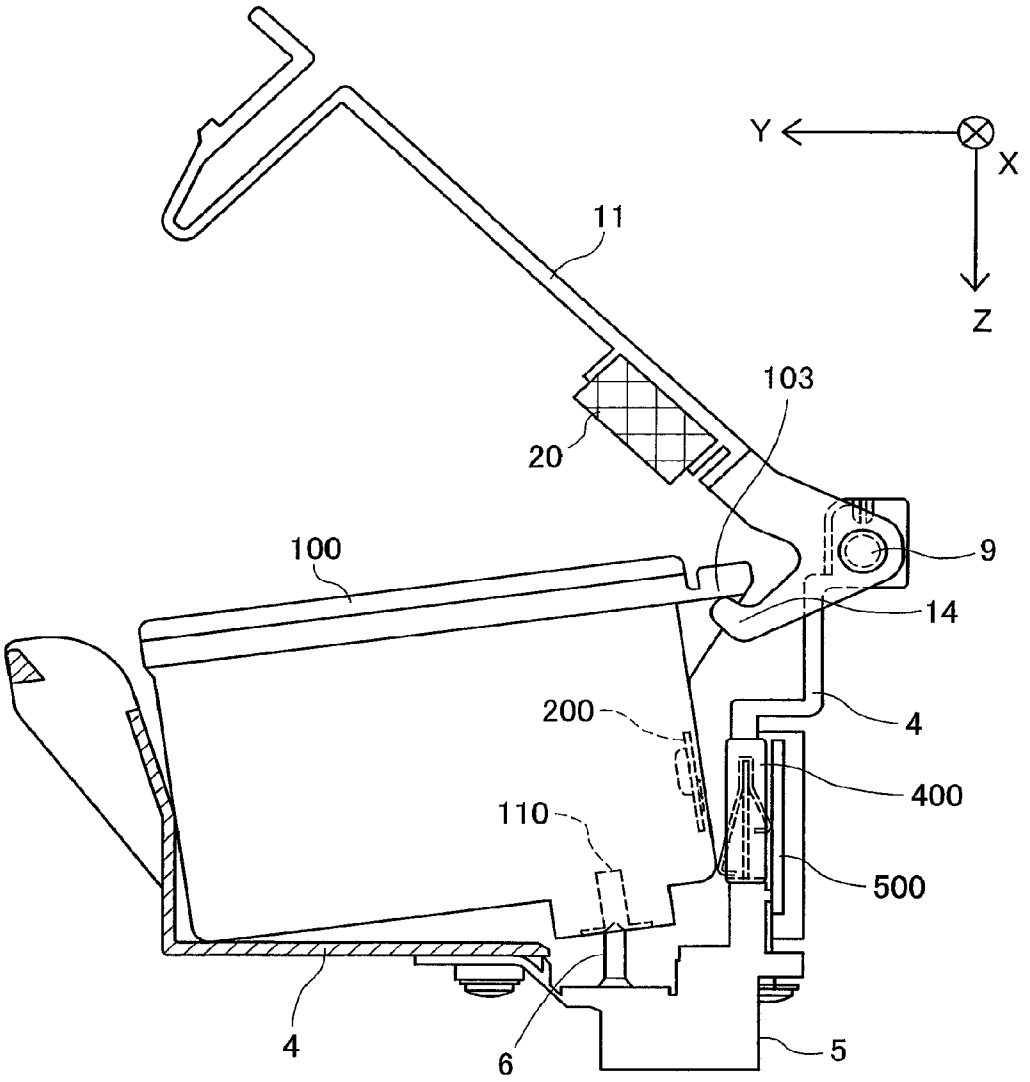


Fig.4



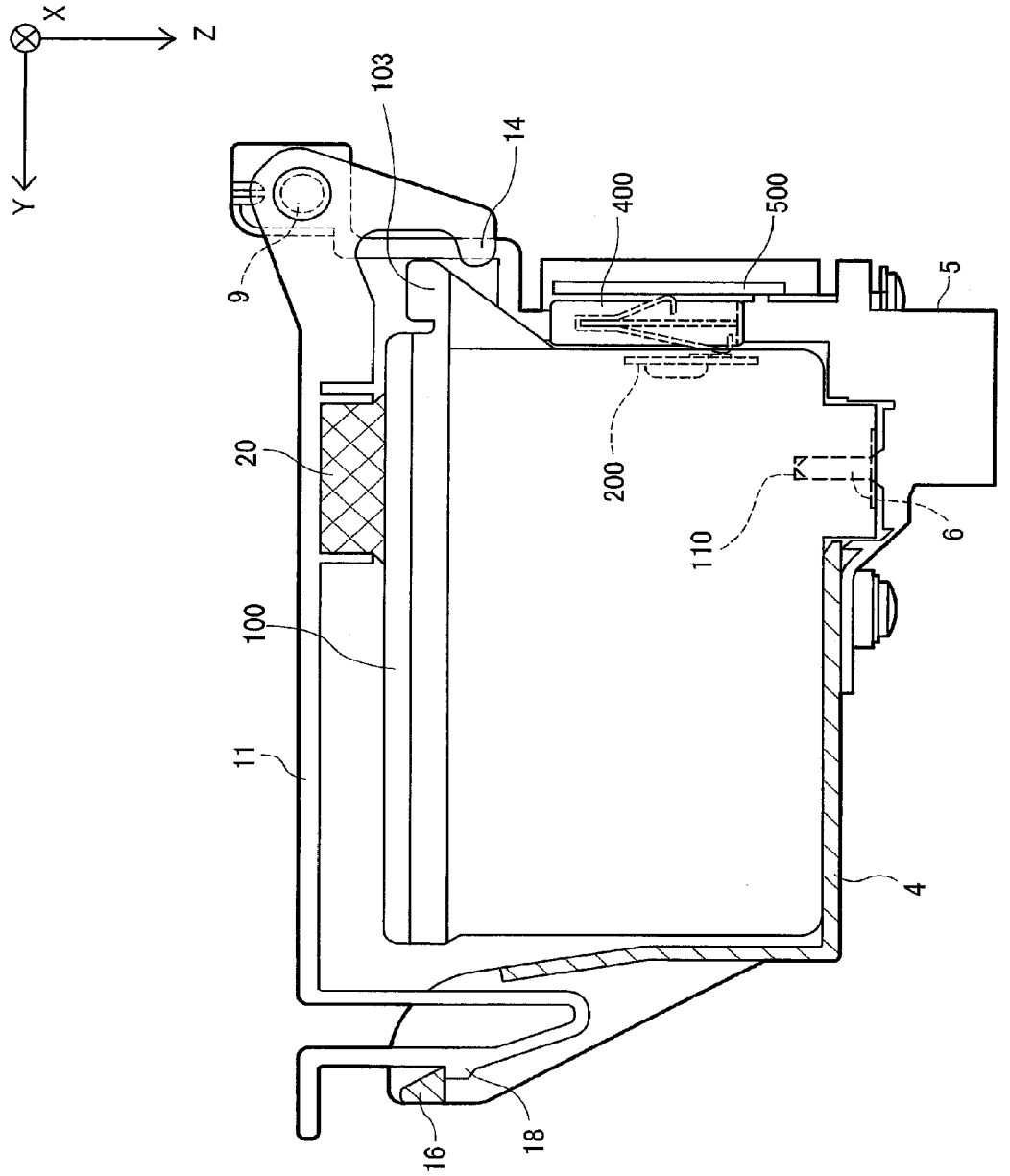


Fig.5

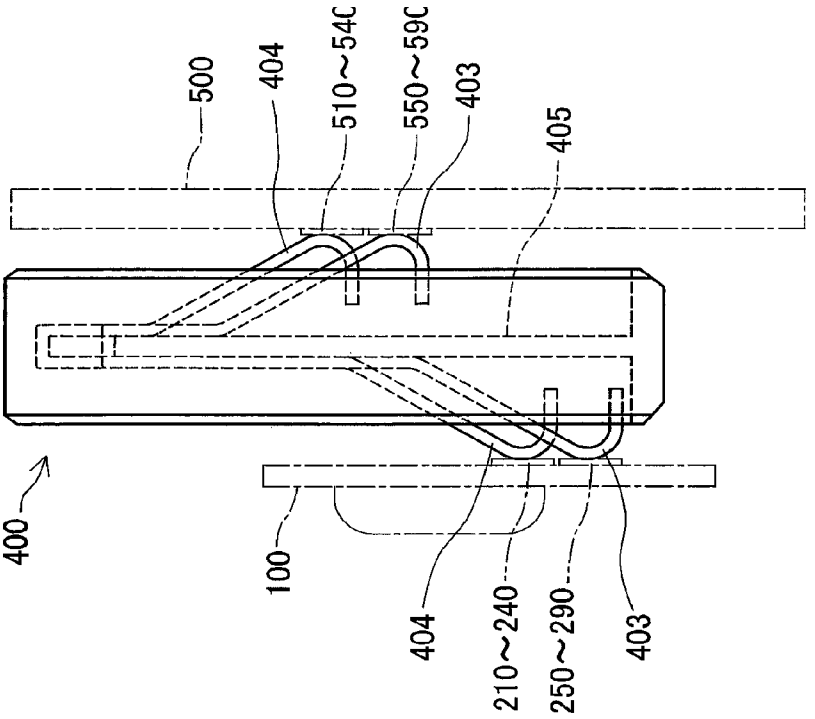

500
404
510~540
550~590
403
405
400
100
404
210~240
250~290
403

Fig.6B

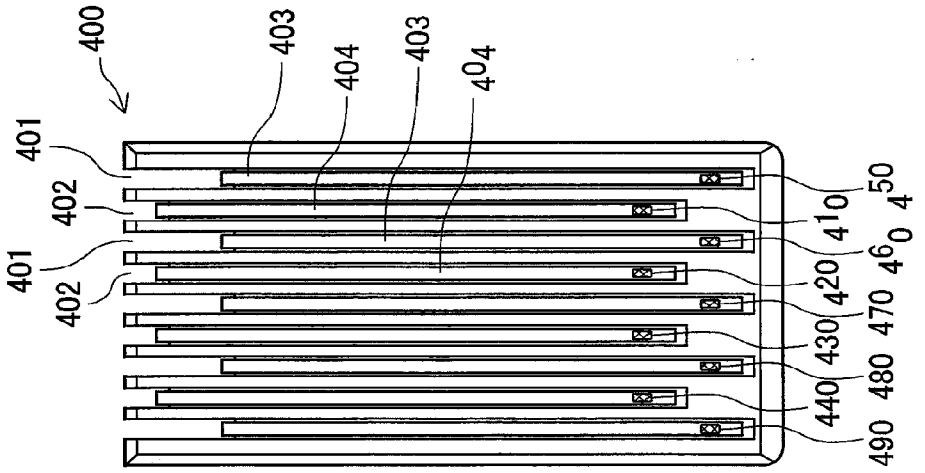

400
403
404
403
404
401
402
401
402
410
450
460
420
470
430
480
440
490

Fig.6A

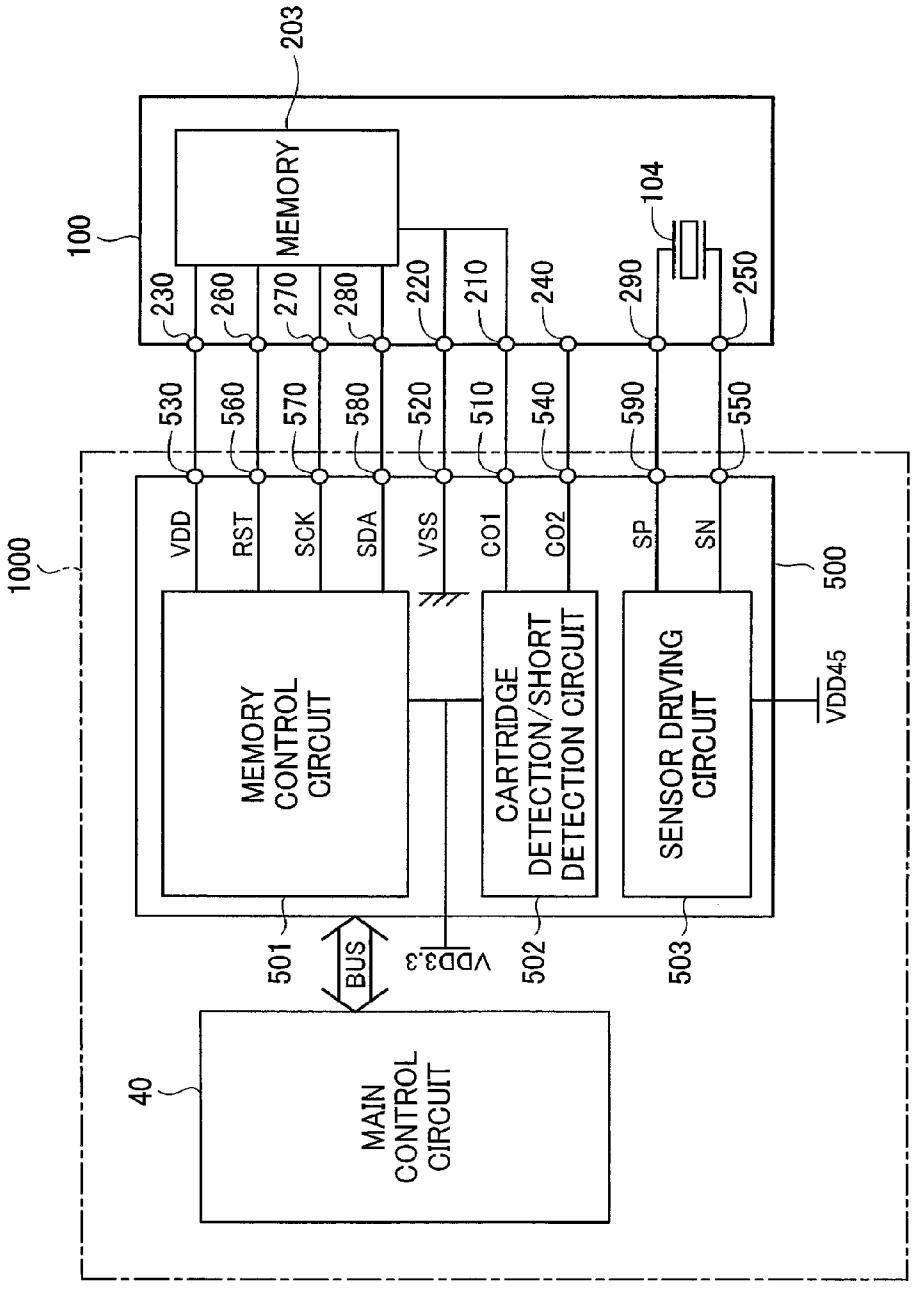

203
MEMORY
100
104
230
260
270
280
220
210
240
290
250
530
560
570
580
520
510
540
590
550
1000
VDD
RST
SCK
SDA
VSS
CO1
CO2
SP
SN
500
MEMORY CONTROL CIRCUIT
CARTRIDGE DETECTION/SHORT DETECTION CIRCUIT
SENSOR DRIVING CIRCUIT
VDD45
501
BUS
VDD3.3
502
503
40
MAIN CONTROL CIRCUIT

Fig.7

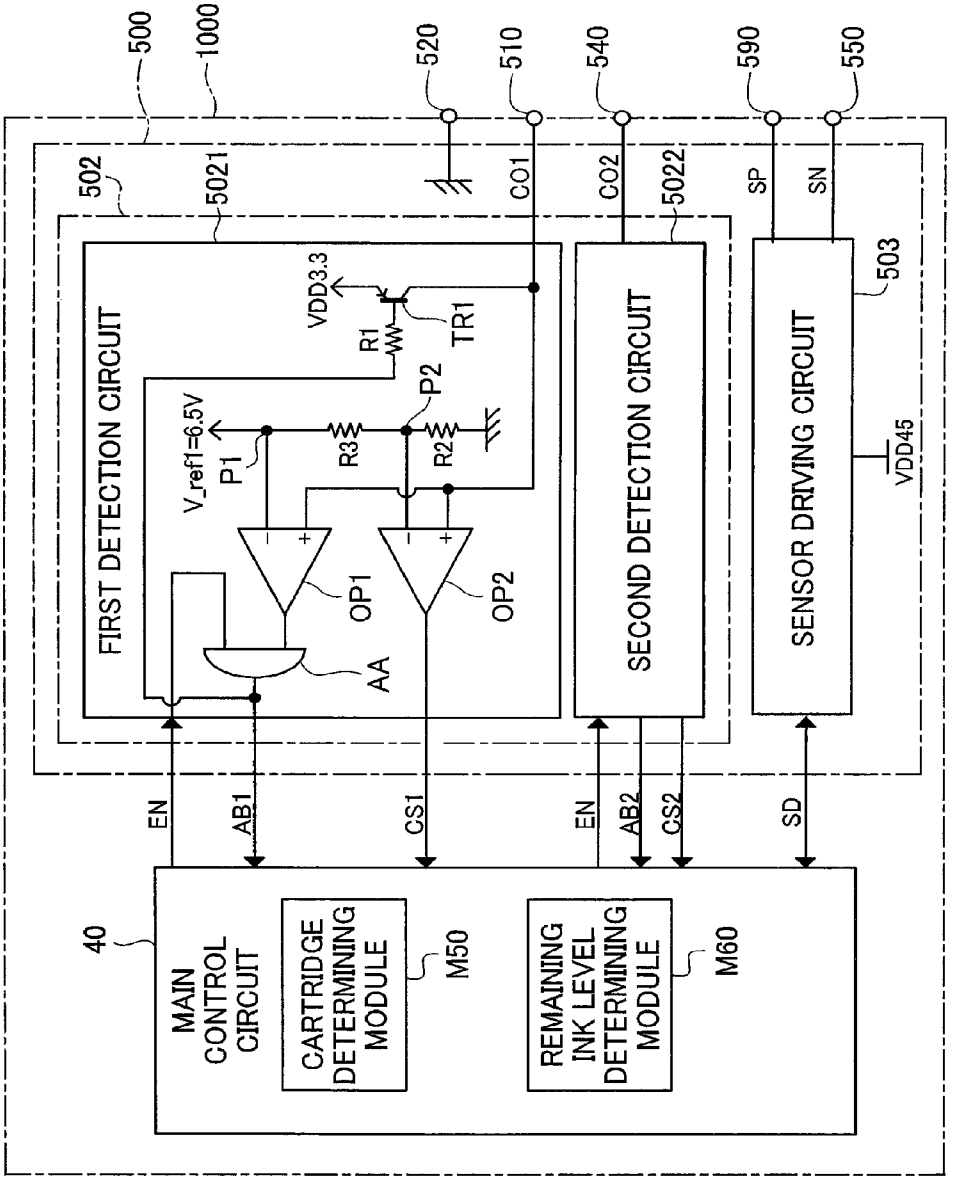

500
1000
520
510
540
590
550
502
5021
CO1
CO2
5022
SP
SN
503
VDD3.3
R1
TR1
P2
V_ref1=6.5V
P1
R3
R2
VDD45
FIRST DETECTION CIRCUIT
SECOND DETECTION CIRCUIT
SENSOR DRIVING CIRCUIT
OP1
OP2
AA
EN
AB1
CS1
EN
AB2
CS2
SD
40
MAIN CONTROL CIRCUIT
CARTRIDGE DETERMINING MODULE
M50
REMAINING INK LEVEL DETERMINING MODULE
M60

Fig.8

Fig.9

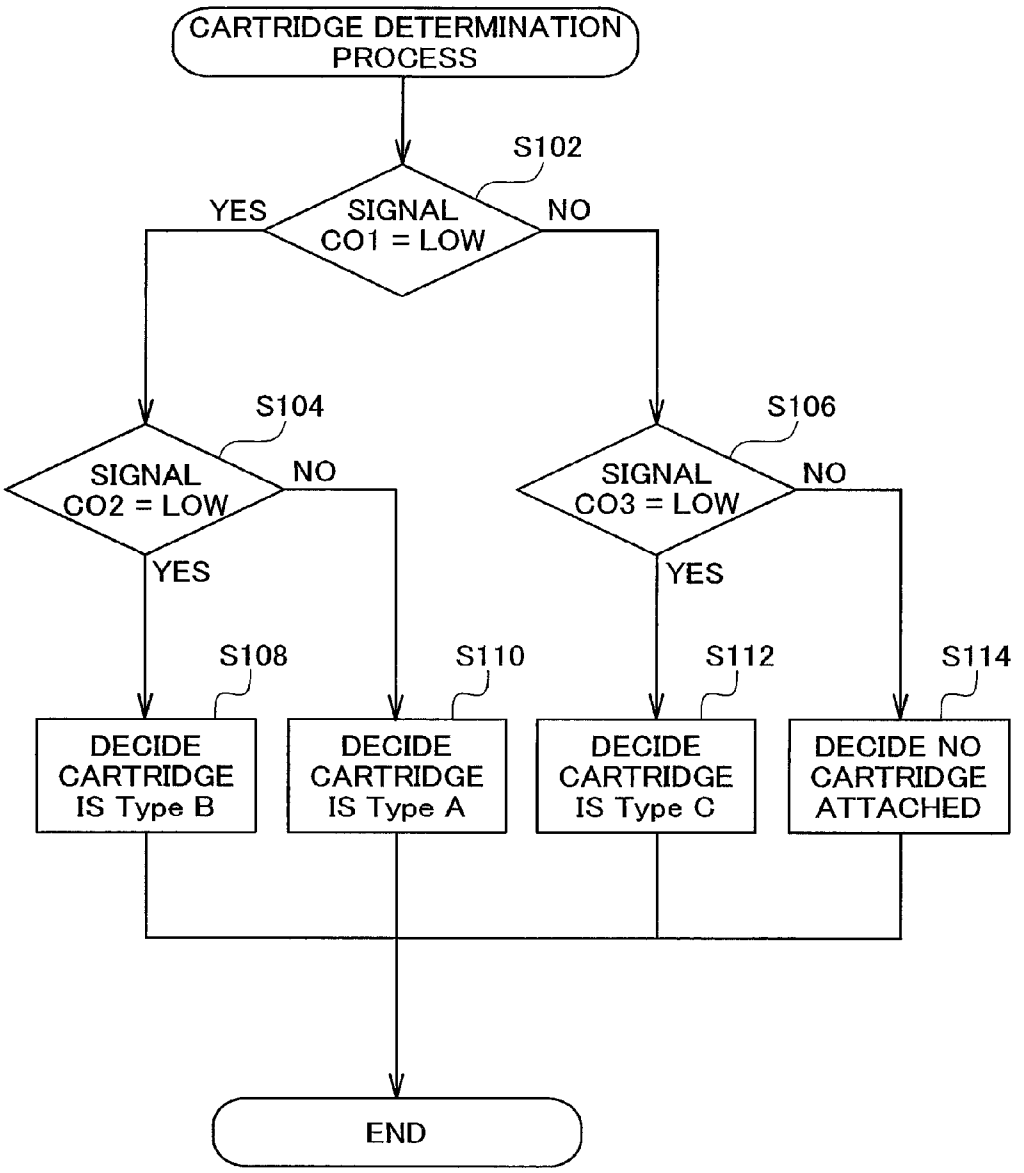
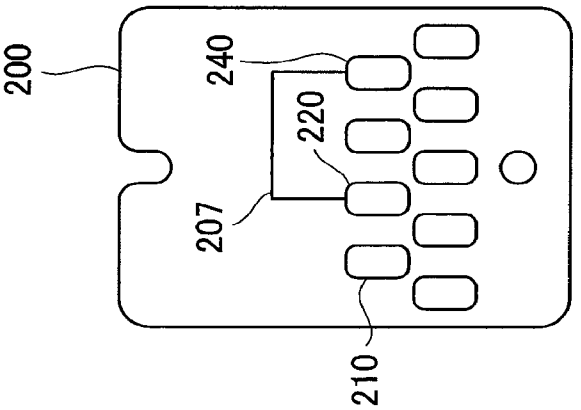
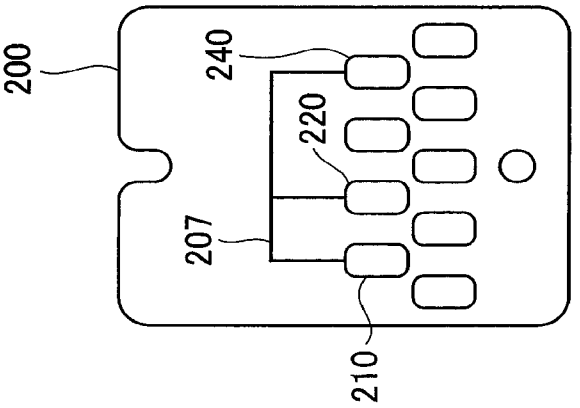

CARTRIDGE DETERMINATION PROCESS
S102
SIGNAL CO1 = LOW
YES
NO
S104
SIGNAL CO2 = LOW
NO
YES
S106
SIGNAL CO3 = LOW
NO
YES
S108
DECIDE CARTRIDGE IS Type B
S110
DECIDE CARTRIDGE IS Type A
S112
DECIDE CARTRIDGE IS Type C
S114
DECIDE NO CARTRIDGE ATTACHED
END

Fig.10C



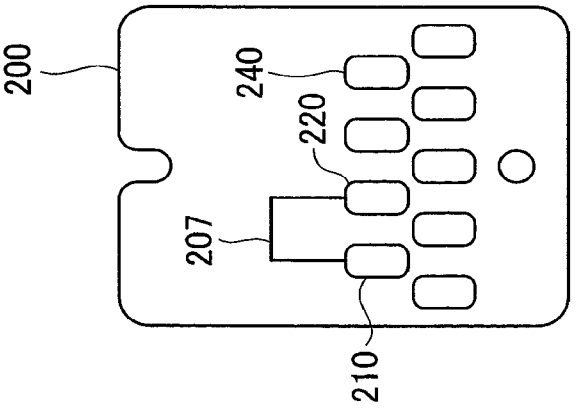
typeC

Fig.10B



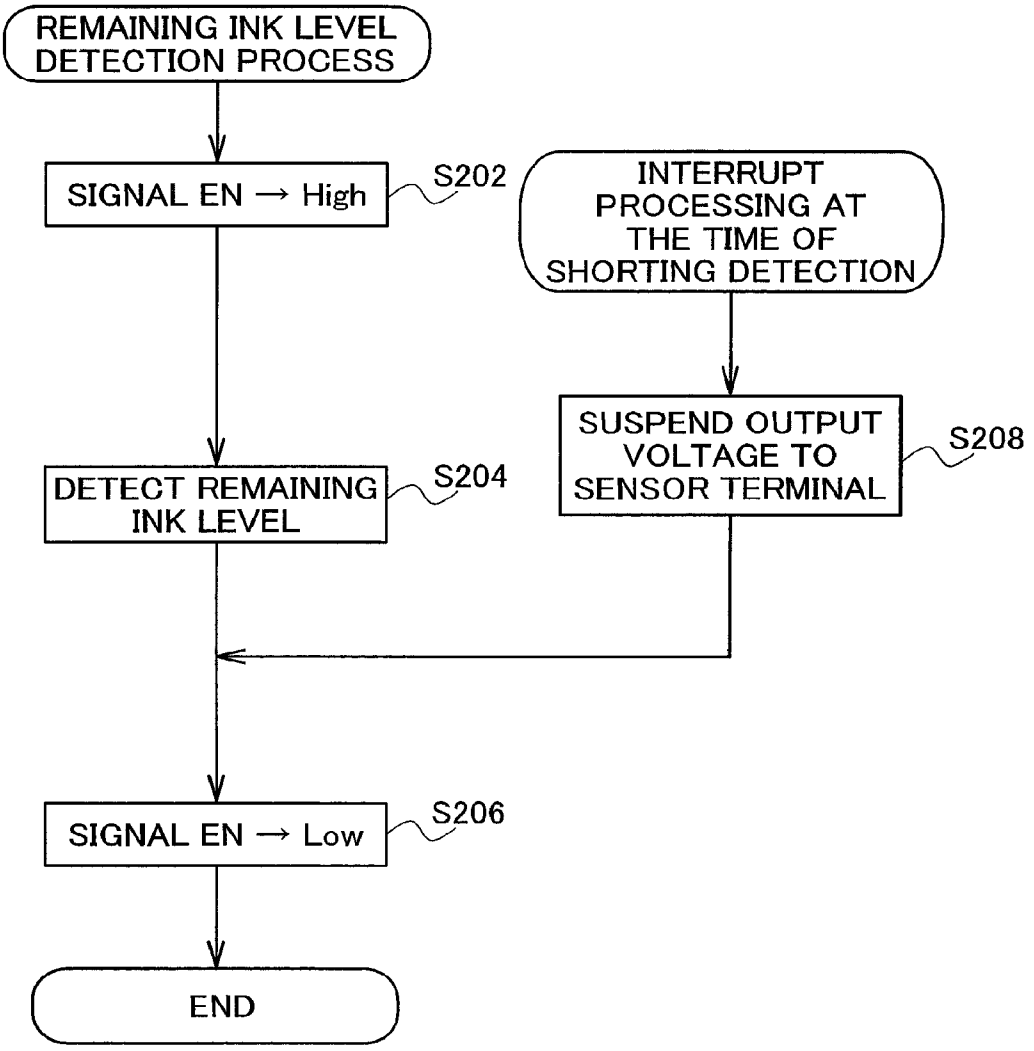
typeB

Fig.10A



typeA

Fig.11


REMAINING INK LEVEL DETECTION PROCESS
SIGNAL EN → High
S202
INTERRUPT PROCESSING AT THE TIME OF SHORTING DETECTION
SUSPEND OUTPUT VOLTAGE TO SENSOR TERMINAL
S208
DETECT REMAINING INK LEVEL
S204
SIGNAL EN → Low
S206
END

