David W. Axelrod, OSB # 750231
E-mail: *daxelrod@schwabe.com*
Schwabe, Williamson & Wyatt, P.C.
Pacwest Center
1211 SW 5th Ave., Suite 1600
Portland, OR 97204
Tel.: (503) 222-9981
Fax: (503) 796-2900

Tigran Guledjian, Cal. Bar # 207613, *pro hac vice pending*
E-mail: *tigranguledjian@quinnemanuel.com*
Quinn Emanuel Urquhart & Sullivan, LLP
865 South Figueroa Street, 10th Floor
Los Angeles, CA 90017
Tel.: (213) 443-3000
Fax: (213) 443-3100

Attorneys for Plaintiffs Seiko Epson Corporation, Epson America, Inc., and Epson Portland Inc.

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF OREGON

PORTLAND DIVISION

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

Plaintiffs,

v.

TA TRIX USA INC., a New York corporation,

Defendant.

Civil No. 3:17-cv-00369

COMPLAINT FOR:

PATENT INFRINGEMENT

DEMAND FOR JURY TRIAL

Plaintiffs Seiko Epson Corporation, Epson America, Inc., and Epson Portland Inc., 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, 35 U.S.C. § 1 *et. seq*.

RELATED ACTIONS

2. This action is related to two actions that are being concurrently filed, captioned as follows:

a. *Seiko Epson Corporation, et al. v. OW Supplies Corp.*, Civil No. ___-cv-_____ (D. Or.); and

b. *Seiko Epson Corporation, et al. v. Gaea Supplies Corporation*, Civil No. ___-cv-_____ (D. Or.).

The same patents that are asserted in the above two cases are asserted in this Complaint against infringing products that, from a patent analysis perspective, are the same in each of the cases.

3. This action is also related to four recently filed actions captioned as follows:

a. *Seiko Epson Corporation, et al. v. Nano Business & Technology, Inc.*, Civil No. 3:16-cv-02211-YY (D. Or.), filed on November 22, 2016 and currently assigned to Magistrate Judge Youlee Yim You;

b. *Seiko Epson Corporation, et al. v. HT Tech, Inc. and HT Imaging Inc.*, Civil No. 3:16-cv-2321-YY (D. Or.) filed December 14, 2016 and currently assigned to Magistrate Judge Youlee Yim You;

c. *Seiko Epson Corporation, et al. v. Inkjet2U LLP*, Civil No. 3:16-cv-2322-YY (D. Or.) filed on December 14, 2016 and currently assigned to Magistrate Judge Youlee Yim You; and

d. *Seiko Epson Corporation, et al. v. Shoppers Smart LLC, Houses Investing, LLLP and Houses Investing Of Florida, Corp.*, Civil No. 3:16-cv-2324-YY (D. Or.) filed on December 14, 2016 and currently assigned to Magistrate Judge Youlee Yim You.

The same patents that are asserted in the foregoing cases are asserted in this Complaint against infringing products that, from a patent analysis perspective, are the same in each of the cases.

4. This action is also related to five legal proceedings, all of which were pending before this Court and were assigned to the Honorable Anna J. Brown. All five proceedings were concluded by settlement, entry of consent orders and/or by entry of defaults and default judgments, with the last of the proceedings concluding on June 15, 2012 when the cases were closed by the Court. One of the two patents (the '917 patent, discussed below) asserted in this case was litigated in each of the five related proceedings against the same or overlapping groups of products that are accused of infringement in this action. The five related proceedings are as follows:

a. *Seiko Epson Corporation, et al. v. Glory South Software Manufacturing Inc., et al.*, Civil No. 06-236-BR (D. Or.), closed June 15, 2012;

b. *Seiko Epson Corporation, et al. v. Glory South Software Manufacturing Inc., et al.*, Civil No. 06-477-BR (D. Or.), closed June 15, 2012;

c. *Seiko Epson Corporation, et al. v. Abacus 24-7 LLC, et al.*, Civil No. 09-477-BR (D. Or.), closed June 15, 2012;

d. *Seiko Epson Corporation, et al. v. E-Babylon, Inc., et al.*, Civil No. 07-896-BR (D. Or.), closed February 27, 2012; and

e. *Seiko Epson Corporation, et al. v. Inkjetmadness.com, Inc., et al*., Civil No. 08-452-BR (D. Or.), closed February 27, 2012.

5. In addition, 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, Washington, D.C. ("ITC"), which has been adjudicated by the ITC in a final determination (Commission Opinion, May 26, 2016) (the "ITC 946 Investigation") and in which the Commission issued a General Exclusion Order and certain Cease and Desist Orders. The other of the two patents (the '749 patent, discussed below) asserted in this case was litigated in the ITC 946 Investigation against the same or overlapping groups of products that are accused of infringement in this action.

6. Lastly, this action is related to *In the Matter of CERTAIN INK CARTRIDGES AND COMPONENTS THEREOF*, Investigation No. 337-TA-565, United States International Trade Commission, Washington, D.C., which has been adjudicated by the ITC in a final determination (Commission Opinion, October 19, 2007) (the "ITC 565 Investigation") in which the Commission issued a General Exclusion Order, a Limited Exclusion Order and certain Cease and Desist Orders. The ITC's final determination was upheld in its entirety in a *per curiam* judgment by the Federal Circuit and on June 1, 2009 the United States Supreme Court denied a Petition for Writ of *Certiorari* for review of the Federal Circuit decision. The '917 patent asserted in this case was litigated in the ITC 565 Investigation against the same or overlapping groups of products that are accused of infringement in this action.

THE PARTIES

7. 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.

8. 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 3840 Kilroy Airport Way, Long Beach, California 90806. As the North American sales, marketing and customer service affiliate of Seiko Epson, Epson America is the exclusive licensee of the Epson Patents described below 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.

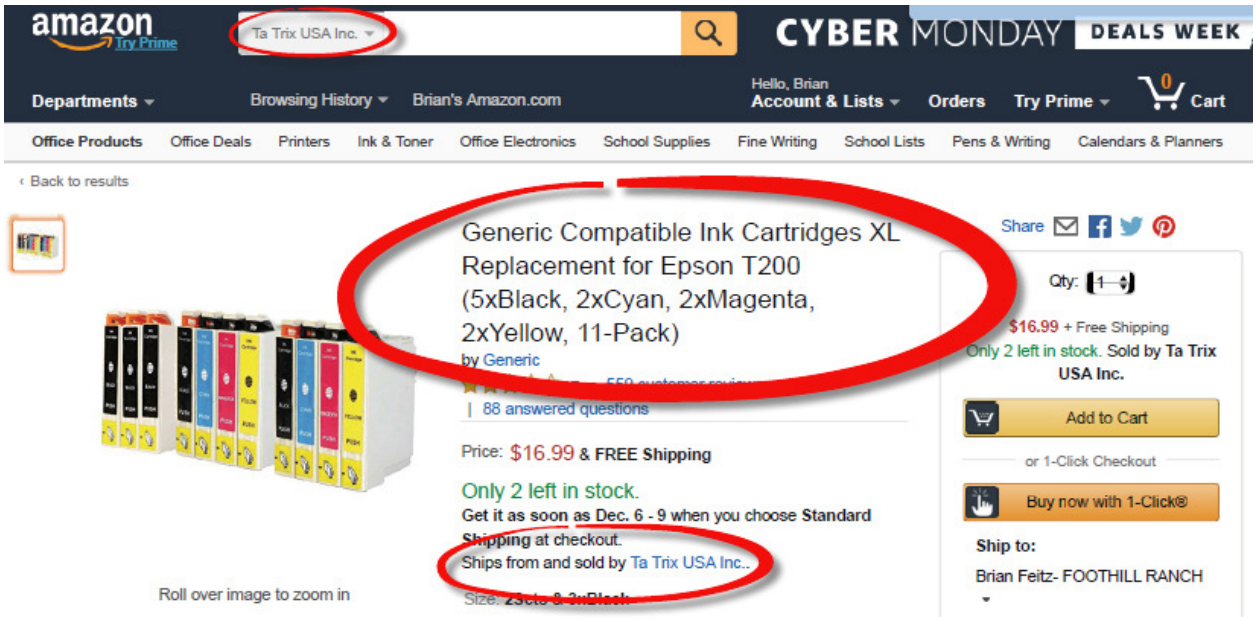
9. Plaintiff Epson Portland Inc. ("Epson Portland") is a corporation organized and existing under the laws of the State of Oregon. Its principal place of business is located at 3950 NW Aloclek Place, Hillsboro, Oregon 97124. Epson Portland is the exclusive licensee of the Epson Patents described below for manufacturing in the United States Epson ink cartridges that embody the inventions contained in the Epson Patents. Seiko Epson, Epson America and Epson Portland are sometimes referred to collectively herein as "Epson" or "Plaintiffs."