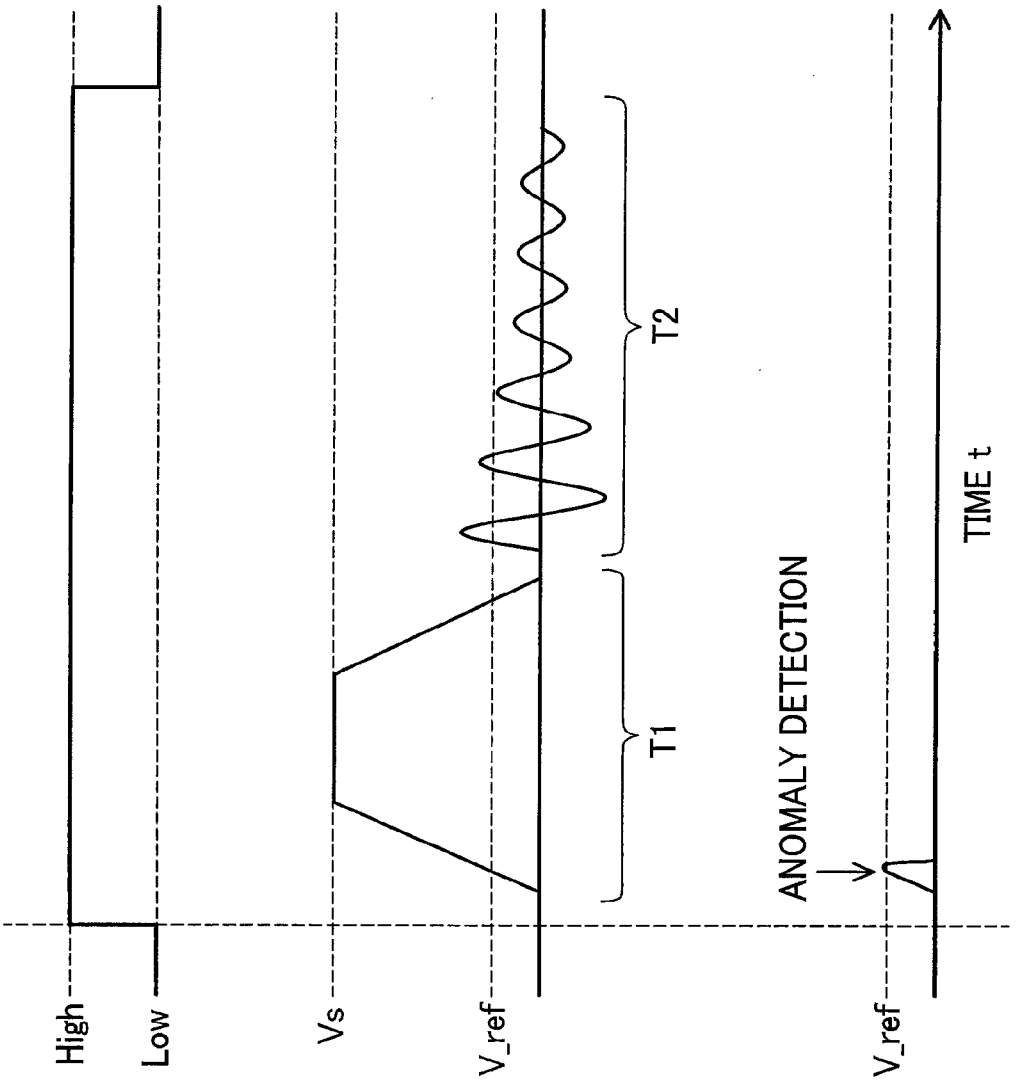


Fig.12A

Fig.12B

Fig.12C

Fig.13

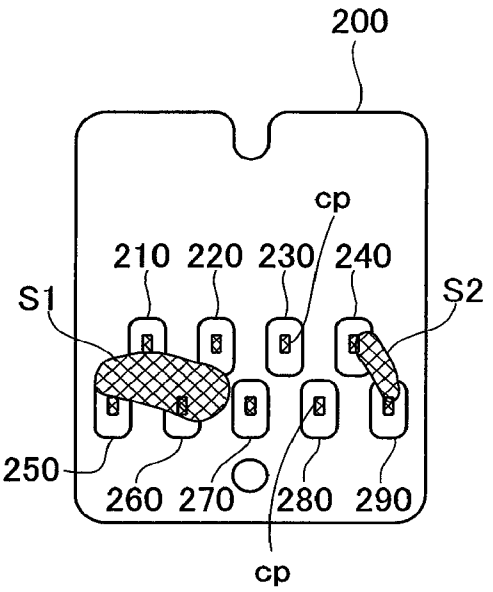


Fig.14A

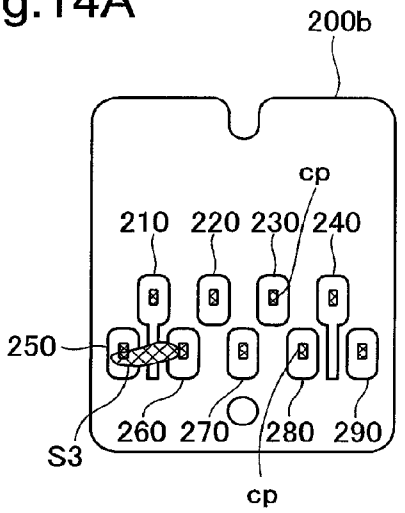


Fig.14B

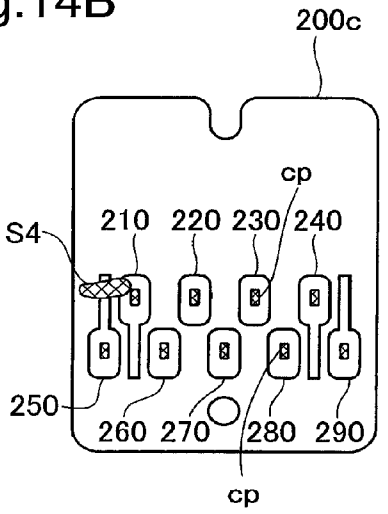


Fig.14C

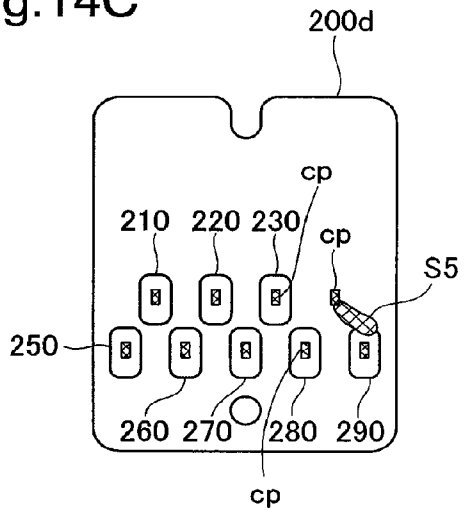


Fig.14D

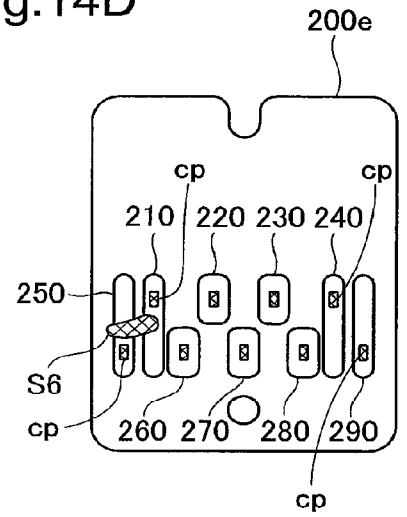


Fig.15A

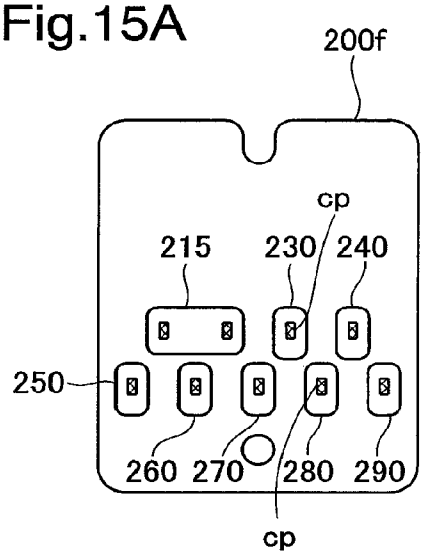


Fig.15B

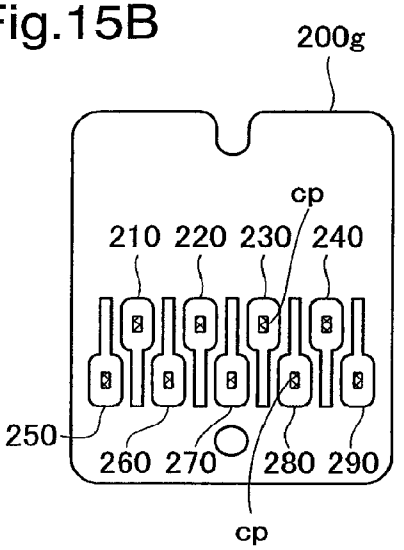


Fig.15C

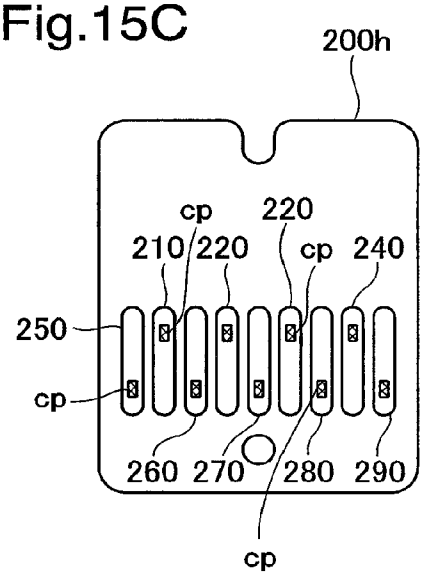


Fig.16A

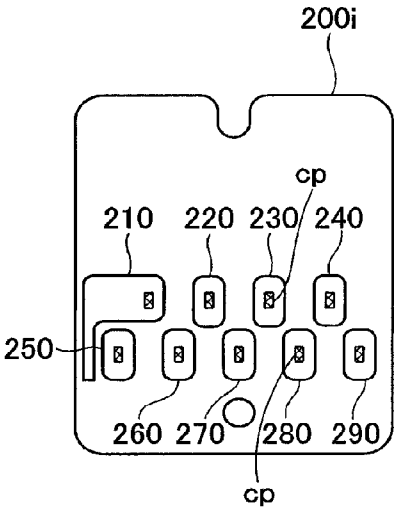


Fig.16B

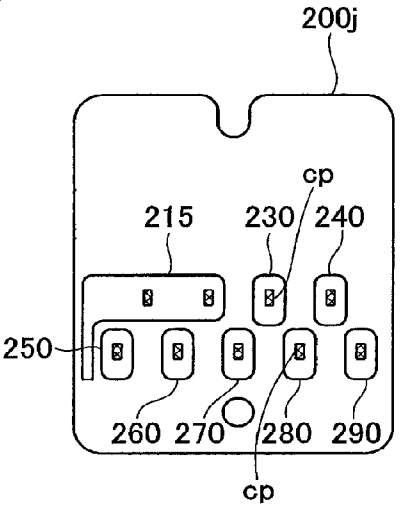


Fig.16C

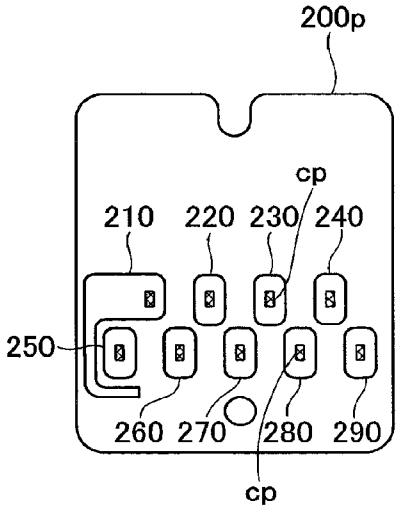


Fig.16D

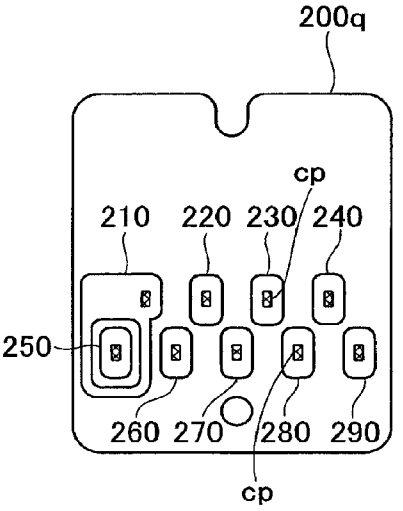


Fig.17A

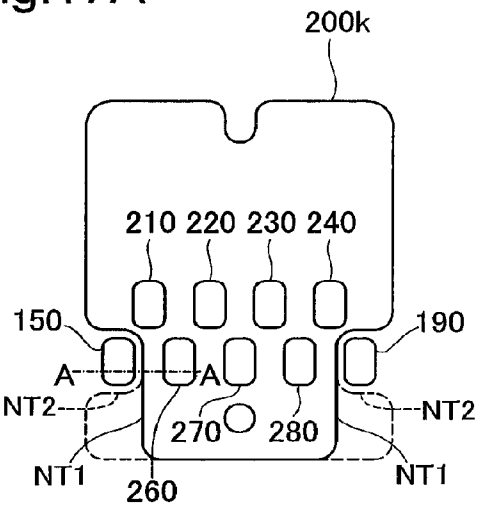


Fig.17B

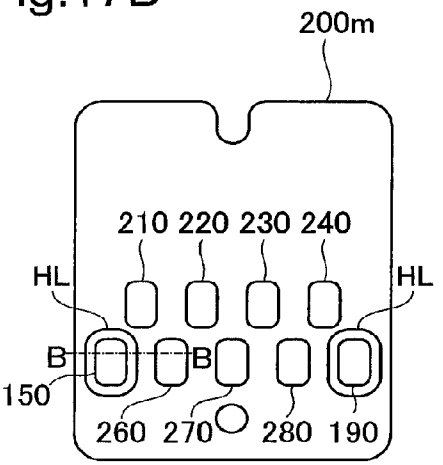


Fig.17C

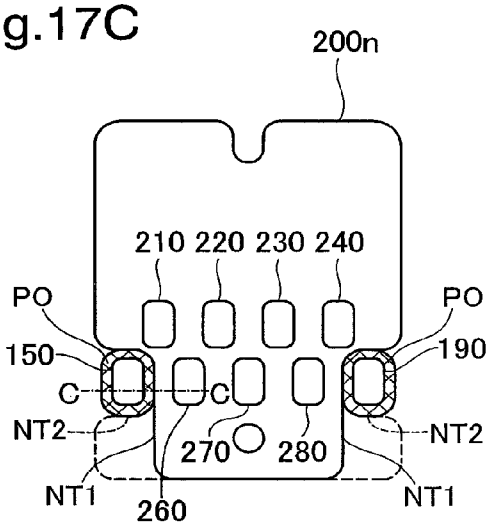


Fig.17D

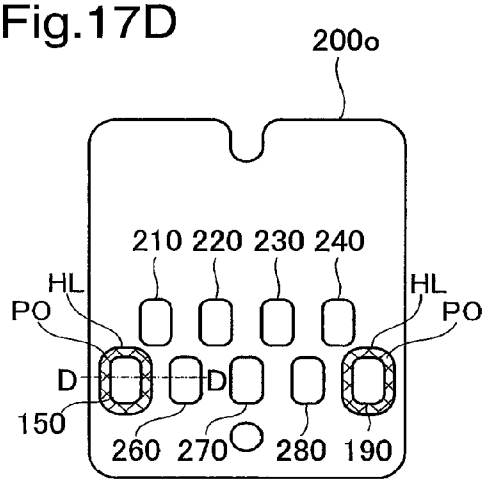


Fig.18A

A-A CROSS SECTION

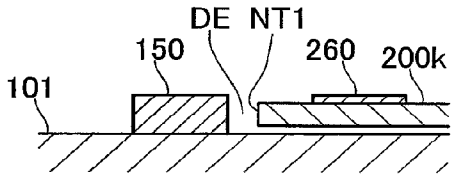


Fig.18B

B-B CROSS SECTION

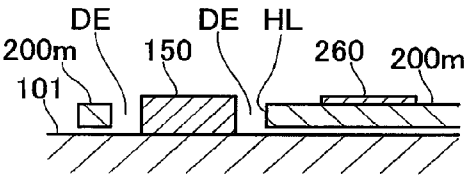


Fig.18C

C-C CROSS SECTION

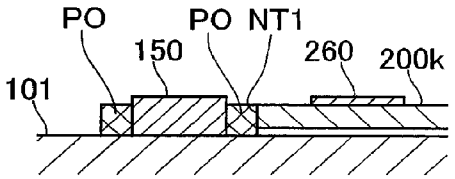


Fig.18D

D-D CROSS SECTION

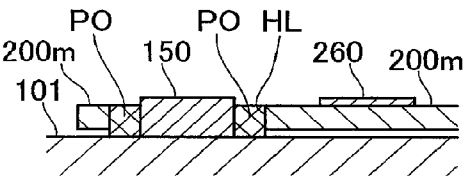


Fig.19A

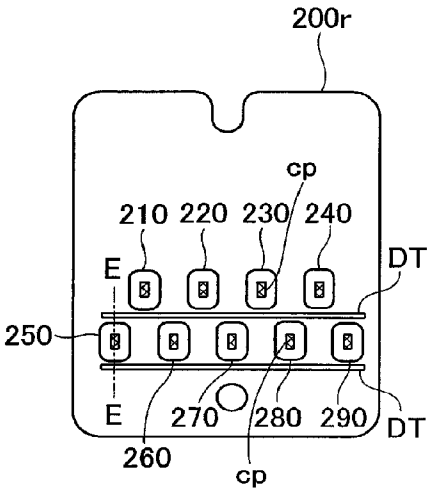


Fig.19B

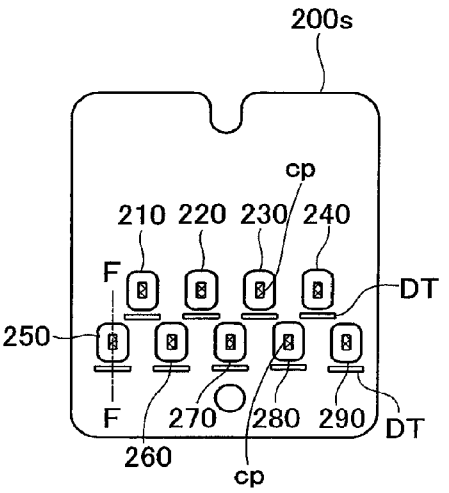


Fig.19C

E-E CROSS SECTION

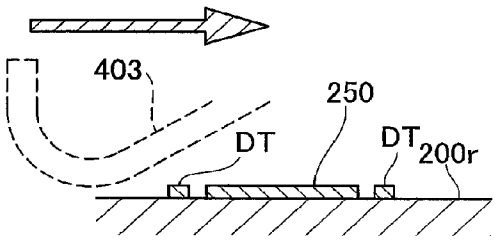
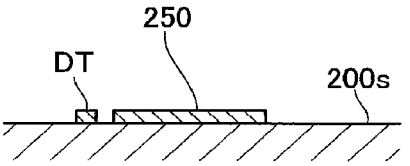


Fig.19D

F-F CROSS SECTION



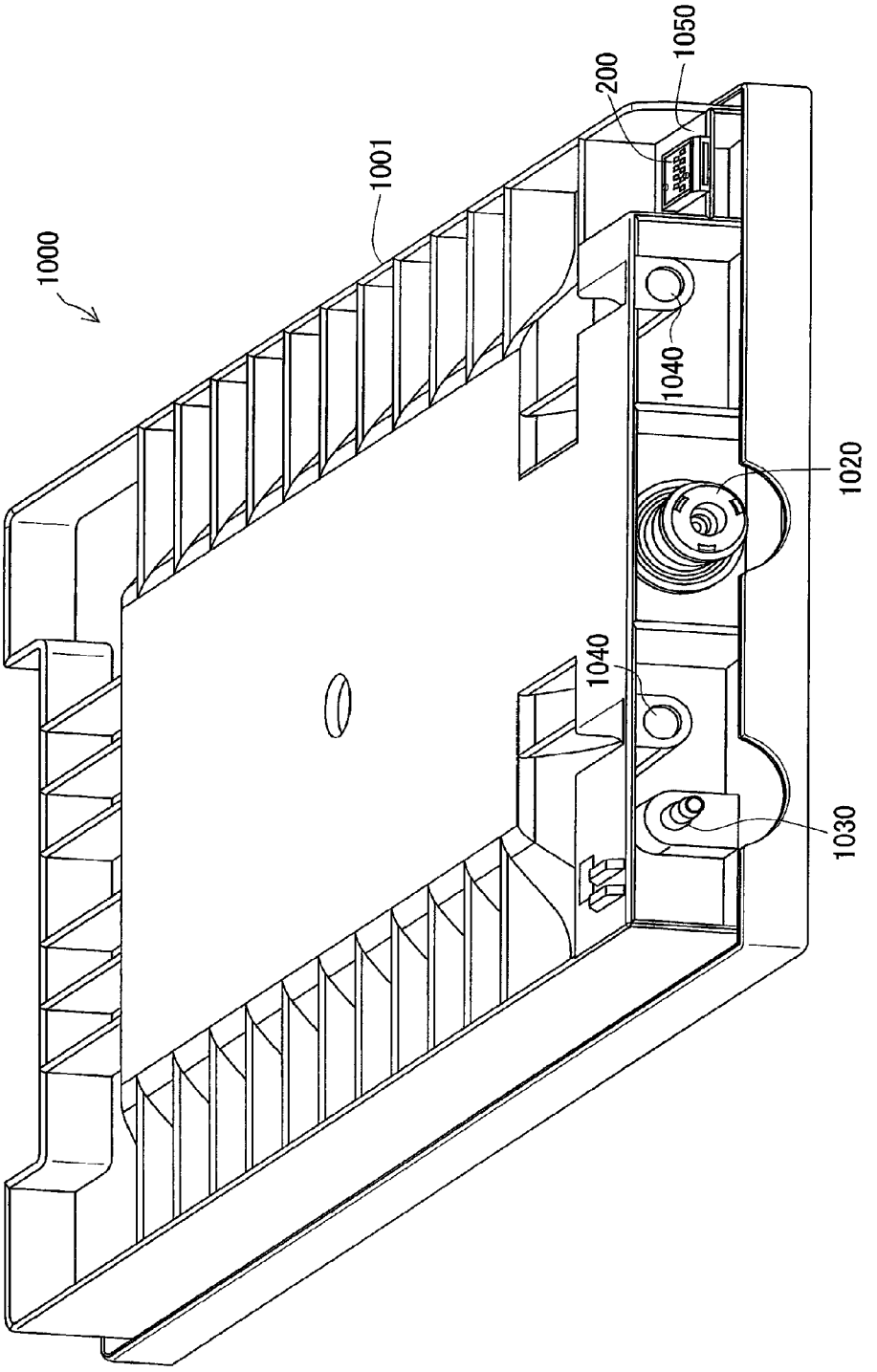


Fig.20

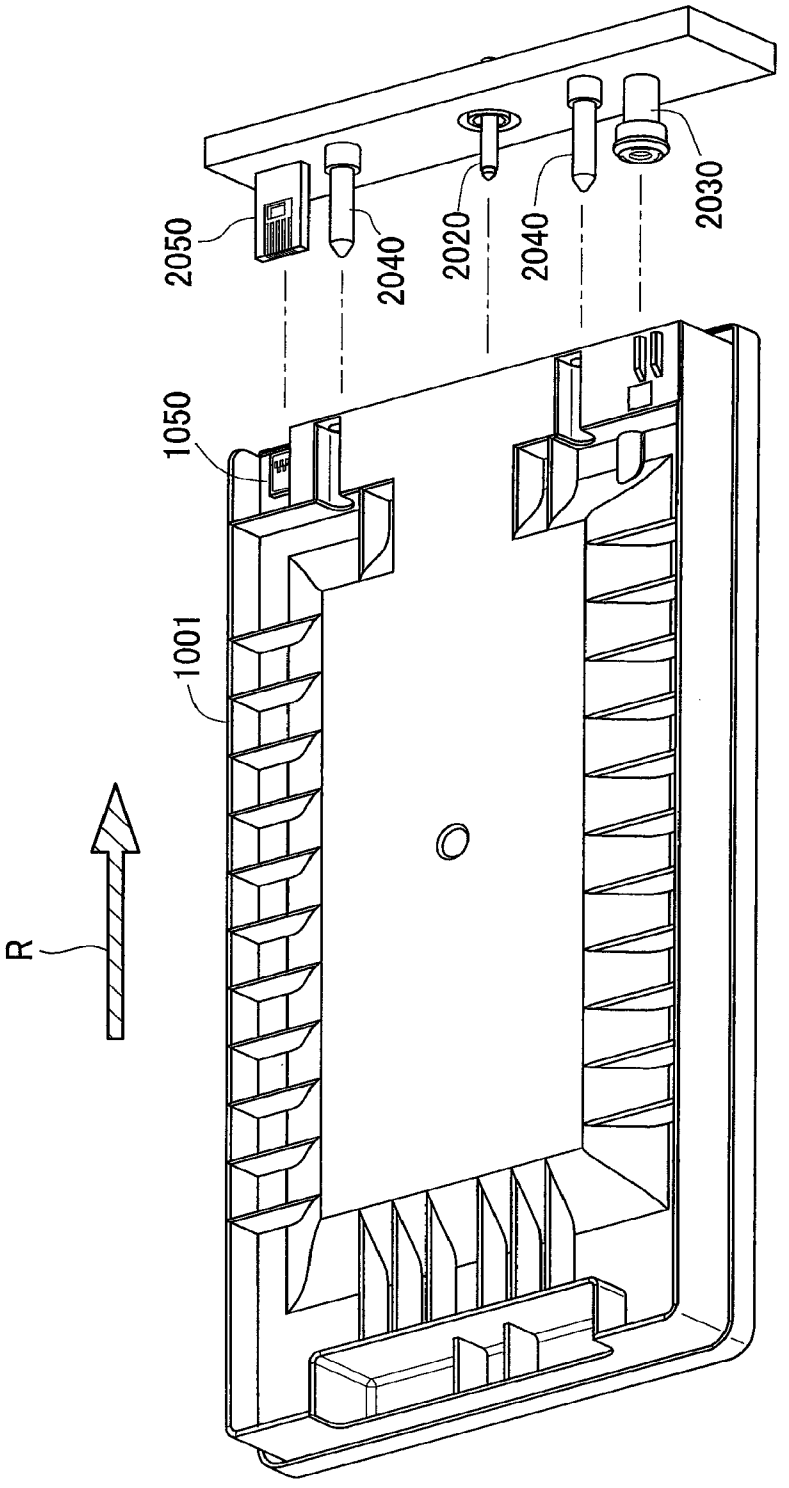


Fig.21

Fig.22

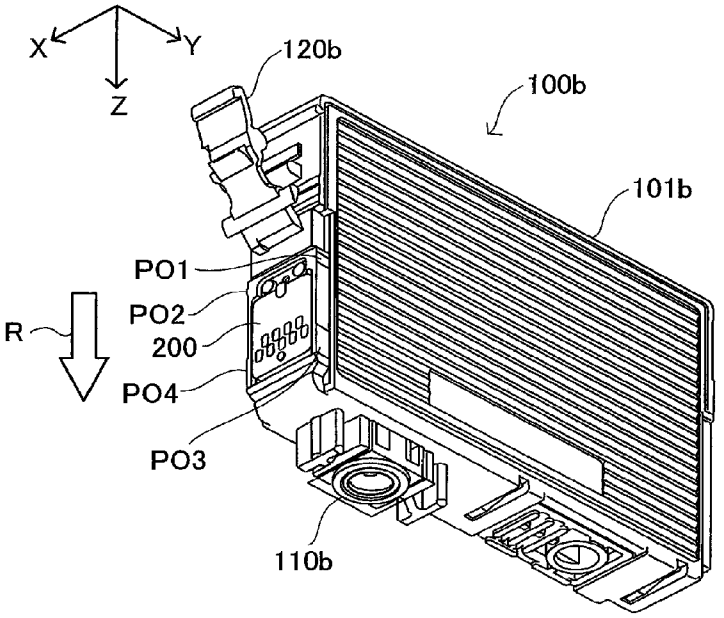

X
Y
Z
120b
100b
101b
PO1
PO2
200
PO4
PO3
R
110b

Fig.23

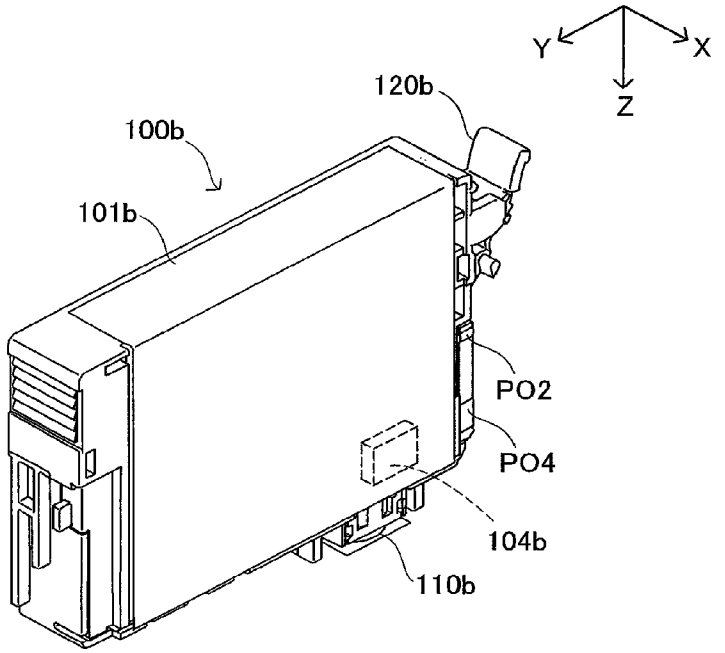
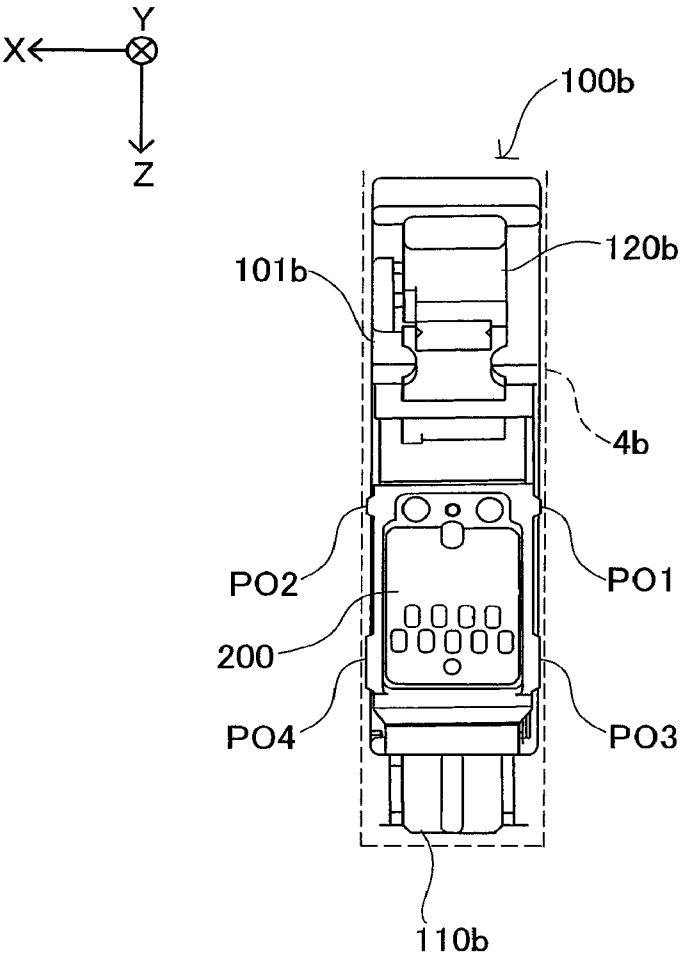

Y
X
Z
120b
100b
101b
PO2
PO4
104b
110b

Fig.24



PRINTING MATERIAL CONTAINER, AND BOARD MOUNTED ON PRINTING MATERIAL CONTAINER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of application Ser. No. 13/608,658, filed on Sep. 10, 2012, which is a continuation of application Ser. No. 12/257,914, filed Oct. 24, 2008, now U.S. Pat. No. 8,366,233, which is a continuation of application Ser. No. 12/040,308, filed on Feb. 29, 2008, now U.S. Pat. No. 7,484,825, which is a continuation of application Ser. No. 11/611,641, filed on Dec. 15, 2006, now U.S. Pat. No. 7,562,958.

This application relates to and claims priority from Japanese Patent Applications No. 2005-372028, filed on Dec. 26, 2005 and No. 2006-220751, filed on Aug. 11, 2006, the entire disclosures of which are incorporated by reference herein.

BACKGROUND

1. Technical Field

The present invention relates in general to a printing material container containing a printing material and a board mounted on the printing material container, and relates in particular to an arrangement for a plurality of terminals disposed on these components.

2. Description of the Related Art

In recent years, it has become common practice to equip ink cartridges used in ink jet printers or other printing apparatus, with a device, for example, a memory for storing information relating to the ink. Also disposed on such ink cartridges is another device, for example, a high voltage circuit (e.g. a remaining ink level sensor using a piezoelectric element) applied to higher voltage than the driving voltage of the memory. In such cases, there are instances in which the ink cartridge and the printing apparatus are electrically connected through terminals. There is proposed a structure for preventing the information storage medium from shorting and becoming damaged due to a drop of liquid being deposited on the terminals connecting the printing apparatus with the storage medium furnished to the ink cartridge.

However, the technologies mentioned above do not contemplate an ink cartridge having equipped with a plurality of devices, for example, a memory and a high voltage circuit, with terminals for one device and the terminals for another device. With this kind of cartridge, there was a risk that shorting could occur between a terminal for the one device and the terminal for the another device. Such shorting caused the problem of possible damage to the ink cartridge or to the printing apparatus in which the ink cartridge is attached. This problem is not limited to ink cartridges, but is a problem common to receptacles containing other printing materials, for example, toner.

SUMMARY

An advantage of some aspects of the present invention is to provide a printing material container having a plurality of devices, wherein damage to the printing material container and the printing apparatus caused by shorting between terminals can be prevented or reduced.

A first aspect of the invention provides a printing material container detachably attachable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the first aspect of the invention

comprises a first device, a second device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connected to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

According to the printing material container pertaining to the first aspect of the invention, the second contact portions of the second terminals connected to the second device are arranged at the ends, whereby other contact portions adjacent to the second contact portions are fewer in number, and consequently the second terminals have less likelihood of shorting to terminals include other contact portions. Accordingly, damage to the printing material container or printing apparatus caused by such shorting can be prevented or reduced.

A second aspect of the invention provides printing material container detachably mountable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the second aspect of the invention comprises a first device, a second device, a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. At least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction, for the detection of shorting between the at least one second terminal and the at least one third terminal.

According to the printing material container pertaining to the second aspect of the invention, at least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction. As a result, shorting between the portion of the at least one third terminal and the potion of the at least one second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A third aspect of the invention provides a printing material container detachably mountable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the third aspect of the invention comprises a first device, a second device, a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals

are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. At least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal in at least one direction.

According to the printing material container pertaining to the third aspect of the invention, at least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal. As a result, shorting between the portion of the at least one third terminal and the potion of the at least one second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A fourth aspect of the invention provides printing material container detachably mountable to a printing apparatus having a apparatus-side terminal group. The apparatus-side terminal group includes a plurality of first apparatus-side terminals, a plurality of second apparatus-side terminals, and a plurality of third apparatus-side terminals. Terminals within the apparatus-side terminal group are arranged so as to form a first row and second row. The plurality of second apparatus-side terminals are respectively arranged at each end of the first row and the third apparatus-side terminals are respectively arranged at each end of the second row. Each of the second apparatus-side terminals is adjacent to any of the third apparatus-side terminals. The printing material container pertaining to the fourth aspect of the invention comprises a first device, a second device, a group of terminals comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device and are respectively contactable to a corresponding terminal among the first apparatus-side terminals. The at least one second terminal is connected to the second device and is respectively contactable to a corresponding terminal among the second apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and is respectively contactable to a corresponding terminal among the third apparatus-side terminals.

The printing material container pertaining to the fourth aspect of the invention can afford working effects analogous to those of the printing material container pertaining to the first aspect. The printing material container pertaining to the fourth aspect of the invention may be reduced to practice in various forms, in the same manner as the printing material container which pertaining to the first aspect.

A fifth aspect of the invention provides a printing material container detachably attachable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the fifth aspect of the invention comprises a first device, a second device, and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. Each of the terminals has an circumferential edge, a portion of the circumferential edge of the third terminal facing a portion of the circumferential edge of the second terminal and a portion of the circumferential edge of the one first terminal facing another portion of the circumferential edge of the second terminal. The length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal.

According to the printing material container pertaining to the fifth aspect of the invention, the length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal. As a result, shorting between the third terminal and the second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A sixth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the sixth aspect of the invention comprises a first device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

A seventh aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the seventh aspect of the invention comprises a first device and a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. At least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction, for the detection of shorting between the at least one second terminal and the at least one third terminal.

A eighth aspect of the invention provides a board mountable on a printing material container detachably attachable to

a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the eighth aspect of the invention comprises a first device and a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. At least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal in at least one direction.

A ninth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus having a apparatus-side terminal group that includes a plurality of first apparatus-side terminals, a plurality of second apparatus-side terminals, and a plurality of third apparatus-side terminals. Terminals within the apparatus-side terminal group are arranged so as to form a first row and second row. The plurality of second apparatus-side terminals are respectively arranged at each end of the first row and the third apparatus-side terminals are respectively arranged at each end of the second row. Each of the second apparatus-side terminals is adjacent to any of the third apparatus-side terminals. The printing material container has second device. The board pertaining to the ninth aspect of the invention comprises a first device and a group of terminals comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device and are respectively contactable to a corresponding terminal among the first apparatus-side terminals. The at least one second terminal is connected to the second device and is respectively contactable to a corresponding terminal among the second apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and is respectively contactable to a corresponding terminal among the third apparatus-side terminals.

A tenth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the tenth aspect of the invention comprises a first device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. Each of the terminals has an circumferential edge, a portion of the circumferential edge of the third terminal facing a portion of the circumferential edge of the second terminal and a portion of the circumferential edge of the one first terminal facing another portion of the circumferential edge of the second terminal. The length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal.

An eleventh aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has a second device. The board pertaining to the eleventh aspect of the invention comprises a first device and a terminal group that includes at least a plurality of first terminals, at least one cut-out portions into which a respective second terminal mounted on the printing material container can be inserted and at least one third terminal. The plurality of first terminals are connectable to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side-terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. When mounted on the printing material container, the at least one third contact portion is located adjacently to the at least one second contact portion. When mounted on the printing material container, the at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. When mounted on the printing material container, the at least one second contact portion is arranged at an end of one row among the one or multiple rows.

A twelfth aspect of the invention provides a board connectable to a printing apparatus that has a plurality of apparatus-side terminals. The board pertaining to the twelfth aspect of the invention comprises a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to a first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to a second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

The boards pertaining to the sixth to the twelfth aspects of the invention can afford working effects analogous to those of the printing material container pertaining to the first to the fifth aspects respectively. The boards pertaining to the sixth to eleventh aspects may be reduced to practice in various forms, in the same manner as the printing material container pertaining to the first to the fifth aspects respectively.

The above and other objects, characterizing features, aspects and advantages of the present invention will be clear from the description of preferred embodiments presented below along with the attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of the construction of the printing apparatus pertaining to an embodiment of the invention;

FIG. **2** shows a perspective view of the construction of the ink cartridge pertaining to the embodiment;

FIGS. **3**A-B show diagrams of the construction of the board pertaining to the embodiment;

FIG. **4** shows an illustration showing attachment of the ink cartridge in the holder;

FIG. **5** shows an illustration showing the ink cartridge attached to the holder;

FIGS. **6**A-B show schematics of the construction of the contact mechanism;

FIG. **7** shows a brief diagram of the electrical arrangement of the ink cartridge and the printing apparatus;

FIG. **8** shows a brief diagram of the electrical arrangement, focusing on the cartridge detection/short detection circuit;

FIG. **9** shows a flowchart depicting the processing routine of the cartridge determination process;

FIGS. **10**A-C show illustrations depicting three types of terminal lines on the board;

FIG. **11** shows a flowchart depicting the processing routine of the remaining ink level detection process;

FIGS. **12**A-C show timing charts depicting temporal change in the shorting-detection enable signal and sensor voltage during execution of the remaining ink level detection process;

FIG. **13** shows an illustration of a scenario of shorting;

FIGS. **14**A-D show first diagrams depicting boards pertaining to variations;

FIGS. **15**A-C show second diagrams depicting boards pertaining to variations;

FIGS. **16**A-D show third diagrams depicting boards pertaining to variations;

FIGS. **17**A-D show diagrams depicting the construction around boards of ink cartridges pertaining to variations;

FIGS. **18**A-D show cross sections A-A to D-D in FIG. **17**;

FIGS. **19**A-D show fourth diagrams depicting boards pertaining to variations;

FIG. **20** shows a perspective view of the construction of the ink cartridge pertaining to a variation;

FIG. **21** shows a picture of the ink cartridge pertaining to a variation being attached to the printer;

FIG. **22** shows a first diagram of the construction of the ink cartridge pertaining to a variation;

FIG. **23** shows a second diagram of the construction of the ink cartridge pertaining to a variation;

FIG. **24** shows a third diagram of the construction of the ink cartridge pertaining to a variation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

A. Embodiment

Arrangement of Printing apparatus and Ink Cartridge:

FIG. **1** shows a perspective view of the construction of the printing apparatus pertaining to an embodiment of the invention. The printing apparatus **1000** has a sub-scan feed mechanism, a main scan feed mechanism, and a head drive mechanism. The sub-scan feed mechanism carries the printing paper P in the sub-scanning direction using a paper feed roller **10** powered by a paper feed motor, not shown. The main scan feed mechanism uses the power of a carriage motor **2** to reciprocate in the main scanning direction a carriage **3** connected to a drive belt. The head drive mechanism drives a print head **5** mounted on the carriage **3**, to eject ink and form dots. The printing apparatus **1000** additionally comprises a main control circuit **40** for controlling the various mechanisms mentioned above. The main control circuit **40** is connected to the carriage **3** via a flexible cable **37**.

The carriage **3** comprises a holder **4**, the print head **5** mentioned above, and a carriage circuit, described later. The holder **4** is designed for attachment of a number of ink cartridges, described later, and is situated on the upper face of the print head **5**. In the example depicted in FIG. **1**, the holder **4** is designed for attachment of four ink cartridges, e.g. individual attachment of four types of ink cartridge containing black, yellow, magenta, and cyan ink. Four openable and closable covers **11** are attached to the holder **4** for each attached ink cartridge. Also disposed on the upper face of the print head **5** are ink supply needles **6** for supplying ink from the ink cartridges to the print head **5**.

The construction of the ink cartridge pertaining to the embodiment will now be described with reference of FIGS. **2**-**5**. FIG. **2** shows a perspective view of the construction of the ink cartridge pertaining to the embodiment. FIGS. **3**A-B show diagrams of the construction of the board pertaining to the embodiment. FIG. **4** shows an illustration showing attachment of the ink cartridge in the holder. FIG. **5** shows an illustration showing the ink cartridge attached to the holder. The ink cartridge **100** attached to the holder **4** comprises a housing **101** containing ink, a lid **102** providing closure to the opening of the housing **101**, a board **200**, and a sensor **104**. On the bottom face of the housing **101** there is formed an ink supply orifice **110** into which the aforementioned ink supply needle **6** inserts when ink cartridge **100** is attached to the holder **4**. At the upper edge of the front face FR of the housing **101** there is formed a flared section **103**. On the lower side of the center of the front face FR of the housing **101** there is formed a recess **105** bounded by upper and lower ribs **107**, **106**. The aforementioned board **200** fits into this recess **105**. The sensor **104** is located in the region posterior to the board **200**. The sensor **104** is used to detect remaining ink level, as will be described later.

FIG. **3**A depicts the arrangement on the surface of the board **200**. This surface is the face that is exposed to the outside when the board **200** is mounted on the ink cartridge **100**. FIG. **3**B depicts the board **200** viewed from the side. A boss slot **201** is formed at the upper edge of the board **200**, and a boss hole **202** is formed at the lower edge of the board **200**. As shown in FIG. **1**, with the board **200** attached to the recess **105** of the housing **101**, bosses **108** and **109** formed on the lower face of the recess **105** mate with the boss slot **201** and the boss hole **202** respectively. The distal ends of the bosses **108** and **109** are crushed to effect caulking. The board **200** is secured within the recess **105** thereby.

The following description of attachment of the ink cartridge **100** makes reference to FIG. **4** and FIG. **5**. As depicted in FIG. **4**, the cover **11** is designed to be rotatable about a rotating shaft **9**. With the cover **11** rotated upward to the open position, when the ink cartridge **100** is being attached to the holder, the flared section **103** of the ink cartridge is received by a projection **14** of the cover **11**. When the cover **11** is closed from this position, the projection **14** rotates downward, and the ink cartridge **100** descends downward (in the Z direction in FIG. **4**). When the cover **11** is completely closed, a hook **18** of the cover **11** interlocks with a hook **16** of the holder **4**. With the cover **11** completely closed, the ink cartridge **100** is secured pressed against the holder **4** by an elastic member **20**. Also, with the cover **11** completely closed, the ink supply needle **6** inserts into the ink supply orifice **110** of the ink cartridge **100**, and the ink contained in the ink cartridge **100** is supplied to the printing apparatus **1000** via the ink supply needle **6**. As will be apparent from the preceding description, the ink cartridge **100** is attached to the holder **4** by means of inserting it so as to move in the forward direction of the Z axis in FIG. **4** and FIG. **5**. The forward direction of the Z axis in FIG. **4** and FIG. **5** shall also be referred to as insertion direction of the ink cartridge **100**.

Returning to FIG. **3**, the board **200** shall be described further. The arrow R in FIG. **3**(*a*) indicates the insertion direction of the ink cartridge **100** discussed above. As depicted in FIG. **3**, the board **200** comprises a memory **203** disposed on its back face, and a terminal group composed of nine terminals **210-290** disposed on its front face. The memory **203** stores information relating to the ink contained in the ink cartridge **100**. The terminals **210-290** are generally rectangular in shape, and are arranged in two rows generally orthogonal to the insertion direction R. Of the two rows, the row on the insertion direction R side, i.e. the row situated on the lower side in FIG. **3**(*a*), shall be termed the lower row, and the row on the opposite side from the insertion direction R, i.e. the row situated on the upper side in FIG. **3** (*a*), shall be termed the upper row. The terminals arranged so as to form the upper row consist, in order from left in FIG. **3**(*a*), of a first short detection terminal **210**, a ground terminal **220**, a power supply terminal **230**, and a second short detection terminal **240**. The terminals arranged so as to form the lower row consist, in order from left in FIG. **3**(*a*), of a first sensor drive terminal **250**, a reset terminal **260**, a clock terminal **270**, a data terminal **280**, and a second sensor drive terminal **290**. As depicted in FIG. **3**, each of the terminals **210-290** contains in its center portion a contact portion CP for contacting a corresponding terminal among the plurality of apparatus-side terminals, described later.

The terminals **210-240** forming the upper row and the terminals **250-290** forming the lower row are arranged differently from one another, constituting a so-called staggered arrangement, so that the terminal centers do not line up with one another in the insertion direction R. As a result, the contact portions CP of the terminals **210-240** forming the upper row and the contact portions CP of the terminals **250-290** forming the lower row are similarly arranged differently from one another, constituting a so-called staggered arrangement.

As will be appreciated from FIG. **3**A, the first sensor drive terminal **250** is situated adjacently to two other terminals (the reset terminal **260** and the first short detection terminal **210**), and of these, the first short detection terminal **210** for detecting shorting is positioned closest to the first sensor drive terminal **250**. Similarly, the second sensor drive terminal **290** is situated adjacently to two other terminals (the second short detection terminal **240** and the data terminal **280**), and of these, the second short detection terminal **240** for detecting shorting is positioned closest to the second sensor drive terminal **290**.

With regard to relationships among the contact portions CP, the contact portion CP of the first sensor drive terminal **250** is situated adjacently to the contact portions CP of two other terminals (the reset terminal **260** and the first short detection terminal **210**). Similarly, the contact portion CP of the second sensor drive terminal **290** is situated adjacently to the contact portions CP of two other terminals (the second short detection terminal **240** and the data terminal **280**).

As will be appreciated from FIG. **3**A, the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated at the ends of the lower row, i.e. at the outermost positions in the lower row. The lower row is composed of a greater number of terminals than the upper row, and the length of the lower row in the direction orthogonal to the insertion direction R is greater than the length of the upper row, and consequently of all the terminals **210-290** contained in the upper and lower rows, the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated at the outermost positions viewed in the direction orthogonal to the insertion direction R.

With regard to relationships among the contact portions CP, the contact portion CP of the first sensor drive terminal **250** and the contact portion CP of the second sensor drive terminal **290** are respectively situated at the ends of the lower row formed by the contact portions CP of the terminals, i.e., at the outermost positions in the lower row. Among the contact portions of all the terminals **210-290** contained in the upper and lower rows, the contact portion CP of the first sensor drive terminal **250** and the contact portion CP of the second sensor drive terminal **290** are situated at the outermost positions viewed in the direction orthogonal to the insertion direction R.

As will be appreciated from FIG. **3**A, the first short detection terminal **210** and the second short detection terminal **240** are respectively situated at the ends of the upper row, i.e., at the outermost positions in the upper row. As a result, the contact portion CP of the first short detection terminal **210** and the contact portion CP of the second short detection terminal **240** are similarly located at the ends of the upper row formed by the contact portions CP of the terminals, i.e. at the outermost positions in the upper row. Consequently, as will be discussed later, the terminals **220**, **230**, **260**, **270** and **280** connected to the memory **203** are situated between the first short detection terminal **210** and the first sensor drive terminal **250**, and the second short detection terminal **240** and the second sensor drive terminal **290**, located to either side.

In the embodiment, the board **200** has width of approximately 12.8 mm in the insertion direction R, width of the approximately 10.1 mm in the direction orthogonal to the insertion direction R, and thickness of approximately 0.71 mm. The terminals **210-290** each have width of approximately 1.8 mm in the insertion direction R and width of approximately 1.05 mm in the direction orthogonal to the insertion direction R. The dimension values given here are merely exemplary, with differences on the order of ±0.5 mm being acceptable, for example. The spacing between adjacent terminals in a given row (the lower row or the upper row), for example the interval K between the first short detection terminal **210** and the ground terminal **220**, is 1 mm for example. With regard to spacing among terminals, differences on the order of ±0.5 mm are acceptable, for example. The interval J between the upper row and the lower row is about 0.2 mm. With regard to spacing among rows, differences on the order of ±0.3 mm are acceptable, for example.

As depicted in FIG. **5**, with the ink cartridge **100** attached completely within the holder **4**, the terminals **210-290** of the board **200** are electrically connected to a carriage circuit **500** via a contact mechanism **400** disposed on the holder **4**. The contact mechanism **400** shall be described briefly making reference to FIGS. **6**A-B.

FIGS. **6**A-B show schematics of the construction of the contact mechanism **400**. The contact mechanism **400** has multiple slits **401**, **402** of two types that differ in depth, formed in alternating fashion at substantially constant pitch in correspondence with the terminals **210-290** on the board **200**. Within each slit **401**, **402** there fits a contact forming member **403**, **404** endowed with electrical conductivity and resistance. Of the two ends of each contact forming member **403** and **404**, the end exposed to the inside of the holder is placed in resilient contact with a corresponding terminal among the terminals **210-290** on the board **200**. In FIG. **6**A, portions **410-490** which are the portions of the contact forming members **403** and **404** that contact the terminals **210-290** are shown. Specifically, the portions **410-490** that contact the terminals **210-290** function as apparatus-side terminals for electrically connecting the printing apparatus **1000** with the terminals **210-290**. The portions **410-490** that contact the terminals **210-290**

shall hereinafter be termed apparatus-side terminals **410**-**490**. With the ink cartridge **100** attached to the holder **4**, the apparatus-side terminals **410**-**490** respectively contact the contact portions CP of the terminals **210**-**290** described above (FIG. **3**A).

On the other hand, of the two ends of each contact forming member **403** and **404**, the end lying exposed on the exterior of the holder **4** is placed in resilient contact with a corresponding terminal among the terminals **510**-**590** furnished to the carriage circuit **500**.

The electrical arrangements of the ink cartridge **100** and the printing apparatus will now be described, focusing on the part relating to the ink cartridge **100**, with reference to FIG. **7** and FIG. **8**. FIG. **7** shows a brief diagram of the electrical arrangement of the ink cartridge and the printing apparatus. FIG. **8** shows a brief diagram of the electrical arrangement, focusing on the cartridge detection/short detection circuit.

First, the electrical arrangement of the ink cartridge **100** shall be described. Of the terminals of the board **200** described with reference to FIG. **3**, the ground terminal **220**, the power supply terminal **230**, the reset terminal **260**, the clock terminal **270** and the data terminal **280** are electrically connected to the memory **203**. The memory **203** is, for example, EEPROM comprising serially accessed memory cells, and performing data read/write operations in sync with a clock signal. The ground terminal **220** is grounded via a terminal **520** on the printing apparatus **1000** side. The reset terminal **260** is electrically connected to a terminal **560** of the carriage circuit **500**, and is used to supply a reset signal RST to the memory **203** from the carriage circuit **500**. The clock terminal **270** is electrically connected to a terminal **570** of the carriage circuit **500**, and is used to supply the clock signal CLK to the memory **203** from the carriage circuit **500**. The data terminal **280** is electrically connected to a terminal **580** of the carriage circuit **500**, and is used for exchange of data signals SDA between the carriage circuit **500** and the memory **203**.

Of the terminals of the board **200** described with reference to FIG. **3**, either the first short detection terminal **210**, the second short detection terminal **240**, or both are electrically connected with the ground terminal **220**. In the example depicted in FIG. **7**, it will be apparent that the first short detection terminal **220** is electrically connected to the ground terminal **220**. The first short detection terminal **210** and the second short detection terminal **240** are electrically connected respectively to the terminals **510**, **540** of the carriage circuit **500**, and used for cartridge detection and short detection, described later.

In the embodiment, a piezoelectric element is used as the sensor **104**. The remaining ink level can be detected by applying driving voltage to the piezoelectric element to induce the piezoelectric element to vibrate through the inverse piezoelectric effect, and measuring the vibration frequency of the voltage produced by the piezoelectric effect of the residual vibration. Specifically, this vibration frequency represents the characteristic frequency of the surrounding structures (.e.g. the housing **101** and ink) that vibrate together with the piezoelectric element. The characteristic frequency changes depending on the amount of ink remaining within the ink cartridge, so the remaining ink level can be detected by measuring this vibration frequency. Of the terminals of the board **200** described with reference to FIG. **3**, the second sensor drive terminal **290** is electrically connected to one electrode of the piezoelectric element used as the sensor **104**, and the first sensor drive terminal **250** is electrically connected to the other electrode. These terminals **250**, **290** are used for exchange of sensor driving voltage and output signals from the sensor **104**, between the carriage circuit **500** and the sensor **104**.

The carriage circuit **500** comprises a memory control circuit **501**, a cartridge detection/short detection circuit **502**, and a sensor driving circuit **503**. The memory control circuit **501** is a circuit connected to the terminals **530**, **560**, **570**, **580** of the carriage circuit **500** mentioned above, and used to control the memory **203** of the ink cartridge **100** to perform data read/write operations. The memory control circuit **501** and the memory **203** are low-voltage circuits driven at relatively low voltage (in the embodiment, a maximum of about 3.3 V). The memory control circuit **501** can employ a known design, and as such need not be described in detail here.

The sensor driving circuit **503** is a circuit connected to the terminals **590** and **550** of the carriage circuit **500**, and used to control the driving voltage output from these terminals **590** and **550** to drive the sensor **104**, causing the sensor **104** to detect the remaining ink level. As will be described later, the driving voltage has a generally trapezoidal shape, and contains relatively high voltage (in the embodiment, about 36 V). Specifically, the sensor driving circuit **503** and the sensor **104** are high-voltage circuits using relatively high voltage via the terminals **590** and **550**. The sensor driving circuit **503** is composed of a logic circuit for example, but need not be described in detail herein.

The cartridge detection/short detection circuit **502**, like the memory control circuit **501**, is a low-voltage circuit driven using relatively low voltage (in the embodiment, a maximum of about 3.3V). As depicted in FIG. **8**, the cartridge detection/short detection circuit **502** comprises a first detection circuit **5021** and a second detection circuit **5022**. The first detection circuit **5021** is connected to the terminal **510** of the carriage circuit **500**. The first detection circuit **5021** has a cartridge detection function for detecting whether there is contact between the terminal **510** and the first short detection terminal **210** of the board **200**, and a short detection function for detecting shorting of the terminal **510** to the terminals **550** and **590** which output high voltage.

To describe in more specific terms, the first detection circuit **5021** has a reference voltage V_ref**1** applied to one end of two series-connected resistors R**2**, R**3**, with the other end being grounded, thereby maintaining the potential at point P**1** and P**2** in FIG. **4** at V_ref**1** and V_ref**2**, respectively. Herein V_ref**1** shall be termed the short detection voltage, and V_ref**2** shall be termed the cartridge detection voltage. In the embodiment, the short detection voltage V_ref**1** is set to 6.5 V, and the cartridge detection voltage V_ref**2** is set to 2.5 V. These values are established by means of the circuits, and are not limited to the values given herein.

As depicted in FIG. **8**, the short detection voltage V_ref**1** (6.5 V) is input to the negative input pin of a first Op-Amp OP**1**, while the cartridge detection voltage V_ref**2** (2.5 V) is input to the negative input pin of a second Op-Amp OP**2**. The potential of the terminal **510** is input to the positive input pins of the first Op-Amp OP**1** and the second Op-Amp OP**2**. These two Op-Amps function as a comparator, outputting a High signal when the potential input to the negative input pin is higher than the potential input to the positive input pin, and conversely outputting a Low signal when the potential input to the negative input pin is lower than the potential input to the positive input pin.

As depicted in FIG. **8**, the terminal **510** is connected to a 3.3 V power supply VDD 3.3 via a transistor TR**1**. By means of this arrangement, if terminal **510** is free e.g. there is no contact with terminal **510**, the potential of the terminal **510** will be set at about 3 V. As noted, when the ink cartridge **100** is attached,

the terminal **510** comes into contact with the first short detection terminal **210** of the board **200** described previously. Here, as depicted in FIG. **7**, with the first short detection terminal **210** and the ground terminal **220** electrically connected (shorted) in the board **200**, when the terminal **510** comes into contact with the first short detection terminal **210** (herein referred to as being in contact), the terminal **510** is electrically continuous with the grounded terminal **520**, and the potential of the terminal **510** drops to 0 V.

Consequently, with the terminal **510** free, a High signal from the second Op-Amp OP**2** is output as the cartridge detection signal CS**1**. With the terminal **510** in contact, a Low signal from the second Op-Amp OP**2** is output as the cartridge detection signal CS**1**.

On the other hand, if the terminal **510** is shorted to the adjacent terminal **550**, there are instances in which the sensor driving voltage (45 V max) will be applied to the terminal **510**. As shown in FIG. **8**, when voltage greater than the short detection voltage V_ref**1** (6.5 V) is applied to the terminal **510** due to shorting, a High signal from the Op-Amp OP**1** will be output to an AND circuit AA.

As shown in FIG. **8**, a short detection enable signal EN is input from the main control circuit **40** to the other input pin of the AND circuit AA. As a result, only during the time interval that a High signal is input as the short detection enable signal EN, the first detection circuit **5021** outputs the High signal from the Op-Amp OP**1** as a short detection signal ABl. That is, execution of the short detection function of the first detection circuit **5021** is controlled by means of the short detection enable signal EN of the main control circuit **40**. The short detection signal AB**1** from the AND circuit AA is output to the main control circuit **40**, as well as being output to the base pin of the transistor TR**1** via resistance R**1**. As a result, by means of the transistor TR**1** it is possible to prevent high voltage from being applied to the power supply VDD **3.3** via the terminal **510** when a short is detected (when the short detection signal AB**1** is HI).

The second detection circuit **5022** has a cartridge detection function for detecting whether there is contact between the terminal **540** and the second short detection terminal **240** of the board **200**, and a short detection function for detecting shorting of the terminal **540** to the terminals **550** and **590** which output high voltage. Since the second detection circuit **5022** has the same arrangement as the first detection circuit **5021**, a detailed illustration and description need not be provided here. Hereinafter, the cartridge detection signal output by the second detection circuit **5022** shall be denoted as CS**2**, and the short detection signal as AB**2**.

An arrangement of the carriage circuit **500** corresponding to a single ink cartridge **100** has been described above. In the embodiment, since four ink cartridges **100** are attached, four of the cartridge detection/short detection circuits **502** described above will be provided, at each of the attachment locations for the four ink cartridges **100**. While only a single sensor driving circuit **503** is provided, and a single sensor driving circuit **503** is connectable to each of the sensors **104** of the ink cartridges **100** attached at the four attachment locations by means of a switch(not shown). The memory control circuit **501** is a single circuit responsible for processes relating to the four ink cartridges.

The main control circuit **40** is a computer of known design comprising a central processing unit (CPU), a read-only memory (ROM), and a random access memory (RAM). As noted, the main control circuit **40** controls the entire printer; in FIG. **8**, however, only those elements necessary for description of the embodiment are selectively illustrated, and the following description refers to the illustrated arrangement. The main control circuit **40** comprises a cartridge determining module M**50** and a remaining ink level determining module M**60**. On the basis of the received cartridge detection signals CS**1**, CS**2**, the cartridge determining module M**50** executes a cartridge determination process, described later. The remaining ink level determining module M**60** controls the sensor driving circuit **503**, and executes a remaining ink level detection process, described later.

Cartridge Determination Process:

The cartridge determination process executed by the cartridge determining module M**50** of the main control circuit **40** will be described with reference to FIG. **9** and FIG. **10**. FIG. **9** shows a flowchart depicting the processing routine of the cartridge determination process. FIGS. **10**A-C show illustrations depicting three types of terminal lines on the board **200**.

Before turning to the cartridge determination process, the board **200** will be described further with reference to FIG. **10**. The board **200** mentioned previously comes in three types, depending on the wiring pattern of the first short detection terminal **210**, the second short detection terminal **240**, and the ground terminal **220**. These three types are designated respectively as Type A, Type B, and Type C. As depicted in FIG. **10**A, the Type A board **200** is arranged with the first short detection terminal **210** and the ground terminal **220** electrically connected by a conducting line **207**, while the second short detection terminal **240** and the ground terminal **220** are not electrically connected. As depicted in FIG. **10**B, the Type B board **200** is arranged with both the first short detection terminal **210** and the second short detection terminal **240** electrically connected with the ground terminal **220** by a conducting line **207**. As depicted in FIG. **10**C, the Type C board **200** is arranged with the second short detection terminal **240** and the ground terminal **220** electrically connected by a conducting line **207**, while the first short detection terminal **210** and the ground terminal **220** are not electrically connected. A board **200** of predetermined type, selected with reference to ink type or ink quantity for example, is disposed on the ink cartridge **100**. Specifically, depending on the quantity of ink contained in the ink cartridge **100**, a Type A board **200** could be disposed on an L size cartridge containing a large quantity of ink; a Type B board **200** could be disposed on an M size cartridge containing a standard quantity of ink; and a Type C board **200** could be disposed on an S size cartridge containing a small quantity of ink.

The cartridge determining module M**50** of the main control circuit **40** constantly receives from the cartridge detection/short detection circuit **502** the cartridge detection signals CS**1**, CS**2** for each of the four attachment locations of the holder **4**, and using these signals executes the cartridge determination process for each of the attachment locations.

When the cartridge determining module M**50** initiates the cartridge determination process for a selected attachment location, the cartridge determining module M**50** first ascertains whether the cartridge detection signal CS**1** from the cartridge detection/short detection circuit **502** in the selected attachment location is a Low signal (Step S**102**). Next, the cartridge determining module M**50** ascertains whether the cartridge detection signal CS**2** in the selected attachment location is a Low signal (Step S**104** or S**106**). If as a result the cartridge detection signals CS**1** and CS**2** are both Low signals (Step S**102**: YES and Step S**104**: YES), the cartridge determining module M**50** decides that the ink cartridge **100** attached to the selected attachment location is furnished with the Type B board **200** (Step S**108**).

Similarly, the cartridge determining module M**50**, in the event that the cartridge detection signal CS**1** is a Low signal and the cartridge detection signal CS**2** is a High signal (Step

S102: YES and Step S104: NO), decides that the ink cartridge is furnished with the Type A board 200 (Step S110); or in the event that the cartridge detection signal CS1 is a High signal and the cartridge detection signal CS2 is a Low signal (Step S102: NO and Step S104: YES), decides that the ink cartridge is furnished with the Type C board 200 described above (Step S112).

In the event that both the cartridge detection signals CS1 and CS2 are High signals Step S102: NO and Step S104: NO), the cartridge determining module M50 decides that no cartridge is attached to the selected attachment location (Step S114). In this way, the cartridge determining module M50 determines whether an ink cartridge 100 is attached, and if so what type, for each of the four attachment locations.

Remaining Ink Level Detection Process:

The remaining ink level detection process executed by the remaining ink level determining module M60 of the main control circuit 40 will now be described with reference to FIG. 11 and FIGS. 12A-C. FIG. 11 shows a flowchart depicting the processing routine of the remaining ink level detection process. FIGS. 12A-C show timing charts depicting temporal change in the shorting-detection enable signal and sensor voltage during execution of the remaining ink level detection process;

The remaining ink level determining module M60 of the main control circuit 40, in the event that the remaining ink level in the ink cartridge 100 attached at any of the attachment locations of the holder 4 is to be detected, first sets to High the short detection enable signal EN to all of the cartridge detection/short detection circuits 502 (Step S202). As a result, the short detection function is enabled in all of the cartridge detection/short detection circuits 502, and if voltage above the reference voltage V_ref1 (6.5 V) is applied to the aforementioned terminal 520 and terminal 540, are able to output High signals as the short detection signals AB1, AB2. In other words, a state in which the short detection enable signal EN are High signals is a state in which shorting of the terminal 510 or terminal 540 to the terminal 550 or terminal 590 is monitored.

Next, the remaining ink level determining module M60 instructs the sensor driving circuit 503 to output driving voltage from the terminal 550 or terminal 590 to the sensor 104, and detect the remaining ink level output (Step S204). To describe in more specific terms, when the sensor driving circuit 503 receives an instruction signal from the remaining ink level determining module M60, the sensor driving circuit 503 outputs driving voltage from either the terminal 550 or the terminal 590, the voltage being applied to the piezoelectric element which constitutes the sensor 104 of the ink cartridge 100, charging the piezoelectric element and causing it to distort by means of the inverse piezoelectric effect. The sensor driving circuit 503 subsequently drops the applied voltage, whereupon the charge built up in the piezoelectric element is discharged, causing the piezoelectric element to vibrate. In FIG. 12, the driving voltage is the voltage shown during time interval T1. As depicted in FIG. 12, the driving voltage fluctuates between the reference voltage and the maximum voltage Vs in such a way as to describe a trapezoidal shape. The maximum voltage Vs is set to relatively high voltage (e.g. about 36 V). Via the terminal 550 of the terminal 590, the sensor driving circuit 503 detects the voltage produced by the piezoelectric effect as a result of vibration of the piezoelectric element (in FIG. 12 depicted as the voltage during time interval T2), and by measuring the vibration frequency thereof detects the remaining ink level. Specifically, this vibration frequency represents the characteristic frequency of the surrounding structures (the housing 101 and ink) that vibrate together with the piezoelectric element, and changes depending on the amount of ink remaining within the ink cartridge 100, so the remaining ink level can be detected by measuring this vibration frequency. The sensor driving circuit 503 outputs the detected result to the remaining ink level determining module M60 of the main control circuit 40.

When the remaining ink level determining module M60 receives the detected result from the sensor driving circuit 503, the remaining ink level determining module M60 brings the short detection enable signal EN, which was previously set to a High signal in Step S202, back to a Low signal (Step S206), and terminates the process. In this process, the interval that the remaining ink level is being detected is a state in which the short detection enable signal EN is set to a High signal to enable short detection. In other words, remaining ink level is detected while the occurrence of shorting is being monitored by the cartridge detection/short detection circuit 502.

Process When Shorting is Detected

The process carried out in the event that, during execution of detection of the remaining ink level (Step S204), the remaining ink level determining module M60 receives a High signal as the short detection signal AB1 or AB2, e.g. shorting is detected shall be described here. In FIG. 11, a flowchart of the interrupt processing routine when shorting is detected is shown as well. When the terminal 510 or the terminal 540 shorts to the terminal that is outputting the sensor driving voltage of the terminals 550 and 590, the sensor driving voltage will be applied to the shorting terminal 510 or terminal 540. Thereupon, since the short detection enable signal EN is currently set to High, at the instant that the sensor driving voltage goes above the short detection voltage V_ref1 (6.5 V), a High signal will be output as the short detection signals AB1, AB2 from the cartridge detection/short detection circuit 502. When the remaining ink level determining module M60 receives either of these short detection signals AB1, AB2, the remaining ink level determining module M60 suspends detection of remaining ink level, and executes the interrupt processing when shorting is detected.

When the interrupt processing is initiated, the remaining ink level determining module M60 immediately instructs the sensor driving circuit 503 to suspend the output of sensor driving voltage (Step S208).

Next, the remaining ink level determining module M60, without carrying out remaining ink level detection process to its conclusion, brings the short detection enable signal EN back to a Low signal (Step S206) to terminate the process. For example, the main control circuit 40 may take some countermeasure, such as notifying the user of the shorting.

FIG. 12A depicts change of the detection enable signal EN through time. FIG. 12B depicts sensor voltage in the event that neither the terminal 510 nor the terminal 540 is shorting to the terminal that outputs the sensor driving voltage of the terminals 550 and 590, so that the remaining ink level detection process is being executed normally. FIG. 12C depicts sensor voltage in the event that the terminal 510 or the terminal 540 is shorting to the terminal that, of the terminals 550 and 590, outputs the sensor driving voltage.

As depicted in FIG. 12A, during execution of the remaining ink level detection process, the detection enable signal EN is a High signal. As shown in FIG. 12B, in the normal state (no shorting), after high voltage Vs has been applied to the sensor 104, the applied voltage drops, and subsequently vibration voltage is produced through the piezoelectric effect. In the embodiment, Vs is set at 36 V.

As depicted in FIG. 12C, on the other hand, in the abnormal state (shorting), the sensor voltage drops at the instant that it

goes above the short detection voltage V_ref1 (6.5 V). This is due to the fact that, at the instant that the sensor voltage goes above the short detection voltage V_ref1 (6.5 V), a High signal is output as the short detection signal AB1 or AB2 from the cartridge detection/short detection circuit **502** to the remaining ink level determining module M**60**, and the remaining ink level determining module M**60** receiving this signal immediately drops the sensor driving voltage.

FIG. **13** shows an illustration of a scenario of shorting. Here, the likely scenario for shorting to other terminals by the terminals **550** and **590** which output the sensor driving voltage is, for example, the case depicted in FIG. **13**, in which an electrically conductive ink drop S**1** or a water drop S**2** formed by condensation has become deposited on the board **200** of the ink cartridge **100**, bridging the gap between the first sensor drive terminal **250** or the second sensor drive terminal **290** and another terminal or terminals on the board **200**, producing shorting. For example, ink drop S**1** that has adhered to the surface of the carriage **3** or ink supply needle **6** disperses and adheres as shown in FIG. **13** by the motion of attaching or detaching of ink cartridge **100**. In this instance, when the ink cartridge **100** is attached, the terminal **550** that outputs the sensor driving voltage, for example, will short to another terminal **510**, **520**, or **560** of the carriage circuit **500** via the first sensor drive terminal **250** and the terminals (FIG. **13**: terminals **210**, **220**, **260**) bridged by the ink drop S**1** to the sensor drive terminal **250**. Or, the terminal **590** that outputs the sensor driving voltage will short to another terminal **540** of the carriage circuit **500** via the second sensor drive terminal **290** and the second short detection terminal **240** (FIG. **13**) bridged by the water drop S**2** to the second sensor drive terminal **290**, for example. Such a shorting is caused by various factor as well as the adhesion of the ink drop. For example, the shorting may be caused by trapping electrically conducting object, for example, paper clip on carriage **3**. The shorting also may be caused by adhesion to terminals of the electrically conducting material, for example, skin oil of user.

As mentioned previously with reference to FIG. **3**, in the ink cartridge **100** pertaining to the embodiment the first sensor drive terminal **250** and the second sensor drive terminal **290** which apply the driving voltage to the sensor are arranged at the two ends of the terminal group, so the number of adjacent terminals is small. As a result, the likelihood of the first sensor drive terminal **250** and the second sensor drive terminal **290** shorting to other terminals is low.

On the board **200**, if the first sensor drive terminal **250** should short to the adjacent first short detection terminal **210**, the shorting will be detected by the aforementioned cartridge detection/short detection circuit **502**. For example, shorting of the first sensor drive terminal **250** to another terminal caused by the ink drop S**1** infiltrating from the first sensor drive terminal **250** side will be detected instantly and the output of sensor driving voltage will be suspend, preventing or reducing damage to the memory **203** and the printing apparatus **1000** circuits (the memory control circuit **501** and the cartridge detection/short detection circuit **502**) caused by the shorting.

Also, the first short detection terminal **210** is adjacent to the first sensor drive terminal **250** and situated closest to the first sensor drive terminal **250**. Consequently, in the event that the first sensor drive terminal **250** should short to another terminal or terminals due to the ink drop S**1** or the water drop S**2**, there is a high likelihood that the first sensor drive terminal **250** will short to the first short detection terminal **210** as well. Consequently, shorting of the first sensor drive terminal **250** to another terminal can be detected more reliably.

In addition to detecting shorting, the first short detection terminal **210** is also used by the cartridge detection/short detection circuit **502** to determine whether an ink cartridge **100** is attached, as well as to determine the type of attached ink cartridge **100**. As a result, the number of terminals on the board **200** can be kept down, and it becomes possible to reduce the number of board **200** manufacturing steps and the number of parts for the board **200**.

Similarly, if the second sensor drive terminal **290** should short to the second short detection terminal **240**, the short will be detected by the cartridge detection/short detection circuit **502**. Consequently, shorting of the second sensor drive terminal **290** to another terminal caused by the ink drop Si or the water drop S**2** infiltrating from the second sensor drive terminal **290** side can be detected instantly. As a result, damage to the circuits of the memory **203** and the printing apparatus **1000** caused by shorting can be prevented or reduced. Similarly, the second short detection terminal **240** is the terminal situated closest to the second sensor drive terminal **290**. Consequently, in the event that the second sensor drive terminal **290** should short to another terminal or terminals due to the ink drop S**1** or the water drop S**2**, there is a high likelihood that the second sensor drive terminal **290** will short to the second short detection terminal **240** as well. Consequently, shorting of the second sensor drive terminal **290** to another terminal can be detected more reliably.

The first sensor drive terminal **250** and the first short detection terminal **210** on the one hand, and the second sensor drive terminal **290** and the second short detection terminal **240** on the other, are situated at the ends of the terminal group so that the other terminals (**220**, **230**, **260**-**270**) lie between them. Consequently, if foreign matter (the ink drop S**1**, water drop S**2** etc.) should infiltrate from either side as indicated by the arrows in FIG. **13**, this infiltration can be detected before it infiltrates as far as the other terminals (**220**, **230**, **260**-**270**). Consequently, damage to the circuits of the memory **203** and the printing apparatus **1000** due to infiltration of foreign matter can be prevented or reduced.

The first sensor drive terminal **250** and the second sensor drive terminal **290** are arranged in the row on the insertion direction R side (lower row). As a result, since the terminals **250**, **290** to which sensor driving voltage including high voltage is applied are situated to the back in the insertion direction, there is less likelihood that ink drops or foreign matter (e.g. a paperclip) will infiltrate to the location of these terminals **250**, **290**. As a result, damage to the circuits of the memory **203** and the printing apparatus **1000** caused by infiltration of foreign matter can be prevented or reduced.

The terminal group of the board **200** is arranged in a staggered pattern. As a result, unwanted contact of the terminals of the ink cartridge **100** with the terminals of the printing apparatus **1000** (the contact forming members **403**, **404** mentioned previously) during the attachment operation can be prevented or reduced.

B. Variations

Variations of the board **200** mounted to the ink cartridge **100** shall be described with reference to FIGS. **14**A-**16**B. FIGS. **14**A-D show first diagrams depicting boards pertaining to variations. FIGS. **15**A-C show second diagrams depicting boards pertaining to variations. FIGS. **16**A-B show third diagrams depicting boards pertaining to variations.

Variation **1**:

On the board **200***b* depicted in FIG. **14**A, the first short detection terminal **210** is similar to the first short detection terminal **210** of the board **200** of the embodiment, but has at its lower end an extended portion that reaches into proximity with the lower edge of the lower row. The extended portion is

positioned between the first sensor drive terminal **250** and the reset terminal **260** of the lower row. As a result, for example, even in the event of adhesion of an ink drop S**3** as depicted in FIG. **14** (a), shorting of the extended portion of the short detection terminal **210** to the first sensor drive terminal **250** will be detected. Like this, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal (in the example of FIG. **14**A, the reset terminal **260**) can be prevented or reduced.

As shown in FIG. **14**A, the second short detection terminal **240** of the board **200***b* is also similar in shape to the first short detection terminal **210** mentioned above, and shorting of the second sensor drive terminal **290** to another terminal will also be detected more reliably.

Variation **2**:

The board **200***c* depicted in FIG. **14**B has, in addition to the arrangement of the board **200***b* described above, also has an extended portion located at the upper side of the first sensor drive terminal **250**, and reaching into proximity with the upper edge of the upper row. As a result, even in the event of adhesion of an ink drop S**4** as depicted in FIG. **14**(*b*), shorting of the short detection terminal **210** to the extended portion of the first sensor drive terminal **250** will be detected. Like this, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

As shown in FIG. **14**B, the second sensor drive terminal **290** of the board **200***c* is also similar in shape to the first sensor drive terminal **250** mentioned above, and infiltration of an ink drop from the end, at the end at which the second sensor drive terminal **290** is situated, can be detected instantly.

Variation **3**:

The board **200***d* depicted in FIG. **14**C differs from the board **200** of the embodiment in that there is no second short detection terminal **240**. In the case of the Type A board **200** depicted in FIG. **10**A, the second short detection terminal **240** does not carry out detection of contact by means of the cartridge detection/short detection circuit **502** (since there is no shorting to the ground terminal **220**). Consequently, in the case of the Type A board **200**, the second short detection terminal **240** is used for short detection only and accordingly can be dispensed with. In this case as well, since the first short detection terminal **210** is at the location closest to the first sensor drive terminal **250**, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Infiltration of an ink drop to second sensor drive terminal **290** side will also be detected to a certain extent. In FIG. **14**C, the symbol CP represents the location of contact with the contact forming member **403** that would contact the second short detection terminal **240** if the second short detection terminal **240** were present (i.e. the contact forming member **403** corresponding to the terminal **540** of the carriage circuit **500**). Even in the case that the second short detection terminal **240** is absent, if a shorting should occur between the second sensor drive terminal **290** and the contact forming member **403** corresponding to the terminal **540** of the carriage circuit **500** due to an ink drop S**5**, infiltration of the ink drop S**5** will be detected. Similarly, in the case of a Type C board **200**, the first short detection terminal **210** may be dispensed with.

Variation **4**:

On the board **200***e* depicted in FIG. **14**D, the first sensor drive terminal **250** and the first short detection terminal **210** have elongated shape reaching from the vicinity of the upper edge of the upper row to the vicinity of the lower edge of the lower row. The terminals of this shape, as the contact locations are indicated by the symbol CP in FIG. **14**D, can contact the corresponding contact forming portions **403** arranged in a staggered pattern. In the case of the board **200***e*, like the board **200***c* described previously, even if an ink drop S**6** should become deposited for example, shorting between the extended portions of the first short detection terminal **210** and the first sensor drive terminal **250** will be detected. Like this, first short detection terminal **210** is located between first sensor drive terminal **250** and terminal other than the first short detection terminal **210**. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended.

The second sensor drive terminal **290** and the second short detection terminal **240** of the board **200***e* have shape similar to the first sensor drive terminal **250** and the first short detection terminal **210** described above. Accordingly, when the second sensor drive terminal **290** and terminal other than the second short detection terminal **240** are shorting, there is a high possibility that the second sensor drive terminal **290** and the second short detection terminal **240** are shorting. As a result, the possibility preventing or reducing the problems caused by shorting of the sensor drive terminal **250**, **290** to another terminal becomes higher.

Variation **5**:

On the board **200***f* depicted in FIG. **15**A, the terminal which corresponds to the first short detection terminal **210** and the ground terminal **220** in the board **200** pertaining to the embodiment is an integral terminal **215** wherein these two terminals are integrally formed as a single member. This board **200***f* can be used in place of the Type A or Type B board **200** (FIG. **10**) whose first short detection terminal **210** and ground terminal **220** are shorted. With the board **200***f*, the need is obviated for a line between the first short detection terminal **210** and the ground terminal **220**, which was required in the case of in the board **200** pertaining to the embodiment, so the board **200** requires fewer process steps and fewer parts.

Variation **6**:

On the board **200***g* depicted in FIG. **15**B, the terminals **210**-**240** of the upper row each have shape similar to the first short detection terminal **210** of the board **200***b* described previously. Specifically, each of the terminals **210**-**240** has an extended portion situated at the lower edge of the corresponding terminal of the board **200** pertaining to the embodiment and reaching into proximity with the lower edge of the lower row. The terminals **250**-**290** of the lower row of the board **200***g* are similar in shape to the first sensor drive terminal **250** of the board **200***c* described earlier. Specifically, the each of the terminals **250**-**290** has an extended portion situated at the upper edge of the corresponding terminal of the board **200** pertaining to the embodiment and reaching into proximity with the upper edge of the upper row.

As a result, the terminals **210**-**290** of the board **200***g* are arranged so as to form a terminal group composed of a single row of terminals of generally oar shape of in mutually differ-

ent arrangement, rather than being arranged in two rows. The first sensor drive terminal **250** and the second sensor drive terminal **290** to which the high-voltage sensor driving voltage is applied are positioned at the two ends of the single row of the terminal group, with the first short detection terminal **210** and the second short detection terminal **240** respectively arranged adjacently inward from the first sensor drive terminal **250** and the second sensor drive terminal **290**.

With the board **200***g*, an ink drop or foreign matter infiltrating from either end can be detected immediately at the point in time that shorting occurs between the first sensor drive terminal **250** and the short detection terminal **210**, or between the second sensor drive terminal **290** and the second short detection terminal **240**. In the event that the first sensor drive terminal **250** or the second sensor drive terminal **290** should short to another terminal, in the case where the shorting is due to an ink drop or the like, the likelihood is extremely high that shorting between the first sensor drive terminal **250** and the short detection terminal **210**, or between the second sensor drive terminal **290** and the second short detection terminal **240**, will occur at the same time. Consequently, shorting of the first sensor drive terminal **250** or the second sensor drive terminal **290** to another terminal can be detected reliably. As a result, damage to the memory **203** and the printing apparatus **1000** circuits (the memory control circuit **501** and the cartridge detection/short detection circuit **502**) caused by the shorting can be prevented or minimized.

Variation **7**:

On the board **200***h* depicted in FIG. **15**C, the terminals **210**-**290** have elongated shape extending over a distance equivalent to two rows of the board **200** pertaining to the embodiment, in a manner similar to the first sensor drive terminal **250** and the first short detection terminal **210** of the board **200***e* described previously. The terminals of this shape, as the contact locations are indicated by the symbol cp in FIG. **15**C, can contact the corresponding contact forming portions **403** arranged in a staggered pattern.

In the board **200***h*, the terminals **210**-**290** are arranged so as to form a single row in the orthogonal direction to the insertion direction R, in a manner similar to the board **200***g* described above. Also, like the board **200***g*, the first sensor drive terminal **250** and the second sensor drive terminal **290** to which the high-voltage sensor driving voltage is applied are positioned at the two ends of the single row of terminals, with the first short detection terminal **210** and the second short detection terminal **240** respectively arranged adjacently inward from the first sensor drive terminal **250** and the second sensor drive terminal **290**. As a result, the board **200***h* affords advantages analogous to those of the board **200***g* described above.

Variation **8**:

The first short detection terminal **210** of the board **200***i* depicted in FIG. **16**A has a shape that is longer on the left side in the drawing, as compared to the first short detection terminal **210** of the board **200** pertaining to the embodiment. Additionally, the first short detection terminal **210** of the board **200***i* has an extended portion reaching from the left edge portion to the vicinity of the lower edge of the lower row. The extended portion is situated to the left of the first sensor drive terminal **250** in the lower row. In other words, the extended portion is disposed to further from the middle of the terminal group in a direction substantially orthogonal to the insertion direction R than the first sensor drive terminal **250**. In this case, whereas viewed in terms of the terminal as a whole, the first short detection terminal **210** is situated outwardly (to the left side) of the first sensor drive terminal **250**, when viewed in terms of the contact portion CP of the terminal, of the contact portions CP of all of the terminals **210**-**290** the contact portion CP of the first sensor drive terminal **250** is the one situated at the outermost position (left side), in the same manner as in the embodiment. Also, shorting between the first sensor drive terminal **250** and the first short detection terminal **210** that includes the contact portion CP adjacent to the contact portion CP of the first sensor drive terminal **250** is detected. Accordingly, the board **200***i* pertaining to this variation affords advantages similar to the board **200** pertaining to the embodiment. Specifically, infiltration of an ink drop from the edge can be detected instantly, and damage to the circuits of the memory **203** and the printing apparatus **1000** can be prevented or minimized. Additionally, since the first short detection terminal **210** has the extended portion, the length of a first portion that is a portion adjacent to the circumferential edge of the first short detection terminal **210** among the circumferential edge of the first sensor drive terminal **250** becomes long. As shown in FIG. **16**B, the length of the first portion is longer than that of a second portion that is a portion adjacent to the circumferential edge of the reset terminal **260** among the among the circumferential edge of the first sensor drive terminal **250**. As a result, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210**, for example, the reset terminal **260** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting. Accordingly, the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced with higher probability.

The first short detection terminal **210** of the board **200***p* in FIG. **16**C has the longer extended portion than the first short detection terminal **210** of the board **200***i*. As shown in FIG. **16**C, the extended portion of the first short detection terminal **210** of the board **200***p* extends from upper left to lower right of the first sensor drive terminal **250** along the circumferential edge of the first sensor drive terminal **250**. As a result, the length of the first portion in the board **200***p* is longer than that in the board **200***i*. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a higher possibility the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

The first short detection terminal **210** of the board **200***q* in FIG. **16**D has the longer extended portion than the first short detection terminal **210** of the board **200***i* and **200***p*. As shown in FIG. **16**D, the extended portion of the first short detection terminal **210** of the board **200***q* extends from upper left through lower to upper right of the first sensor drive terminal **250** along the circumferential edge of the first sensor drive terminal **250**. In other words, the first short detection terminal **210** is formed so as to surround the first sensor drive terminal **250** completely. As a result, the length of the first portion in the board **200***q* is longer than that in the board **200***i* and **200***p*. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a higher possibility the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

As shown in FIGS. **16**A-C, board **200***i*, **200***p*, **200***q* are added the direction in which the portion of the first short detection terminal **210** is located adjacently to a portion of the sensor drive terminal **250** by providing the extended portion of the first short detection terminal **210**. About board **200***i*, the extended potion of the first short detection terminal **210**

located adjacently to left border of the first sensor drive terminal **250** in a lateral direction towards an edge of the ink cartridge **100**, and the first short detection terminal **210** itself is located adjacently to upper border of the first sensor drive terminal **250** in opposite direction of the insertion direction R. Meanwhile, about board **200***p*, in addition to above-mentioned two directions, the extended potion of the first short detection terminal **210** is located adjacently to lower border of the first sensor drive terminal **250** in the insertion direction R. Furthermore, about board **200***q*, the extended potion of the first short detection terminal **210** is located adjacently to right border of the first sensor drive terminal **250** in lateral direction away from an edge of the ink cartridge **100**. In other words, about board **200***q*, at least a potion of the first short detection terminal **210** is located adjacently to the first sensor drive terminal **250** in all direction.

When the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting by ink drop or other object infiltrating from the direction in which the portion of the first short detection terminal **210** is located adjacently to the portion of the first sensor drive terminal **250**, there is a much high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal by ink drop or other object infiltrating from such direction can be prevented or reduced with much high probability. In the present variations, the extended portion of the first short detection terminal **210** adds the direction in which the first short detection terminal **210** and the first sensor drive terminal **250** are adjacent each other, and prevents or reduces problems caused by shorting of the first sensor drive terminal **250** to another terminal with much high probability.

In the boards **200***i*, **200***p*, **200***q* pertaining to this variation, only the first short detection terminal **210** on the left side is furnished with a structure having the extended portion described above, but it would be possible to furnish the second short detection terminal **240** on the right side with a structure having an extended portion, in addition to the first short detection terminal **210** or instead of the first short detection terminal **210**. In this case as well, there are afforded advantages analogous to those of the boards **200***i*, **200***p*, **200***q* pertaining to this variation.

Variation **9**:

The board **200***j* depicted in FIG. **16**B, like the board **200***f* described previously in Variation **5**, has an integral terminal **215** wherein the first short detection terminal **210** and the ground terminal **220** in the board **200** pertaining to the embodiment are integrally formed as a single member. The integral terminal **215** of the board **200***j* differs in shape from the integral terminal **215** of the board **200***f* described previously. Specifically, the integral terminal **215** of the board **200***j*, like the first short detection terminal **210** of the board **200***i* described in Variation **8**, has a shape elongated on the left side, and has an extended portion reaching from the left edge portion to the vicinity of the lower edge of the lower row. In this case, advantages analogous to those of the board **200***i* pertaining to Variation **8** are attained, while reducing the number of production steps and parts needed for the board.

In the embodiment and variations described hereinabove, all of the terminals are situated on the board **200**, but it is not necessary that all terminals be situated on the board **200**. For example, it would be acceptable for some of the terminals to be situated on the housing **101** of the ink cartridge **100**. By way of specific examples, Variation **10** and Variation **11** shall be described below with reference to FIGS. **17**A-**18**D. FIGS. **17**A-D show diagrams depicting the construction around boards of ink cartridges pertaining to variations. FIGS. **18**A-D show cross sections A-A to D-D in FIG. **17**.

Variation **10**:

The board **200***k* depicted in FIG. **17**A is furnished with seven terminals **210**-**240** and **260**-**280**, out of the nine terminals **210**-**290** furnished to the board **200** of the embodiment. Out of the nine terminals **210**-**290** furnished to the board **200** of the embodiment, the board **200***k* lacks the first sensor drive terminal **250** and the second sensor drive terminal **290**. The board **200***k* pertaining to this variation is furnished with notches NT**1** or NT**2** situated in zones that include the locations where the first sensor drive terminal **250** and the second sensor drive terminal **290** were disposed on the board **200** pertaining to the embodiment. The notches may have the shape indicated by the solid lines NT**1**, or the shape indicated by the broken lines NT**2**, in FIG. **17**A. Terminals **150** and **190** having function similar to the first sensor drive terminal **250** and the second sensor drive terminal **290** of the board **200** in the embodiment are arranged on the housing **101** situated to the rear of the board **200***k*. Naturally, with the ink cartridge **100** attached to the holder **4**, these terminals **150** and **190** are situated at locations contacting the corresponding apparatus-side terminals **450** and **490**.

A-A cross section viewed in FIG. **17**A is depicted in FIG. **18**A. As shown in FIG. **18**A, a depressed portion DE, formed by a gap between the notch NT**1** of the board **200***k* and the terminal **150**, is situated between the terminal **150** and the adjacent terminals **260**, **210** (in FIG. **18**A, the reset terminal **260** is shown). While omitted from the drawing, a similar depressed portion DE is situated between the terminal **190** and the adjacent terminals **280**, **240**.

According to this variation, the following advantages are afforded in addition to those analogous to the board **200** pertaining to the embodiment. If an ink drop or foreign matter should infiltrate from the end of the ink cartridge **100** pertaining to this variation, it will become trapped in the depressed portion DE arranged surrounding the terminal **150** or the terminal **190**, whereby shorting of the terminal **150** or the terminal **190** to another terminal due to an infiltrating ink drop or foreign matter can be further prevented or minimized.

Variation **11**

The board **200***m* depicted in FIG. **17**B, rather than having the notches NT**1** or NT**2** pertaining to Variation **10**, is instead furnished with through-holes HL situated at locations corresponding to the locations where the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated on the board **200** pertaining to the embodiment. B-B cross section viewed in FIG. **17**B is depicted in FIG. **18**B. Other arrangements of the ink cartridge **100** pertaining to Variation **11** are the same as those of the ink cartridge **100** pertaining to Variation **10**. In this variation as well, depressed portions DE are situated between the terminals **150**, **190** and the adjacent terminals. Accordingly, the ink cartridge **100** pertaining to this variation affords advantages analogous to those of the ink cartridge **100** pertaining to Variation **10**.

Variation **12**:

In the boards pertaining to the embodiment and variations, all terminals are connected to one of memory **203** and sensor **104**. However, the board may include dummy terminal that is not connected to any device. An example of such type of the board will be described as Variation **12** with reference to FIGS. **19**A-D. FIGS. **19**A-D show fourth diagrams depicting boards pertaining to variations.

The board **200***r* includes the upper row formed by four terminals and the lower row formed by five terminals, as with the board **200** pertaining to the embodiment. Arrangement and function of the terminals **210**-**290** forming the upper row

and the lower row of board **200***r* is the same as those of the terminals of board **200** in the embodiment, so the detailed description thereof is omitted.