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

11. On information and belief, defendant Ta Trix USA Inc. ("Ta Trix") is a corporation organized and existing under the laws of the State of New York. Based on information and belief, and according to Ta Trix's filings with the New York Secretary of State, Ta Trix's address for service of process is located at 36-04 Main Street, Suite 202B, Flushing, New York, New York, 11354. On information and belief, Ta Trix also has a place of business address located at 256 Silver Lane Drive,

Old Bridge, New Jersey, 08857, from where it ships infringing products. On information and belief, Vivian Ying is an officer of Ta Trix and also has an address located at 256 Silver Lane Drive, Old Bridge, New Jersey, 08857.

12. On information and belief, Ta Trix does business online as "Ta Trix USA Inc." through at least its listings on Amazon using at least the online seller name Ta Trix USA Inc. Directly through Amazon, Ta Trix offers for sale and sells ink cartridges that infringe the Epson patents as complained of herein. For example, in the annotated screen capture below of an Amazon.com listing, visited on November 30, 2016, Ta Trix offers for sale infringing ink cartridges for Epson printers and describes the infringing ink cartridges as "Generic Compatible Ink Cartridges XL Replacement for Epson T200 (5xBlack, 2xCyan, 2xMagenta, 2xYellow, 11-Pack)" and that these infringing ink cartridges are shipped and sold by Ta Trix USA Inc.



On information and belief, most sales by Defendant are of generic (unbranded) infringing ink cartridges.

13. Numerous purchases of infringing ink cartridges were made by Epson from Defendant's "Ta Trix USA Inc." online listings discussed above. The infringing ink cartridges were shipped by Defendant to Epson from Defendant's 256 Silver Lane Drive, Old Bridge, New Jersey, 08857 address, the same address identified above in paragraph 11.

JURISDICTION AND VENUE

14. 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 and 1338(a). This Court has personal jurisdiction of the Defendant at least because Defendant has committed acts of direct and indirect patent infringement in this judicial district and reside in this judicial district. Venue is proper in this district under 28 U.S.C. §§ 1391(b), (c) and 1400(b).

FIRST CLAIM FOR RELIEF

(Patent Infringement—35 U.S.C. § 271)

INFRINGEMENT OF U.S. PATENT NO. 6,502,917

15. Epson incorporates by reference each and every allegation contained in Paragraphs 1 through 14 as though fully set forth at length here.

16. 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. 6,502,917, which was duly and legally issued to Seiko Epson by the United States Patent and Trademark Office on January 7, 2003. Attached as Exhibit A to this Complaint is a true and correct copy of the 6,502,917 patent. On February 3, 2009, reexamination certificate 6,502,917 C1 was duly and legally issued to Seiko Epson by the Unites States Patent and Trademark Office. Attached as Exhibit B to this Complaint is a true and correct copy of the reexamination certificate of the '917 patent. The original patent and the

reexamination certificate are collectively referred to herein as "the '917 patent." The '917 patent relates generally to ink cartridges for printers.

17. The '917 patent is valid and enforceable.

18. On information and belief after conducting a reasonable investigation, Defendant has infringed and is infringing the '917 patent, as defined by numerous claims 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 having model nos. 2002XL, 2003XL, 2004XL, E-771, 1261, E-1262, 1263, and 1264, as well as others that are no more than colorably different from the foregoing (collectively, the "Accused '917 Ink Cartridges"). The specific models of Accused '917 Ink Cartridges identified above were obtained by Epson during its investigation leading to this Complaint from Defendant's "Ta Trix USA Inc." online listings. The Accused '917 Ink Cartridges were shipped by Defendant from its 256 Silver Lane Old Bridge, New Jersey, 08857 address.

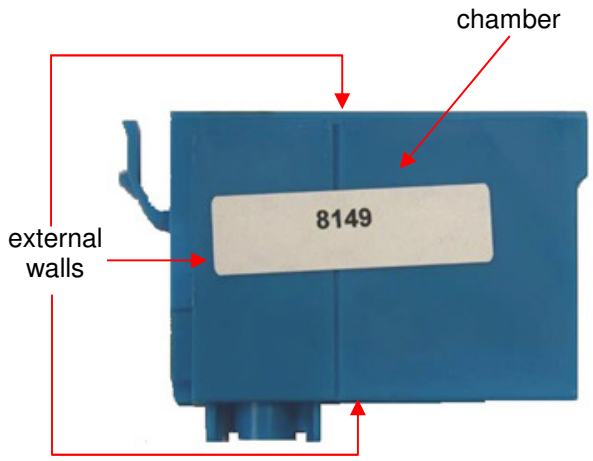
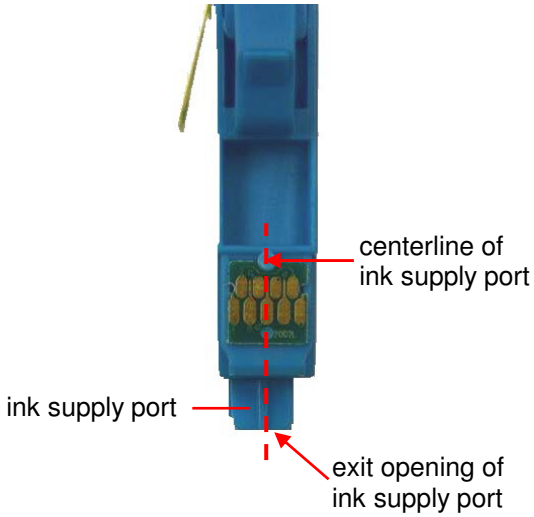
19. As a non-limiting example, set forth below is a claim chart with a description of Defendant's infringement of exemplary claim 9 of the '917 patent by the Accused '917 Ink Cartridges. The infringement is shown using a representative ink cartridge (Model No. 2002XL; Control No.[1] 8149) from among the Accused '917 Ink Cartridges purchased from Defendant that, for infringement purposes, is representative of and represents all of Defendant's ink cartridges in the Accused '917 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 '917 Ink Cartridge." The Representative '917 Ink Cartridge was designed for use in a specific Epson printer, the Epson

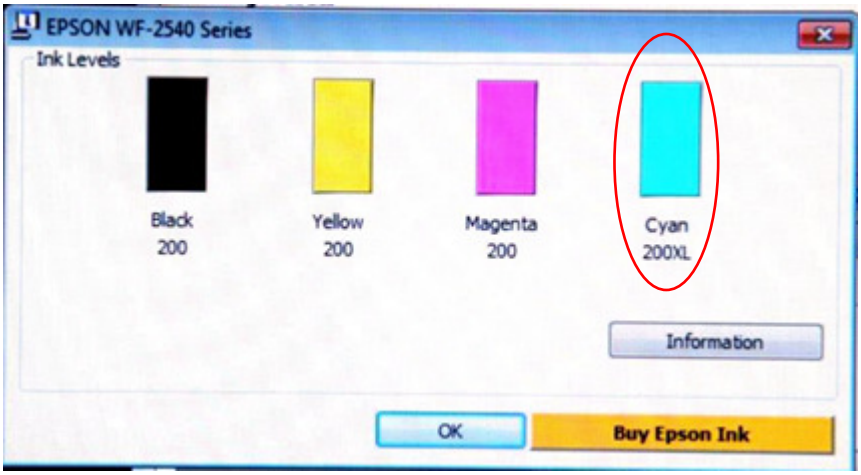
[1] For identification purposes, a unique "control number" ("Control No.") has been assigned by Epson to this ink cartridge, and all other ink cartridges, purchased by Epson from Defendant as

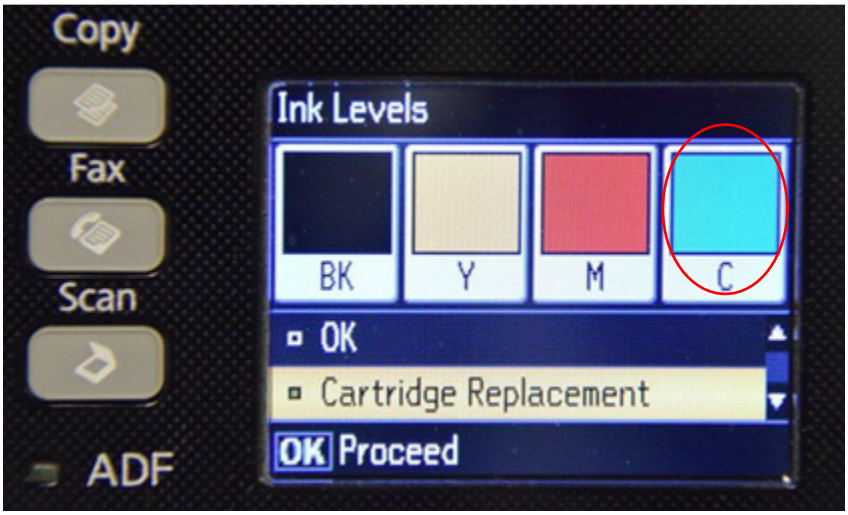
WorkForce WF-2540 printer ("the Representative '917 Epson Printer"), and for purposes of the analysis set forth herein, the Representative '917 Ink Cartridge was tested in the Representative '917 Epson Printer, as discussed in further detail in the claim chart below.