The board **200***r* shown in FIG. **19**A has the dummy terminals DT between the upper row and the lower row and on the underside (the insertion direction side) of the lower row. The dummy terminals DT, for example, are made of the same material as other terminal **210**-**290**. FIG. **19**C shows E-E cross-section including dummy terminals DT. The dummy terminals DT has about the same thickness as other terminal **210**-**290**.

The dummy terminals DT are for scraping away foreign object adherent on the contact forming members **403**, for example, dust when ink cartridge **100** is attached or detached. This enables to prevent foreign object from being brought to the terminal to be contacted by contact forming member **403** (for example, the first sensor drive terminal **250** in FIG. **19**C) when ink cartridge **100** is attached or detached, and to prevent contact failure between the terminal and the contact forming member **403**.

The board **200***r* shown in FIG. **19**A has the dummy terminal DT between the first sensor drive terminal **250** and the short detection terminal **210**, so you can't say first sensor drive terminal **250** is located adjacent to first short detection terminal **210**. However, the dummy terminals DT is not connected to memory **203** and not connected to the apparatus-side terminals **510**-**590** on printing apparatus **1000**. Therefore, the shorting between the first sensor drive terminal **250** and the dummy terminals DT never cause any problem. Accordingly, the board **200***r* can afford working effects analogous to the board **200** pertaining to the embodiment. That is to say, about the board **200***r*, even if first sensor drive terminal **250** is not located adjacent to first short detection terminal **210** in a precise sense, at least a portion of the first short detection terminal **210** is arranged relative to at least a portion of the first sensor drive terminal **250**, without a terminal connected to memory **203** (terminal **220**, **230**, **260**-**280**) therebetween in at least one direction, for the detection of shorting between the first sensor drive terminal **250** and the first short detection terminal **210**. In such a case, the first sensor drive terminal **250** is substantially located adjacent to first short detection terminal **210**. Consequently, in the event that the first sensor drive terminal **250** should short to another terminal or terminals due to the ink drop or the water drop, there is a high likelihood that the first sensor drive terminal **250** will short to the short detection terminal **210** as well. As a result, the output of sensor driving voltage is suspend and damage to the circuits of the memory **203** and the printing apparatus **1000** caused by shorting can be prevented or reduced.

Variation **13**:

The boards pertaining to the embodiment and variations, as shown in FIG. **2**, are described as the board mounted on a ink cartridge **100** used for "on carriage" type printer. However, the boards pertaining to the embodiment and variations may be mounted on an ink cartridge used for "off carriage" type printer. The ink cartridge used for "off carriage" type printer will be described below with reference to FIG. **20** and FIG. **21**. FIG. **20** shows a perspective view of the construction of the ink cartridge pertaining to the variation **13**. FIG. **21** shows a picture of the ink cartridge pertaining to the variation **13** being attached to the printer.

Ink cartridge **100***b* pertaining to Variation **13** is configured for installation in an "off carriage" type printer, i.e., one in which the ink cartridge is not installed on a carriage. Off carriage type printers are typically large-scale printers; the ink cartridges employed in such large-scale printers are typically larger in size than the ink cartridges employed in on-carriage type printers.

Ink cartridge **100***b* comprises a housing **1001** containing ink, a board mounting portion **1050** for mounting board **200**, an ink feed orifice **1020** for supplying ink from a housing **1001** to the printer; an air feed orifice **1030** allowing intake of air into ink cartridge **100***b* to allow smooth flow of ink; and guide portions **1040** for installation in the printer. The exterior dimensions of ink cartridge **100***b* are such that the side thereof (i.e. the depth direction) extending perpendicular to the side on which the guide portions **1040**, etc. are formed (i.e. the width direction) is longer than the width direction. The relationship of the depth-wise dimension to the width-wise dimension of board **200**, expressed as a ratio of the two, is 15:1 or greater, for example.

As in the case of the above-mentioned embodiment, board **200** is positioned by means of boss hole **202** and boss slot **201**, and secured on the board mounting portion **1050** of ink cartridge **100***b*.

As shown in FIG. **21**, when installing the ink cartridge **100***b* in the printer, the guide portions **1040** of ink cartridge **100***b* guide the guide pins **2040** on the printer so that the board mounting portion **1050**, ink feed orifice **1020**, and air feed orifice **1030** are appropriately contacted/coupled with a contact pin **2050**, ink feed orifice **2020**, and air feed orifice **2030** on the printer. The insertion direction of ink cartridge **100***b* is indicated by arrow R in FIG. **21**. The insertion direction R on board **200** in this variation is the same as that in the above-mentioned embodiment.

Ink cartridge **100***b* used for off carriage type printer pertaining to this variation can prevent or reduce problems caused by shorting of the first sensor drive terminal **250** to another terminal as in the case of the embodiment and variations described above.

Variation **14**:

Configuration of the ink cartridge for "on carriage" type printer shown in FIG. **2** is one example among many. Configuration of the ink cartridge for "on carriage" type printer is not limited to this. Other configuration of the ink cartridge for "on carriage" type printer shall be described as Variation **14** with reference to FIGS. **22**-**24**. FIG. **22** shows a first diagram of the construction of the ink cartridge pertaining to Variation **14**. FIG. **23** shows a second diagram of the construction of the ink cartridge pertaining to variation **14**. FIG. **24** shows a third diagram of the construction of the ink cartridge pertaining to Variation **14**.

As shown in FIGS. **22** and **23**, the ink cartridge **100***b* pertaining to Variation **14** includes housing **101***b*, board **200** and sensor **104***b*. On the bottom face of the housing **101***b*, as with ink cartridge **100** in the embodiment, there is formed an ink supply orifice **110***b* into which the ink supply needle inserts when ink cartridge **100***b* is attached to the holder **4***b*. The board **200** is mounted on the lower side (Z-axis plus direction side) of the front face (Y-axis plus direction side face) of the housing **101** as with ink cartridge **100** in the embodiment. Configuration of the board **200** is identical with the board **200** in the embodiment. The sensor **104***b* is embedded in the side wall of the housing **101***b* and used for detection of remaining ink level. Hook **120***b* that engages with catching part of the holder **4***b* when the ink cartridge **100***b* is attached to the holder **4***b* is mounted on the upper side of the front face of the housing **101***b*. Hook **120***b* fixates the Ink cartridge **100***b* to the holder **4***b*. The insertion direction when the ink cartridge **100***b* is attached to the holder **4***b* is a direction of arrow R in FIG. **22** (Z-axis plus direction) as with the ink cartridge **100** in the embodiment.

The housing **101***b* has displacement preventers PO**1**-PO**4** on the side portion (x-axis direction side) of housing **101***b* close to the board **200**. The displacement preventers PO**1**-PO**4** comes into contact with or close to a corresponding potion of the side wall of the holder **4***b* when the ink cartridge **100***b* is attached to the holder **4***b*. This prevents the ink cartridge **100***b* from moving in X-axial direction from its ideal position on the holder **4***b*. Specifically, the displacement preventers PO**1** and PO**2** are located on the upper side of the board **200** and prevent the upper side of the **100***b* from swinging in X-axial direction taking the ink supply orifice **110***b* as an axis of rotation. The displacement preventers PO**3** and PO**4** are lateral to the terminals **210**-**290** on the board **200** (FIG. **3**) and keep the terminals **210**-**290** in the correct position so as to contact the corresponding apparatus-side terminal **410**-**490** correctly.

The electrical arrangements of the ink cartridge **100***b* pertaining to Variation **14** is identical with those of the ink cartridge **100** pertaining to above-embodiment described with reference to FIG. **7**. So, the description thereof is omitted.

The ink cartridge **100***b* pertaining to Variation **14** affords the following working effects in addition to the same working effects as the ink cartridge **100** pertaining to the embodiment. Since the ink cartridge **100***b* has the displacement preventers PO**1**-PO**4**, it can prevent or reduce the position displacement when the ink cartridge **100***b* is attached to the holder **4***b*. Especially, since the displacement preventers PO**3** and PO**4** are lateral to the terminals **210**-**290** on the board **200**, accuracy of positioning of the terminals **210**-**290** relative to the corresponding apparatus-side terminals can be improved. Further, as described with reference to FIG. **3**, in the board **200**, the sensor drive terminal **250** and the second sensor drive terminal **290** are arranged at each end of the terminals **210**-**290**, that is, the sensor drive terminal **250** and the second sensor drive terminal **290** are closest to the displacement preventers PO**4** and PO**4** respectively. This lead to improvement of accuracy of positioning of the sensor drive terminal **250** and the second sensor drive terminal **290**. Therefore, the false contact between the terminals **250**, **290** to which high voltage is applied and one of the non-corresponding apparatus-side terminals can be prevented or reduced.

As substitute for the board **200** in the embodiment, one of the boards **200***b*-**200***s* shown in FIGS. **14**-**19** can be mounted on the ink cartridge **100***b* shown in FIG. **22**-**24**.

Other Variations:

As depicted in FIGS. **17**C-D and in FIGS. **18**C-D, porous elements PO may be disposed within the depressed portions DE in Variation **10** and Variation **11** described above, i.e. between the terminals **150**, **190** and the board. By so doing, ink drops or condensed water, which can easily cause shorting of the terminals **150**, **190** to other terminals, can be effectively absorbed by the porous elements PO. Accordingly, this design also affords advantages analogous to those of Variation **10** and Variation **11** discussed above.

In the embodiment herein, the ink cartridge **100** is furnished with a sensor **104** (piezoelectric element) and memory **203** as the plurality of the devices; however, the plurality of the devices are not limited to a sensor **104** and memory **203**. For example, the sensor **104** may be a sensor of a type that detects the properties or level of ink by means of applying voltage to the ink within an ink cartridge **100**, and measuring its resistance. In the embodiment, among the plurality of the devices, the sensor **104** is mounted on the housing **101** and the memory **203** is mounted on the board **200**. However, the arrangements of the plurality of the devices are not limited to those in the embodiment. For example, the memory **203** and the board **200** may be separate, and the memory **203** and the board **200** may be installed on the housing **101** individually. The plurality of the devices may be integrated into a circuit board or a single module. The circuit board or the single module may be mounted on the housing **101** or the board **200**. It's preferred that terminals connected to a device to which relatively high voltage among the plurality of the devices are arranged in positions of the first sensor drive terminal **250** and the second sensor drive terminal **290** described above, and terminals connected to a device to which relatively low voltage among the plurality of the devices are arranged in positions of the terminals **220**, **230**, **260**-**280**. In this case, damage to the ink cartridge **100** and the printing apparatus **1000** caused by shorting between the terminal connected to the device to which relatively high voltage and the terminal connected to the device to which relatively low voltage can be prevented or reduced.

In above-mentioned embodiment, five terminals for memory **203** (**220**, **230**, **260**-**280**) and two terminals for sensor **104** (**250**, **290**) are employed, however, other number of terminals may be employed due to the specification of the device. For example, the terminal connected to the device to which relatively high voltage may be one. In this case, such terminal may be arranged in a position of any of the terminals **250**, **290** described above.

Whereas in the embodiment herein the invention is implemented in an ink cartridge **100**, implementation thereof is not limited to ink cartridges, with implementation in a similar manner to receptacles containing other types of printing material, such as toner, being possible as well.

With regard to the arrangements of the main control circuit **40** and the carriage circuit **500** in the printing apparatus, portions of these arrangements implemented through hardware could instead be implemented through software, and conversely portions implemented through software could instead be implemented through hardware.

While the printing material container and board pertaining to the invention have been shown and described on the basis of the embodiment and variation, the embodiments of the invention described herein are merely intended to facilitate understanding of the invention, and implies no limitation thereof. Various modifications and improvements of the invention are possible without departing from the spirit and scope thereof as recited in the appended claims, and these will naturally be included as equivalents in the invention.

What is claimed is:

1. A printing material container adapted to be attached to a printing apparatus by being inserted into the printing apparatus in an insertion direction, the printing apparatus having a print head and a plurality of apparatus-side electrical contact members, the printing material container comprising:

an ink supply opening, having an exit, adapted to supply ink from the ink cartridge to the printing apparatus;

a low voltage electronic device adapted to receive and function with a low voltage, the low voltage electronic device comprising a memory device;

a high voltage electronic device adapted to receive and function with a high voltage, which is a higher voltage than the low voltage of the low voltage electronic device; and

a plurality of container-side terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled between the container and the printing apparatus, the contact portions of the terminals including a plurality of low voltage electronic device contact portions electrically coupled to the low voltage electronic device, and a first high voltage elec-

tronic device contact portion and a second high voltage electronic device contact portion, each electrically coupled to the high voltage electronic device, wherein:

the contact portions are arranged in a first row of contact portions and in a second row of contact portions, the first row of contact portions and the second row of contact portions extending in a row direction which is generally orthogonal to the insertion direction,

the first row of contact portions is disposed at a location that is further in the insertion direction than the second row of contact portions, and,

the first row of contact portions has a first end position and a second end position at opposite ends thereof, the first high voltage electronic device contact portion is disposed at the first end position of the first row of contact portions and the second high voltage electronic device contact portion is disposed at the second end position of the first row of contact portions.

2. The printing material container according to claim **1**, wherein the low voltage electronic device contact portions, are located between the first and second high voltage electronic device contact portions, with respect to the row direction.

3. The printing material container according to claim **1**, wherein the high voltage electronic device is adapted to output an oscillating signal, in response to receiving the high voltage.

4. The printing material container according to claim **1**, wherein the high voltage electronic device is an ink level sensor.

5. The printing material container according to claim **1**, wherein the first row of contact portions is longer than the second row of contact portions, in the row direction.

6. The printing material container according to claim **1**, wherein the number of contact portions in the first row is larger than the number of contact portions in the second row.

7. The printing material container according to claim **1**, wherein the plurality of terminals includes a first short detection terminal provided at a location and adapted to detect shorting between at least the terminal in which the first high voltage electronic device contact portion is located and the first short detection terminal.

8. The printing material container according to claim **7**, wherein there are fewer low voltage electronic device contact portions adjacent to the first high voltage electronic device contact portion than are adjacent to the contact portion of the first short detection terminal.

9. The printing material container according to claim **7**, wherein the first short detection terminal is the closest terminal to the terminal in which the first high voltage electronic device contact portion is located.

10. The printing material container according to claim **7**, wherein the contact portion of the first short detection terminal is located between one of the low voltage electronic device contact portions and the first high voltage electronic device contact portion with respect to the row direction.

11. The printing material container according to claim **7**, wherein the plurality of terminals, include a second short detection terminal, which is provided at a location and adapted to detect shorting between at least the terminal in which the second high voltage electronic device contact portion is located and the second short detection terminal.

12. The printing material container according to claim **11**, wherein the low voltage electronic device contact portions are disposed in between the contact portion of the first short detection terminal and the contact portion of the second short detection terminal, with respect to the row direction.

13. The printing material container according to claim **12**, wherein the contact portions of the first short detection terminal and the second short detection terminal are disposed in between the first and second high voltage electronic device contact portions, with respect to the row direction.

14. The printing material container according to claim **11**, wherein the contact portions of the first short detection terminal and the second short detection terminal are disposed in between the first and second high voltage electronic device contact portions, with respect to the row direction.

15. The printing material container according to claim **11**, wherein the first high voltage electronic device contact portion and contact portion of the first short detection terminal are disposed on one side of the low voltage electronic device contact portions, with respect to the row direction, and the second high voltage electronic device contact portion and the contact portion of the second short detection terminal are disposed on the other side of the low voltage electronic device contact portions, with respect to the row direction.

16. The printing material container according to claim **11**, wherein the first short detection terminal and the terminal in which the first high voltage electronic device contact portion is located are disposed on one side of the terminals in which the low voltage electronic device contact portions are located, with respect to the row direction, and the second short detection terminal and the terminal in which the second high voltage electronic device contact portion is located are disposed on the other side of terminals in which the low voltage electronic device contact portions are located with respect to the row direction.

17. The printing material container according to claim **11**, wherein the number of low voltage electronic device contact portions adjacent to the second high voltage electronic device contact portion is smaller than the number of low voltage electronic device contact portions adjacent to the contact portion of the second short detection terminal.

18. A printing material container for mounting in a printing apparatus having a print head and a plurality of apparatus-side contact forming members, the printing material container comprising:

an ink supply opening, having an exit, adapted to supply ink from the ink cartridge to the printing apparatus;

a low voltage electronic device constructed to receive and function with a low voltage;

a high voltage electronic device constructed to receive and function with a high voltage, which is a higher voltage than the low voltage; and

a plurality of terminals having contact portions adapted to contact corresponding apparatus-side contact forming members so that electrical communication is enabled with the printing apparatus when the printing material container is mounted on the printing apparatus, the contact portions of the terminals including a plurality of low voltage electronic device contact portions electrically coupled to the low voltage electronic device, a first high voltage electronic device contact portion electrically coupled to the high voltage electronic device, and a second high voltage electronic device contact portion electrically coupled to the high voltage electronic device and arranged to have applied thereto a higher voltage than the low voltage electronic device contact portions, wherein:

the contact portions are arranged in a first row of contact portions and in a second row of contact portions, such that when the plurality of terminals is viewed from the vantage of the apparatus-side contact forming members, with the plurality of terminals oriented as if in

contact with the apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the exit of the ink supply opening facing downward, the first row of contact portions and the second row of contact portions extend in a row direction which is generally horizontal and the first row of contact portions is disposed at a location below the second row of contact portions, and

the first high voltage electronic device contact portion is disposed at one end of the first row of contact portions and the second high voltage electronic device contact portion is disposed at the opposite end of the first row of contact portions.

19. The printing material container according to claim **18**, wherein the low voltage electronic device contact portions are located between the first and second high voltage electronic device contact portions, with respect to the row direction.

20. The printing material container according to claim **18**, wherein the high voltage electronic device is adapted to output an oscillating signal, in response to receiving the high voltage.

21. The printing material container according to claim **18**, wherein the high voltage electronic device is an ink level sensor.

22. The printing material container according to claim **18**, wherein the first row of contact portions is longer than the second row of contact portions.

23. The printing material container according to claim **18**, wherein the number of contact portions in the first row is larger than the number of contact portions in the second row.

24. The printing material container according to claim **18**, wherein the plurality of terminals include a first short detection terminal provided at a location and adapted to detect shorting between at least the terminal in which the first high voltage electronic device contact portion is located and the first short detection terminal.

25. The printing material container according to claim **24**, wherein fewer low voltage electronic device contact portions are adjacent to the first high voltage electronic device contact portion than are adjacent to the first short detection terminal.

26. The printing material container according to claim **24**, wherein the first short detection terminal is the closest terminal to the terminal in which the first high voltage electronic device contact portion is located.

27. The printing material container according to claim **24**, wherein the contact portion of the first short detection terminal is located between a low voltage electronic device contact portion and the first high voltage electronic device contact portion, with respect to the row direction.

28. The printing material container according to claim **24**, wherein the plurality of terminals include a second short detection terminal provided at a location and adapted to detect shorting between at least the terminal in which the second high voltage electronic device contact portion is located and the second short detection terminal.

29. The printing material container according to claim **28**, wherein the low voltage electronic device contact portions are disposed in between the first short detection terminal and the second short detection terminal, with respect to the row direction.

30. The printing material container according to claim **29**, wherein the contact portions of the first short detection terminal and the second short detection terminal are disposed in between the first and second high voltage electronic device contact portions, with respect to the row direction.

31. The printing material container according to claim **28**, wherein the contact portions of the first short detection terminal and the second short detection terminal are disposed in between the first and second high voltage electronic device contact portion with respect to the row direction.

32. The printing material container according to claim **28**, wherein the first high voltage electronic device contact portion and the contact portion of the first short detection terminal are disposed on one side of the low voltage electronic device contact portions, with respect to the row direction, and the second high voltage electronic device contact portion and the contact portion of the second short detection terminal are disposed on the other side of the low voltage electronic device contact portions, with respect to the row direction.

33. The printing material container according to claim **28**, wherein the first short detection terminal and the terminal in which the first high voltage electronic device contact portion is located are disposed on one side of the terminals in which the low voltage electronic device contact portions are located, with respect to the row direction, and the second short detection terminal and the terminal in which the second high voltage electronic device contact portion is located are disposed on the other side of the terminals in which the low voltage electronic device contact portions are located, with respect to the row direction.

34. The printing material container according to claim **28**, wherein the number of low voltage electronic device contact portions adjacent to the second high voltage electronic device contact portion is smaller than the number of low voltage electronic device contact portions adjacent to the contact portion of the second short detection terminal.

35. The printing material container according to claim **1**, wherein the first row of contact portions includes at least one of the plurality of low voltage electronic device contact portions.

36. The printing material container according to claim **35**, wherein the low voltage electronic device contact portions in the first row of contact portions are arranged in between the first and second high voltage electronic device contact portions.

37. The printing material container according to claim **35**, wherein the first row of contact portions is the leading row of contact portions in the insertion direction.

38. The printing material container according to claim **35**, wherein the first row of contact portions is the row of contact portions furthest in the insertion direction.

39. The printing material container according to claim **7**, wherein the first row of contact portions includes at least one of the plurality of low voltage electronic device contact portions.

40. The printing material container according to claim **7**, wherein the contact portion of the first short detection terminal and a portion of the low voltage electronic device contact portions are located in the second row of contact portions.

41. The printing material container according to claim **40**, wherein the plurality of terminals include a second short detection terminal, which is provided at a location and adapted to detect shorting between at least the terminal in which the second high voltage electronic device contact portion is located and the second short detection terminal, the contact portion of the second short detection terminal being located in the second row of contact portions, the portion of the low voltage electronic device contact portions being located in between the contact portions of the first and second short detection terminal in the second row of contact portions.

42. The printing material container according to claim **41**, wherein the remainder of the low voltage electronic device

contact portions are located in the first row of contact portions, the remainder of the low voltage electronic device contact portions being located in between the contact portions of the first and second short detection terminals, with respect to the row direction.

43. The printing material container according to claim **40**, wherein the remainder of the low voltage electronic device contact portions are located in the first row of contact portions.

44. The printing material container according to claim **43**, wherein the low voltage electronic device contact portions in the first row of contact portions are arranged in between the first and second high voltage electronic device contact portions.

45. The printing material container according to claim **43**, wherein the first row of contact portions is the leading row of contact portions in the insertion direction.

46. The printing material container according to claim **43**, wherein the first row of contact portions is the row of contact portions that is furthest in the insertion direction.

47. The printing material container according to claim **18**, wherein the first row of contact portions includes at least one of the plurality of low voltage electronic device contact portions.

48. The printing material container according to claim **47**, wherein the low voltage electronic device contact portions in the first row of contact portions are arranged in between the first and second high voltage electronic device contact portions.

49. The printing material container according to claim **47**, wherein the contact portions in the first row of contact portions are the lowest row of contact portions when the plurality of terminals is viewed from the vantage of the apparatus-side contact forming members, with the plurality of terminals oriented as if in contact with the apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the exit of the ink supply opening facing downward.

50. The printing material container according to claim **47**, wherein the first row of contact portions is longer than the second row of contact portions.

51. The printing material container according to claim **24**, wherein the first row of contact portions includes at least one of the plurality of low voltage electronic device contact portions.

52. The printing material container according to claim **24**, wherein the contact portion of the first short detection terminal and at least one of the low voltage electronic device contact portions are located in the second row of contact portions.

53. The printing material container according to claim **52**, wherein the plurality of terminals include a second short detection terminal, which is provided at a location and adapted to detect shorting between at least the terminal in which the second high voltage electronic device contact portion is located and the second short detection terminal, the contact portion of the second short detection terminal being located in the second row of contact portions.

54. The printing material container according to claim **53**, wherein the remainder of the low voltage electronic device contact portions are located in the first row of contact portions, the remainder of the low voltage electronic device contact portions being located in between the contact portions of the first and second short detection terminals, at least one of the low voltage electronic device contact portions being located in between the contact portions of the first and second short detection terminals in the second row of contact portions.

55. The printing material container according to claim **52** wherein the remainder of the low voltage electronic device contact portions are located in the first row of contact portions.

56. The printing material container according to claim **55**, wherein the low voltage electronic device contact portions in the first row of contact portions are arranged in between the first and second high voltage electronic device contact portions.

57. The printing material container according to claim **55**, wherein the contact portions in the first row of contact portions is the lowest row of contact portions when the plurality of terminals is viewed from the vantage of the apparatus-side contact forming members, with the plurality of terminals oriented as if in contact with the apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the exit of the ink supply opening facing downward.

58. The printing material container according to claim **57**, wherein the first row of contact portions is longer than the second row of contact portions.

59. The printing material container according to claim **42**, wherein the first row of contact portions is the leading row of contact portions in the insertion direction.

60. The printing material container according to claim **42**, wherein the first row of contact portions is the furthest row of contact portions in the insertion direction.

61. The printing material container according to claim **54**, wherein the contact portions in the first row of contact portions is the lowest row of contact portions when the plurality of terminals is viewed from the vantage of the apparatus-side contact forming members, with the plurality of terminals oriented as if in contact with the apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and the exit of the ink supply opening facing downward.

62. The printing material container according to claim **61**, wherein the first row of contact portions is longer than the second row of contact portions.

* * * * *

EXHIBIT B

US008454116B2

(12) **United States Patent**
Asauchi

(10) **Patent No.: US 8,454,116 B2**
(45) **Date of Patent: Jun. 4, 2013**

(54) **PRINTING MATERIAL CONTAINER, AND BOARD MOUNTED ON PRINTING MATERIAL CONTAINER**

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(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,683,481 A 7/1987 Johnson
4,739,352 A 4/1988 Gorelick et al.
5,032,855 A 7/1991 Taniguchi et al.
5,049,898 A 9/1991 Arthur et al.
5,278,584 A 1/1994 Keefe et al.
5,565,786 A 10/1996 Balousek
5,610,635 A 3/1997 Murray et al.
5,646,660 A 7/1997 Murray

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1272081 A 11/2000
CN 1532064 A 9/2004

(Continued)

OTHER PUBLICATIONS

Photos of HP No. 10 cartridge.

(Continued)

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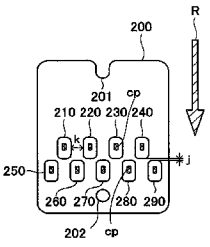
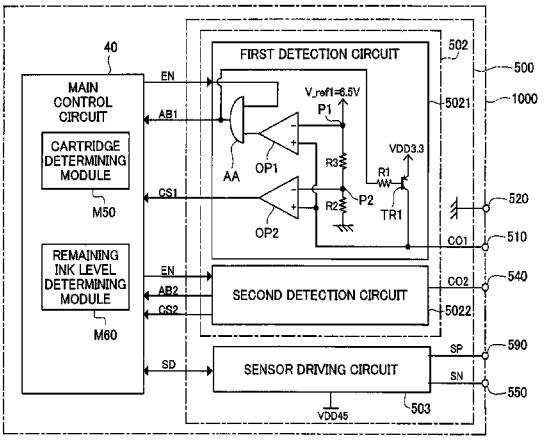
(74) *Attorney, Agent, or Firm* — Stroock & Stroock & Lavan LLP

(57) **ABSTRACT**

A printing material container detachably attachable to a printing apparatus having apparatus-side terminals. The container can comprise an electrical device, a memory device and a plurality of terminals. First and second terminals can be coupled to the electrical device and a plurality of memory terminals can be coupled to the memory device. Terminal contact portions are present where the terminals contact a respective apparatus side contact forming member. A short detection contact portion can be positioned to contact a contact forming member that itself is coupled to a short detection circuit of the printing apparatus. The terminals can be arranged with the memory terminal contact portions located to the left of the second terminal contact portion and to the right of the first terminal contact portion. The contact portion that is second farthest to the right can be the third contact portion.

30 Claims, 22 Drawing Sheets





U.S. PATENT DOCUMENTS

5,699,091	A	12/1997	Bullock et al.
5,710,582	A	1/1998	Hawkins et al.
5,751,311	A	5/1998	Drake
5,788,388	A	8/1998	Cowger et al.
5,940,095	A	8/1999	Parish et al.
6,039,428	A	3/2000	Juve
6,086,193	A	7/2000	Shimada et al.
6,130,695	A	10/2000	Childers et al.
6,155,664	A	12/2000	Cook
6,155,678	A	12/2000	Komplin et al.
6,161,915	A	12/2000	Bolash et al.
6,164,743	A	12/2000	Hmelar et al.
6,260,942	B1	7/2001	Ahne et al.
6,280,017	B1	8/2001	Miyauchi
6,550,902	B2	4/2003	Shinada et al.
6,585,359	B1	7/2003	Gasvoda et al.
6,749,287	B2	6/2004	Osada et al.
7,008,053	B2	3/2006	Hashii et al.
7,175,244	B2	2/2007	Usui et al.
7,201,463	B2	4/2007	Kosugi et al.
7,219,985	B2	5/2007	Shinada et al.
7,237,864	B2	7/2007	Sarmast et al.
7,306,308	B2	12/2007	Tsukada
2002/0003551	A1	1/2002	Beck et al.
2002/0024559	A1	2/2002	Murray et al.
2002/0135623	A1	9/2002	Tsukada et al.
2002/0167574	A1	11/2002	Shinada et al.
2002/0171700	A1	11/2002	Shinada et al.
2002/0180823	A1	12/2002	Shinada et al.
2003/0043216	A1	3/2003	Usui et al.
2003/0054003	A1	3/2003	Leung et al.
2003/0058296	A1	3/2003	Shinada et al.
2003/0079655	A1	5/2003	Takahashi et al.
2003/0085969	A1	5/2003	Shinada et al.
2003/0137568	A1	7/2003	Shinada et al.
2004/0155913	A1	8/2004	Kosugi et al.
2005/0057622	A1	3/2005	Kimura et al.
2005/0146576	A1	7/2005	Shinada et al.
2005/0146579	A1	7/2005	Sasaki et al.
2005/0195255	A1	9/2005	Shinada et al.
2005/0219303	A1	10/2005	Matsumoto et al.
2005/0237349	A1	10/2005	Nishihara
2005/0270315	A1	12/2005	Yamamoto
2006/0007253	A1	1/2006	Kosugi
2006/0033790	A1	2/2006	Shinada et al.
2006/0119677	A1	6/2006	Shinada et al.
2006/0203050	A1	9/2006	Shinada et al.
2006/0250426	A1	11/2006	Wanibe et al.
2006/0250446	A1	11/2006	Wanibe et al.
2007/0149044	A1	6/2007	Asauchi
2008/0158318	A1	7/2008	Asauchi
2008/0259135	A1	10/2008	Asauchi et al.

FOREIGN PATENT DOCUMENTS

DE	102006060705	A1	6/2007
EA	1155864	A1	11/2001
EP	0412459	A2	2/1991
EP	0593282	A2	4/1994
EP	0789322	A2	8/1997
EP	0805028	A1	11/1997
EP	0812693	A1	12/1997
EP	0873873	A2	10/1998
EP	0882595	A2	12/1998
EP	0997297	A1	5/2000
EP	1013426	A2	6/2000
EP	1219437	A2	7/2002
EP	1279503	A2	1/2003
EP	1281523	A2	2/2003
EP	1300245	A1	4/2003
EP	1314565	A2	5/2003
EP	1462262	A1	9/2004
EP	1188567	A2	3/2005
EP	1514690	A1	3/2005
EP	1097043	B1	11/2005
EP	1598198	A2	11/2005
EP	1792733	A1	6/2007
EP	1800872	A1	6/2007
EP	2080622	A1	7/2009
EP	2080622	B1	2/2011
GB	2369801	A	6/2002
GB	2424623	A	10/2006
GB	2446311	A	8/2008
GB	2447150	A	9/2008
JP	62-184856	A	8/1987
JP	02-009645	A	1/1990
JP	02-279344	A	11/1990
JP	03-211060	A	9/1991
JP	05-246032	A	9/1993
JP	06-320818	A	11/1994
JP	07-052411	A	2/1995
JP	07-060954	A	3/1995
JP	07-309018		11/1995
JP	08-090871	A	4/1996
JP	08-221158	A	8/1996
JP	09-174827	A	7/1997
JP	10-006535	A	1/1998
JP	10-086357	A	4/1998
JP	11-312554	A	11/1999
JP	11-320857	A	11/1999
JP	2000-006413	A	1/2000
JP	2000-198190	A	7/2000
JP	2001-147146	A	5/2001
JP	2002-079655	A	3/2002
JP	2002-154222	A	5/2002
JP	2002-513340	A	5/2002
JP	2002-198627	A	7/2002
JP	2003-054003	A	2/2003
JP	2003-103796	A	4/2003
JP	2003-152297	A	5/2003
JP	2004-050573	A	2/2004
JP	2004-261970	A	9/2004
JP	2004-310312	A	11/2004
JP	2005-161764	A	6/2005
JP	2005-246664	A	9/2005
JP	2005-343037	A	12/2005
JP	2005-372028		12/2005
JP	2006-100398	A	4/2006
JP	2007-196664		8/2007
TW	310363		7/1997
TW	200520981		7/2005
TW	200526423	A	8/2005
WO	98/04414	A1	2/1998
WO	98/55318	A1	12/1998
WO	98/55324	A1	12/1998
WO	02/04215	A1	1/2002
WO	2005/000591	A1	1/2005
WO	2006/025578	A1	3/2006
WO	2006/104258	A1	10/2006
WO	2006104258	A1	10/2006

OTHER PUBLICATIONS

The Hard Copy Supplies Journal dated Apr. 1998.
HP2000C User Guide.
Dallas Semiconductor, DS1220AB/AD, 16K Nonvolatile SRAM.
Notice of Opposition for EP2080622 dated Dec. 7, 2011.
Opposition Form for EP2080622 filed Nov. 28, 2011.
Grounds of Opposition for EP2080622 dated Nov. 23, 2011 and English translation.
Decision of Appeal for Invalidation 2011-800028 received Nov. 25, 2011 and English translation.
HL4a-d, Anspruch 1, 10, 11 and 12—EP2080622BA received at the EPO on Nov. 23, 2011.
Office Action issued on Oct. 23, 2012 in Taiwan Patent Appln. No. 099126391 and its English Translation.
U.S. Appl. No. 12/257,827.
Office Action in U.S. Appl. No. 11/572,880 dated Dec. 7, 2010.
Notice of Opposition filed against EP1800872B1, Annexes of the Notice of Opposition, and an English translation thereof.
Accelerated Graphic Port Interface Specification, Jul. 31, 1996, pp. 89-96.
English Translation of Taiwanese Search Report issued Apr. 22, 2010 in a related Taiwanese application.
European Patent Office—Extended European Search Report Pursuant to Rule 62 EPC dated Mar. 8, 2010.

"Written Statement", in Japanese Patent Document No. 4144637, (original Japanese and English), dated Aug. 26, 2011.
"Dallas Semiconductor DS1220AB/AD 16k Nonvolatile SRAM", cited in Japanese Patent Document No. 4144637.
"Rebuttal to Corrected Claims", in Japanese Patent Document No. 4144637, (original Japanese and English) dated Jul. 11, 2011.
"Rebuttal to the Reply Brief", in Japanese Patent Document No. 4144637, (original Japanese and English) dated Jul. 11, 2011.
"Opinion Brief", in Japanese Patent Document No. 4144637, (original Japanese and English) dated Jul. 11, 2011.
"Notice of Examination", in Japanese Patent Document No. 4144637, (original Japanese and English) dated Aug. 22, 2011.
"Notice of Reasons for Rejection (of Amendments)", in Japanese Patent Document No. 4144637, (original Japanese and English) dated Aug. 26, 2011.
Statement of Defense and Counterclaim dated Dec. 29, 2010 in Dutch Case No. 378291 re EP1800872B and English translation.
Defendant's Brief dated Dec. 17, 2010 in Japanese Patent Rights Infringement Demand for Injury case 2010 (Wa) No. 7482 (3-20101217) and English translation.
Response to Complaint dated Sep. 17, 2010 in German Action re EP1800872B and English translation.
Response to Complaint dated Sep. 17, 2010 in German Action re Utility Model DE 20 2006 020 730 U1 and English translation.
Allowed claims of U.S. Appl. No. 11/611,641 (published as US-2007/0149044-A1).
Allowed claims of U.S. Appl. No. 12/040,308 (published as US-2008/0158318-A1).
U.S. Appl. No. 12/257,914.
Defendant's Deed of Appearance and Reply (Italian language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275.
Defendant's Deed of Appearance and Reply (English language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275.
Defendant's Second Preparatory Brief dated Feb. 16, 2011; 2010 (Wa) No. 7482 Patents Rights Infringement Demand for Injunction Case for JP4144637B.
International Preliminary Report on Patentability and Written Opinion dated Jul. 1, 2008 in PCT/JP2006/325448.
Spanish Patent Application P200603218 Search Report and Written Opinion dated Sep. 21, 2009.
Malaysian Patent Application PI20091706 Office Action dated Dec. 31, 2010.
European Patent Application EP10184458.7 Search Report dated Dec. 27, 2010.
Summons to Oral Proceeding and Notification in JP4144637B dated Feb. 22, 2011.
Translation of Summons to Oral Proceeding and Notification in JP4144637B dated Feb. 22, 2011.
Opponent's Comments to the Patent Proprietor's Rejoinder in the Opposition Proceedings of EP 1 800 872 B1.
Notification of Reason for Rejection of Correction From Proceedings regarding JP Patent No. 4144637, dated Mar. 1, 2011.
Combined Search and Examination Report, U.K. Patent Appln. No. GB 0819699.0, Feb. 27, 2009.
Search and Examination Report issued in counterpart application GB0922617.6 by the Intellectual Property Office of the United Kingdom.
Petition to Tokyo District Court, Civil Affairs Div. 29-C in connection with "2010 (wa) No. 7482 Patent Infringement Injunction" dated Feb. 26, 2010, and English translation thereof.
Defendant's first preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Jun. 7, 2010, and English translation thereof.
Australian Search and Examination Report (May 8, 2007) and letter from Singapore Patent Office forwarding same dated Jun. 4, 2007.
U.S. Appl. No. 11/572,880.
New Zealand Examination Report for NZ patent appln. No. 552094 dated Dec. 19, 2006.
United Kingdom Search Report for UK patent appln. No. GB0625839.6 dated Apr. 20, 2007.
Extended European Search Report for European patent appln. No. 06256540.3 dated May 4, 2007.
International Search Report and Written Opinion for international patent appln. No. PCT/JP2006/325448 dated May 8, 2007.
Search Report for PCT/JP2005/016205 dated Nov. 22, 2005.
English translation of Written Opinion of the International Searching Authority issued in PCT/JP2005/016205 dated Mar. 29, 2007.
Allowed claims corresponding to Application No. 2002-167574.
Allowed claims corresponding to Application No. 2002-171700.
Allowed claims corresponding to Application No. 2002-180823.
Allowed claims corresponding to Application No. 2003-58296.
Allowed claims corresponding to Application No. 2006-33790.
Allowed claims corresponding to Application No. 2006-119677.
Search Report from British patent appln. No. GB0804416.6 dated May 30, 2008.
Defendant's third preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 30, 2010.
Defendant's second preparatory pleadings to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 30, 2010.
Defendant's Demand for Judgment to Tokyo District Court, Civil Affairs Div. 29-C in connection with 2010 (wa) No. 7482 Patent Infringement Injunction dated Sep. 29, 2010.
Written Submission by Pelikan Hardcopy Production AG in Opposition Proceedings of EP 1 800 872, dated Aug. 31, 2011.
English Translation of Written Submission by Pelikan Hardcopy Production AG in Opposition Proceedings of EP 1 800 872, dated Aug. 31, 2011.
Interlocutory decision in opposition proceedings for EP-B-1 800 872 dated Nov. 29, 2011.
Dallas Semiconductor, DS1220AB/AD, 16K Nonvolatile SRAM, apparently dated Feb. 19, 1998 and listed on an EPO Opposition filing dated Nov. 23, 2011.
Photos of HP No. 10 cartridge listed on an EPO Opposition filing dated Nov. 23, 2011.
HP2000C User Guide listed on an EPO Opposition filing dated Nov. 23, 2011.
Allowed claims corresponding to US Application No. 2006-0033790 filed Oct. 19, 2005.
Allowed claims corresponding to US Application No. 2006-0119677 filed Jan. 30, 2006.
Defendant's Deed of Appearance and Reply (Italian language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275 dated Feb. 9, 2011.
Defendant's Deed of Appearance and Reply (English language version)—Patent infringement litigation based on two counterpart patents EP1800872B1 and IT1374275 dated Feb. 9, 2011.
U.S. Appl. No. 11/572,880, filed Jun. 25, 2008.
Opponent's Comments to the Patent Proprietor's Rejoinder in the Opposition Proceedings of EP1800872B1 dated Jan. 27, 2011.
Notice of Opposition filed against EP1800872B1, Annexes of the Notice of Opposition, and an English translation thereof dated Dec. 7, 2011.
Search and Examination Report issued in counterpart application GB0922617.6 by the Intellectual Property Office of the United Kingdom dated Mar. 12, 2010.
Allowed claims of U.S. Appl. No. 11/611,641 (published as US-2007/149944-A1) filed Dec. 15, 2006.
Allowed claims of U.S. Appl. No. 12/040,308 (published as US-2008/158318-A1) filed Feb. 29, 2008.
U.S. Appl. No. 12/257,827, filed Oct. 24, 2008.
Allowed claims corresponding to Publication No. US-2002-0167574-A1 published Nov. 14, 2002.
Allowed claims corresponding to Publication No. US-2002-0171700-A1 published Nov. 21, 2002.
Allowed claims corresponding to Application No. US-2002-0180823-A1 published Dec. 5, 2002.
Allowed claims corresponding to Application No. US-2003-0058296-A1 published Mar. 27, 2003.
Response to Appeal dated Oct. 1, 2012 for European Patent No. 1800872 B1.