Claim 9 of the '917 Patent	**Where found in the Accused '917 Ink Cartridges**
[9a] An ink cartridge for mounting on a carriage of an ink jet printing apparatus and for supplying ink to a printhead of said ink jet printing apparatus through an ink supply needle, the ink cartridge comprising:	Each of the Accused '917 Ink Cartridges is an ink cartridge for mounting on the carriage of an Epson ink jet printer (an ink jet printing apparatus). Defendant markets and sells the Accused '917 Ink Cartridges as being compatible with one or more specific Epson ink jet printers. For example, the Representative '917 Ink Cartridge is compatible with the Representative '917 Epson Printer. When mounted, each of the Accused '917 Ink Cartridges supplies ink to the printhead of the ink jet printer through an ink supply needle of the printer (the needle, which is part of the carriage inside the ink jet printer and not part of the cartridge, has a passage that allows ink to pass from the ink cartridge through the needle). Accordingly, the Accused '917 Ink Cartridges literally meet the preamble of claim 9 of the '917 patent.

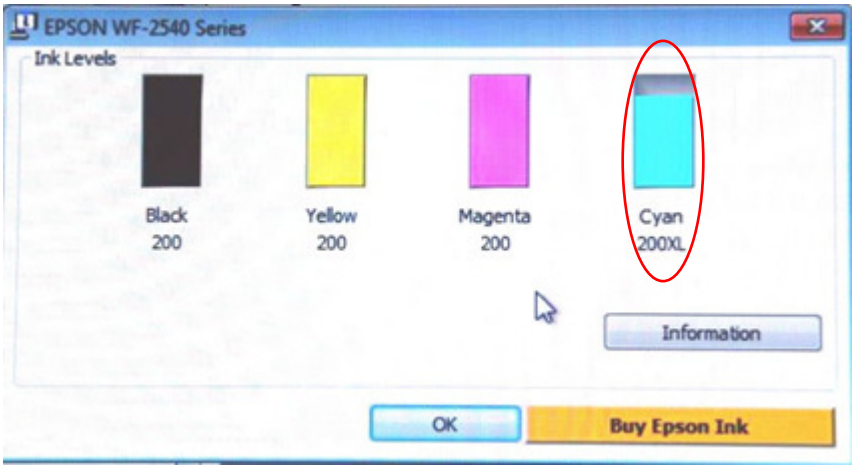
part of Epson's investigation leading to the filing of this Complaint.

[9b] a plurality of external walls defining at least some of a chamber;	Each of the Accused '917 Ink Cartridges includes several external walls that define a chamber, and therefore also at least some of a chamber. These features are shown below using the Representative '917 Ink Cartridge:  Accordingly, the Accused '917 Ink Cartridges literally meet this limitation of claim 9 of the '917 patent.
[9c] an ink supply port for receiving said ink supply needle, the ink supply port having an exit opening and a centerline and communicating with the chamber;	Each of the Accused '917 Ink Cartridges includes an ink-supply port (i.e., a structure with an opening for the movement of ink) in the bottom of the cartridge. The ink supply port receives the ink-supply needle of the printer when the cartridge is mounted. The ink supply port is the conduit that allows the ink to leave the cartridge. Consequently, the ink supply port communicates with the chamber. The ink supply port also has a centerline and an exit opening at its end outside the cartridge. These features can be seen as shown below using the Representative '917 Ink Cartridge: 

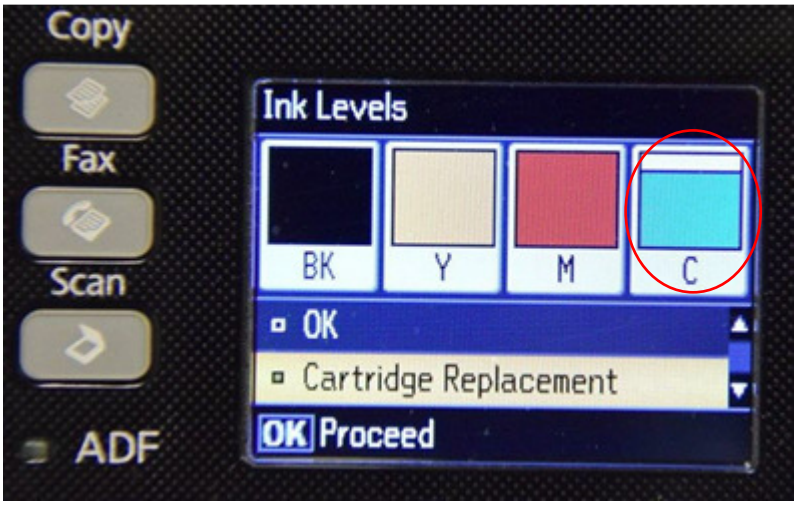
	Accordingly, the Accused '917 Ink Cartridges literally meet this limitation of claim 9 of the '917 patent.
[9d] a semiconductor storage device storing information about the ink carried by said cartridge; and	Each of the Accused '917 Ink Cartridges includes a chip (a semiconductor storage device) on the back of a printed circuit board (the circuit board is mounted on the front wall of the ink cartridge). The chip stores information about the ink carried by the cartridge. Testing of the Representative '917 Ink Cartridge in the Representative '917 Epson Printer confirms that the chip stores information about the ink, for example, the quantity of consumed ink. The following photographs show that the printer utility window on the computer (i.e., the computer to which the printer is connected) and the printer's on-board monitor displayed that the level of ink in the Representative '917 Ink Cartridge had decremented after printing a number of pages. In addition, after removing and reinstalling the ink cartridge into the printer, the computer's printer utility window and the printer's on-board monitor continued to display the same level of ink in the ink cartridge. This testing confirms that the chip on the Representative '917 Ink Cartridge stores information about the ink carried by the cartridge, namely the amount of consumed ink. The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the computer's printer utility window before any printing has been carried out (showing full):  The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the printer's on-board monitor before any printing has been carried out (showing full):



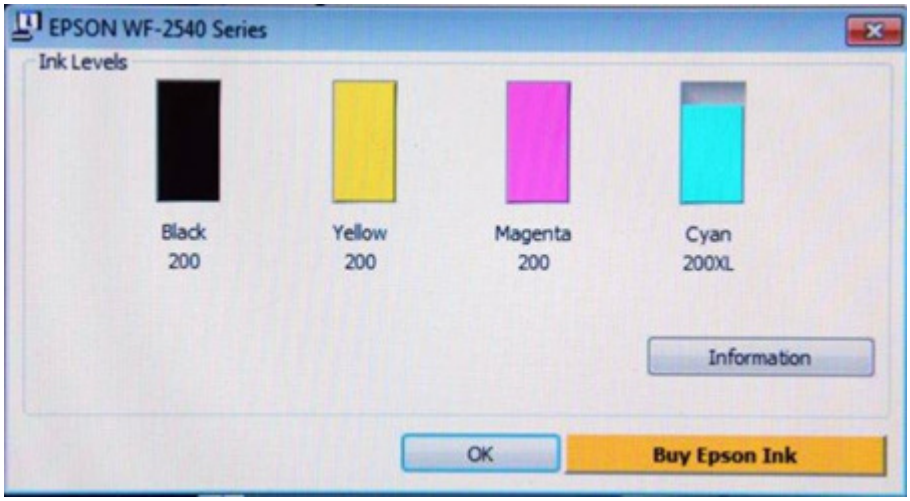
The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the computer's printer utility window after several pages have been printed (showing partial depletion):



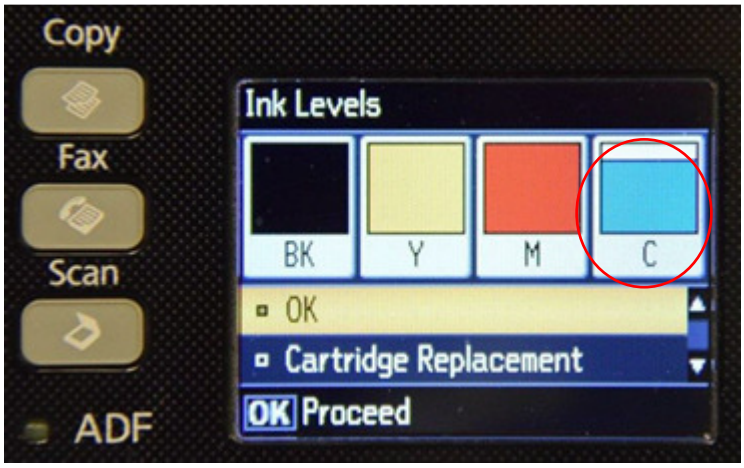
The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the printer's on-board monitor after several pages have been printed (showing partial depletion):



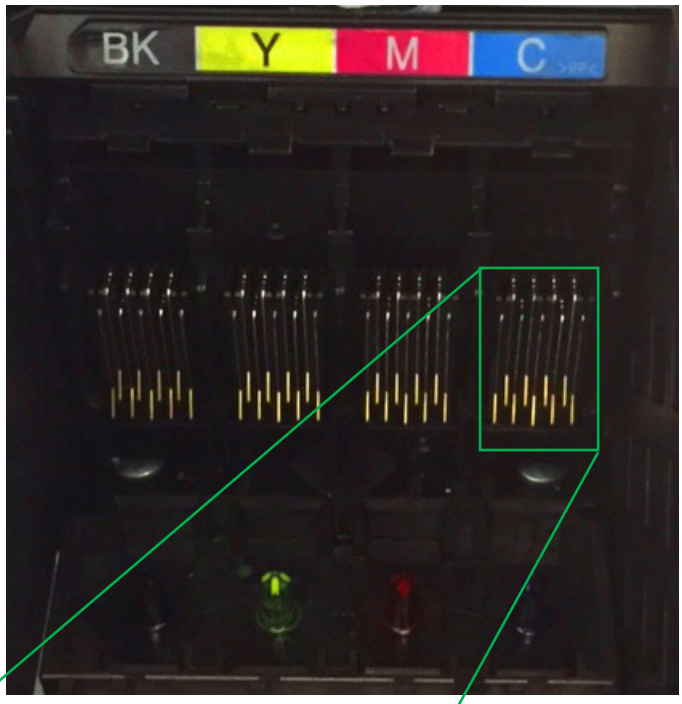
The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the computer's printer utility window after the ink cartridge was removed from and reinstalled in the printer (showing the same level of partial depletion as before the ink cartridge was removed):

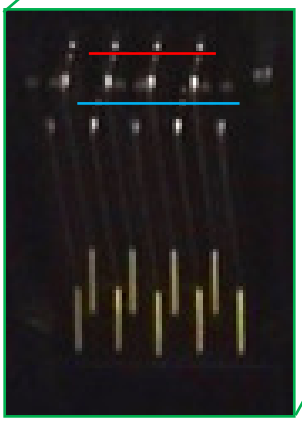


The Ink level of the Representative '917 Ink Cartridge (a cyan-ink ink cartridge) is shown on the printer's on-board monitor after the ink cartridge was removed from and reinstalled in the printer (showing the same level of partial depletion):

	 The testing of the Representative '917 Ink Cartridge is applicable to each of the Accused '917 Ink Cartridges. Accordingly, the Accused '917 Ink Cartridges literally meet this limitation of claim 9 of the '917 patent.
[9e] a plurality of contacts for connecting said semiconductor storage device to the ink jet printing apparatus, the contacts being formed in a plurality of rows so that one of said rows is closer to said exit opening of said ink supply port than an other of said rows, the row of said contacts which is closest to said exit opening of said ink supply port being longer than the row of said contacts which is furthest from said exit opening of said ink supply port.	Each of the Accused '917 Ink Cartridges includes a plurality of contacts for connecting the chip (the semiconductor storage device) to the ink jet printer (ink jet printing apparatus). The testing described above with respect to the preceding limitation confirms that there is an electrical connection between the chip and the ink jet printer. The contacts are the discrete portions of conductive material on the cartridge that are present there to make an electrical connection between the cartridge and the printer (i.e., they contact the printer-side contact forming members when the cartridge is installed in the printer). The contacts allow communication between the chip and the printer through corresponding printer-side contact forming members. Every Epson ink jet printer has printer-side contact forming members, as seen, for example, in the Representative '917 Epson Printer discussed with respect to the preceding limitation. The printer-side contact forming members are configured in two rows with one row above the other row. In addition, the lower row is longer than the upper row. When an ink cartridge from the Accused '917 Ink Cartridges is fully inserted into the printer and in an installed position, the printer-side contact forming members come into contact and make an electrical connection with the cartridge contacts (i.e., the discrete portions located on the larger pattern of electrically conductive material on the cartridge). The contacts are formed in two rows, one above the other. Consequently, the lower row is closer to the exit opening of the ink supply port than the upper row, and the lower row is longer than the upper row. The above described features are shown in the photos below. Shown below are the printer-side contact forming members of the

Representative '917 Epson Printer, with which, as discussed above, the Representative '917 Ink Cartridge works. The printer's contact forming members are formed in two rows, one above the other, with the lower row of contact forming members longer than the upper row, as can be seen below:



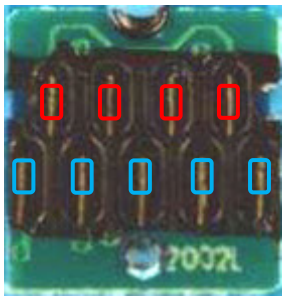


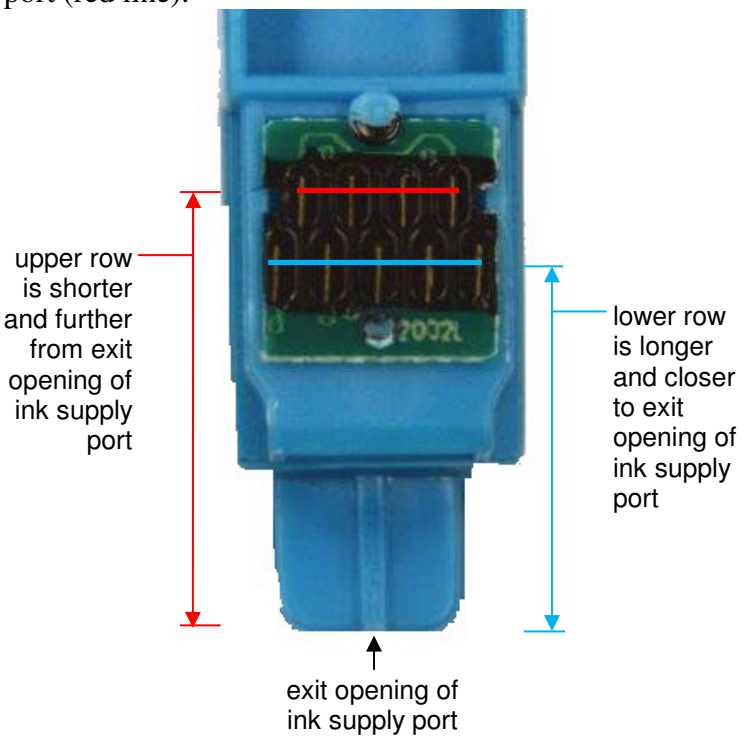
Shown at left is an enlarged view of the printer-side contact forming members of the Representative '917 Epson Printer that accepts the Representative '917 Ink Cartridge. The printer-side contact forming members are arranged in two rows with the lower row (blue line) longer than the upper row (red line).

The contacts of the Representative '917 Ink Cartridge are shown below. The contacts are located on the gold colored metallic conductive pattern. To confirm the location and arrangement of the contacts, the conductive pattern was marked with cyan ink, the cartridge was installed in and then removed from the printer (which caused the printer's contact forming

members to leave scratch marks on the conductive pattern thereby removing a portion of the cyan ink that was applied and therefore indicating the location of the contacts), and the conductive pattern was then photographed. For example, the conductive pattern of the Representative '917 Ink Cartridge before marking with cyan ink is shown on the left and after marking with cyan ink is shown on the right:

The resulting marks left by the printer's contact forming members on the conductive material of the ink cartridge show the arrangement of the contacts of the ink cartridge. These are shown below with red boxes (top row of contacts) and blue boxes (bottom of row of contacts).



	As shown below, the lower row of contacts is longer and closer to the exit opening of the ink supply port (blue line) than the upper row of contacts, which is shorter and further from the exit opening of the ink supply port (red line):  Accordingly, the Accused '917 Ink Cartridges literally meet this limitation of claim 9 of the '917 patent.