English translation of Response to Appeal dated Oct. 1, 2012 for European Patent No. 1800872 B1.
Statement of grounds for appeal for EP 1800872 B1 dated Apr. 10, 2012 and English translation.
Canon Colour Bubble Jet Printer BJC-7000 User Manual dated 1997 and English translation.
Affidavit of Daniel Sulser regarding analysis of "T0714" Epson ink cartrige and "Epson Stylus D78" and photos from Sep. 2006 and English translation.
Article on Epson Stylus D120 dated Dec. 14, 2007 and English translation.
Article on Epson Stylus D78 and D88 plus dated Aug. 21, 2006 and English translation.
Photo of Epson cartridge dated Apr. 10, 2012.
Affidavit of Joachim Kretschmer regarding analysis of "T071x" Epson ink cartrige and "Epson Stylus D78" dated Apr. 10, 2012 and English translation.

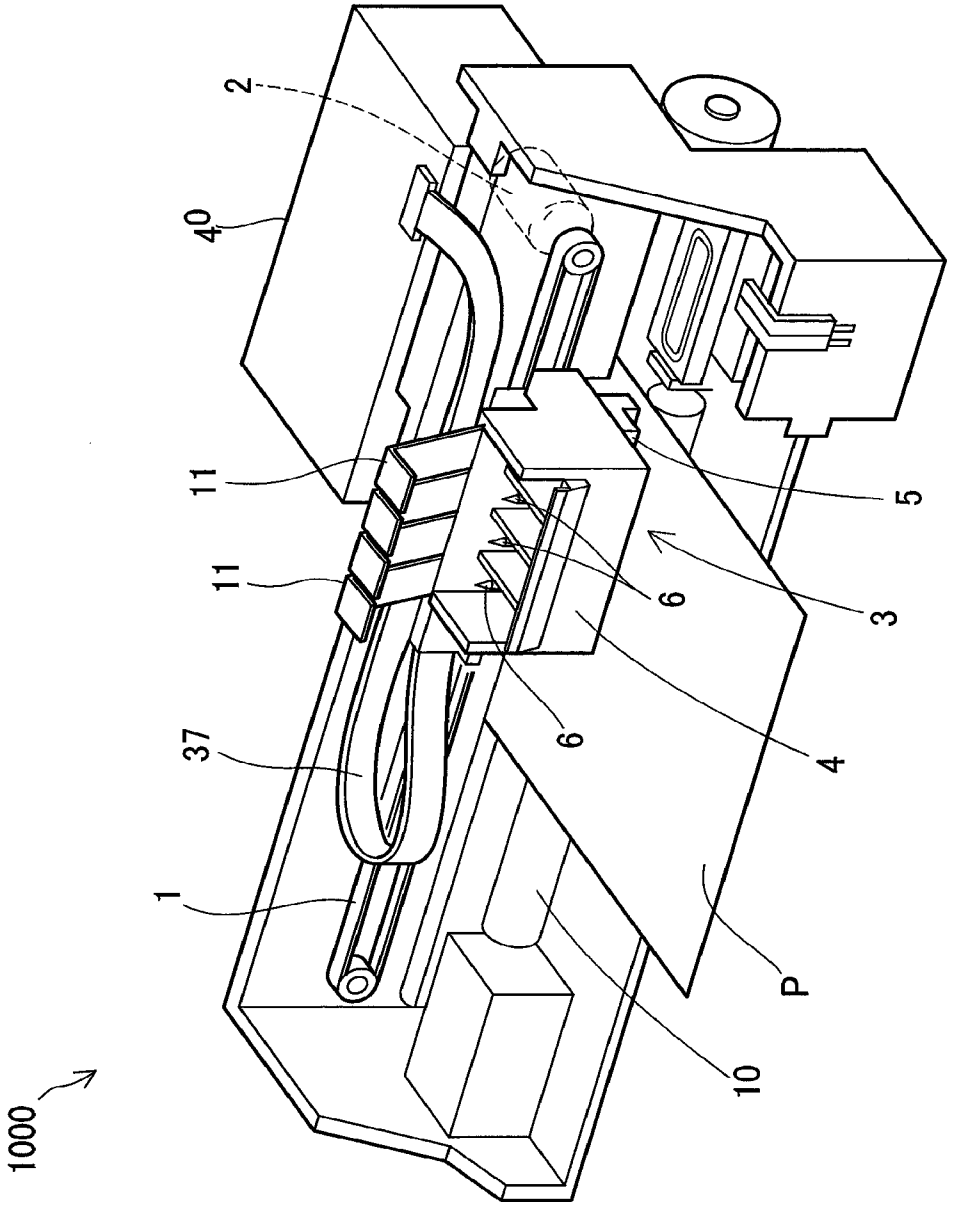


Fig.1

Fig.2

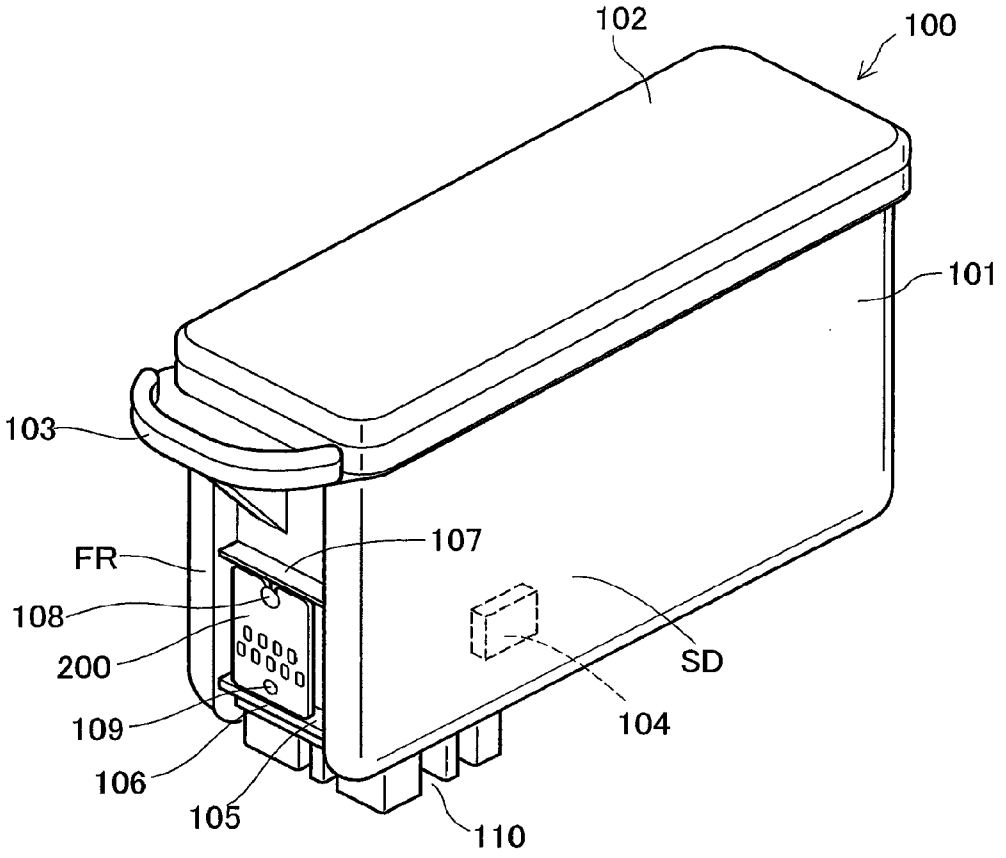


Fig.3A

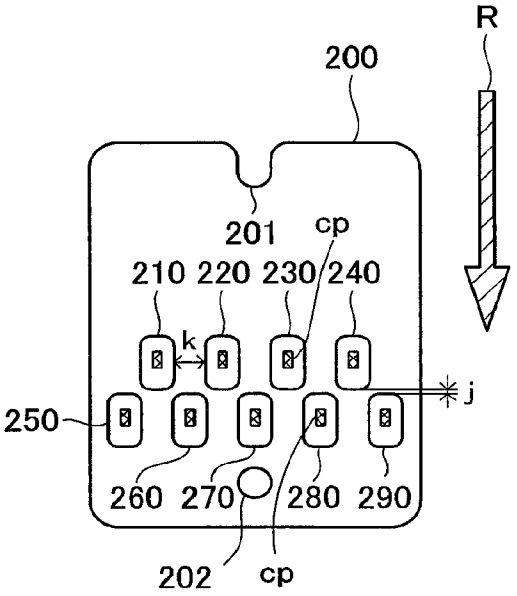


Fig.3B

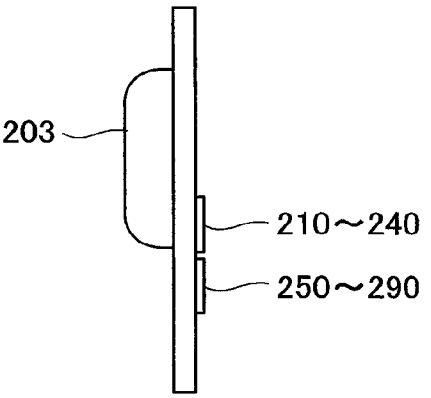
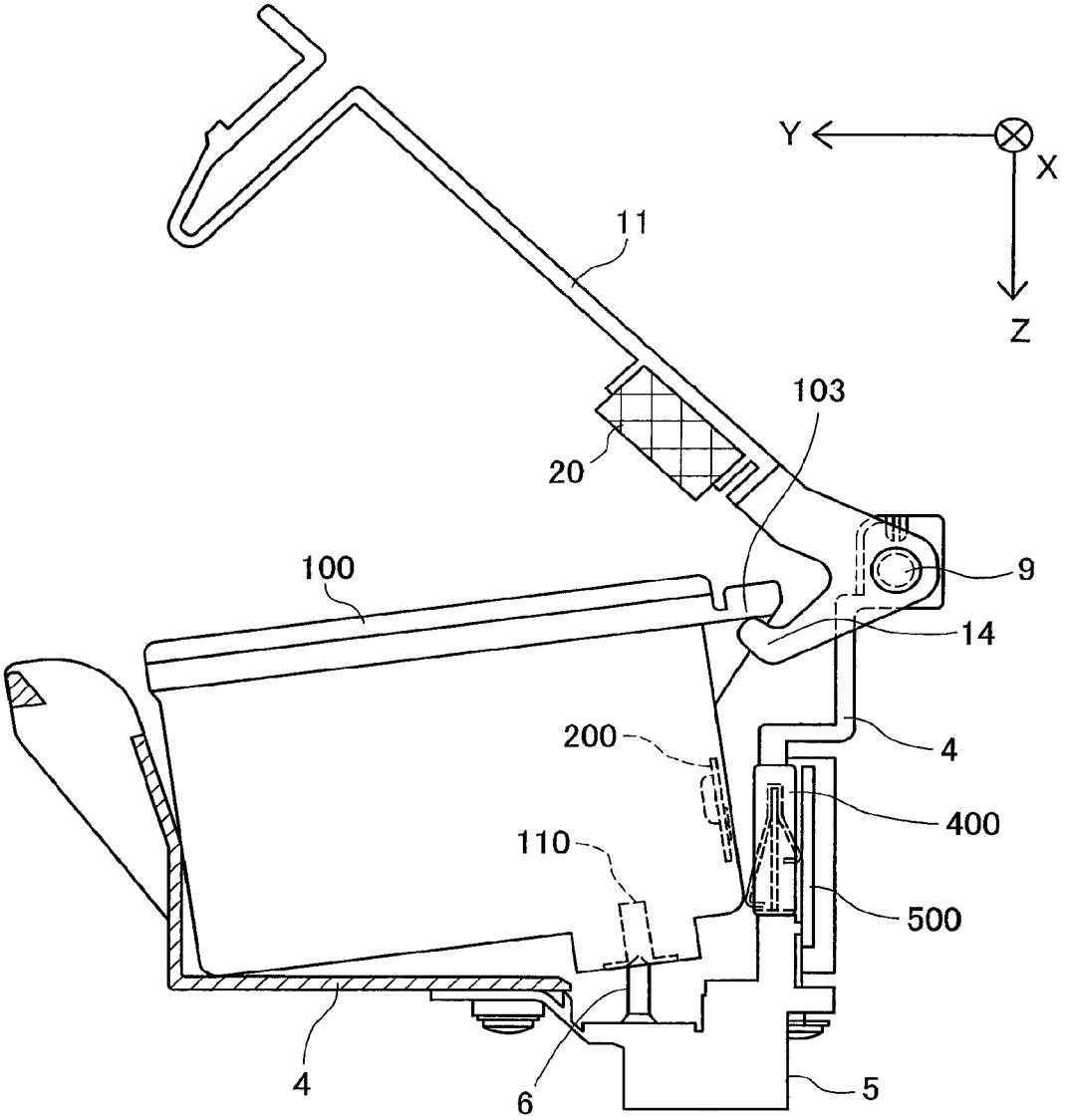


Fig.4



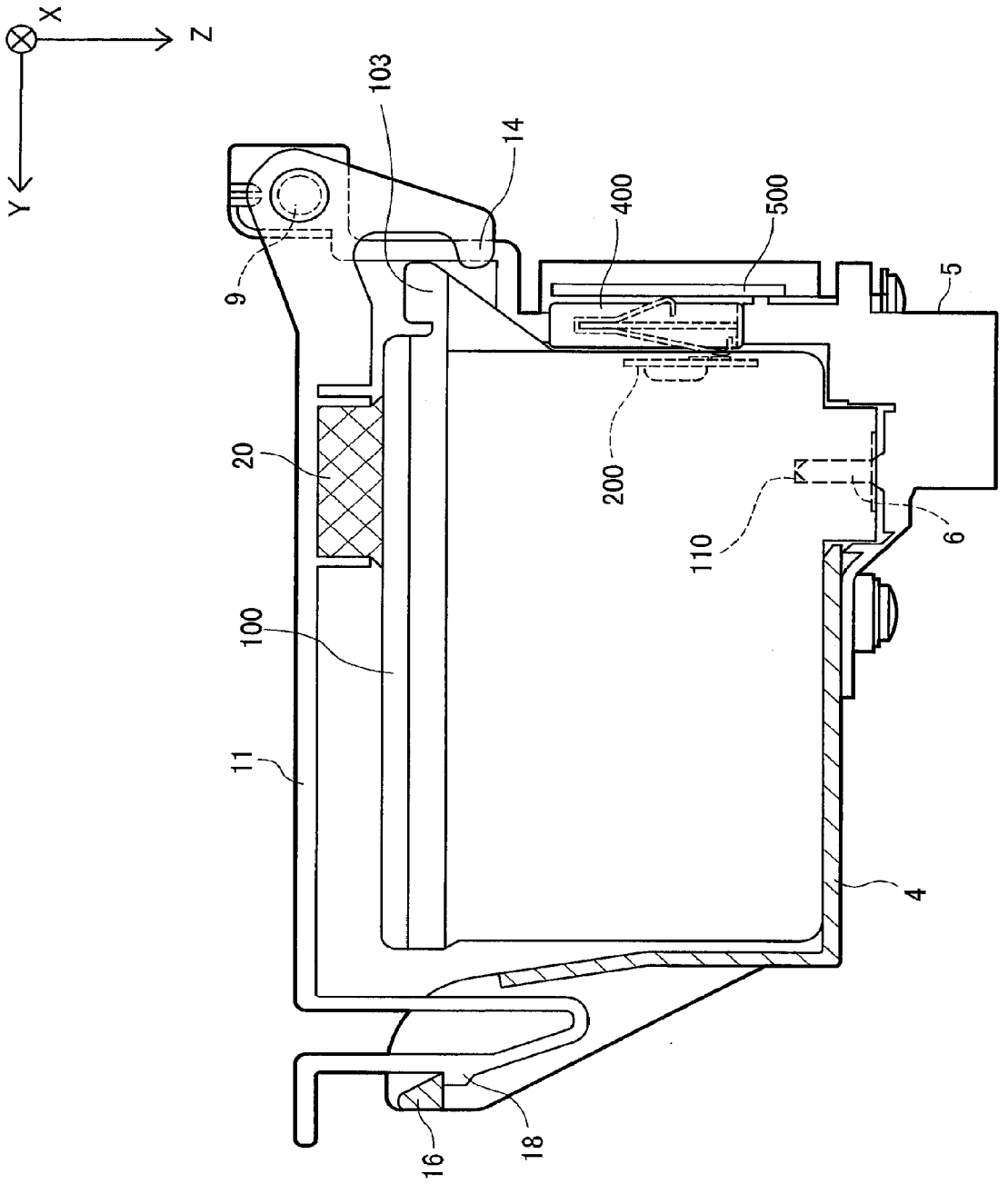


Fig.5

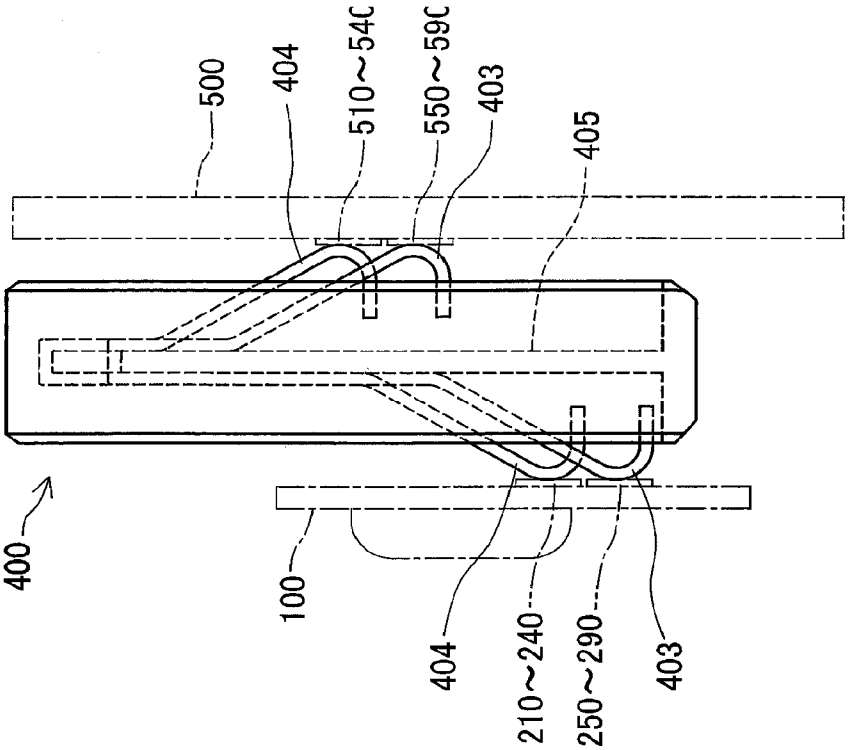

500
404
510~540
550~590
403
405
400
100
404
210~240
250~290
403

Fig.6B

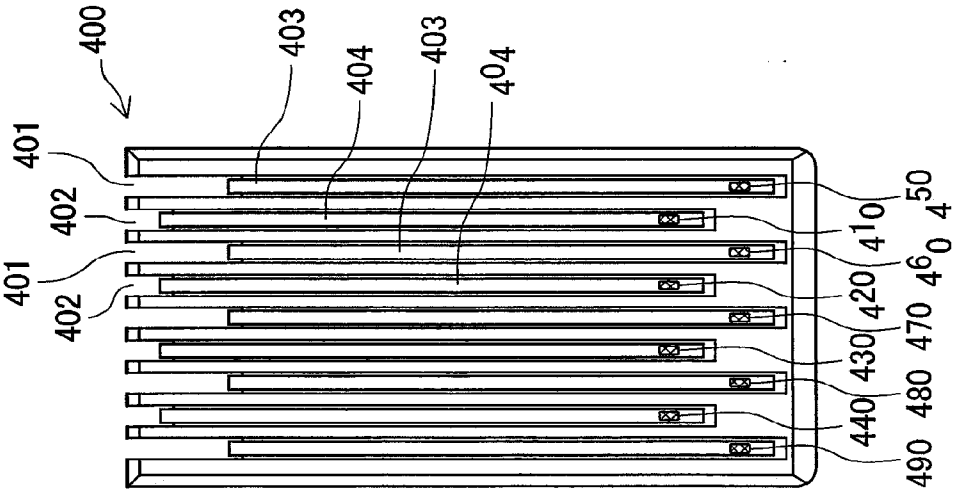

400
403
404
403
404
401
402
401
402
410
450
460
420
470
430
480
440
490

Fig.6A

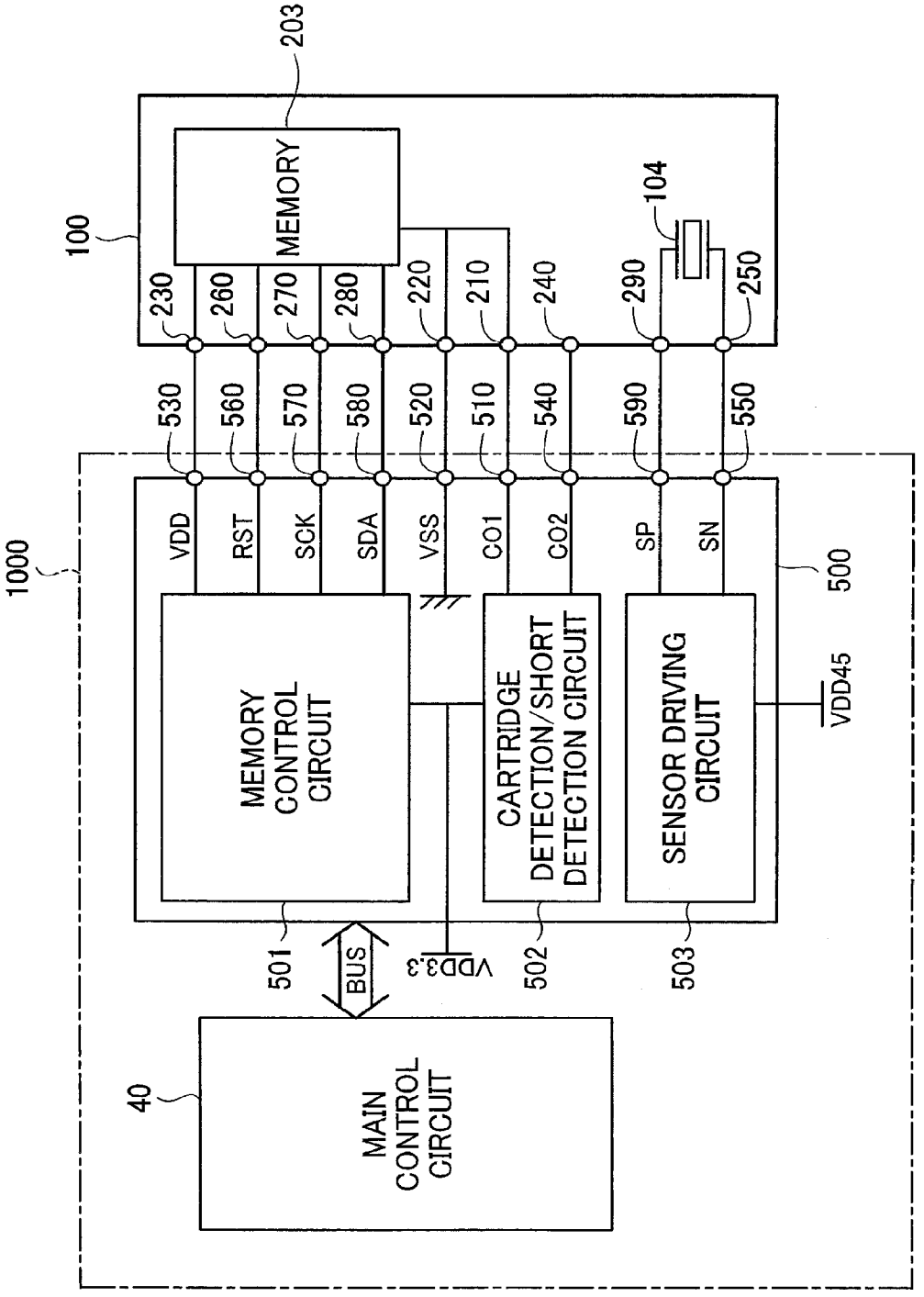

203
MEMORY
100
104
230
260
270
280
220
210
240
290
250
530
560
570
580
520
510
540
590
550
1000
VDD
RST
SCK
SDA
VSS
CO1
CO2
SP
SN
500
MEMORY CONTROL CIRCUIT
CARTRIDGE DETECTION/SHORT DETECTION CIRCUIT
SENSOR DRIVING CIRCUIT
VDD45
501
BUS
VDD3
502
503
40
MAIN CONTROL CIRCUIT

Fig.7

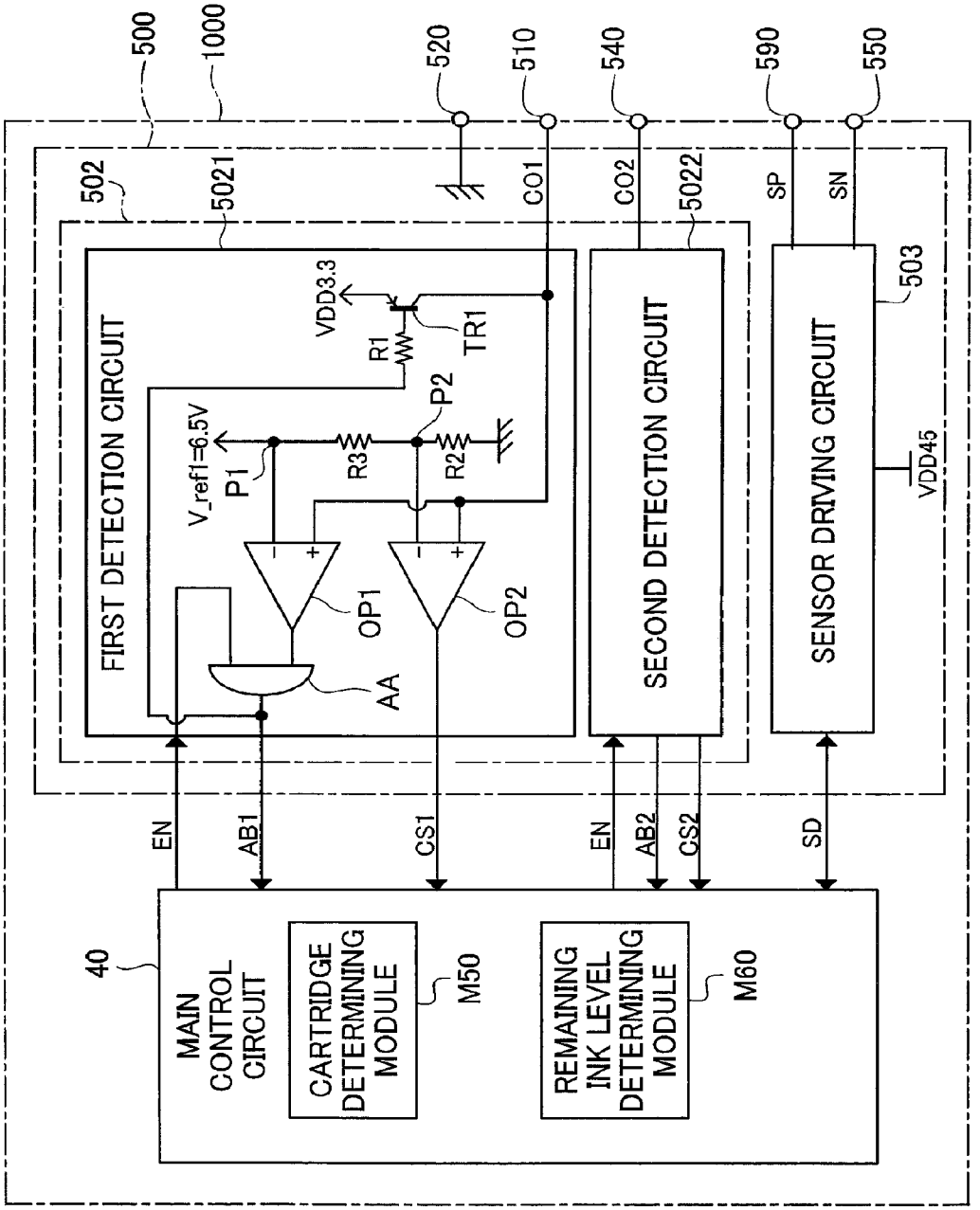

500
1000
520
510
540
590
550
502
5021
CO1
CO2
5022
SP
SN
503
FIRST DETECTION CIRCUIT
VDD3.3
R1
TR1
P2
V_ref1=6.5V
P1
R3
R2
OP1
OP2
AA
SECOND DETECTION CIRCUIT
SENSOR DRIVING CIRCUIT
VDD45
EN
AB1
CS1
EN
AB2
CS2
SD
40
MAIN CONTROL CIRCUIT
CARTRIDGE DETERMINING MODULE
M50
REMAINING INK LEVEL DETERMINING MODULE
M60

Fig.8

Fig.9

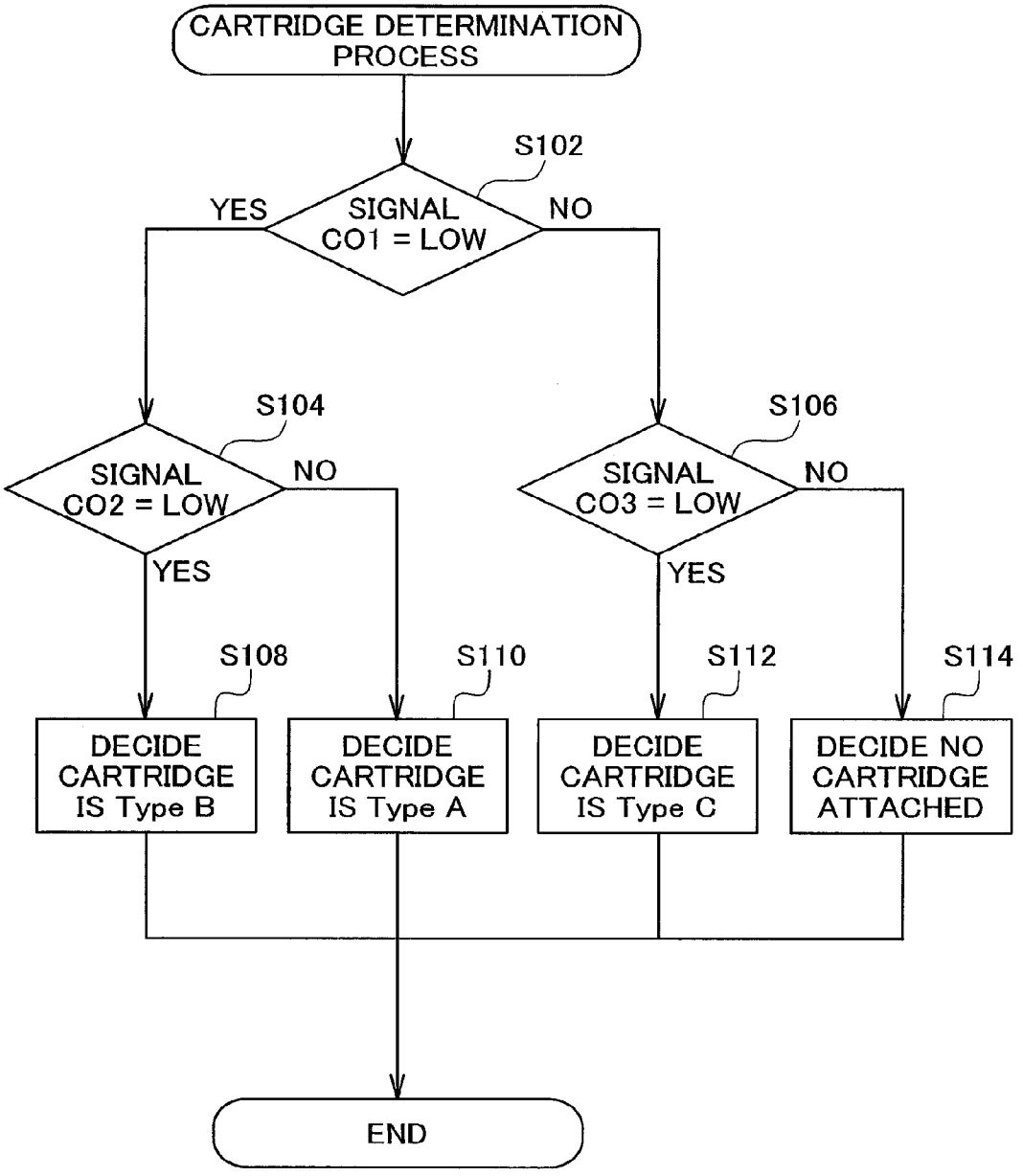
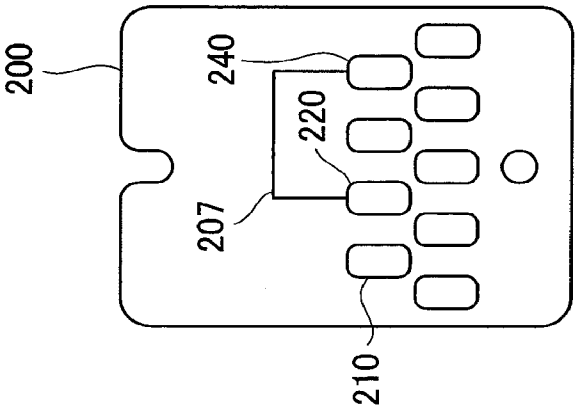
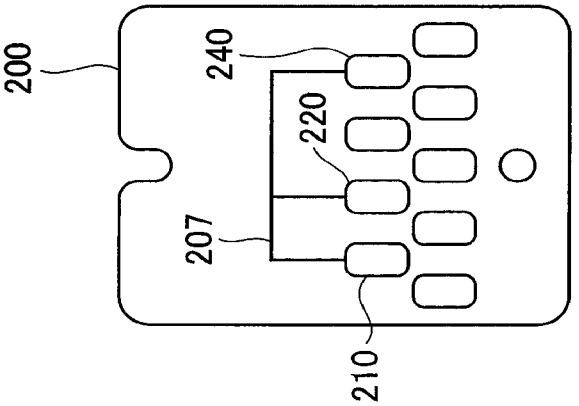

CARTRIDGE DETERMINATION PROCESS
S102
SIGNAL CO1 = LOW
YES
NO
S104
SIGNAL CO2 = LOW
NO
YES
S106
SIGNAL CO3 = LOW
NO
YES
S108
DECIDE CARTRIDGE IS Type B
S110
DECIDE CARTRIDGE IS Type A
S112
DECIDE CARTRIDGE IS Type C
S114
DECIDE NO CARTRIDGE ATTACHED
END

Fig.10C



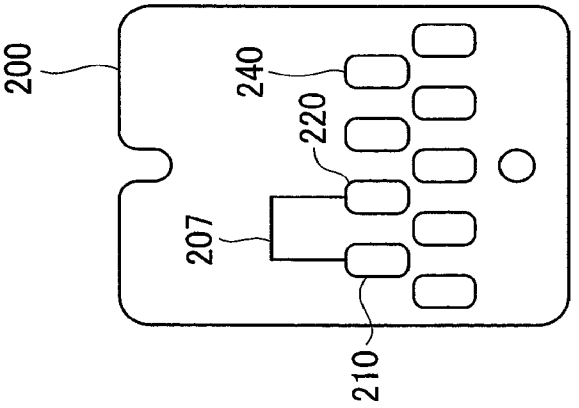
typeC

Fig.10B



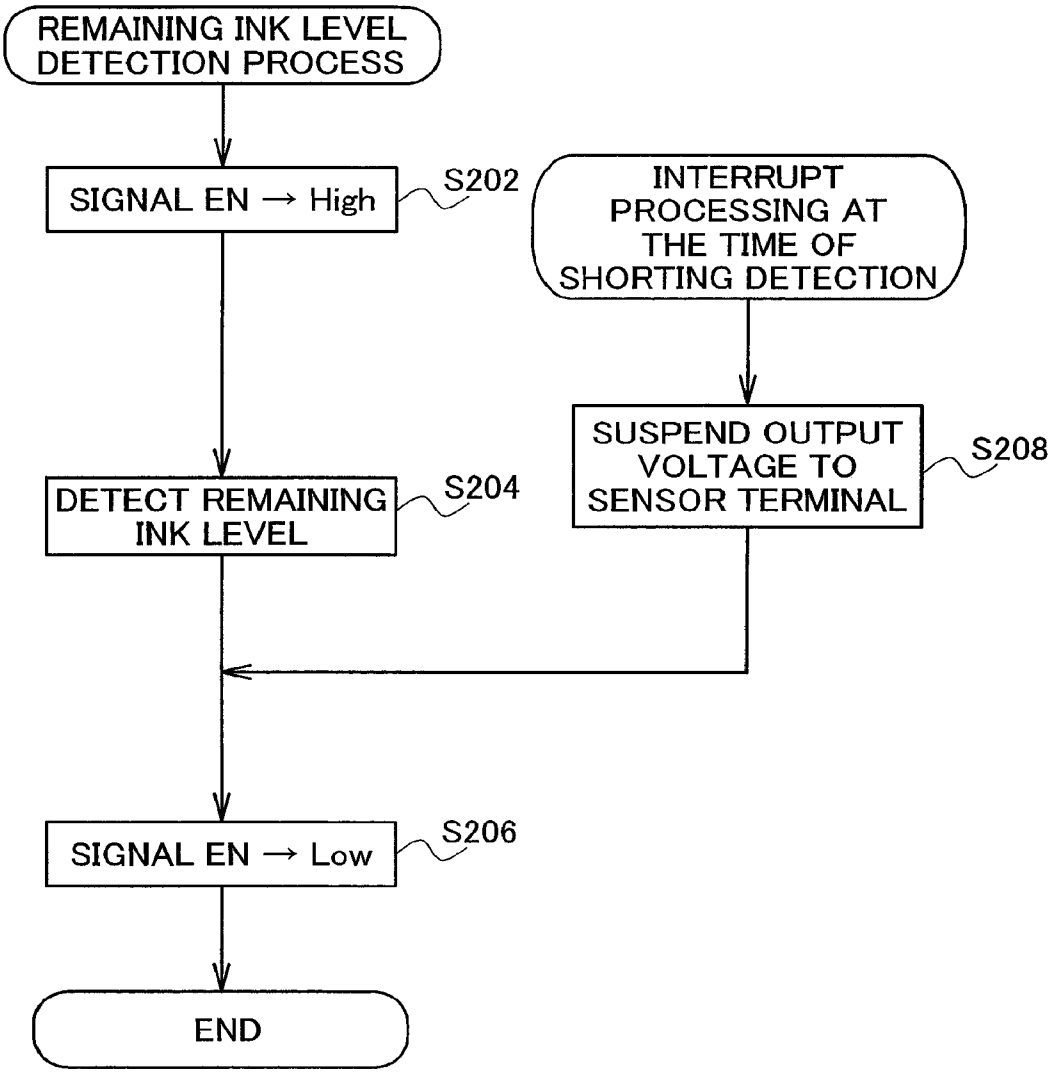
typeB

Fig.10A



typeA

Fig.11


REMAINING INK LEVEL DETECTION PROCESS
SIGNAL EN → High
S202
INTERRUPT PROCESSING AT THE TIME OF SHORTING DETECTION
SUSPEND OUTPUT VOLTAGE TO SENSOR TERMINAL
S208
DETECT REMAINING INK LEVEL
S204
SIGNAL EN → Low
S206
END