20. On information and belief after conducting a reasonable investigation, Defendant has and is actively, knowingly and intentionally aiding and abetting and inducing infringement of the '917 patent in violation of 35 U.S.C. § 271(b) by non-parties, including end-users.

21. On information and belief, Defendant is contributing to the infringement of the '917 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 '917 patent. The components constitute a material part of the inventions. Defendant knows that such components are especially made or especially adapted for use in an infringement of the '917 patent. The components are not a staple article or commodity of commerce suitable for substantial

noninfringing use.

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

23. Defendant's 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 Defendant and its agents, servants, and employees, and all persons acting thereunder, in concert with, or on their behalf, from infringing the claims of the '917 patent.

24. Defendant is not licensed or otherwise authorized to make, use, import, sell, or offer to sell any ink cartridge or process/method claimed in the '917 patent, and Defendant's conduct is, in every instance, without Epson's consent.

25. On information and belief, Defendant's 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. 8,794,749

26. Epson incorporates by reference each and every allegation contained in Paragraphs 1 through 14 as though fully set forth at length here.

27. 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 C to this Complaint is a true and correct copy of the '749 patent.

28. The '749 patent is valid and enforceable.

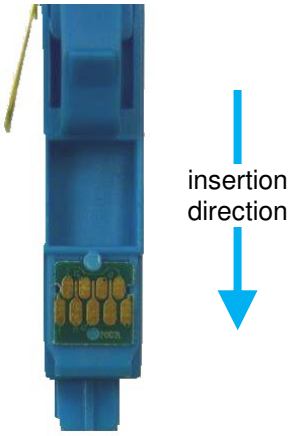
29. On information and belief after conducting a reasonable investigation, Defendant has infringed and is infringing the '749 patent, as defined by numerous claims of the patent in violation of 35 U.S.C. § 271(a) by making, using, importing, offering to sell, and selling in this judicial district and elsewhere aftermarket ink cartridges that operate with Epson ink jet printers, including but not limited to ink cartridges having model nos. 2002XL, 2003XL, 2004XL, E-771, 1261, E-1262, 1263, and 1264, as well as others that are no more than colorably different from the foregoing (collectively, the "Accused '749 Ink Cartridges"). The specific models of Accused '749 Ink Cartridges identified above were obtained by Epson during its investigation leading to this Complaint from Defendant's "Ta Trix USA Inc." online listings. The Accused '917 Ink Cartridges were shipped by Defendant from its 256 Silver Lane Old Bridge, New Jersey, 08857 address.

30. As a non-limiting example, set forth below is a claim chart with a description of Defendant's infringement of exemplary claim 1 of the '749 patent by the Accused '749 Ink Cartridges. The infringement is shown using a representative ink cartridge (Model No. 2002XL; Control No. 8149, the same representative ink cartridge as used in the analysis of the '917 patent above) from among the Accused '749 Ink Cartridges purchased from Defendant that, for infringement purposes, is representative of and represents all of Defendant's ink cartridges in 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 a specific Epson printer, the Epson WorkForce WF-2540 printer ("the Representative '749 Epson Printer"), 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.

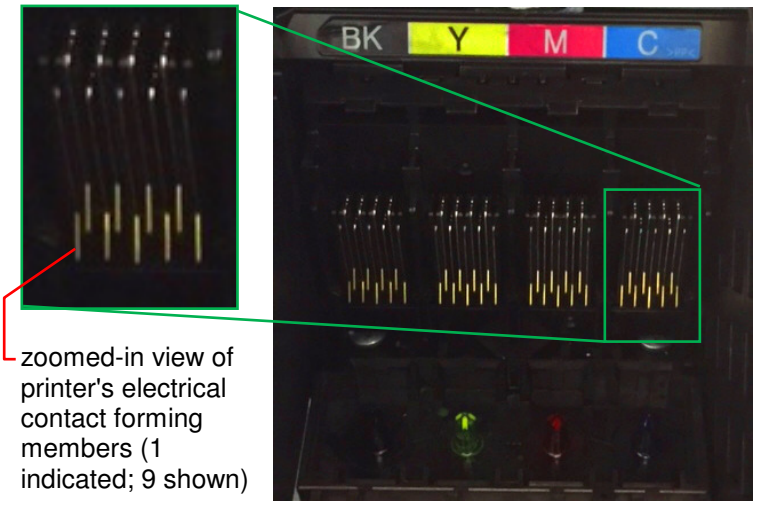
Claim 1 of the '749 Patent	Where found in the Accused '749 Ink Cartridges
[1a] A printing material container adapted to be attached to a printing apparatus by being inserted into the printing apparatus in an insertion direction, the printing apparatus having a print head and a plurality of apparatus-side electrical contact members, the printing material container comprising:	Each of the Accused '749 Ink Cartridges is a printing material container (an ink cartridge) 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 accept 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. 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:

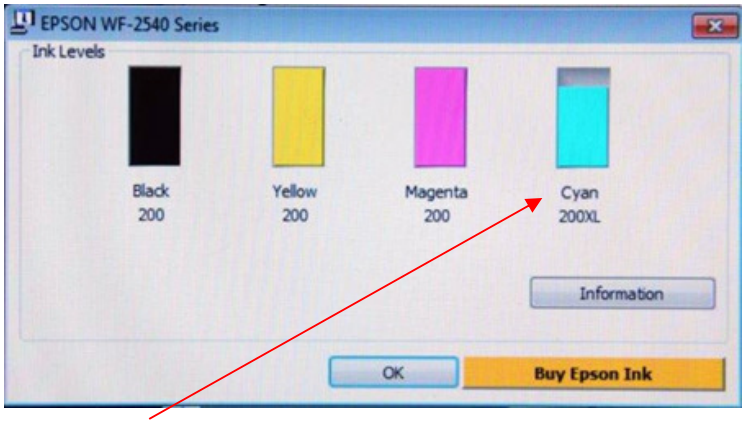


The following photograph shows the Representative '749 Ink Cartridge, a cyan-ink ink cartridge, attached in the Representative '749 Epson Printer after the cartridge has been inserted into the printer in the insertion direction (the black, yellow, and magenta ink cartridges, which are genuine Epson ink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

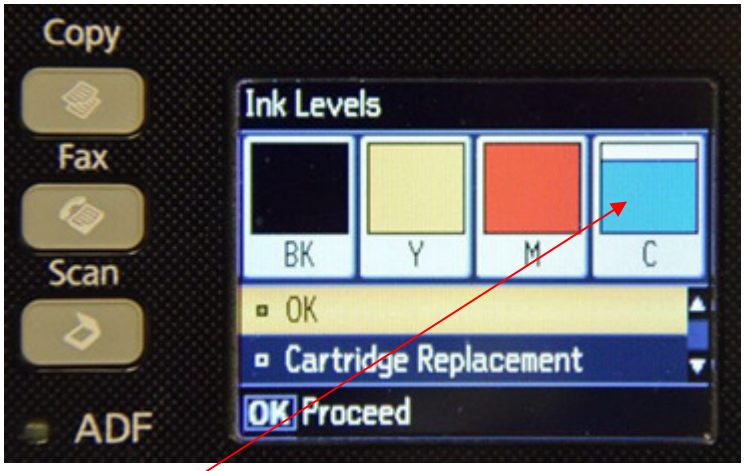
	Representative '749 Ink Cartridge installed in the Representative '749 Epson Printer  The Epson ink jet printers that accept the Accused '749 Ink Cartridges each include a print head for printing and multiple printer-side electrical contact forming members for each ink cartridge accepted by the printer.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

an exit, adapted to supply ink from the ink cartridge to the printing apparatus;	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:  exit of ink supply opening (shown here with anti-leak film undisturbed and in place) 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:  printed circuit board (green) with low voltage electronic device located on back 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 computer and on the printer's display screen. The following photographs show the display of such information on the computer display screen and the printer's display screen for the Representative '749 Ink Cartridge, containing cyan ink, attached to the Representative '749 Epson Printer:



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



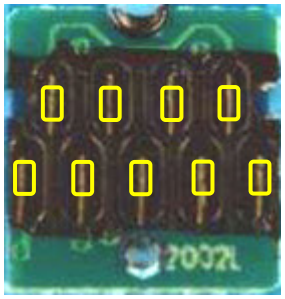
memory device shows, on the printer's display screen, the amount of cyan ink remaining in the Representative '749 Ink Cartridge

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:  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

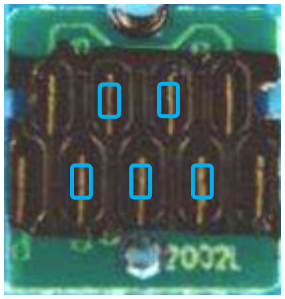
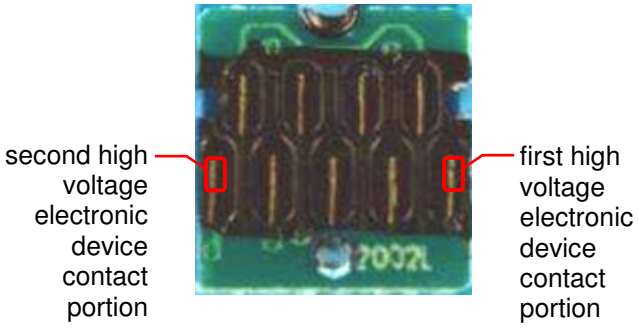
	contact portions are located on the gold terminals of the ink cartridge shown above). In particular, Epson printers apply a voltage of approximately 42 volts (a high voltage as compared to the low voltage of approximately 4 volts applied to the low voltage electronic device discussed in the preceding 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 electronic device, wherein:	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:

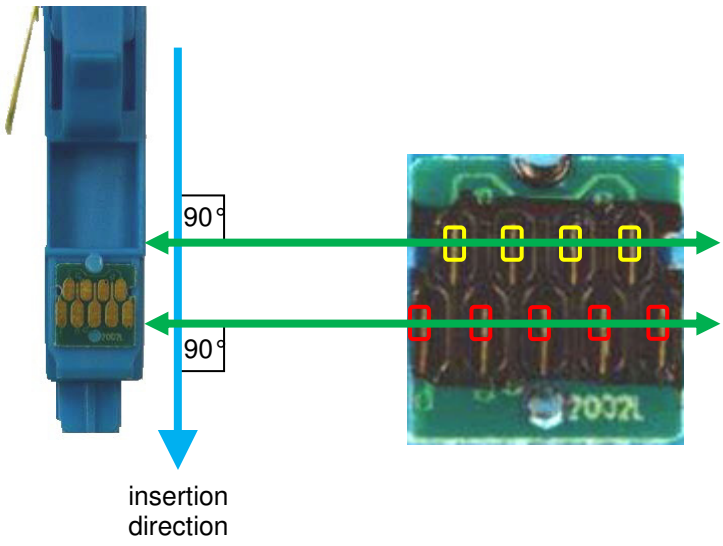

The resulting marks left by the printer's contact forming members on the terminals show the location and arrangement of the contact portions. These are indicated below with annotated yellow boxes superimposed on the terminals to indicate the location of the contact portions (there are a total of nine contact portions, with four contact portions in a top row and five contact portions in a bottom row):

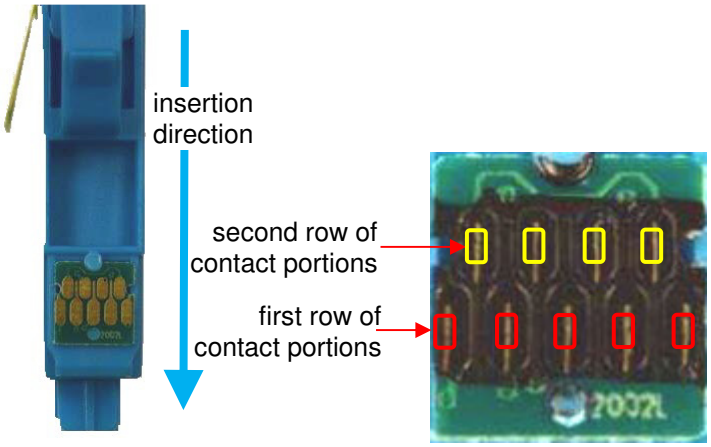
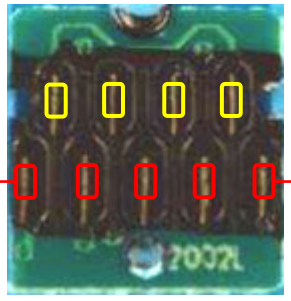


The contact portions shown above correspond to their printer-side contact forming members so that electrical communication is enabled between the ink cartridge and the printer, e.g., so the printer can read remaining ink level and other information from the memory device as described above with respect 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	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

orthogonal to the insertion 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 right photo shows an enlarged and annotated view of the printed circuit board shown in the left photo.  first row of contact portions (red squares) and second row of contact portions (yellow squares), each extending in a row direction (green arrows) orthogonal to cartridge insertion direction (blue arrow) 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.

31. On information and belief, Defendant has and is actively, knowingly and intentionally aiding and abetting and inducing infringement of the '749 patent by non-parties in violation of 35 U.S.C. § 271(b), including end-users, despite Defendant's knowledge of the '749 patent.

32. On information and belief, Defendant is 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. Defendant knows 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.

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

34. Defendant's 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 Defendant and its agents, servants, and employees, and all persons acting thereunder, in concert with, or on their behalf, from infringing the claims of the '749 patent.

35. Defendant is not licensed or otherwise authorized to make, use, import, sell, or offer to sell any ink cartridge or process/method claimed in the '749 patent, and Defendant's conduct is, in every instance, without Epson's consent.

36. On information and belief, Defendant's infringement has been and continues to be willful.

PRAYER FOR RELIEF

WHEREFORE, Epson prays for judgment against Defendant as follows:

A. That the Epson Patents are valid and enforceable;

B. That Defendant has infringed and is infringing the Epson Patents;

C. That such infringement is willful;

D. That Defendant and its subsidiaries, affiliates, parents, successors, assigns, officers, agents, representatives, servants, and employees, and all persons in active concert or participation with it, be preliminarily and permanently enjoined from continued infringement of the Epson Patents;

E. That Defendant be ordered to pay Epson its damages caused by Defendant's infringement of the Epson 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; and

G. 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: March 3, 2017

SCHWABE, WILLIAMSON & WYATT, P.C.

By: s/David W. Axelrod
David W. Axelrod, OSB #75023
Telephone: (503) 222-9981

Tigran Guledjian, Cal. Bar # 207613
pro hac vice pending
Quinn Emanuel Urquhart & Sullivan, LLP
865 South Figueroa Street, 10th Floor
Los Angeles, CA 90017
Telephone: (213) 443-3000

Attorneys for Plaintiffs Seiko Epson Corporation, Epson America, Inc., and Epson Portland Inc.

US006502917B1

(12) **United States Patent**
Shinada et al.

(10) **Patent No.: US 6,502,917 B1**
(45) **Date of Patent: Jan. 7, 2003**

(54) **INK-JET PRINTING APPARATUS AND INK CARTRIDGE THEREFOR**

(75) Inventors: **Satoshi Shinada**; **Fujio Akahane**; **Minoru Usui**; **Takao Kobayashi**; **Makoto Matsuzaki**, all of Nagano (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.: **09/484,458**

(22) Filed: **Jan. 18, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/JP99/02579, filed on May 18, 1999.

(30) **Foreign Application Priority Data**

May 18, 1998 (JP) 10-151882
May 18, 1998 (JP) 10-151883
Jun. 26, 1998 (JP) 10-180519
Sep. 21, 1998 (JP) 10-266109
Oct. 23, 1998 (JP) 10-301782
Mar. 24, 1999 (JP) 11-078843

(51) **Int. Cl.**[7] **B41J 29/393**; B41J 2/175
(52) **U.S. Cl.** **347/19**; 347/86
(58) **Field of Search** 347/19, 86, 14, 347/23, 108, 85, 50, 87, 49

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,629,164 A 12/1986 Sommerville 239/69
4,961,088 A 10/1990 Gilliland et al. 355/206
4,990,938 A 2/1991 Brandon et al. 347/37
5,049,898 A 9/1991 Arthur et al. 346/1.1
5,137,379 A 8/1992 Ukai et al. 400/121
5,138,344 A 8/1992 Ujita ..... 346/140 R
5,208,610 A 5/1993 Su et al.
5,414,452 A 5/1995 Accatino et al. 347/7
D365,596 S 12/1995 Miyazawa et al. D18/56
5,491,540 A 2/1996 Hirst 355/200
D369,383 S 4/1996 Miyazawa et al. D18/56
5,506,611 A 4/1996 Ujita et al. 347/86
5,528,269 A 6/1996 Drogo et al. 347/19
5,610,635 A 3/1997 Murray et al. 347/7
5,640,186 A 6/1997 Swanson et al. 347/86
5,646,660 A 7/1997 Murray 347/59
5,691,753 A 11/1997 Hilton 347/85
5,699,091 A 12/1997 Bullock et al. 347/19
5,751,320 A 5/1998 Scheffelin et al. 347/85
5,788,388 A 8/1998 Cowger et al. 400/703
5,812,156 A 9/1998 Bullock et al. 347/19
5,835,817 A 11/1998 Bullock et al. 399/25
5,861,897 A * 1/1999 Ide et al.
5,949,459 A 9/1999 Gasvoda et al. 347/86
5,975,677 A 11/1999 Marler et al. 347/40

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

DE 91 16 990.9 U1 1/1995
EP 0 412 459 2/1991

(List continued on next page.)