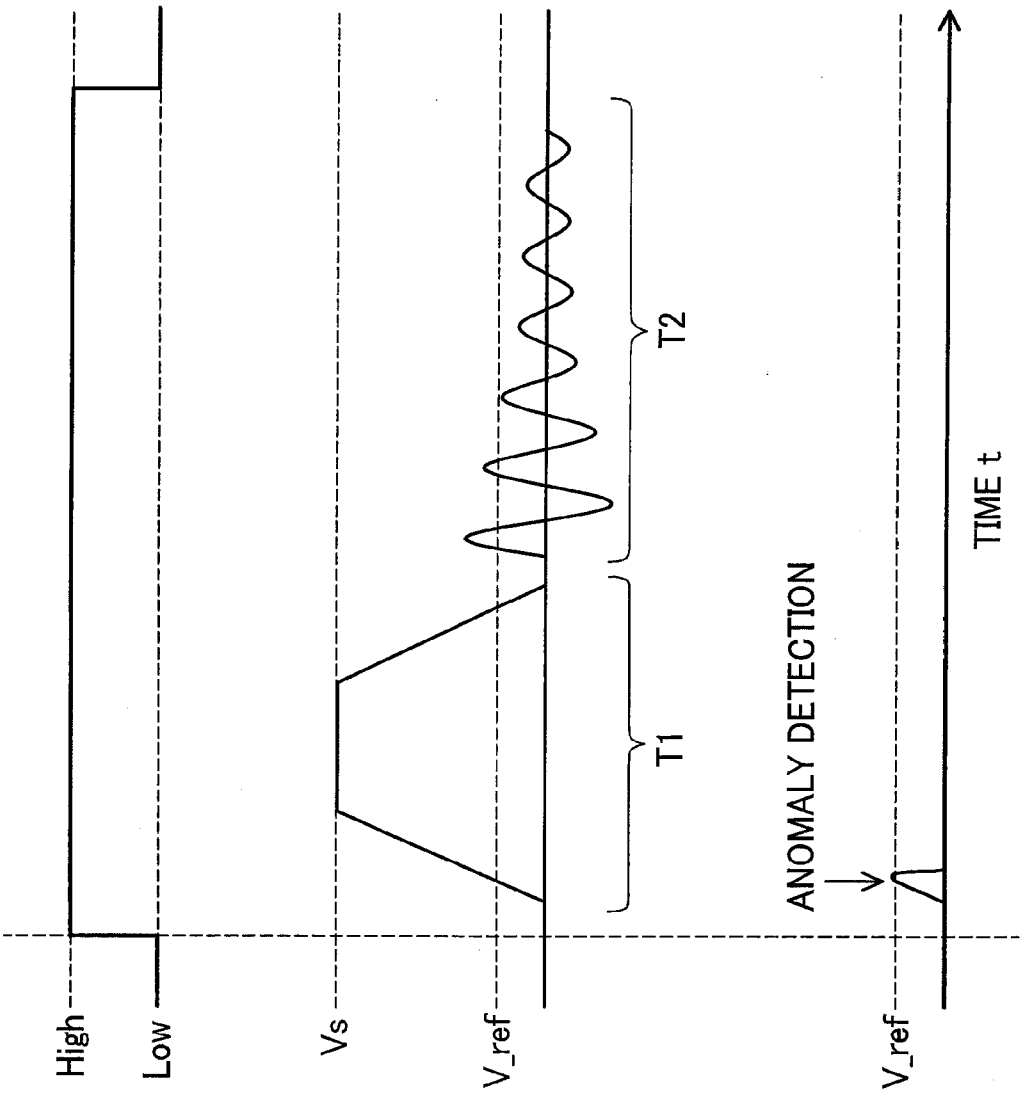


Fig.12A

Fig.12B

Fig.12C

Fig.13

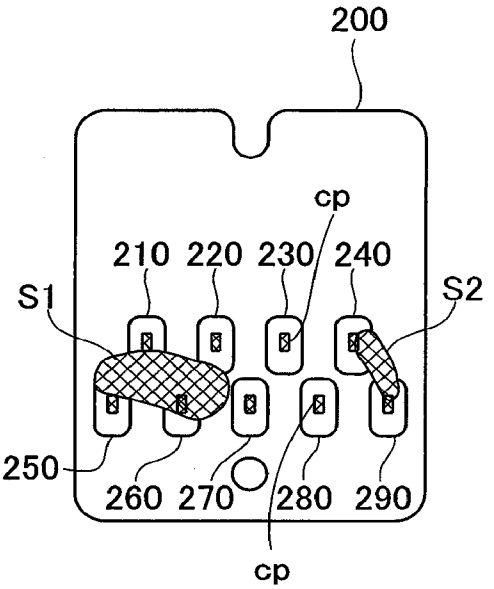


Fig.14A

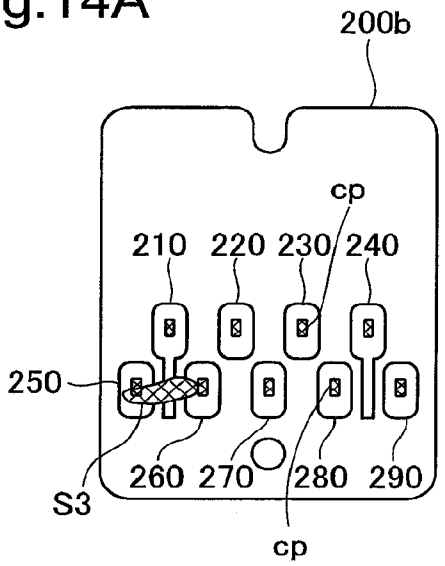


Fig.14B

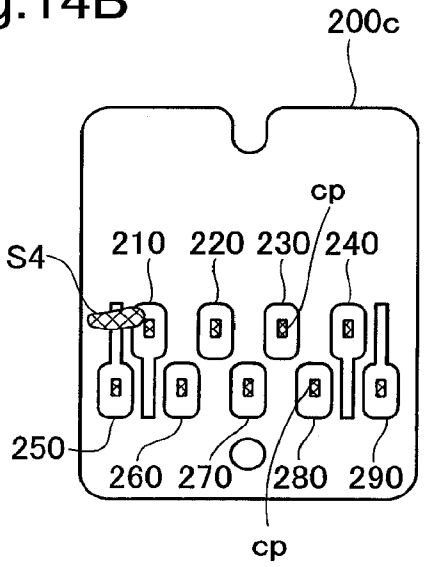


Fig.14C

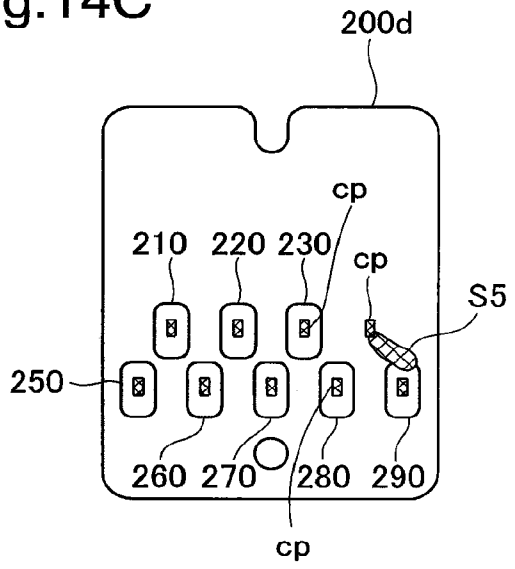


Fig.14D

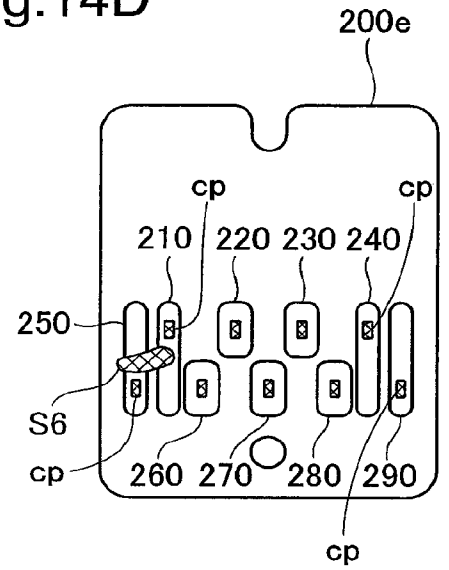


Fig.15A

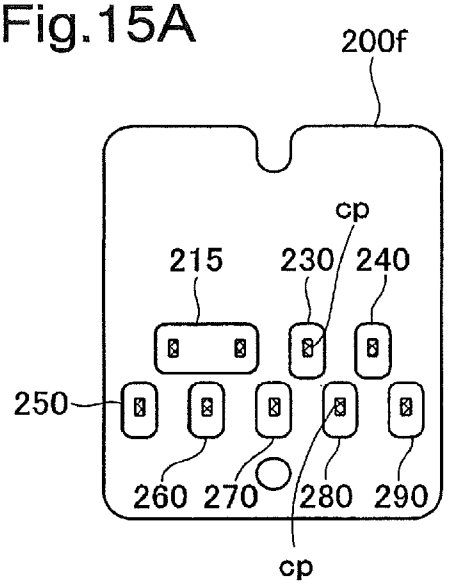


Fig.15B

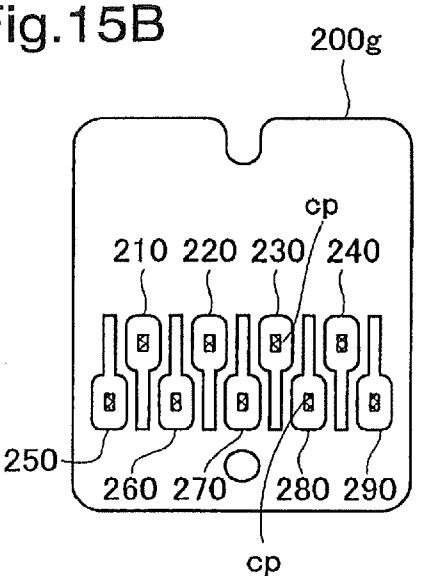


Fig.15C

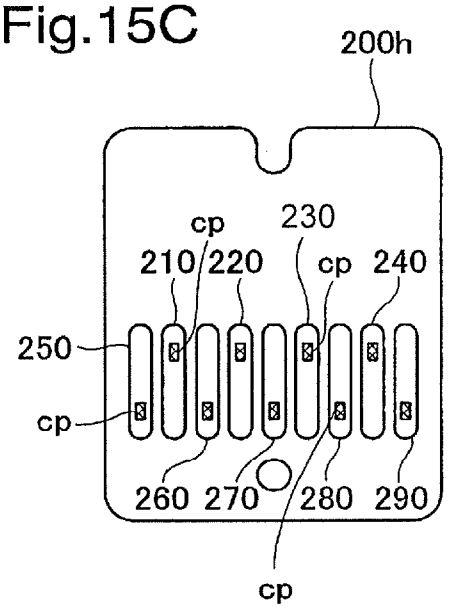


Fig.16A

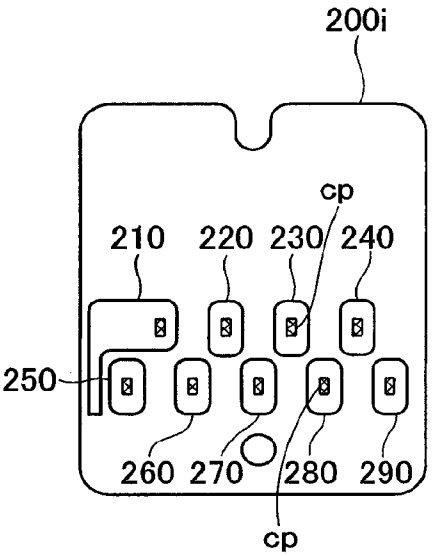


Fig.16B

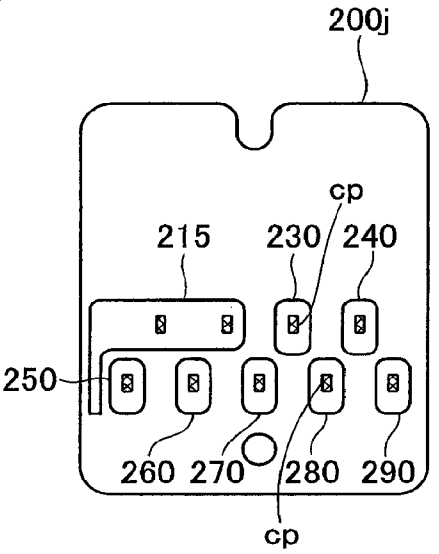


Fig.16C

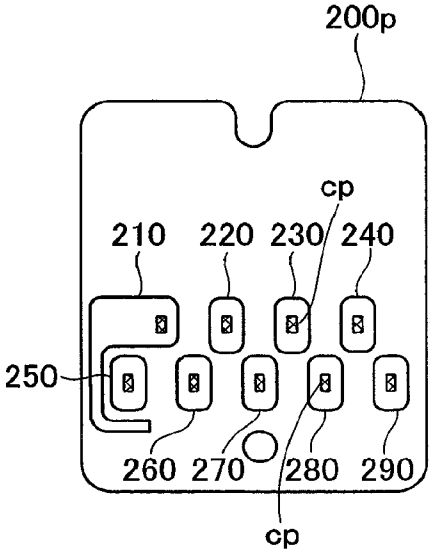


Fig.16D

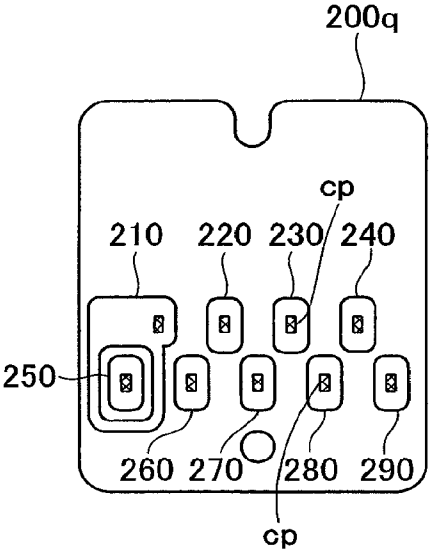


Fig.17A

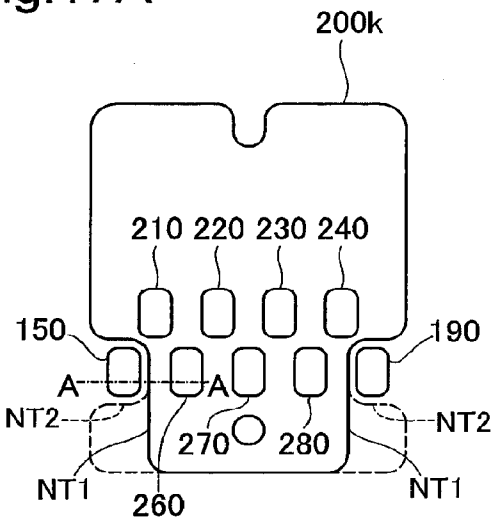


Fig.17B

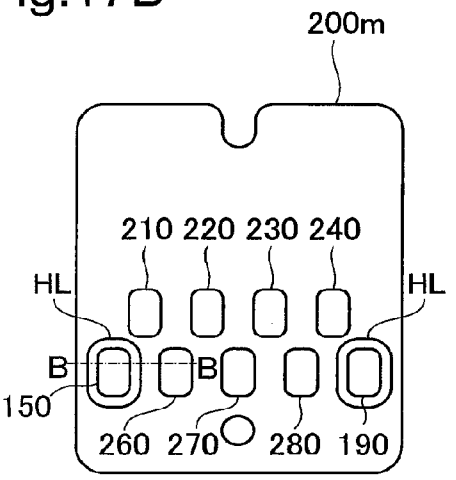


Fig.17C

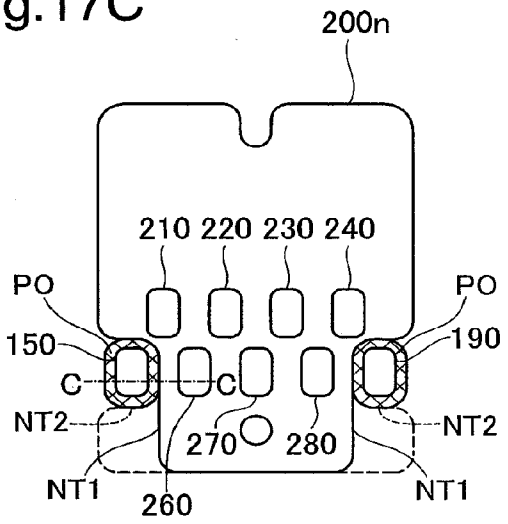


Fig.17D

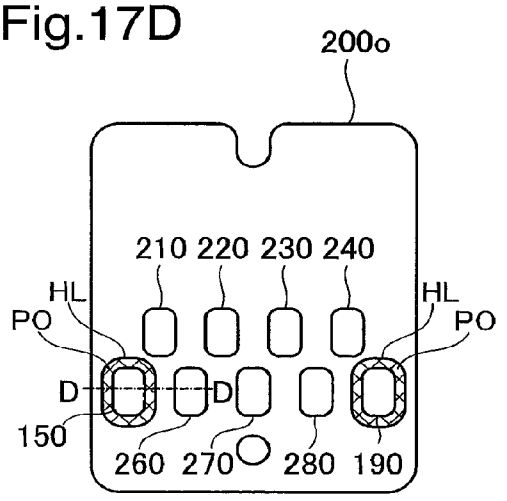


Fig.18A

A–A CROSS SECTION

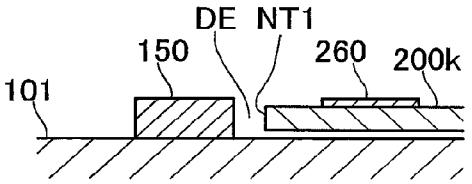


Fig.18B

B–B CROSS SECTION

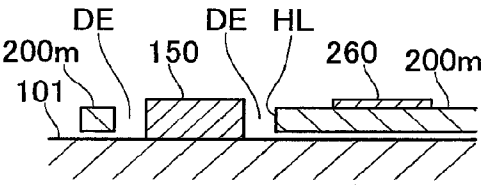


Fig.18C

C–C CROSS SECTION

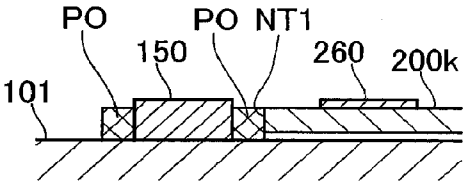


Fig.18D

D–D CROSS SECTION

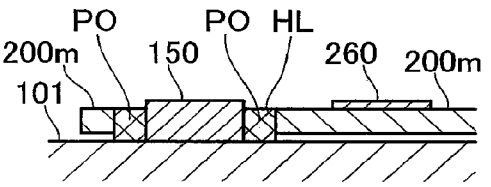


Fig.19A

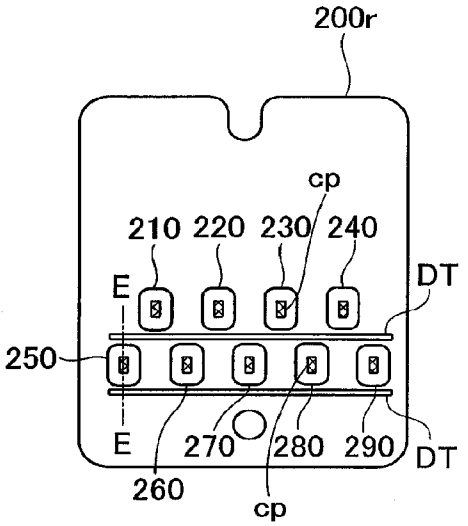


Fig.19B

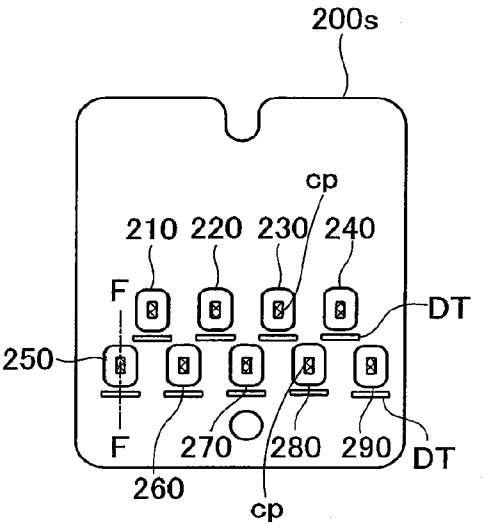


Fig.19C

E-E CROSS SECTION

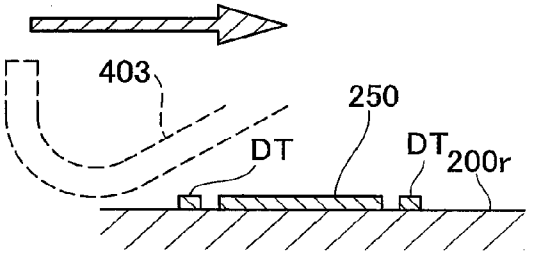
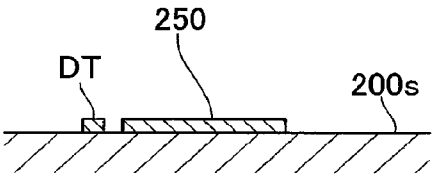


Fig.19D

F-F CROSS SECTION



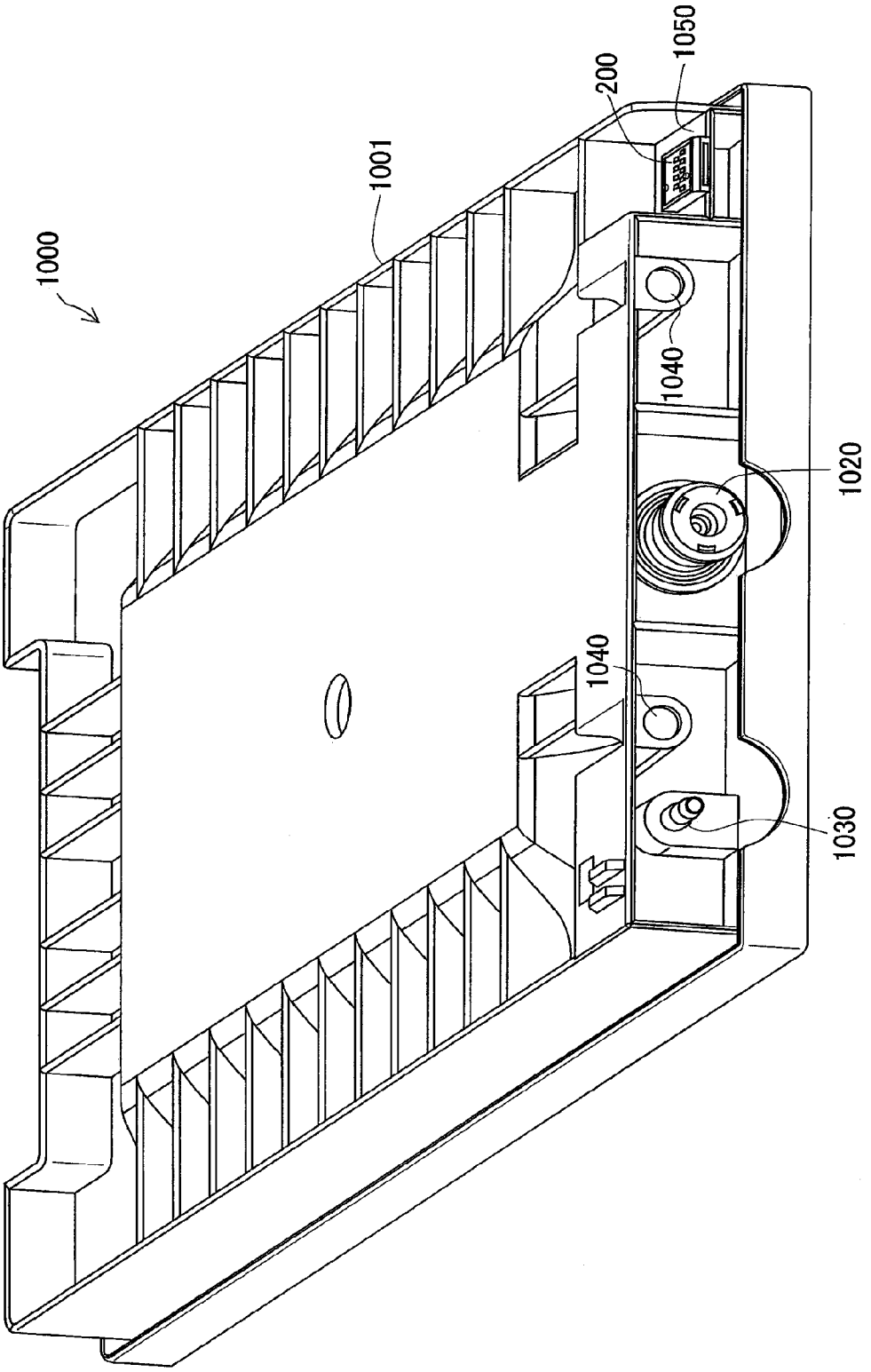


Fig.20

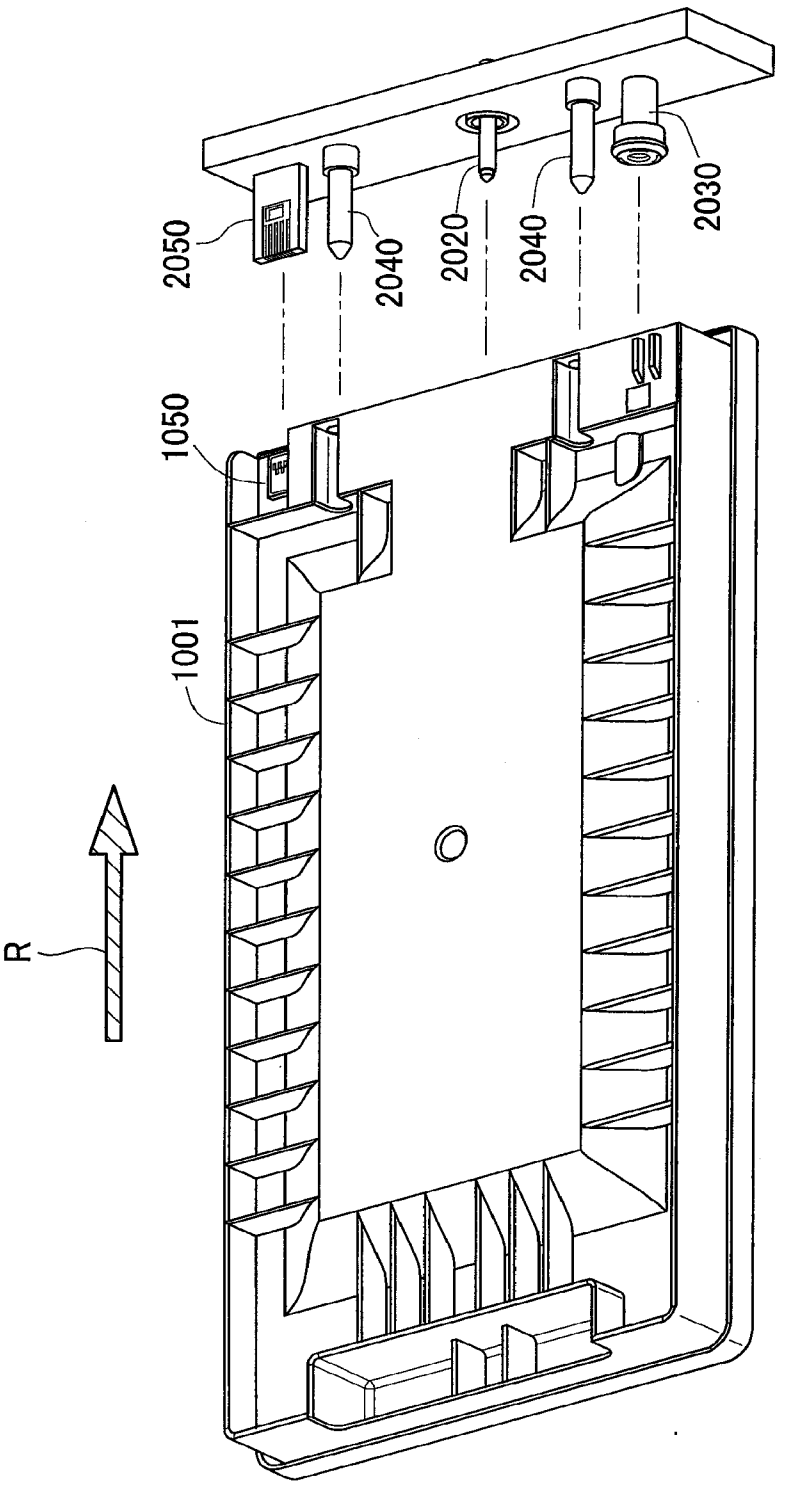


Fig.21

Fig.22

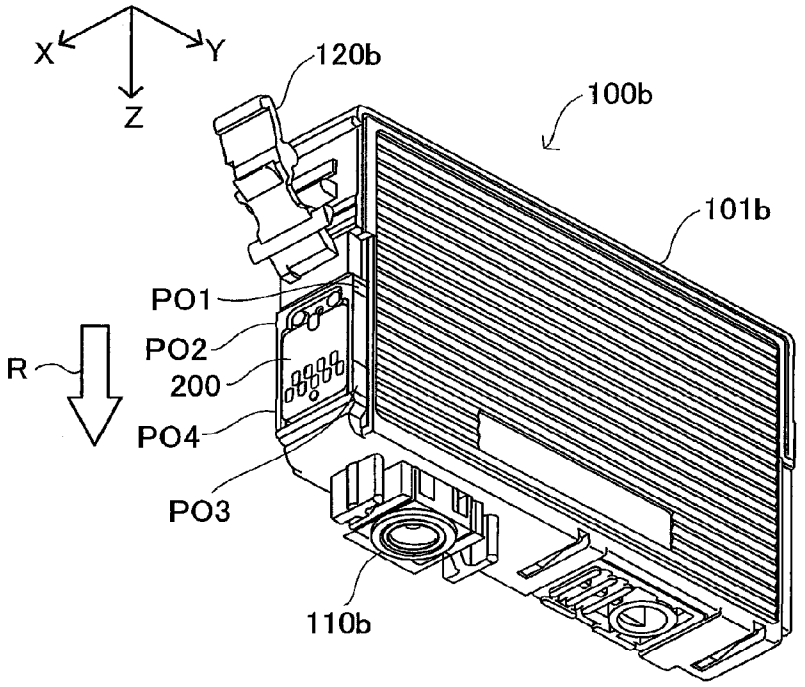

X
Y
Z
120b
100b
101b
PO1
PO2
200
PO4
PO3
R
110b

Fig.23

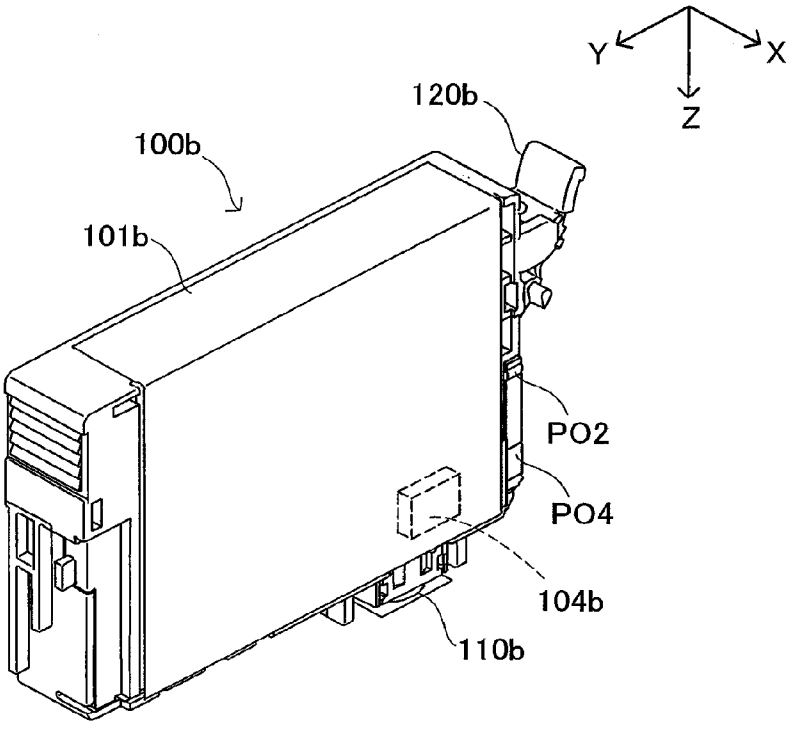
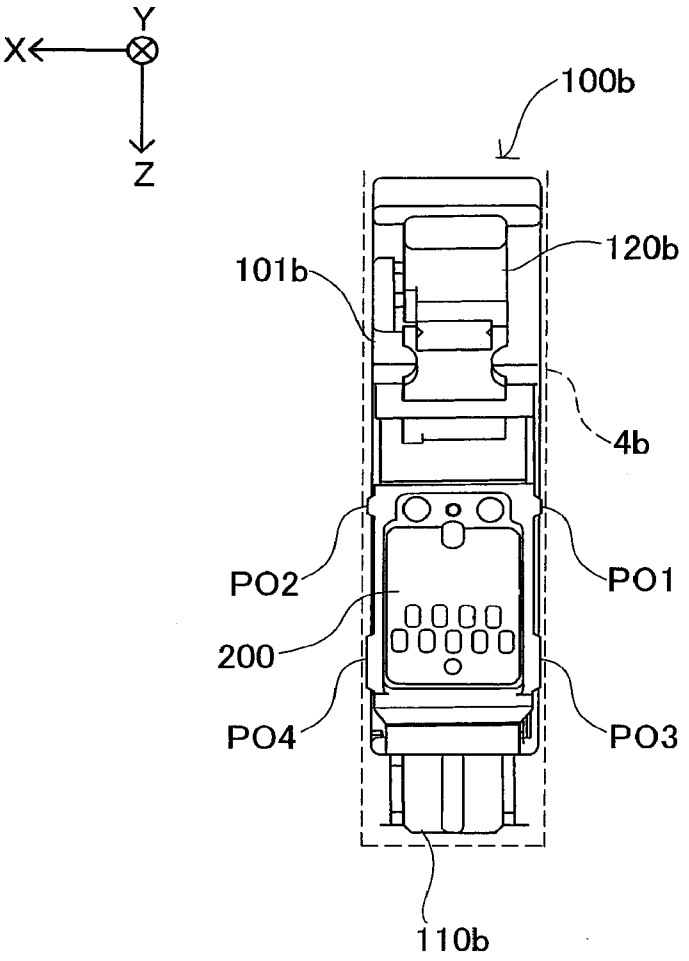

Y
X
Z
120b
100b
101b
PO2
PO4
104b
110b

Fig.24



PRINTING MATERIAL CONTAINER, AND BOARD MOUNTED ON PRINTING MATERIAL CONTAINER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of copending application Ser. No. 12/257,914, filed Oct. 24, 2008, which is a continuation of application Ser. No. 12/040,308, filed on Feb. 29, 2008, now U.S. Pat. No. 7,484,825, which is a continuation of application Ser. No. 11/611,641, filed on Dec. 15, 2006, now U.S. Pat. No. 7,562,958.

This application relates to and claims priority from Japanese Patent Applications No. 2005-372028, filed on Dec. 26, 2005 and No. 2006-220751, filed on Aug. 11, 2006, the entire disclosures of which are incorporated by reference herein.

BACKGROUND

1. Technical Field

The present invention relates in general to a printing material container containing a printing material and a board mounted on the printing material container, and relates in particular to an arrangement for a plurality of terminals disposed on these components.

2. Description of the Related Art

In recent years, it has become common practice to equip ink cartridges used in ink jet printers or other printing apparatus, with a device, for example, a memory for storing information relating to the ink. Also disposed on such ink cartridges is another device, for example, a high voltage circuit (e.g. a remaining ink level sensor using a piezoelectric element) applied to higher voltage than the driving voltage of the memory. In such cases, there are instances in which the ink cartridge and the printing apparatus are electrically connected through terminals. There is proposed a structure for preventing the information storage medium from shorting and becoming damaged due to a drop of liquid being deposited on the terminals connecting the printing apparatus with the storage medium furnished to the ink cartridge.

However, the technologies mentioned above do not contemplate an ink cartridge having equipped with a plurality of devices, for example, a memory and a high voltage circuit, with terminals for one device and the terminals for another device. With this kind of cartridge, there was a risk that shorting could occur between a terminal for the one device and the terminal for the another device. Such shorting caused the problem of possible damage to the ink cartridge or to the printing apparatus in which the ink cartridge is attached. This problem is not limited to ink cartridges, but is a problem common to receptacles containing other printing materials, for example, toner.

SUMMARY

An advantage of some aspects of the present invention is to provide a printing material container having a plurality of devices, wherein damage to the printing material container and the printing apparatus caused by shorting between terminals can be prevented or reduced.

A first aspect of the invention provides a printing material container detachably attachable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the first aspect of the invention comprises a first device, a second device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connected to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

According to the printing material container pertaining to the first aspect of the invention, the second contact portions of the second terminals connected to the second device are arranged at the ends, whereby other contact portions adjacent to the second contact portions are fewer in number, and consequently the second terminals have less likelihood of shorting to terminals include other contact portions. Accordingly, damage to the printing material container or printing apparatus caused by such shorting can be prevented or reduced.

A second aspect of the invention provides printing material container detachably mountable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the second aspect of the invention comprises a first device, a second device, a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. At least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction, for the detection of shorting between the at least one second terminal and the at least one third terminal.

According to the printing material container pertaining to the second aspect of the invention, at least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction. As a result, shorting between the portion of the at least one third terminal and the potion of the at least one second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A third aspect of the invention provides a printing material container detachably mountable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the third aspect of the invention comprises a first device, a second device, a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one

third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. At least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal in at least one direction.

According to the printing material container pertaining to the third aspect of the invention, at least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal. As a result, shorting between the portion of the at least one third terminal and the potion of the at least one second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A fourth aspect of the invention provides printing material container detachably mountable to a printing apparatus having a apparatus-side terminal group. The apparatus-side terminal group includes a plurality of first apparatus-side terminals, a plurality of second apparatus-side terminals, and a plurality of third apparatus-side terminals. Terminals within the apparatus-side terminal group are arranged so as to form a first row and second row. The plurality of second apparatus-side terminals are respectively arranged at each end of the first row and the third apparatus-side terminals are respectively arranged at each end of the second row. Each of the second apparatus-side terminals is adjacent to any of the third apparatus-side terminals. The printing material container pertaining to the fourth aspect of the invention comprises a first device, a second device, a group of terminals comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device and are respectively contactable to a corresponding terminal among the first apparatus-side terminals. The at least one second terminal is connected to the second device and is respectively contactable to a corresponding terminal among the second apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and is respectively contactable to a corresponding terminal among the third apparatus-side terminals.

The printing material container pertaining to the fourth aspect of the invention can afford working effects analogous to those of the printing material container pertaining to the first aspect. The printing material container pertaining to the fourth aspect of the invention may be reduced to practice in various forms, in the same manner as the printing material container which pertaining to the first aspect.

A fifth aspect of the invention provides a printing material container detachably attachable to a printing apparatus having a plurality of apparatus-side terminals. The printing material container pertaining to the fifth aspect of the invention comprises a first device, a second device, and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. Each of the terminals has an circumferential edge, a portion of the circumferential edge of the third terminal facing a portion of the circumferential edge of the second terminal and a portion of the circumferential edge of the one first terminal facing another portion of the circumferential edge of the second terminal. The length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal.

According to the printing material container pertaining to the fifth aspect of the invention, the length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal. As a result, shorting between the third terminal and the second terminal have a greater tendency to occur than shorting between the first terminal and the second terminal. Accordingly, in the event that the shorting between the first terminal and the second terminal occurs by a drop of ink or foreign matter, it is highly likely that the shorting between the portion of the at least one third terminal and the potion of the at least one second terminal also occurs, and is detected as anomaly. As a result, damage to the printing material container or printing apparatus caused by a shorting between the first terminal and the second terminal can be prevented or reduced.

A sixth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the sixth aspect of the invention comprises a first device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

A seventh aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the seventh aspect of the invention comprises a first device and a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. At least a portion of the at least one third terminal is arranged relative to at least a portion of the at least one second terminal, without a said first terminal therebetween in at least one direction, for the detection of shorting between the at least one second terminal and the at least one third terminal.

A eighth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device.

The board pertaining to the eighth aspect of the invention comprises a first device and a group of terminals for connection to the apparatus-side terminals and comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. At least a portion of the at least one third terminal is located adjacently to at least a portion of the at least one second terminal in at least one direction.

A ninth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus having a apparatus-side terminal group that includes a plurality of first apparatus-side terminals, a plurality of second apparatus-side terminals, and a plurality of third apparatus-side terminals. Terminals within the apparatus-side terminal group are arranged so as to form a first row and second row. The plurality of second apparatus-side terminals are respectively arranged at each end of the first row and the third apparatus-side terminals are respectively arranged at each end of the second row. Each of the second apparatus-side terminals is adjacent to any of the third apparatus-side terminals. The printing material container has second device. The board pertaining to the ninth aspect of the invention comprises a first device and a group of terminals comprising a plurality of first terminals, at least one second terminal, and at least one third terminal. The plurality of first terminals are connected to the first device and are respectively contactable to a corresponding terminal among the first apparatus-side terminals. The at least one second terminal is connected to the second device and is respectively contactable to a corresponding terminal among the second apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and is respectively contactable to a corresponding terminal among the third apparatus-side terminals.

A tenth aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has second device. The board pertaining to the tenth aspect of the invention comprises a first device and a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to the first device. The at least one second terminal is connected to the second device. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal. Each of the terminals has an circumferential edge, a portion of the circumferential edge of the third terminal facing a portion of the circumferential edge of the second terminal and a portion of the circumferential edge of the one first terminal facing another portion of the circumferential edge of the second terminal. The length of the portion of circumferential edge of the third terminal is longer than that of the portion of the circumferential edge of the one first terminal.

An eleventh aspect of the invention provides a board mountable on a printing material container detachably attachable to a printing apparatus that has a plurality of apparatus-side terminals. The printing material container has a second device. The board pertaining to the eleventh aspect of the invention comprises a first device and a terminal group that includes at least a plurality of first terminals, at least one cut-out portions into which a respective second terminal mounted on the printing material container can be inserted and at least one third terminal. The plurality of first terminals are connectable to the first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to the second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side-terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. When mounted on the printing material container, the at least one third contact portion is located adjacently to the at least one second contact portion. When mounted on the printing material container, the at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. When mounted on the printing material container, the at least one second contact portion is arranged at an end of one row among the one or multiple rows.