OTHER PUBLICATIONS

U.S. Ser. No. 09/686,877 applicant name Shinada et al.
European Search Report Jan. 11, 2001.
European Search Report Jan. 15, 2001.

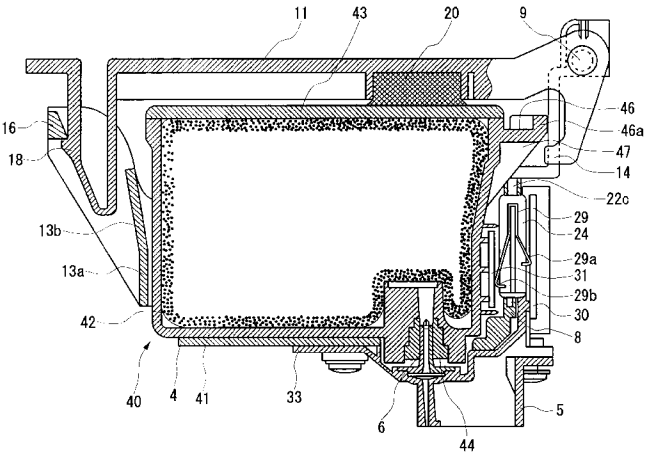
(List continued on next page.)

Primary Examiner—John Barlow
Assistant Examiner—Charles W. Stewart, Jr.
(74) *Attorney, Agent, or Firm*—Stroock & Stroock & Lavan LLP

(57) **ABSTRACT**

An ink jet type printing apparatus in which an ink supply needle is located near one side in a direction perpendicular to the reciprocated directions of a carriage, a circuit board is mounted on a wall of an ink cartridge in the vicinity of the side on which an ink supply port is formed and plural contacts for connecting to external control means are formed on the exposed surface of the circuit board.

38 Claims, 24 Drawing Sheets



U.S. PATENT DOCUMENTS

6,011,937	A	1/2000	Chaussade et al.	
6,017,118	A	1/2000	Gasvoda et al.	347/86
6,019,461	A	2/2000	Yoshimura et al.	347/86
6,039,430	A	3/2000	Helterline et al.	347/19
6,065,824	A	5/2000	Bullock et al.	347/19
6,074,042	A	6/2000	Gasvoda et al.	347/50
6,109,723	A	8/2000	Castle et al.	347/19
6,126,265	A	10/2000	Childers et al.	347/23
6,130,695	A	10/2000	Childers et al.	
6,168,262	B1	1/2001	Clark et al.	347/50
6,170,939	B1	1/2001	Ujita et al.	
6,170,940	B1	1/2001	Shinada et al.	347/86
6,196,670	B1	3/2001	Saruta	
6,227,643	B1	5/2001	Purcell et al.	
6,312,088	B1	11/2001	Seino	
15,067	A1	2/2002	Studholme	
6,361,138	B1	3/2002	Seino et al.	
6,371,586	B1	4/2002	Saruta	
2001/0007458	A1 *	7/2001	Purcell et al.	

FOREIGN PATENT DOCUMENTS

EP	0 412 459	A2	2/1991	347/19
EP	0 440 261		8/1991	
EP	0 498 117	A2 *	8/1992	
EP	0 639 462		2/1995	
EP	0 710 568	*	5/1996	
EP	0 713 778	*	5/1996	
EP	0 778 145	B1 *	6/1997	
EP	0 778 148	*	6/1997	
EP	0 789 322	A2	8/1997	
EP	0 822 084	A2	2/1998	
EP	0 832 747		4/1998	
EP	0 839 660		5/1998	
EP	0 940 260		9/1999	
EP	0 960 736	A1	12/1999	
EP	0 963 847	A1	12/1999	347/19
EP	0 963 847		12/1999	
EP	0 985 537	A1 *	3/2000	
EP	WO 00/21756	A1	4/2000	
EP	0 997 297	A1	5/2000	347/19
EP	0 997 297		5/2000	
EP	1 004 449	A2	5/2000	
EP	1 038 682	A2	9/2000	
JP	09/686877		of 0000	
JP	2594912		3/1987	
JP	62-184856		8/1987	B41J/2/175
JP	2-99333		4/1990	B41J/2/045
JP	3-67657		3/1991	B41J/2/175
JP	4-247955		9/1992	B41J/2/165
JP	5-229137		9/1993	
JP	6-126981		5/1994	B41J/2/175
JP	6-155758		6/1994	B41J/2/175
JP	7-81077		3/1995	
JP	7-232438	*	9/1995	
JP	7-232439		9/1995	
JP	8-132635		5/1996	B41J/2/175
JP	8-197748		8/1996	
JP	9-174876	*	7/1997	
JP	9-174879		7/1997	
JP	10-146680		6/1998	347/23
JP	10-151882		6/1998	347/23
JP	10-151883		6/1998	347/28
JP	2000-177145		6/2000	
WO	96-05061		2/1996	
WO	WO 97/23352	A1	7/1997	
WO	WO98/52762	A2 *	11/1998	
WO	98/55318		12/1998	B41J/2/175
WO	98/55322		12/1998	B41J/2/175
WO	98/55323		12/1998	B41J/2/175
WO	98/55324		12/1998	B41J/2/175
WO	98/55325		12/1998	B41J/2/175
WO	99/65695		12/1999	
WO	WO 00/26034	A2	5/2000	
WO	WO 02/11986	A2	2/2002	

OTHER PUBLICATIONS

U.S. patent application Ser. No. 09/318,268, Matsumoto et al., filed May 25, 1999.

U.S. patent application Ser. No. 09/318,269, Naka, filed May 25, 1999.

U.S. patent application Ser. No. 09/432,272, Saruta et al., filed Nov. 2, 1999.

U.S. patent application Ser. No. 09/442,646, Saruta et al., filed Nov. 18, 1999.

U.S. patent application Ser. No. 09/449,732, Saruta, filed Nov. 26, 1999.

U.S. patent application Ser. No. 09/449,737, Saruta, filed Nov. 26, 1999.