A twelfth aspect of the invention provides a board connectable to a printing apparatus that has a plurality of apparatus-side terminals. The board pertaining to the twelfth aspect of the invention comprises a terminal group that includes a plurality of first terminals, at least one second terminal and at least one third terminal. The plurality of first terminals are connected to a first device and respectively include a first contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second terminal is connectable to a second device and includes a second contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one third terminal is for the detection of shorting between the at least one second terminal and the at least one third terminal and includes a third contact portion for contacting a corresponding terminal among the plurality of apparatus-side terminals. The at least one second contact portion, the plurality of the first contact portions, and the at least one third contact portion are arranged so as to form one or multiple rows. The at least one second contact portion is arranged at an end of one row among the one or multiple rows.

The boards pertaining to the sixth to the twelfth aspects of the invention can afford working effects analogous to those of the printing material container pertaining to the first to the fifth aspects respectively. The boards pertaining to the sixth to eleventh aspects may be reduced to practice in various forms, in the same manner as the printing material container pertaining to the first to the fifth aspects respectively.

The above and other objects, characterizing features, aspects and advantages of the present invention will be clear from the description of preferred embodiments presented below along with the attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of the construction of the printing apparatus pertaining to an embodiment of the invention;

FIG. **2** shows a perspective view of the construction of the ink cartridge pertaining to the embodiment;

FIGS. **3**A-B show diagrams of the construction of the board pertaining to the embodiment;

FIG. **4** shows an illustration showing attachment of the ink cartridge in the holder;

FIG. **5** shows an illustration showing the ink cartridge attached to the holder;

FIGS. **6**A-B show schematics of the construction of the contact mechanism;

FIG. **7** shows a brief diagram of the electrical arrangement of the ink cartridge and the printing apparatus;

FIG. **8** shows a brief diagram of the electrical arrangement, focusing on the cartridge detection/short detection circuit;

FIG. **9** shows a flowchart depicting the processing routine of the cartridge determination process;

FIGS. **10**A-C show illustrations depicting three types of terminal lines on the board;

FIG. **11** shows a flowchart depicting the processing routine of the remaining ink level detection process;

FIGS. **12**A-C show timing charts depicting temporal change in the shorting-detection enable signal and sensor voltage during execution of the remaining ink level detection process;

FIG. **13** shows an illustration of a scenario of shorting;

FIGS. **14**A-D show first diagrams depicting boards pertaining to variations;

FIGS. **15**A-C show second diagrams depicting boards pertaining to variations;

FIGS. **16**A-D show third diagrams depicting boards pertaining to variations;

FIGS. **17**A-D show diagrams depicting the construction around boards of ink cartridges pertaining to variations;

FIGS. **18**A-D show cross sections A-A to D-D in FIG. **17**;

FIGS. **19**A-D show fourth diagrams depicting boards pertaining to variations;

FIG. **20** shows a perspective view of the construction of the ink cartridge pertaining to a variation;

FIG. **21** shows a picture of the ink cartridge pertaining to a variation being attached to the printer;

FIG. **22** shows a first diagram of the construction of the ink cartridge pertaining to a variation;

FIG. **23** shows a second diagram of the construction of the ink cartridge pertaining to a variation;

FIG. **24** shows a third diagram of the construction of the ink cartridge pertaining to a variation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

A. Embodiment

Arrangement of Printing Apparatus and Ink Cartridge:

FIG. **1** shows a perspective view of the construction of the printing apparatus pertaining to an embodiment of the invention. The printing apparatus **1000** has a sub-scan feed mechanism, a main scan feed mechanism, and a head drive mechanism. The sub-scan feed mechanism carries the printing paper P in the sub-scanning direction using a paper feed roller **10** powered by a paper feed motor, not shown. The main scan feed mechanism uses the power of a carriage motor **2** to reciprocate in the main scanning direction a carriage **3** connected to a drive belt. The head drive mechanism drives a print head **5** mounted on the carriage **3**, to eject ink and form dots. The printing apparatus **1000** additionally comprises a main control circuit **40** for controlling the various mechanisms mentioned above. The main control circuit **40** is connected to the carriage **3** via a flexible cable **37**.

The carriage **3** comprises a holder **4**, the print head **5** mentioned above, and a carriage circuit, described later. The holder **4** is designed for attachment of a number of ink cartridges, described later, and is situated on the upper face of the print head **5**. In the example depicted in FIG. **1**, the holder **4** is designed for attachment of four ink cartridges, e.g. individual attachment of four types of ink cartridge containing black, yellow, magenta, and cyan ink. Four openable and closable covers **11** are attached to the holder **4** for each attached ink cartridge. Also disposed on the upper face of the print head **5** are ink supply needles **6** for supplying ink from the ink cartridges to the print head **5**.

The construction of the ink cartridge pertaining to the embodiment will now be described with reference of FIGS. **2**-**5**. FIG. **2** shows a perspective view of the construction of the ink cartridge pertaining to the embodiment. FIGS. **3**A-B show diagrams of the construction of the board pertaining to the embodiment. FIG. **4** shows an illustration showing attachment of the ink cartridge in the holder. FIG. **5** shows an illustration showing the ink cartridge attached to the holder. The ink cartridge **100** attached to the holder **4** comprises a housing **101** containing ink, a lid **102** providing closure to the opening of the housing **101**, a board **200**, and a sensor **104**. On the bottom face of the housing **101** there is formed an ink supply orifice **110** into which the aforementioned ink supply needle **6** inserts when ink cartridge **100** is attached to the holder **4**. At the upper edge of the front face FR of the housing **101** there is formed a flared section **103**. On the lower side of the center of the front face FR of the housing **101** there is formed a recess **105** bounded by upper and lower ribs **107**, **106**. The aforementioned board **200** fits into this recess **105**. The sensor **104** is located in the region posterior to the board **200**. The sensor **104** is used to detect remaining ink level, as will be described later.

FIG. **3**A depicts the arrangement on the surface of the board **200**. This surface is the face that is exposed to the outside when the board **200** is mounted on the ink cartridge **100**. FIG. **3**B depicts the board **200** viewed from the side. A boss slot **201** is formed at the upper edge of the board **200**, and a boss hole **202** is formed at the lower edge of the board **200**. As shown in FIG. **1**, with the board **200** attached to the recess **105** of the housing **101**, bosses **108** and **109** formed on the lower face of the recess **105** mate with the boss slot **201** and the boss hole **202** respectively. The distal ends of the bosses **108** and **109** are crushed to effect caulking. The board **200** is secured within the recess **105** thereby.

The following description of attachment of the ink cartridge **100** makes reference to FIG. **4** and FIG. **5**. As depicted in FIG. **4**, the cover **11** is designed to be rotatable about a rotating shaft **9**. With the cover **11** rotated upward to the open position, when the ink cartridge **100** is being attached to the holder, the flared section **103** of the ink cartridge is received by a projection **14** of the cover **11**. When the cover **11** is closed from this position, the projection **14** rotates downward, and the ink cartridge **100** descends downward (in the Z direction in FIG. **4**). When the cover **11** is completely closed, a hook **18** of the cover **11** interlocks with a hook **16** of the holder **4**. With the cover **11** completely closed, the ink cartridge **100** is secured pressed against the holder **4** by an elastic member **20**. Also, with the cover **11** completely closed, the ink supply needle **6** inserts into the ink supply orifice **110** of the ink cartridge **100**, and the ink contained in the ink cartridge **100** is supplied to the printing apparatus **1000** via the ink supply needle **6**. As will be apparent from the preceding description, the ink cartridge **100** is attached to the holder **4** by means of inserting it so as to move in the forward direction of the Z axis in FIG. **4** and FIG. **5**. The forward direction of the Z axis in FIG. **4** and FIG. **5** shall also be referred to as insertion direction of the ink cartridge **100**.

Returning to FIG. **3**, the board **200** shall be described further. The arrow R in FIG. **3**(*a*) indicates the insertion

direction of the ink cartridge **100** discussed above. As depicted in FIG. **3**, the board **200** comprises a memory **203** disposed on its back face, and a terminal group composed of nine terminals **210-290** disposed on its front face. The memory **203** stores information relating to the ink contained in the ink cartridge **100**. The terminals **210-290** are generally rectangular in shape, and are arranged in two rows generally orthogonal to the insertion direction R. Of the two rows, the row on the insertion direction R side, i.e. the row situated on the lower side in FIG. **3**(*a*), shall be termed the lower row, and the row on the opposite side from the insertion direction R, i.e. the row situated on the upper side in FIG. **3**(*a*), shall be termed the upper row. The terminals arranged so as to form the upper row consist, in order from left in FIG. **3**(*a*), of a first short detection terminal **210**, a ground terminal **220**, a power supply terminal **230**, and a second short detection terminal **240**. The terminals arranged so as to form the lower row consist, in order from left in FIG. **3**(*a*), of a first sensor drive terminal **250**, a reset terminal **260**, a clock terminal **270**, a data terminal **280**, and a second sensor drive terminal **290**. As depicted in FIG. **3**, each of the terminals **210-290** contains in its center portion a contact portion CP for contacting a corresponding terminal among the plurality of apparatus-side terminals, described later.

The terminals **210-240** forming the upper row and the terminals **250-290** forming the lower row are arranged differently from one another, constituting a so-called staggered arrangement, so that the terminal centers do not line up with one another in the insertion direction R. As a result, the contact portions CP of the terminals **210-240** forming the upper row and the contact portions CP of the terminals **250-290** forming the lower row are similarly arranged differently from one another, constituting a so-called staggered arrangement.

As will be appreciated from FIG. **3**A, the first sensor drive terminal **250** is situated adjacently to two other terminals (the reset terminal **260** and the first short detection terminal **210**), and of these, the first short detection terminal **210** for detecting shorting is positioned closest to the first sensor drive terminal **250**. Similarly, the second sensor drive terminal **290** is situated adjacently to two other terminals (the second short detection terminal **240** and the data terminal **280**), and of these, the second short detection terminal **240** for detecting shorting is positioned closest to the second sensor drive terminal **290**.

With regard to relationships among the contact portions CP, the contact portion CP of the first sensor drive terminal **250** is situated adjacently to the contact portions CP of two other terminals (the reset terminal **260** and the first short detection terminal **210**). Similarly, the contact portion CP of the second sensor drive terminal **290** is situated adjacently to the contact portions CP of two other terminals (the second short detection terminal **240** and the data terminal **280**).

As will be appreciated from FIG. **3**A, the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated at the ends of the lower row, i.e. at the outermost positions in the lower row. The lower row is composed of a greater number of terminals than the upper row, and the length of the lower row in the direction orthogonal to the insertion direction R is greater than the length of the upper row, and consequently of all the terminals **210-290** contained in the upper and lower rows, the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated at the outermost positions viewed in the direction orthogonal to the insertion direction R.

With regard to relationships among the contact portions CP, the contact portion CP of the first sensor drive terminal **250** and the contact portion CP of the second sensor drive terminal **290** are respectively situated at the ends of the lower row formed by the contact portions CP of the terminals, i.e., at the outermost positions in the lower row. Among the contact portions of all the terminals **210-290** contained in the upper and lower rows, the contact portion CP of the first sensor drive terminal **250** and the contact portion CP of the second sensor drive terminal **290** are situated at the outermost positions viewed in the direction orthogonal to the insertion direction R.

As will be appreciated from FIG. **3**A, the first short detection terminal **210** and the second short detection terminal **240** are respectively situated at the ends of the upper row, i.e., at the outermost positions in the upper row. As a result, the contact portion CP of the first short detection terminal **210** and the contact portion CP of the second short detection terminal **240** are similarly located at the ends of the upper row formed by the contact portions CP of the terminals, i.e. at the outermost positions in the upper row. Consequently, as will be discussed later, the terminals **220**, **230**, **260**, **270** and **280** connected to the memory **203** are situated between the first short detection terminal **210** and the first sensor drive terminal **250**, and the second short detection terminal **240** and the second sensor drive terminal **290**, located to either side.

In the embodiment, the board **200** has width of approximately 12.8 mm in the insertion direction R, width of the approximately 10.1 mm in the direction orthogonal to the insertion direction R, and thickness of approximately 0.71 mm. The terminals **210-290** each have width of approximately 1.8 mm in the insertion direction R and width of approximately 1.05 mm in the direction orthogonal to the insertion direction R. The dimension values given here are merely exemplary, with differences on the order of ±0.5 mm being acceptable, for example. The spacing between adjacent terminals in a given row (the lower row or the upper row), for example the interval K between the first short detection terminal **210** and the ground terminal **220**, is 1 mm for example. With regard to spacing among terminals, differences on the order of ±0.5 mm are acceptable, for example. The interval J between the upper row and the lower row is about 0.2 mm. With regard to spacing among rows, differences on the order of ±0.3 mm are acceptable, for example.

As depicted in FIG. **5**, with the ink cartridge **100** attached completely within the holder **4**, the terminals **210-290** of the board **200** are electrically connected to a carriage circuit **500** via a contact mechanism **400** disposed on the holder **4**. The contact mechanism **400** shall be described briefly making reference to FIGS. **6**A-B.

FIGS. **6**A-B show schematics of the construction of the contact mechanism **400**. The contact mechanism **400** has multiple slits **401**, **402** of two types that differ in depth, formed in alternating fashion at substantially constant pitch in correspondence with the terminals **210-290** on the board **200**. Within each slit **401**, **402** there fits a contact forming member **403**, **404** endowed with electrical conductivity and resistance. Of the two ends of each contact forming member **403** and **404**, the end exposed to the inside of the holder is placed in resilient contact with a corresponding terminal among the terminals **210-290** on the board **200**. In FIG. **6**A, portions **410-490** which are the portions of the contact forming members **403** and **404** that contact the terminals **210-290** are shown. Specifically, the portions **410-490** that contact the terminals **210-290** function as apparatus-side terminals for electrically connecting the printing apparatus **1000** with the terminals **210-290**. The portions **410-490** that contact the terminals **210-290** shall hereinafter be termed apparatus-side terminals **410-490**. With the ink cartridge **100** attached to the holder **4**, the appa-

ratus-side terminals **410**-**490** respectively contact the contact portions CP of the terminals **210**-**290** described above (FIG. **3**A).

On the other hand, of the two ends of each contact forming member **403** and **404**, the end lying exposed on the exterior of the holder **4** is placed in resilient contact with a corresponding terminal among the terminals **510**-**590** furnished to the carriage circuit **500**.

The electrical arrangements of the ink cartridge **100** and the printing apparatus will now be described, focusing on the part relating to the ink cartridge **100**, with reference to FIG. **7** and FIG. **8**. FIG. **7** shows a brief diagram of the electrical arrangement of the ink cartridge and the printing apparatus. FIG. **8** shows a brief diagram of the electrical arrangement, focusing on the cartridge detection/short detection circuit.

First, the electrical arrangement of the ink cartridge **100** shall be described. Of the terminals of the board **200** described with reference to FIG. **3**, the ground terminal **220**, the power supply terminal **230**, the reset terminal **260**, the clock terminal **270** and the data terminal **280** are electrically connected to the memory **203**. The memory **203** is, for example, EEPROM comprising serially accessed memory cells, and performing data read/write operations in sync with a clock signal. The ground terminal **220** is grounded via a terminal **520** on the printing apparatus **1000** side. The reset terminal **260** is electrically connected to a terminal **560** of the carriage circuit **500**, and is used to supply a reset signal RST to the memory **203** from the carriage circuit **500**. The clock terminal **270** is electrically connected to a terminal **570** of the carriage circuit **500**, and is used to supply the clock signal CLK to the memory **203** from the carriage circuit **500**. The data terminal **280** is electrically connected to a terminal **580** of the carriage circuit **500**, and is used for exchange of data signals SDA between the carriage circuit **500** and the memory **203**.

Of the terminals of the board **200** described with reference to FIG. **3**, either the first short detection terminal **210**, the second short detection terminal **240**, or both are electrically connected with the ground terminal **220**. In the example depicted in FIG. **7**, it will be apparent that the first short detection terminal **220** is electrically connected to the ground terminal **220**. The first short detection terminal **210** and the second short detection terminal **240** are electrically connected respectively to the terminals **510**, **540** of the carriage circuit **500**, and used for cartridge detection and short detection, described later.

In the embodiment, a piezoelectric element is used as the sensor **104**. The remaining ink level can be detected by applying driving voltage to the piezoelectric element to induce the piezoelectric element to vibrate through the inverse piezoelectric effect, and measuring the vibration frequency of the voltage produced by the piezoelectric effect of the residual vibration. Specifically, this vibration frequency represents the characteristic frequency of the surrounding structures (.e.g. the housing **101** and ink) that vibrate together with the piezoelectric element. The characteristic frequency changes depending on the amount of ink remaining within the ink cartridge, so the remaining ink level can be detected by measuring this vibration frequency. Of the terminals of the board **200** described with reference to FIG. **3**, the second sensor drive terminal **290** is electrically connected to one electrode of the piezoelectric element used as the sensor **104**, and the first sensor drive terminal **250** is electrically connected to the other electrode. These terminals **250**, **290** are used for exchange of sensor driving voltage and output signals from the sensor **104**, between the carriage circuit **500** and the sensor **104**.

The carriage circuit **500** comprises a memory control circuit **501**, a cartridge detection/short detection circuit **502**, and a sensor driving circuit **503**. The memory control circuit **501** is a circuit connected to the terminals **530**, **560**, **570**, **580** of the carriage circuit **500** mentioned above, and used to control the memory **203** of the ink cartridge **100** to perform data read/write operations. The memory control circuit **501** and the memory **203** are low-voltage circuits driven at relatively low voltage (in the embodiment, a maximum of about 3.3 V). The memory control circuit **501** can employ a known design, and as such need not be described in detail here.

The sensor driving circuit **503** is a circuit connected to the terminals **590** and **550** of the carriage circuit **500**, and used to control the driving voltage output from these terminals **590** and **550** to drive the sensor **104**, causing the sensor **104** to detect the remaining ink level. As will be described later, the driving voltage has a generally trapezoidal shape, and contains relatively high voltage (in the embodiment, about 36 V). Specifically, the sensor driving circuit **503** and the sensor **104** are high-voltage circuits using relatively high voltage via the terminals **590** and **550**. The sensor driving circuit **503** is composed of a logic circuit for example, but need not be described in detail herein.

The cartridge detection/short detection circuit **502**, like the memory control circuit **501**, is a low-voltage circuit driven using relatively low voltage (in the embodiment, a maximum of about 3.3V). As depicted in FIG. **8**, the cartridge detection/short detection circuit **502** comprises a first detection circuit **5021** and a second detection circuit **5022**. The first detection circuit **5021** is connected to the terminal **510** of the carriage circuit **500**. The first detection circuit **5021** has a cartridge detection function for detecting whether there is contact between the terminal **510** and the first short detection terminal **210** of the board **200**, and a short detection function for detecting shorting of the terminal **510** to the terminals **550** and **590** which output high voltage.

To describe in more specific terms, the first detection circuit **5021** has a reference voltage V_ref**1** applied to one end of two series-connected resistors R**2**, R**3**, with the other end being grounded, thereby maintaining the potential at point P**1** and P**2** in FIG. **4** at V_ref**1** and V_ref**2**, respectively. Herein V_ref**1** shall be termed the short detection voltage, and V_ref**2** shall be termed the cartridge detection voltage. In the embodiment, the short detection voltage V_ref**1** is set to 6.5 V, and the cartridge detection voltage V_ref**2** is set to 2.5 V. These values are established by means of the circuits, and are not limited to the values given herein.

As depicted in FIG. **8**, the short detection voltage V_ref**1** (6.5 V) is input to the negative input pin of a first Op-Amp OP**1**, while the cartridge detection voltage V_ref**2** (2.5 V) is input to the negative input pin of a second Op-Amp OP**2**. The potential of the terminal **510** is input to the positive input pins of the first Op-Amp OP**1** and the second Op-Amp OP**2**. These two Op-Amps function as a comparator, outputting a High signal when the potential input to the negative input pin is higher than the potential input to the positive input pin, and conversely outputting a Low signal when the potential input to the negative input pin is lower than the potential input to the positive input pin.

As depicted in FIG. **8**, the terminal **510** is connected to a 3.3 V power supply VDD 3.3 via a transistor TR**1**. By means of this arrangement, if terminal **510** is free e.g. there is no contact with terminal **510**, the potential of the terminal **510** will be set at about 3 V. As noted, when the ink cartridge **100** is attached, the terminal **510** comes into contact with the first short detection terminal **210** of the board **200** described previously. Here, as depicted in FIG. **7**, with the first short detection terminal

210 and the ground terminal 220 electrically connected (shorted) in the board 200, when the terminal 510 comes into contact with the first short detection terminal 210 (herein referred to as being in contact), the terminal 510 is electrically continuous with the grounded terminal 520, and the potential of the terminal 510 drops to 0 V.

Consequently, with the terminal 510 free, a High signal from the second Op-Amp OP2 is output as the cartridge detection signal CS1. With the terminal 510 in contact, a Low signal from the second Op-Amp OP2 is output as the cartridge detection signal CS1.

On the other hand, if the terminal 510 is shorted to the adjacent terminal 550, there are instances in which the sensor driving voltage (45 V max) will be applied to the terminal 510. As shown in FIG. 8, when voltage greater than the short detection voltage V_ref1 (6.5 V) is applied to the terminal 510 due to shorting, a High signal from the Op-Amp OP1 will be output to an AND circuit AA.

As shown in FIG. 8, a short detection enable signal EN is input from the main control circuit 40 to the other input pin of the AND circuit AA. As a result, only during the time interval that a High signal is input as the short detection enable signal EN, the first detection circuit 5021 outputs the High signal from the Op-Amp OP1 as a short detection signal AB1. That is, execution of the short detection function of the first detection circuit 5021 is controlled by means of the short detection enable signal EN of the main control circuit 40. The short detection signal AB1 from the AND circuit AA is output to the main control circuit 40, as well as being output to the base pin of the transistor TR1 via resistance R1. As a result, by means of the transistor TR1 it is possible to prevent high voltage from being applied to the power supply VDD 3.3 via the terminal 510 when a short is detected (when the short detection signal AB1 is HI).

The second detection circuit 5022 has a cartridge detection function for detecting whether there is contact between the terminal 540 and the second short detection terminal 240 of the board 200, and a short detection function for detecting shorting of the terminal 540 to the terminals 550 and 590 which output high voltage. Since the second detection circuit 5022 has the same arrangement as the first detection circuit 5021, a detailed illustration and description need not be provided here. Hereinafter, the cartridge detection signal output by the second detection circuit 5022 shall be denoted as CS2, and the short detection signal as AB2.

An arrangement of the carriage circuit 500 corresponding to a single ink cartridge 100 has been described above. In the embodiment, since four ink cartridges 100 are attached, four of the cartridge detection/short detection circuits 502 described above will be provided, at each of the attachment locations for the four ink cartridges 100. While only a single sensor driving circuit 503 is provided, and a single sensor driving circuit 503 is connectable to each of the sensors 104 of the ink cartridges 100 attached at the four attachment locations by means of a switch(not shown). The memory control circuit 501 is a single circuit responsible for processes relating to the four ink cartridges.

The main control circuit 40 is a computer of known design comprising a central processing unit (CPU), a read-only memory (ROM), and a random access memory (RAM). As noted, the main control circuit 40 controls the entire printer; in FIG. 8, however, only those elements necessary for description of the embodiment are selectively illustrated, and the following description refers to the illustrated arrangement. The main control circuit 40 comprises a cartridge determining module M50 and a remaining ink level determining module M60. On the basis of the received cartridge detection signals CS1, CS2, the cartridge determining module M50 executes a cartridge determination process, described later. The remaining ink level determining module M60 controls the sensor driving circuit 503, and executes a remaining ink level detection process, described later.

Cartridge Determination Process:

The cartridge determination process executed by the cartridge determining module M50 of the main control circuit 40 will be described with reference to FIG. 9 and FIG. 10. FIG. 9 shows a flowchart depicting the processing routine of the cartridge determination process. FIGS. 10A-C show illustrations depicting three types of terminal lines on the board 200.

Before turning to the cartridge determination process, the board 200 will be described further with reference to FIG. 10. The board 200 mentioned previously comes in three types, depending on the wiring pattern of the first short detection terminal 210, the second short detection terminal 240, and the ground terminal 220. These three types are designated respectively as Type A, Type B, and Type C. As depicted in FIG. 10A, the Type A board 200 is arranged with the first short detection terminal 210 and the ground terminal 220 electrically connected by a conducting line 207, while the second short detection terminal 240 and the ground terminal 220 are not electrically connected. As depicted in FIG. 10B, the Type B board 200 is arranged with both the first short detection terminal 210 and the second short detection terminal 240 electrically connected with the ground terminal 220 by a conducting line 207. As depicted in FIG. 10C, the Type C board 200 is arranged with the second short detection terminal 240 and the ground terminal 220 electrically connected by a conducting line 207, while the first short detection terminal 210 and the ground terminal 220 are not electrically connected. A board 200 of predetermined type, selected with reference to ink type or ink quantity for example, is disposed on the ink cartridge 100. Specifically, depending on the quantity of ink contained in the ink cartridge 100, a Type A board 200 could be disposed on an L size cartridge containing a large quantity of ink; a Type B board 200 could be disposed on an M size cartridge containing a standard quantity of ink; and a Type C board 200 could be disposed on an S size cartridge containing a small quantity of ink.

The cartridge determining module M50 of the main control circuit 40 constantly receives from the cartridge detection/short detection circuit 502 the cartridge detection signals CS1, CS2 for each of the four attachment locations of the holder 4, and using these signals executes the cartridge determination process for each of the attachment locations.

When the cartridge determining module M50 initiates the cartridge determination process for a selected attachment location, the cartridge determining module M50 first ascertains whether the cartridge detection signal CS1 from the cartridge detection/short detection circuit 502 in the selected attachment location is a Low signal (Step S102). Next, the cartridge determining module M50 ascertains whether the cartridge detection signal CS2 in the selected attachment location is a Low signal (Step S104 or S106). If as a result the cartridge detection signals CS1 and CS2 are both Low signals (Step S102: YES and Step S104: YES), the cartridge determining module M50 decides that the ink cartridge 100 attached to the selected attachment location is furnished with the Type B board 200 (Step S108).

Similarly, the cartridge determining module M50, in the event that the cartridge detection signal CS1 is a Low signal and the cartridge detection signal CS2 is a High signal (Step S102: YES and Step S104: NO), decides that the ink cartridge is furnished with the Type A board 200 (Step S110); or in the event that the cartridge detection signal CS1 is a High signal

and the cartridge detection signal CS2 is a Low signal (Step S102: NO and Step S104: YES), decides that the ink cartridge is furnished with the Type C board **200** described above (Step S112).

In the event that both the cartridge detection signals CS1 and CS2 are High signals Step S102: NO and Step S104: NO), the cartridge determining module M50 decides that no cartridge is attached to the selected attachment location (Step S114). In this way, the cartridge determining module M50 determines whether an ink cartridge **100** is attached, and if so what type, for each of the four attachment locations.

Remaining Ink Level Detection Process:

The remaining ink level detection process executed by the remaining ink level determining module M60 of the main control circuit **40** will now be described with reference to FIG. **11** and FIGS. **12**A-C. FIG. **11** shows a flowchart depicting the processing routine of the remaining ink level detection process. FIGS. **12**A-C show timing charts depicting temporal change in the shorting-detection enable signal and sensor voltage during execution of the remaining ink level detection process;

The remaining ink level determining module M60 of the main control circuit **40**, in the event that the remaining ink level in the ink cartridge **100** attached at any of the attachment locations of the holder **4** is to be detected, first sets to High the short detection enable signal EN to all of the cartridge detection/short detection circuits **502** (Step S202). As a result, the short detection function is enabled in all of the cartridge detection/short detection circuits **502**, and if voltage above the reference voltage V_ref1 (6.5 V) is applied to the aforementioned terminal **520** and terminal **540**, are able to output High signals as the short detection signals AB1, AB2. In other words, a state in which the short detection enable signal EN are High signals is a state in which shorting of the terminal **510** or terminal **540** to the terminal **550** or terminal **590** is monitored.

Next, the remaining ink level determining module M60 instructs the sensor driving circuit **503** to output driving voltage from the terminal **550** or terminal **590** to the sensor **104**, and detect the remaining ink level output (Step S204). To describe in more specific terms, when the sensor driving circuit **503** receives an instruction signal from the remaining ink level determining module M60, the sensor driving circuit **503** outputs driving voltage from either the terminal **550** or the terminal **590**, the voltage being applied to the piezoelectric element which constitutes the sensor **104** of the ink cartridge **100**, charging the piezoelectric element and causing it to distort by means of the inverse piezoelectric effect. The sensor driving circuit **503** subsequently drops the applied voltage, whereupon the charge built up in the piezoelectric element is discharged, causing the piezoelectric element to vibrate. In FIG. **12**, the driving voltage is the voltage shown during time interval T1. As depicted in FIG. **12**, the driving voltage fluctuates between the reference voltage and the maximum voltage Vs in such a way as to describe a trapezoidal shape. The maximum voltage Vs is set to relatively high voltage (e.g. about 36 V). Via the terminal **550** of the terminal **590**, the sensor driving circuit **503** detects the voltage produced by the piezoelectric effect as a result of vibration of the piezoelectric element (in FIG. **12** depicted as the voltage during time interval T2), and by measuring the vibration frequency thereof detects the remaining ink level. Specifically, this vibration frequency represents the characteristic frequency of the surrounding structures (the housing **101** and ink) that vibrate together with the piezoelectric element, and changes depending on the amount of ink remaining within the ink cartridge **100**, so the remaining ink level can be detected by measuring this vibration frequency. The sensor driving circuit **503** outputs the detected result to the remaining ink level determining module M60 of the main control circuit **40**.

When the remaining ink level determining module M60 receives the detected result from the sensor driving circuit **503**, the remaining ink level determining module M60 brings the short detection enable signal EN, which was previously set to a High signal in Step S202, back to a Low signal (Step S206), and terminates the process. In this process, the interval that the remaining ink level is being detected is a state in which the short detection enable signal EN is set to a High signal to enable short detection. In other words, remaining ink level is detected while the occurrence of shorting is being monitored by the cartridge detection/short detection circuit **502**.

Process when Shorting is Detected

The process carried out in the event that, during execution of detection of the remaining ink level (Step S204), the remaining ink level determining module M60 receives a High signal as the short detection signal AB1 or AB2, e.g. shorting is detected shall be described here. In FIG. **11**, a flowchart of the interrupt processing routine when shorting is detected is shown as well. When the terminal **510** or the terminal **540** shorts to the terminal that is outputting the sensor driving voltage of the terminals **550** and **590**, the sensor driving voltage will be applied to the shorting terminal **510** or terminal **540**. Thereupon, since the short detection enable signal EN is currently set to High, at the instant that the sensor driving voltage goes above the short detection voltage V_ref1 (6.5 V), a High signal will be output as the short detection signals AB1, AB2 from the cartridge detection/short detection circuit **502**. When the remaining ink level determining module M60 receives either of these short detection signals AB1, AB2, the remaining ink level determining module M60 suspends detection of remaining ink level, and executes the interrupt processing when shorting is detected.

When the interrupt processing is initiated, the remaining ink level determining module M60 immediately instructs the sensor driving circuit **503** to suspend the output of sensor driving voltage (Step S208).

Next, the remaining ink level determining module M60, without carrying out remaining ink level detection process to its conclusion, brings the short detection enable signal EN back to a Low signal (Step S206) to terminate the process. For example, the main control circuit **40** may take some countermeasure, such as notifying the user of the shorting.

FIG. **12**A depicts change of the detection enable signal EN through time. FIG. **12**B depicts sensor voltage in the event that neither the terminal **510** nor the terminal **540** is shorting to the terminal that outputs the sensor driving voltage of the terminals **550** and **590**, so that the remaining ink level detection process is being executed normally. FIG. **12**C depicts sensor voltage in the event that the terminal **510** or the terminal **540** is shorting to the terminal that, of the terminals **550** and **590**, outputs the sensor driving voltage.

As depicted in FIG. **12**A, during execution of the remaining ink level detection process, the detection enable signal EN is a High signal. As shown in FIG. **12**B, in the normal state (no shorting), after high voltage Vs has been applied to the sensor **104**, the applied voltage drops, and subsequently vibration voltage is produced through the piezoelectric effect. In the embodiment, Vs is set at 36 V.

As depicted in FIG. **12**C, on the other hand, in the abnormal state (shorting), the sensor voltage drops at the instant that it goes above the short detection voltage V_ref1 (6.5 V). This is due to the fact that, at the instant that the sensor voltage goes above the short detection voltage V_ref1 (6.5 V), a High

signal is output as the short detection signal AB1 or AB2 from the cartridge detection/short detection circuit **502** to the remaining ink level determining module M**60**, and the remaining ink level determining module M**60** receiving this signal immediately drops the sensor driving voltage.

FIG. **13** shows an illustration of a scenario of shorting. Here, the likely scenario for shorting to other terminals by the terminals **550** and **590** which output the sensor driving voltage is, for example, the case depicted in FIG. **13**, in which an electrically conductive ink drop S**1** or a water drop S**2** formed by condensation has become deposited on the board **200** of the ink cartridge **100**, bridging the gap between the first sensor drive terminal **250** or the second sensor drive terminal **290** and another terminal or terminals on the board **200**, producing shorting. For example, ink drop S**1** that has adhered to the surface of the carriage **3** or ink supply needle **6** disperses and adheres as shown in FIG. **13** by the motion of attaching or detaching of ink cartridge **100**. In this instance, when the ink cartridge **100** is attached, the terminal **550** that outputs the sensor driving voltage, for example, will short to another terminal **510**, **520**, or **560** of the carriage circuit **500** via the first sensor drive terminal **250** and the terminals (FIG. **13**: terminals **210**, **220**, **260**) bridged by the ink drop S**1** to the sensor drive terminal **250**. Or, the terminal **590** that outputs the sensor driving voltage will short to another terminal **540** of the carriage circuit **500** via the second sensor drive terminal **290** and the second short detection terminal **240** (FIG. **13**) bridged by the water drop S**2** to the second sensor drive terminal **290**, for example. Such a shorting is caused by various factor as well as the adhesion of the ink drop. For example, the shorting may be caused by trapping electrically conducting object, for example, paper clip on carriage **3**. The shorting also may be caused by adhesion to terminals of the electrically conducting material, for example, skin oil of user.

As mentioned previously with reference to FIG. **3**, in the ink cartridge **100** pertaining to the embodiment the first sensor drive terminal **250** and the second sensor drive terminal **290** which apply the driving voltage to the sensor are arranged at the two ends of the terminal group, so the number of adjacent terminals is small. As a result, the likelihood of the first sensor drive terminal **250** and the second sensor drive terminal **290** shorting to other terminals is low.

On the board **200**, if the first sensor drive terminal **250** should short to the adjacent first short detection terminal **210**, the shorting will be detected by the aforementioned cartridge detection/short detection circuit **502**. For example, shorting of the first sensor drive terminal **250** to another terminal caused by the ink drop S**1** infiltrating from the first sensor drive terminal **250** side will be detected instantly and the output of sensor driving voltage will be suspend, preventing or reducing damage to the memory **203** and the printing apparatus **1000** circuits (the memory control circuit **501** and the cartridge detection/short detection circuit **502**) caused by the shorting.

Also, the first short detection terminal **210** is adjacent to the first sensor drive terminal **250** and situated closest to the first sensor drive terminal **250**. Consequently, in the event that the first sensor drive terminal **250** should short to another terminal or terminals due to the ink drop S**1** or the water drop S**2**, there is a high likelihood that the first sensor drive terminal **250** will short to the first short detection terminal **210** as well. Consequently, shorting of the first sensor drive terminal **250** to another terminal can be detected more reliably.

In addition to detecting shorting, the first short detection terminal **210** is also used by the cartridge detection/short detection circuit **502** to determine whether an ink cartridge **100** is attached, as well as to determine the type of attached ink cartridge **100**. As a result, the number of terminals on the board **200** can be kept down, and it becomes possible to reduce the number of board **200** manufacturing steps and the number of parts for the board **200**.

Similarly, if the second sensor drive terminal **290** should short to the second short detection terminal **240**, the short will be detected by the cartridge detection/short detection circuit **502**. Consequently, shorting of the second sensor drive terminal **290** to another terminal caused by the ink drop S**1** or the water drop S**2** infiltrating from the second sensor drive terminal **290** side can be detected instantly. As a result, damage to the circuits of the memory **203** and the printing apparatus **1000** caused by shorting can be prevented or reduced. Similarly, the second short detection terminal **240** is the terminal situated closest to the second sensor drive terminal **290**. Consequently, in the event that the second sensor drive terminal **290** should short to another terminal or terminals due to the ink drop S**1** or the water drop S**2**, there is a high likelihood that the second sensor drive terminal **290** will short to the second short detection terminal **240** as well. Consequently, shorting of the second sensor drive terminal **290** to another terminal can be detected more reliably.

The first sensor drive terminal **250** and the first short detection terminal **210** on the one hand, and the second sensor drive terminal **290** and the second short detection terminal **240** on the other, are situated at the ends of the terminal group so that the other terminals (**220**, **230**, **260-270**) lie between them. Consequently, if foreign matter (the ink drop S**1**, water drop S**2** etc.) should infiltrate from either side as indicated by the arrows in FIG. **13**, this infiltration can be detected before it infiltrates as far as the other terminals (**220**, **230**, **260-270**). Consequently, damage to the circuits of the memory **203** and the printing apparatus **1000** due to infiltration of foreign matter can be prevented or reduced.

The first sensor drive terminal **250** and the second sensor drive terminal **290** are arranged in the row on the insertion direction R side (lower row). As a result, since the terminals **250**, **290** to which sensor driving voltage including high voltage is applied are situated to the back in the insertion direction, there is less likelihood that ink drops or foreign matter (e.g. a paperclip) will infiltrate to the location of these terminals **250**, **290**. As a result, damage to the circuits of the memory **203** and the printing apparatus **1000** caused by infiltration of foreign matter can be prevented or reduced.

The terminal group of the board **200** is arranged in a staggered pattern. As a result, unwanted contact of the terminals of the ink cartridge **100** with the terminals of the printing apparatus **1000** (the contact forming members **403**, **404** mentioned previously) during the attachment operation can be prevented or reduced.

B. Variations:

Variations of the board **200** mounted to the ink cartridge **100** shall be described with reference to FIGS. **14**A-**16**B. FIGS. **14**A-D show first diagrams depicting boards pertaining to variations. FIGS. **15**A-C show second diagrams depicting boards pertaining to variations. FIGS. **16**A-B show third diagrams depicting boards pertaining to variations.

Variation 1:

On the board **200***b* depicted in FIG. **14**A, the first short detection terminal **210** is similar to the first short detection terminal **210** of the board **200** of the embodiment, but has at its lower end an extended portion that reaches into proximity with the lower edge of the lower row. The extended portion is positioned between the first sensor drive terminal **250** and the reset terminal **260** of the lower row. As a result, for example, even in the event of adhesion of an ink drop S**3** as depicted in FIG. **14**(*a*), shorting of the extended portion of the short

detection terminal **210** to the first sensor drive terminal **250** will be detected. Like this, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal (in the example of FIG. **14**A, the reset terminal **260**) can be prevented or reduced.

As shown in FIG. **14**A, the second short detection terminal **240** of the board **200***b* is also similar in shape to the first short detection terminal **210** mentioned above, and shorting of the second sensor drive terminal **290** to another terminal will also be detected more reliably.

Variation 2:

The board **200***c* depicted in FIG. **14**B has, in addition to the arrangement of the board **200***b* described above, also has an extended portion located at the upper side of the first sensor drive terminal **250**, and reaching into proximity with the upper edge of the upper row. As a result, even in the event of adhesion of an ink drop S**4** as depicted in FIG. **14**(*b*), shorting of the short detection terminal **210** to the extended portion of the first sensor drive terminal **250** will be detected. Like this, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

As shown in FIG. **14**B, the second sensor drive terminal **290** of the board **200***c* is also similar in shape to the first sensor drive terminal **250** mentioned above, and infiltration of an ink drop from the end, at the end at which the second sensor drive terminal **290** is situated, can be detected instantly.

Variation 3:

The board **200***d* depicted in FIG. **14**C differs from the board **200** of the embodiment in that there is no second short detection terminal **240**. In the case of the Type A board **200** depicted in FIG. **10**A, the second short detection terminal **240** does not carry out detection of contact by means of the cartridge detection/short detection circuit **502** (since there is no shorting to the ground terminal **220**). Consequently, in the case of the Type A board **200**, the second short detection terminal **240** is used for short detection only and accordingly can be dispensed with. In this case as well, since the first short detection terminal **210** is at the location closest to the first sensor drive terminal **250**, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended. Infiltration of an ink drop to second sensor drive terminal **290** side will also be detected to a certain extent. In FIG. **14**C, the symbol CP represents the location of contact with the contact forming member **403** that would contact the second short detection terminal **240** if the second short detection terminal **240** were present (i.e. the contact forming member **403** corresponding to the terminal **540** of the carriage circuit **500**). Even in the case that the second short detection terminal **240** is absent, if a shorting should occur between the second sensor drive terminal **290** and the contact forming member **403** corresponding to the terminal **540** of the carriage circuit **500** due to an ink drop S**5**, infiltration of the ink drop S**5** will be detected. Similarly, in the case of a Type C board **200**, the first short detection terminal **210** may be dispensed with.

Variation 4:

On the board **200***e* depicted in FIG. **14**D, the first sensor drive terminal **250** and the first short detection terminal **210** have elongated shape reaching from the vicinity of the upper edge of the upper row to the vicinity of the lower edge of the lower row. The terminals of this shape, as the contact locations are indicated by the symbol CP in FIG. **14**D, can contact the corresponding contact forming portions **403** arranged in a staggered pattern. In the case of the board **200***e*, like the board **200***c* described previously, even if an ink drop S**6** should become deposited for example, shorting between the extended portions of the first short detection terminal **210** and the first sensor drive terminal **250** will be detected. Like this, first short detection terminal **210** is located between first sensor drive terminal **250** and terminal other than the first short detection terminal **210**. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting and the sensor driving voltage is suspended.

The second sensor drive terminal **290** and the second short detection terminal **240** of the board **200***e* have shape similar to the first sensor drive terminal **250** and the first short detection terminal **210** described above. Accordingly, when the second sensor drive terminal **290** and terminal other than the second short detection terminal **240** are shorting, there is a high possibility that the second sensor drive terminal **290** and the second short detection terminal **240** are shorting. As a result, the possibility preventing or reducing the problems caused by shorting of the sensor drive terminal **250**, **290** to another terminal becomes higher.

Variation 5:

On the board **200***f* depicted in FIG. **15**A, the terminal which corresponds to the first short detection terminal **210** and the ground terminal **220** in the board **200** pertaining to the embodiment is an integral terminal **215** wherein these two terminals are integrally formed as a single member. This board **200***f* can be used in place of the Type A or Type B board **200** (FIG. **10**) whose first short detection terminal **210** and ground terminal **220** are shorted. With the board **200***f*, the need is obviated for a line between the first short detection terminal **210** and the ground terminal **220**, which was required in the case of in the board **200** pertaining to the embodiment, so the board **200** requires fewer process steps and fewer parts.

Variation 6:

On the board **200***g* depicted in FIG. **15**B, the terminals **210**-**240** of the upper row each have shape similar to the first short detection terminal **210** of the board **200***b* described previously. Specifically, each of the terminals **210**-**240** has an extended portion situated at the lower edge of the corresponding terminal of the board **200** pertaining to the embodiment and reaching into proximity with the lower edge of the lower row. The terminals **250**-**290** of the lower row of the board **200***g* are similar in shape to the first sensor drive terminal **250** of the board **200***c* described earlier. Specifically, the each of the terminals **250**-**290** has an extended portion situated at the upper edge of the corresponding terminal of the board **200** pertaining to the embodiment and reaching into proximity with the upper edge of the upper row.

As a result, the terminals **210**-**290** of the board **200***g* are arranged so as to form a terminal group composed of a single row of terminals of generally oar shape of in mutually different arrangement, rather than being arranged in two rows. The first sensor drive terminal **250** and the second sensor drive terminal **290** to which the high-voltage sensor driving voltage is applied are positioned at the two ends of the single row of

the terminal group, with the first short detection terminal **210** and the second short detection terminal **240** respectively arranged adjacently inward from the first sensor drive terminal **250** and the second sensor drive terminal **290**.

With the board **200***g*, an ink drop or foreign matter infiltrating from either end can be detected immediately at the point in time that shorting occurs between the first sensor drive terminal **250** and the short detection terminal **210**, or between the second sensor drive terminal **290** and the second short detection terminal **240**. In the event that the first sensor drive terminal **250** or the second sensor drive terminal **290** should short to another terminal, in the case where the shorting is due to an ink drop or the like, the likelihood is extremely high that shorting between the first sensor drive terminal **250** and the short detection terminal **210**, or between the second sensor drive terminal **290** and the second short detection terminal **240**, will occur at the same time. Consequently, shorting of the first sensor drive terminal **250** or the second sensor drive terminal **290** to another terminal can be detected reliably. As a result, damage to the memory **203** and the printing apparatus **1000** circuits (the memory control circuit **501** and the cartridge detection/short detection circuit **502**) caused by the shorting can be prevented or minimized.

Variation 7:

On the board **200***h* depicted in FIG. **15**C, the terminals **210-290** have elongated shape extending over a distance equivalent to two rows of the board **200** pertaining to the embodiment, in a manner similar to the first sensor drive terminal **250** and the first short detection terminal **210** of the board **200***e* described previously. The terminals of this shape, as the contact locations are indicated by the symbol cp in FIG. **15**C, can contact the corresponding contact forming portions **403** arranged in a staggered pattern.

In the board **200***h*, the terminals **210-290** are arranged so as to form a single row in the orthogonal direction to the insertion direction R, in a manner similar to the board **200***g* described above. Also, like the board **200***g*, the first sensor drive terminal **250** and the second sensor drive terminal **290** to which the high-voltage sensor driving voltage is applied are positioned at the two ends of the single row of terminals, with the first short detection terminal **210** and the second short detection terminal **240** respectively arranged adjacently inward from the first sensor drive terminal **250** and the second sensor drive terminal **290**. As a result, the board **200***h* affords advantages analogous to those of the board **200***g* described above.

Variation 8:

The first short detection terminal **210** of the board **200***i* depicted in FIG. **16**A has a shape that is longer on the left side in the drawing, as compared to the first short detection terminal **210** of the board **200** pertaining to the embodiment. Additionally, the first short detection terminal **210** of the board **200***i* has an extended portion reaching from the left edge portion to the vicinity of the lower edge of the lower row. The extended portion is situated to the left of the first sensor drive terminal **250** in the lower row. In other words, the extended portion is disposed to further from the middle of the terminal group in a direction substantially orthogonal to the insertion direction R than the first sensor drive terminal **250**. In this case, whereas viewed in terms of the terminal as a whole, the first short detection terminal **210** is situated outwardly (to the left side) of the first sensor drive terminal **250**, when viewed in terms of the contact portion CP of the terminal, of the contact portions CP of all of the terminals **210-290** the contact portion CP of the first sensor drive terminal **250** is the one situated at the outermost position (left side), in the same manner as in the embodiment. Also, shorting between the first sensor drive terminal **250** and the first short detection terminal **210** that includes the contact portion CP adjacent to the contact portion CP of the first sensor drive terminal **250** is detected. Accordingly, the board **200***i* pertaining to this variation affords advantages similar to the board **200** pertaining to the embodiment. Specifically, infiltration of an ink drop from the edge can be detected instantly, and damage to the circuits of the memory **203** and the printing apparatus **1000** can be prevented or minimized. Additionally, since the first short detection terminal **210** has the extended portion, the length of a first portion that is a portion adjacent to the circumferential edge of the first short detection terminal **210** among the circumferential edge of the first sensor drive terminal **250** becomes long. As shown in FIG. **16**B, the length of the first portion is longer than that of a second portion that is a portion adjacent to the circumferential edge of the reset terminal **260** among the among the circumferential edge of the first sensor drive terminal **250**. As a result, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210**, for example, the reset terminal **260** are shorting, there is a high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting. Accordingly, the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced with higher probability.

The first short detection terminal **210** of the board **200***p* in FIG. **16**C has the longer extended portion than the first short detection terminal **210** of the board **200***i*. As shown in FIG. **16**C, the extended portion of the first short detection terminal **210** of the board **200***p* extends from upper left to lower right of the first sensor drive terminal **250** along the circumferential edge of the first sensor drive terminal **250**. As a result, the length of the first portion in the board **200***p* is longer than that in the board **200***i*. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a higher possibility the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

The first short detection terminal **210** of the board **200***q* in FIG. **16**D has the longer extended portion than the first short detection terminal **210** of the board **200***i* and **200***p*. As shown in FIG. **16**D, the extended portion of the first short detection terminal **210** of the board **200***q* extends from upper left through lower to upper right of the first sensor drive terminal **250** along the circumferential edge of the first sensor drive terminal **250**. In other words, the first short detection terminal **210** is formed so as to surround the first sensor drive terminal **250** completely. As a result, the length of the first portion in the board **200***q* is longer than that in the board **200***i* and **200***p*. Accordingly, when the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting, there is a higher possibility the sensor driving voltage is suspended and problems caused by shorting of the first sensor drive terminal **250** to another terminal can be prevented or reduced.

As shown in FIGS. **16**A-C, board **200***i*, **200***p*, **200***q* are added the direction in which the portion of the first short detection terminal **210** is located adjacently to a portion of the sensor drive terminal **250** by providing the extended portion of the first short detection terminal **210**. About board **200***i*, the extended potion of the first short detection terminal **210** located adjacently to left border of the first sensor drive terminal **250** in a lateral direction towards an edge of the ink cartridge **100**, and the first short detection terminal **210** itself is located adjacently to upper border of the first sensor drive

terminal **250** in opposite direction of the insertion direction R. Meanwhile, about board **200***p*, in addition to above-mentioned two directions, the extended potion of the first short detection terminal **210** is located adjacently to lower border of the first sensor drive terminal **250** in the insertion direction R. Furthermore, about board **200***q*, the extended potion of the first short detection terminal **210** is located adjacently to right border of the first sensor drive terminal **250** in lateral direction away from an edge of the ink cartridge **100**. In other words, about board **200***q*, at least a potion of the first short detection terminal **210** is located adjacently to the first sensor drive terminal **250** in all direction.

When the first sensor drive terminal **250** and terminal other than the first short detection terminal **210** are shorting by ink drop or other object infiltrating from the direction in which the portion of the first short detection terminal **210** is located adjacently to the portion of the first sensor drive terminal **250**, there is a much high possibility that the first sensor drive terminal **250** and the first short detection terminal **210** are shorting. Accordingly, problems caused by shorting of the first sensor drive terminal **250** to another terminal by ink drop or other object infiltrating from such direction can be prevented or reduced with much high probability. In the present variations, the extended portion of the first short detection terminal **210** adds the direction in which the first short detection terminal **210** and the first sensor drive terminal **250** are adjacent each other, and prevents or reduces problems caused by shorting of the first sensor drive terminal **250** to another terminal with much high probability.

In the boards **200***i*, **200***p*, **200***q* pertaining to this variation, only the first short detection terminal **210** on the left side is furnished with a structure having the extended portion described above, but it would be possible to furnish the second short detection terminal **240** on the right side with a structure having an extended portion, in addition to the first short detection terminal **210** or instead of the first short detection terminal **210**. In this case as well, there are afforded advantages analogous to those of the boards **200***i*, **200***p*, **200***q* pertaining to this variation.

Variation 9:

The board **200***j* depicted in FIG. **16**B, like the board **200***f* described previously in Variation 5, has an integral terminal **215** wherein the first short detection terminal **210** and the ground terminal **220** in the board **200** pertaining to the embodiment are integrally formed as a single member. The integral terminal **215** of the board **200***j* differs in shape from the integral terminal **215** of the board **200***f* described previously. Specifically, the integral terminal **215** of the board **200***j*, like the first short detection terminal **210** of the board **200***i* described in Variation 8, has a shape elongated on the left side, and has an extended portion reaching from the left edge portion to the vicinity of the lower edge of the lower row. In this case, advantages analogous to those of the board **200***i* pertaining to Variation 8 are attained, while reducing the number of production steps and parts needed for the board.

In the embodiment and variations described hereinabove, all of the terminals are situated on the board **200**, but it is not necessary that all terminals be situated on the board **200**. For example, it would be acceptable for some of the terminals to be situated on the housing **101** of the ink cartridge **100**. By way of specific examples, Variation 10 and Variation 11 shall be described below with reference to FIGS. **17**A-**18**D. FIGS. **17**A-D show diagrams depicting the construction around boards of ink cartridges pertaining to variations. FIGS. **18**A-D show cross sections A-A to D-D in FIG. **17**.

Variation 10:

The board **200***k* depicted in FIG. **17**A is furnished with seven terminals **210**-**240** and **260**-**280**, out of the nine terminals **210**-**290** furnished to the board **200** of the embodiment. Out of the nine terminals **210**-**290** furnished to the board **200** of the embodiment, the board **200***k* lacks the first sensor drive terminal **250** and the second sensor drive terminal **290**. The board **200***k* pertaining to this variation is furnished with notches NT**1** or NT**2** situated in zones that include the locations where the first sensor drive terminal **250** and the second sensor drive terminal **290** were disposed on the board **200** pertaining to the embodiment. The notches may have the shape indicated by the solid lines NT**1**, or the shape indicated by the broken lines NT**2**, in FIG. **17**A. Terminals **150** and **190** having function similar to the first sensor drive terminal **250** and the second sensor drive terminal **290** of the board **200** in the embodiment are arranged on the housing **101** situated to the rear of the board **200***k*. Naturally, with the ink cartridge **100** attached to the holder **4**, these terminals **150** and **190** are situated at locations contacting the corresponding apparatus-side terminals **450** and **490**.

A-A cross section viewed in FIG. **17**A is depicted in FIG. **18**A. As shown in FIG. **18**A, a depressed portion DE, formed by a gap between the notch NT**1** of the board **200***k* and the terminal **150**, is situated between the terminal **150** and the adjacent terminals **260**, **210** (in FIG. **18**A, the reset terminal **260** is shown). While omitted from the drawing, a similar depressed portion DE is situated between the terminal **190** and the adjacent terminals **280**, **240**.

According to this variation, the following advantages are afforded in addition to those analogous to the board **200** pertaining to the embodiment. If an ink drop or foreign matter should infiltrate from the end of the ink cartridge **100** pertaining to this variation, it will become trapped in the depressed portion DE arranged surrounding the terminal **150** or the terminal **190**, whereby shorting of the terminal **150** or the terminal **190** to another terminal due to an infiltrating ink drop or foreign matter can be further prevented or minimized.

Variation 11:

The board **200***m* depicted in FIG. **17**B, rather than having the notches NT**1** or NT**2** pertaining to Variation 10, is instead furnished with through-holes HL situated at locations corresponding to the locations where the first sensor drive terminal **250** and the second sensor drive terminal **290** are situated on the board **200** pertaining to the embodiment. B-B cross section viewed in FIG. **17**B is depicted in FIG. **18**B. Other arrangements of the ink cartridge **100** pertaining to Variation 11 are the same as those of the ink cartridge **100** pertaining to Variation 10. In this variation as well, depressed portions DE are situated between the terminals **150**, **190** and the adjacent terminals. Accordingly, the ink cartridge **100** pertaining to this variation affords advantages analogous to those of the ink cartridge **100** pertaining to Variation 10.

Variation 12:

In the boards pertaining to the embodiment and variations, all terminals are connected to one of memory **203** and sensor **104**. However, the board may include dummy terminal that is not connected to any device. An example of such type of the board will be described as Variation 12 with reference to FIGS. **19**A-D. FIGS. **19**A-D show fourth diagrams depicting boards pertaining to variations.

The board **200***r* includes the upper row formed by four terminals and the lower row formed by five terminals, as with the board **200** pertaining to the embodiment. Arrangement and function of the terminals **210**-**290** forming the upper row and the lower row of board **200***r* is the same as those of the terminals of board **200** in the embodiment, so the detailed description thereof is omitted.

The board **200***r* shown in FIG. **19**A has the dummy terminals DT between the upper row and the lower row and on the underside (the insertion direction side) of the lower row. The dummy terminals DT, for example, are made of the same material as other terminal **210**-**290**. FIG. **19**C shows E-E cross-section including dummy terminals DT. The dummy terminals DT has about the same thickness as other terminal **210**-**290**.

The dummy terminals DT are for scraping away foreign object adherent on the contact forming members **403**, for example, dust when ink cartridge **100** is attached or detached. This enables to prevent foreign object from being brought to the terminal to be contacted by contact forming member **403** (for example, the first sensor drive terminal **250** in FIG. **19**C) when ink cartridge **100** is attached or detached, and to prevent contact failure between the terminal and the contact forming member **403**.

The board **200***r* shown in FIG. **19**A has the dummy terminal DT between the first sensor drive terminal **250** and the short detection terminal **210**, so you can't say first sensor drive terminal **250** is located adjacent to first short detection terminal **210**. However, the dummy terminals DT is not connected to memory **203** and not connected to the apparatus-side terminals **510**-**590** on printing apparatus **1000**. Therefore, the shorting between the first sensor drive terminal **250** and the dummy terminals DT never cause any problem. Accordingly, the board **200***r* can afford working effects analogous to the board **200** pertaining to the embodiment. That is to say, about the board **200***r*, even if first sensor drive terminal **250** is not located adjacent to first short detection terminal **210** in a precise sense, at least a portion of the first short detection terminal **210** is arranged relative to at least a portion of the first sensor drive terminal **250**, without a terminal connected to memory **203** (terminal **220**, **230**, **260**-**280**) therebetween in at least one direction, for the detection of shorting between the first sensor drive terminal **250** and the first short detection terminal **210**. In such a case, the first sensor drive terminal **250** is substantially located adjacent to first short detection terminal **210**. Consequently, in the event that the first sensor drive terminal **250** should short to another terminal or terminals due to the ink drop or the water drop, there is a high likelihood that the first sensor drive terminal **250** will short to the short detection terminal **210** as well. As a result, the output of sensor driving voltage is suspend and damage to the circuits of the memory **203** and the printing apparatus **1000** caused by shorting can be prevented or reduced.

Variation 13:

The boards pertaining to the embodiment and variations, as shown in FIG. **2**, are described as the board mounted on a ink cartridge **100** used for "on carriage" type printer. However, the boards pertaining to the embodiment and variations may be mounted on an ink cartridge used for "off carriage" type printer. The ink cartridge used for "off carriage" type printer will be described below with reference to FIG. **20** and FIG.**21**. FIG. **20** shows a perspective view of the construction of the ink cartridge pertaining to the variation 13. FIG. **21** shows a picture of the ink cartridge pertaining to the variation 13 being attached to the printer.

Ink cartridge **100***b* pertaining to Variation 13 is configured for installation in an "off carriage" type printer, i.e., one in which the ink cartridge is not installed on a carriage. Off carriage type printers are typically large-scale printers; the ink cartridges employed in such large-scale printers are typically larger in size than the ink cartridges employed in on-carriage type printers.

Ink cartridge **100***b* comprises a housing **1001** containing ink, a board mounting portion **1050** for mounting board **200**, an ink feed orifice **1020** for supplying ink from a housing **1001** to the printer; an air feed orifice **1030** allowing intake of air into ink cartridge **100***b* to allow smooth flow of ink; and guide portions **1040** for installation in the printer. The exterior dimensions of ink cartridge **100***b* are such that the side thereof (i.e. the depth direction) extending perpendicular to the side on which the guide portions **1040**, etc. are formed (i.e. the width direction) is longer than the width direction. The relationship of the depth-wise dimension to the width-wise dimension of board **200**, expressed as a ratio of the two, is 15:1 or greater, for example.

As in the case of the above-mentioned embodiment, board **200** is positioned by means of boss hole **202** and boss slot **201**, and secured on the board mounting portion **1050** of ink cartridge **100***b*.

As shown in FIG. **21**, when installing the ink cartridge **100***b* in the printer, the guide portions **1040** of ink cartridge **100***b* guide the guide pins **2040** on the printer so that the board mounting portion **1050**, ink feed orifice **1020**, and air feed orifice **1030** are appropriately contacted/coupled with a contact pin **2050**, ink feed orifice **2020**, and air feed orifice **2030** on the printer. The insertion direction of ink cartridge **100***b* is indicated by arrow R in FIG. **21**. The insertion direction R on board **200** in this variation is the same as that in the above-mentioned embodiment.

Ink cartridge **100***b* used for off carriage type printer pertaining to this variation can prevent or reduce problems caused by shorting of the first sensor drive terminal **250** to another terminal as in the case of the embodiment and variations described above.

Variation 14:

Configuration of the ink cartridge for "on carriage" type printer shown in FIG. **2** is one example among many. Configuration of the ink cartridge for "on carriage" type printer is not limited to this. Other configuration of the ink cartridge for "on carriage" type printer shall be described as Variation 14 with reference to FIGS. **22**-**24**. FIG. **22** shows a first diagram of the construction of the ink cartridge pertaining to Variation 14. FIG. **23** shows a second diagram of the construction of the ink cartridge pertaining to variation 14. FIG. **24** shows a third diagram of the construction of the ink cartridge pertaining to Variation 14.

As shown in FIGS. **22** and **23**, the ink cartridge **100***b* pertaining to Variation 14 includes housing **101***b*, board **200** and sensor **104***b*. On the bottom face of the housing **101***b*, as with ink cartridge **100** in the embodiment, there is formed an ink supply orifice **110***b* into which the ink supply needle inserts when ink cartridge **100***b* is attached to the holder **4***b*. The board **200** is mounted on the lower side (Z-axis plus direction side) of the front face (Y-axis plus direction side face) of the housing **101** as with ink cartridge **100** in the embodiment. Configuration of the board **200** is identical with the board **200** in the embodiment. The sensor **104***b* is embedded in the side wall of the housing **101***b* and used for detection of remaining ink level. Hook **120***b* that engages with catching part of the holder **4***b* when the ink cartridge **100***b* is attached to the holder **4***b* is mounted on the upper side of the front face of the housing **101***b*. Hook **120***b* fixates the Ink cartridge **100***b* to the holder **4***b*. The insertion direction when the ink cartridge **100***b* is attached to the holder **4***b* is a direction of arrow R in FIG. **22** (Z-axis plus direction) as with the ink cartridge **100** in the embodiment.

The housing **101***b* has displacement preventers PO1-PO4 on the side portion (x-axis direction side) of housing **101***b* close to the board **200**. The displacement preventers PO1-

PO4 comes into contact with or close to a corresponding potion of the side wall of the holder **4***b* when the ink cartridge **100***b* is attached to the holder **4***b*. This prevents the ink cartridge **100***b* from moving in X-axial direction from its ideal position on the holder **4***b*. Specifically, the displacement preventers PO1 and PO2 are located on the upper side of the board **200** and prevent the upper side of the **100***b* from swinging in X-axial direction taking the ink supply orifice **110***b* as an axis of rotation. The displacement preventers PO3 and PO4 are lateral to the terminals **210**-**290** on the board **200** (FIG. **3**) and keep the terminals **210**-**290** in the correct position so as to contact the corresponding apparatus-side terminal **410**-**490** correctly.

The electrical arrangements of the ink cartridge **100***b* pertaining to Variation 14 is identical with those of the ink cartridge **100** pertaining to above-embodiment described with reference to FIG. **7**. So, the description thereof is omitted.

The ink cartridge **100***b* pertaining to Variation 14 affords the following working effects in addition to the same working effects as the ink cartridge **100** pertaining to the embodiment. Since the ink cartridge **100***b* has the displacement preventers PO1-PO4, it can prevent or reduce the position displacement when the ink cartridge **100***b* is attached to the holder **4***b*. Especially, since the displacement preventers PO3 and PO4 are lateral to the terminals **210**-**290** on the board **200**, accuracy of positioning of the terminals **210**-**290** relative to the corresponding apparatus-side terminals can be improved. Further, as described with reference to FIG. **3**, in the board **200**, the sensor drive terminal **250** and the second sensor drive terminal **290** are arranged at each end of the terminals **210**-**290**, that is, the sensor drive terminal **250** and the second sensor drive terminal **290** are closest to the displacement preventers PO4 and PO4 respectively. This lead to improvement of accuracy of positioning of the sensor drive terminal **250** and the second sensor drive terminal **290**. Therefore, the false contact between the terminals **250**, **290** to which high voltage is applied and one of the non-corresponding apparatus-side terminals can be prevented or reduced.

As substitute for the board **200** in the embodiment, one of the boards **200***b*-**200***s* shown in FIGS. **14**-**19** can be mounted on the ink cartridge **100***b* shown in FIG. **22**-**24**.

Other Variations:

As depicted in FIGS. **17**C-D and in FIGS. **18**C-D, porous elements PO may be disposed within the depressed portions DE in Variation 10 and Variation 11 described above, i.e. between the terminals **150**, **190** and the board. By so doing, ink drops or condensed water, which can easily cause shorting of the terminals **150**, **190** to other terminals, can be effectively absorbed by the porous elements PO. Accordingly, this design also affords advantages analogous to those of Variation 10 and Variation 11 discussed above.

In the embodiment herein, the ink cartridge **100** is furnished with a sensor **104** (piezoelectric element) and memory **203** as the plurality of the devices; however, the plurality of the devices are not limited to a sensor **104** and memory **203**. For example, the sensor **104** may be a sensor of a type that detects the properties or level of ink by means of applying voltage to the ink within an ink cartridge **100**, and measuring its resistance. In the embodiment, among the plurality of the devices, the sensor **104** is mounted on the housing **101** and the memory **203** is mounted on the board **200**. However, the arrangements of the plurality of the devices are not limited to those in the embodiment. For example, the memory **203** and the board **200** may be separate, and the memory **203** and the board **200** may be installed on the housing **101** individually. The plurality of the devices may be integrated into a circuit board or a single module. The circuit board or the single module may be mounted on the housing **101** or the board **200**. It's preferred that terminals connected to a device to which relatively high voltage among the plurality of the devices are arranged in positions of the first sensor drive terminal **250** and the second sensor drive terminal **290** described above, and terminals connected to a device to which relatively low voltage among the plurality of the devices are arranged in positions of the terminals **220**, **230**, **260**-**280**. In this case, damage to the ink cartridge **100** and the printing apparatus **1000** caused by shorting between the terminal connected to the device to which relatively high voltage and the terminal connected to the device to which relatively low voltage can be prevented or reduced.

In above-mentioned embodiment, five terminals for memory **203** (**220**, **230**, **260**-**280**) and two terminals for sensor **104** (**250**, **290**) are employed, however, other number of terminals may be employed due to the specification of the device. For example, the terminal connected to the device to which relatively high voltage may be one. In this case, such terminal may be arranged in a position of any of the terminals **250**, **290** described above.

Whereas in the embodiment herein the invention is implemented in an ink cartridge **100**, implementation thereof is not limited to ink cartridges, with implementation in a similar manner to receptacles containing other types of printing material, such as toner, being possible as well.

With regard to the arrangements of the main control circuit **40** and the carriage circuit **500** in the printing apparatus, portions of these arrangements implemented through hardware could instead be implemented through software, and conversely portions implemented through software could instead be implemented through hardware.

While the printing material container and board pertaining to the invention have been shown and described on the basis of the embodiment and variation, the embodiments of the invention described herein are merely intended to facilitate understanding of the invention, and implies no limitation thereof. Various modifications and improvements of the invention are possible without departing from the spirit and scope thereof as recited in the appended claims, and these will naturally be included as equivalents in the invention.

What is claimed is:

1. An ink cartridge for mounting on an ink jet printing apparatus, the ink jet printing apparatus having a print head and a plurality of apparatus-side contact forming members, the ink cartridge comprising:

a body;

an ink supply opening having an exit on an exterior portion of the body, adapted to supply ink from the ink cartridge to the printing apparatus;

a memory device adapted to be driven by a memory driving voltage;

an electronic device adapted to receive a voltage higher than the memory driving voltage; and

a plurality of terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, the contact portions of the terminals including a plurality of memory contact portions electrically coupled to the memory device, a first electronic device contact portion electrically coupled to the electronic device, a second electronic device contact portion electrically coupled to the electronic device, and a short detection contact portion positioned and arranged to electrically contact a

contact forming member that itself is electrically coupled to a short detection circuit of the printing apparatus, wherein:

the contact portions are arranged so that, when the terminal arrangement is viewed from the vantage of the contact forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the ink cartridge oriented with the exit of the ink supply opening facing downwards, the contact portion farthest to the left is the first electronic device contact portion, the contact portion that is farthest to the right is the second electronic device contact portion, the contact portion that is second farthest to the right is the short detection contact portion, and the memory contact portions are located to the left of the short detection contact portion and to the right of the first electronic device contact portion.

2. The ink cartridge of claim **1**, wherein the short detection contact portion is positioned and adapted for detecting a short between the short detection contact portion and at least the second electronic device contact portion, the short detection contact portion being adjacent to the second electronic device contact portion, with no other contact portion therebetween.

3. The ink cartridge of claim **1**, wherein the electronic device is adapted to receive a first voltage and output a voltage lower than the first voltage.

4. The ink cartridge of claim **1**, and including a second short detection contact portion arranged so that the second short detection contact portion is the second farthest of the contact portions to the left.

5. The ink cartridge of claim **4**, wherein the memory contact portions are to the left of the short detection contact portion and the second electronic device contact portion and to the right of the second short detection contact portion and the first electronic device contact portion.

6. The ink cartridge of claim **1**, wherein the number of contact portions adjacent to the second electronic device contact portion is smaller than the number of contact portions adjacent to the short detection contact portion.

7. The ink cartridge of claim **1**, wherein

the contact portions are arranged in a first row of contact portions and in a second row of contact portions such that the first row of contact portions is below the second row of contact portions, and

the first electronic device contact portion and the second electronic device contact portion are located at the ends of the first row of contact portions.

8. The ink cartridge of claim **1**, wherein:

the contact portions are arranged in a first row of contact portions and in a second row of contact portions,

the first row of contact portions and the second row of contact portions extend in a row direction which is generally orthogonal to an insertion direction in which the ink cartridge is mounted into the ink jet printing apparatus,

the first row of contact portions is disposed at a location that is further in the insertion direction than the second row of contact portions, and

the first electronic device contact portion and the second electronic device contact portion are located at the ends of the first row of contact portions.

9. An ink cartridge for mounting on an ink jet printing apparatus, the ink jet printing apparatus having a print head and a plurality of apparatus-side contact forming members, the ink cartridge comprising:

a body;

an ink supply opening having an exit on an exterior portion of the body, adapted to supply ink from the ink cartridge to the printing apparatus;

a low voltage electronic device;

a high voltage electronic device; and

a plurality of terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, the contact portions of the terminals including a plurality of low voltage electronic device contact portions electrically coupled to the low voltage electronic device, a first high voltage electronic device contact portion electrically coupled to the high voltage electronic device, a second high voltage electronic device contact portion electrically coupled to the high voltage electronic device and arranged to have applied thereto a higher voltage than the low voltage electronic device contact portions, and a short detection contact portion positioned and arranged to electrically contact a contact forming member that itself is electrically coupled to a short detection circuit of the printing apparatus, wherein:

the contact portions are arranged so that, when the terminal arrangement is viewed from the vantage of the contact forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and from the perspective with the ink cartridge oriented with the exit of the ink supply opening facing downwards, the contact portion farthest to the left is the first high voltage electronic device contact portion, the contact portion that is farthest to the right is the second high voltage electronic device contact portion, the contact portion that is second farthest to the right is the short detection contact portion, and the low voltage electronic device contact portions are located to the left of the short detection contact portion and to the right of the first high voltage electronic device contact portion.

10. The ink cartridge of claim **9**, wherein the low voltage electronic device is a memory.

11. The ink cartridge of claim **9**, wherein the short detection contact portion is positioned and adapted for detecting a short between the short detection contact portion and at least the second electronic device contact portion, the short detection contact portion being adjacent to the second electronic device contact portion, with no other contact portion therebetween.

12. The ink cartridge of claim **9**, wherein the high voltage electronic device is adapted to receive a first voltage and output a voltage lower than the first voltage.

13. The ink cartridge of claim **9**, and including a second short detection contact portion arranged so that the second short detection contact portion is the second farthest of the contact portions to the left.

14. The ink cartridge of claim **13**, wherein the low voltage electronic device contact portions are to the left of the short detection contact portion and the second high voltage electronic device contact portion and to the right of the second short detection contact portion and the first high voltage electronic device contact portion.

15. The ink cartridge of claim **9**, wherein the number of contact portions adjacent to the second high voltage elec-

tronic device contact portion is smaller than the number of contact portions adjacent to the short detection contact portion.

16. The ink cartridge of claim **9**, wherein

the contact portions are arranged in a first row of contact portions and in a second row of contact portions such that the first row of contact portions is below the second row of contact portions, and

the first high voltage electronic device contact portion and the second high voltage electronic device contact portion are located at the ends of the first row of contact portions.

17. The ink cartridge of claim **9**, wherein:

the contact portions are arranged in a first row of contact portions and in a second row of contact portions,

the first row of contact portions and the second row of contact portions extend in a row direction which is generally orthogonal to an insertion direction in which the ink cartridge is mounted into the ink jet printing apparatus,

the first row of contact portions is disposed at a location that is further in the insertion direction than the second row of contact portions, and

the first high voltage electronic device contact portion and the second high voltage electronic device contact portion are located at the ends of the first row of contact portions.

18. A circuit board mountable on a printing material container that is used in an ink jet printing apparatus, the ink jet printing apparatus having a print head and a plurality of apparatus-side contact forming members, the printing material container having a body and an ink supply opening, the ink supply opening having an exit on an exterior portion of the body and being adapted to supply ink from the printing material container to the printing apparatus, the circuit board comprising:

a memory device adapted to be driven by a memory driving voltage;

an electronic device adapted to receive a voltage higher than the memory driving voltage; and

a plurality of terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing apparatus, the contact portions of the terminals including a plurality of memory contact portions electrically coupled to the memory device, a first electronic device contact portion electrically coupled to the electronic device, a second electronic device contact portion electrically coupled to the electronic device, and a short detection contact portion positioned and arranged to electrically contact a contact forming member that itself is electrically coupled to a short detection circuit of the printing apparatus, wherein:

the contact portions are arranged so that, when the terminal arrangement is viewed from the vantage of the contact forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the ink cartridge oriented with the exit of the ink supply opening facing downwards, the contact portion farthest to the left is the first electronic device contact portion, the contact portion that is farthest to the right is the second electronic device contact portion, the contact portion that is second farthest to the right is the short detection contact portion, and the memory contact portions are located to the left of the short detection contact portion and to the right of the first electronic device contact portion.

19. The circuit board of claim **18**, wherein the electronic device is adapted to receive a first voltage and output a voltage lower than the first voltage.

20. The circuit board of claim **18**, and including a second short detection contact portion arranged so that when the circuit board is mounted on the printing material the second short detection contact portion is the second farthest of the contact portions to the left.

21. The circuit board of claim **20**, wherein the memory contact portions are to the left of the short detection contact portion and the second electronic device contact portion and to the right of the second short detection contact portion and the first electronic device contact portion.

22. The circuit board of claim **18**, wherein the short detection contact portion is positioned and adapted for detecting a short between he short detection contact portion and at least the second electronic device contact portion, the short detection contact portion being adjacent to the second electronic device contact portion, with no other contact portion therebetween.

23. The circuit board of claim **18**, wherein

the contact portions are arranged in a first row of contact portions and in a second row of contact portions such that, when the circuit board is mounted on the printing material container and the terminal arrangement is viewed with the printing material container oriented with the exit of the ink supply opening at the bottom, the first row of contact portions is below the second row of contact portions, and

the first electronic device contact portion and the second electronic device contact portion are located at the ends of the first row of contact portions.

24. The circuit board of claim **18**, wherein:

the contact portions are arranged in a first row of contact portions and in a second row of contact portions,

the first row of contact portions and the second row of contact portions extend in a row direction that is, with respect to a condition in which the circuit board is mounted on the printing material container, generally orthogonal to an insertion direction in which the printing material container is mounted into the ink jet printing apparatus,

the first row of contact portions is disposed at a location that is, with respect to a condition in which the circuit board is mounted on the printing material container, further in the insertion direction than the second row of contact portions, and

the first electronic device contact portion and the second electronic device contact portion are located at the ends of the first row of contact portions.

25. An ink supply system connectable to an ink jet printing apparatus, the ink jet printing apparatus having a print head and a plurality of apparatus-side contact forming members, the ink supply system comprising:

an ink supply structure having an exit opening adapted to supply ink to the printing apparatus:

a circuit board comprising:

a memory device adapted to be driven by a memory driving voltage;

an electronic device adapted to receive a voltage higher than the memory driving voltage; and

a plurality of terminals having contact portions adapted and positioned to contact corresponding apparatus-side contact forming members so that electrical communication is enabled with the ink jet printing appa-

ratus, the contact portions of the terminals including a plurality of memory contact portions electrically coupled to the memory device, a first electronic device contact portion electrically coupled to the electronic device, a second electronic device contact portion electrically coupled to the electronic device, and a short detection contact portion positioned and arranged to electrically contact a contact forming member that itself is electrically coupled to a short detection circuit of the printing apparatus, wherein:

the contact portions are arranged so that, when the terminal arrangement is viewed from the vantage of the contact forming members, with the terminals oriented as if in contact with the contact forming members so that electrical communication is enabled with the ink jet printing apparatus, and with the ink cartridge oriented with the exit opening of the ink supply structure facing downwards, the contact portion farthest to the left is the first electronic device contact portion, the contact portion that is farthest to the right is the second electronic device contact portion, the contact portion that is second farthest to the right is the short detection contact portion, and the memory contact portions are located to the left of the short detection contact portion and to the right of the first electronic device contact portion.

26. The ink supply system of claim **25**, wherein the electronic device is adapted to receive a first voltage and output a voltage lower than the first voltage.

27. The ink supply system of claim **25**, and including a second short detection contact portion arranged so that the second short detection contact portion is the second farthest of the contact portions to the left.

28. The ink supply system of claim **27**, wherein the memory contact portions are to the left of the short detection contact portion and the second electronic device contact portion and to the right of the second short detection contact portion and the first electronic device contact portion.

29. The ink supply system of claim **25**, wherein the short detection contact portion is positioned and adapted for detecting a short between the short detection contact portion and at least the second electronic device contact portion, the short detection contact portion being adjacent to the second electronic device contact portion, with no other contact portion therebetween.

30. The ink supply system of claim **25**, wherein

the contact portions are arranged in a first row of contact portions and in a second row of contact portions such that, when the ink supply system is connected to the ink jet printing apparatus , the first row of contact portions is below the second row of contact portions, and

the first electronic device contact portion and the second electronic device contact portion are located at the ends of the first row of contact portions.

* * * * *

EXHIBIT C

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,454,116 B2
APPLICATION NO. : 13/608658
DATED : June 4, 2013
INVENTOR(S) : Noboru Asauchi

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

At Claim number 18, Column 31, Line number 60, delete "the ink cartridge" and insert --the printing material container--.

At Claim number 20, Column 32, Line 8, delete "the printing material" and insert --the printing material container--.

At Claim number 25, Column 33, Line 16, delete "the ink cartridge" and insert --the ink supply structure--.

Signed and Sealed this
Twenty-sixth Day of April, 2022

Katherine Kelly Vidal

Katherine Kelly Vidal
Director of the United States Patent and Trademark Office

EXHIBIT D

United States of America
United States Patent and Trademark Office

252

Reg. No. 7,055,411

Registered May 16, 2023

Int. Cl.: 2

Trademark

Principal Register

Epson America, Inc. (CALIFORNIA CORPORATION)
3131 Katella Avenue
Los Alamitos, CALIFORNIA 90720

CLASS 2: Filled ink cartridges for printers and photocopiers

FIRST USE 4-00-2014; IN COMMERCE 4-00-2014

THE MARK CONSISTS OF STANDARD CHARACTERS WITHOUT CLAIM TO ANY PARTICULAR FONT STYLE, SIZE OR COLOR

SER. NO. 97-650,666, FILED 10-27-2022

Katherine Kelly Vidal

Director of the United States
Patent and Trademark Office

EXHIBIT E

United States of America
United States Patent and Trademark Office

502

Reg. No. 7,048,971

Registered May 09, 2023

Int. Cl.: 2

Trademark

Principal Register

Epson America, Inc. (CALIFORNIA CORPORATION)
3131 Katella Avenue
Los Alamitos, CALIFORNIA 90720

CLASS 2: Filled ink bottles for printers and photocopiers

FIRST USE 9-00-2017; IN COMMERCE 9-00-2017

THE MARK CONSISTS OF STANDARD CHARACTERS WITHOUT CLAIM TO ANY PARTICULAR FONT STYLE, SIZE OR COLOR

SER. NO. 97-556,666, FILED 08-19-2022

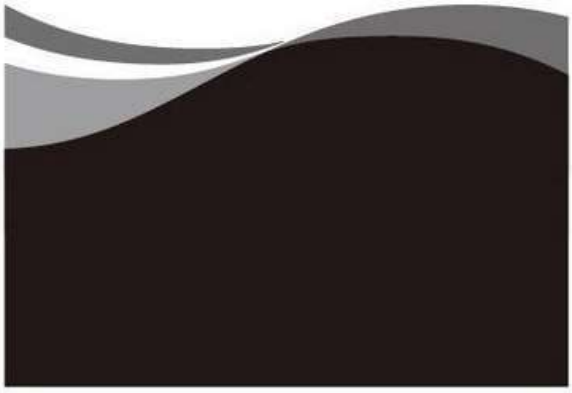
Katherine Kelly Vidal

Director of the United States
Patent and Trademark Office

EXHIBIT F

United States of America

United States Patent and Trademark Office



Reg. No. 5,402,648

Registered Feb. 13, 2018

Int. Cl.: 2

Trademark

Principal Register

Seiko Epson Kabushiki Kaisha (JAPAN JOINT STOCK COMPANY), TA Seiko Epson Corporation
1-6, Shinjuku 4-chome, Shinjuku-ku
Tokyo, JAPAN

CLASS 2: Printer's ink, filled ink bottles and filled ink cartridges for ink jet printers and for multi-function printers incorporating one or more additional feature, namely, copying, scanning and faxing capabilities; filled ink bottles in retail packaging for printers; filled ink cartridges in retail packaging for printers; printing ink; ink bottles filled with ink for printers; filled ink bottles for printers

FIRST USE 2-28-2017; IN COMMERCE 2-28-2017

The mark consists of a stylized wave design wherein the lower portion appears solid. A curved band and a wavy band appear at the top.

SER. NO. 87-190,044, FILED 09-30-2016

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

Director of the United States
Patent and Trademark Office