* cited by examiner

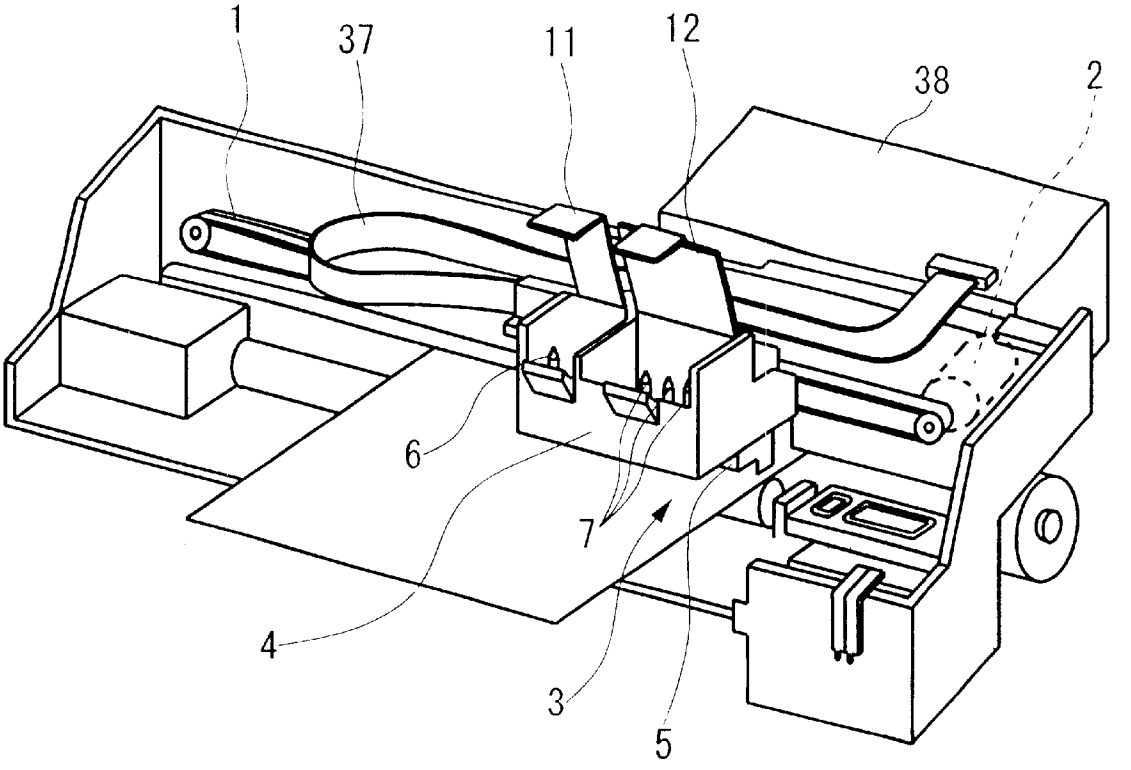


FIG. 1

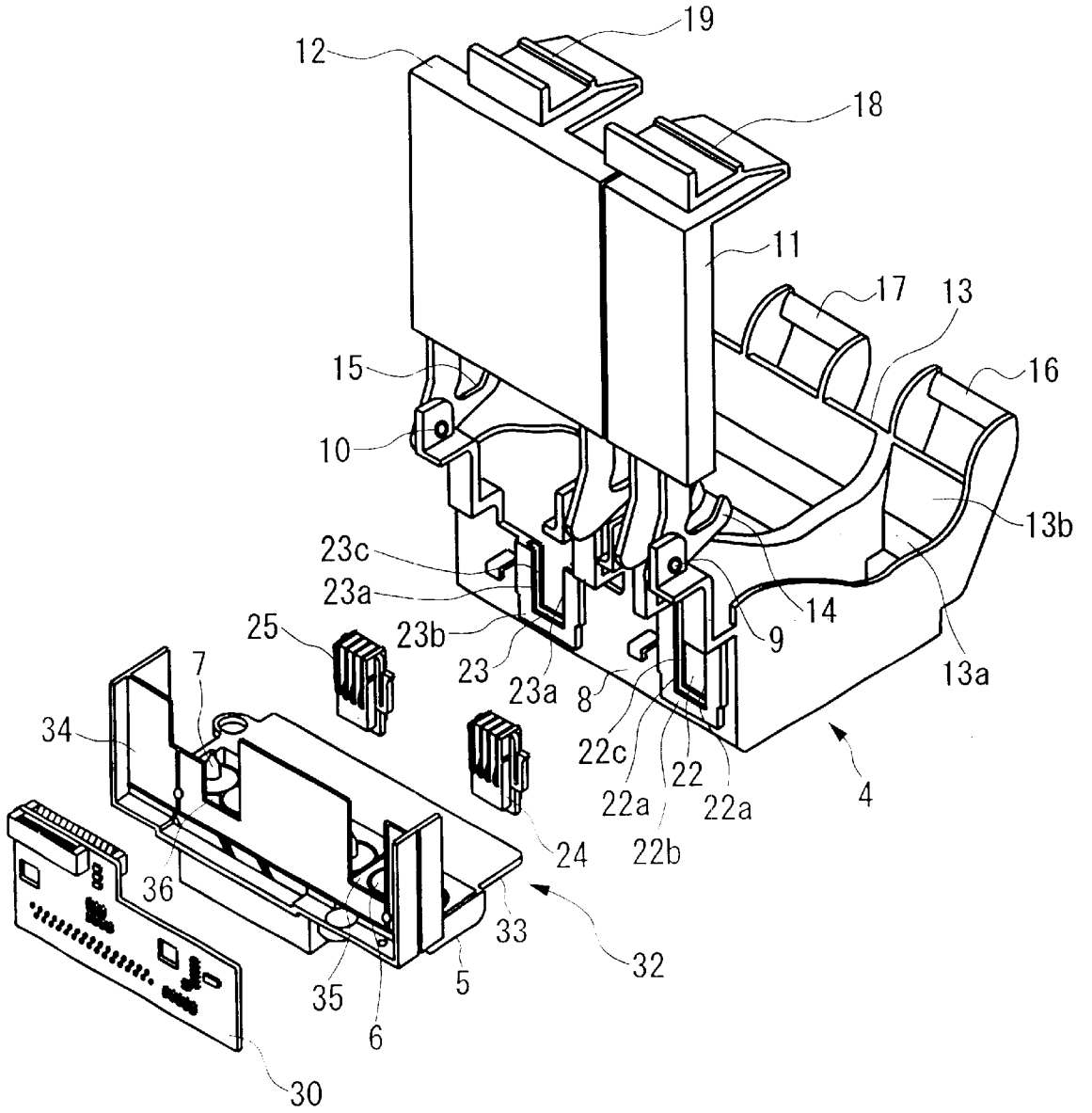

19
12
18
11
17
13
15
16
10
13b
23c
23a
25
23b
14
9
23
23a
8
13a
7
34
22c
22
22a
22a
4
24
22b
36
33
32
35
5
6
30

FIG. 2

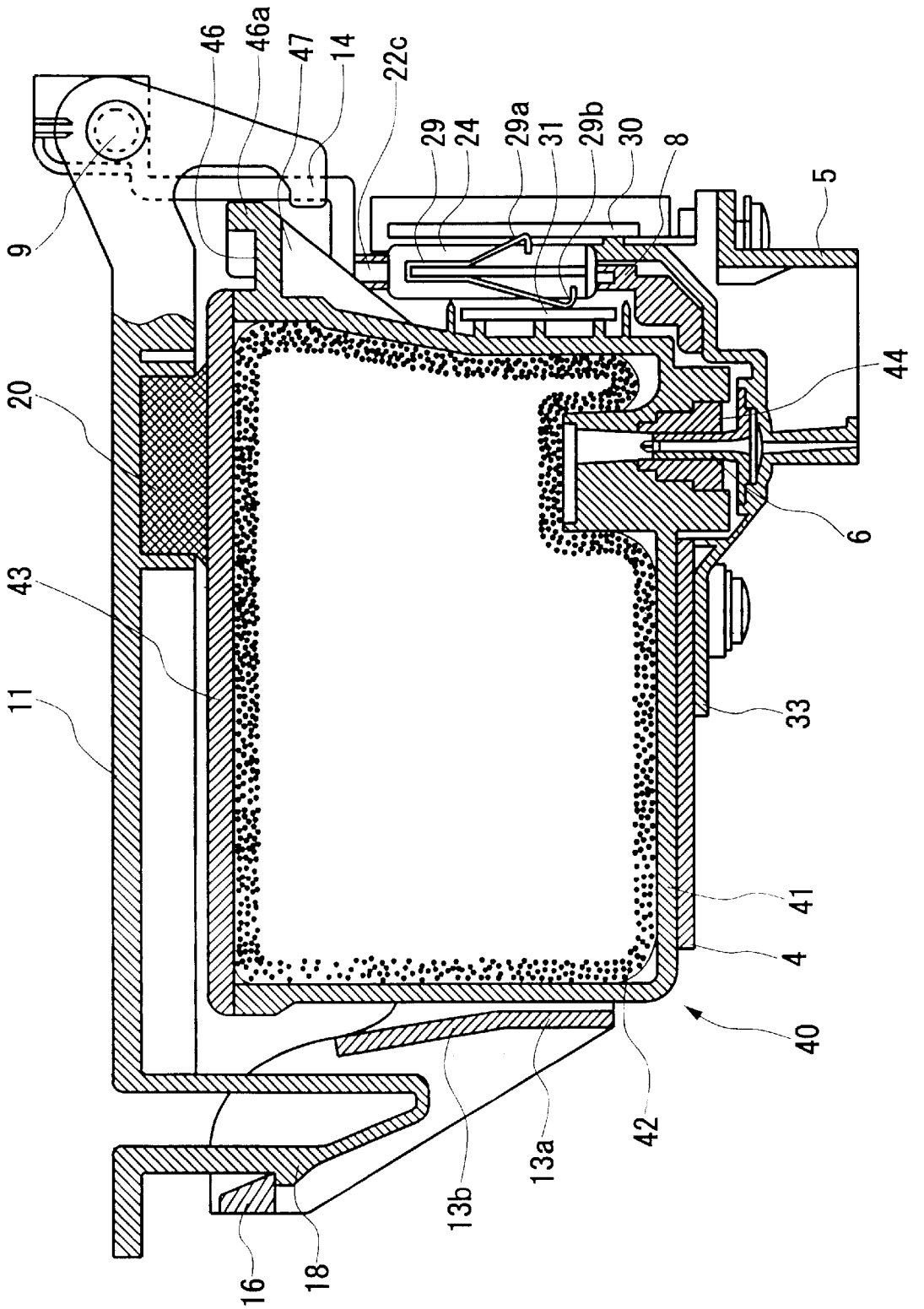

46
46a
47
14
22c
29
24
29a
31
29b
30
8
5
9
20
44
6
43
11
33
41
4
40
42
13a
13b
16
18

FIG. 3

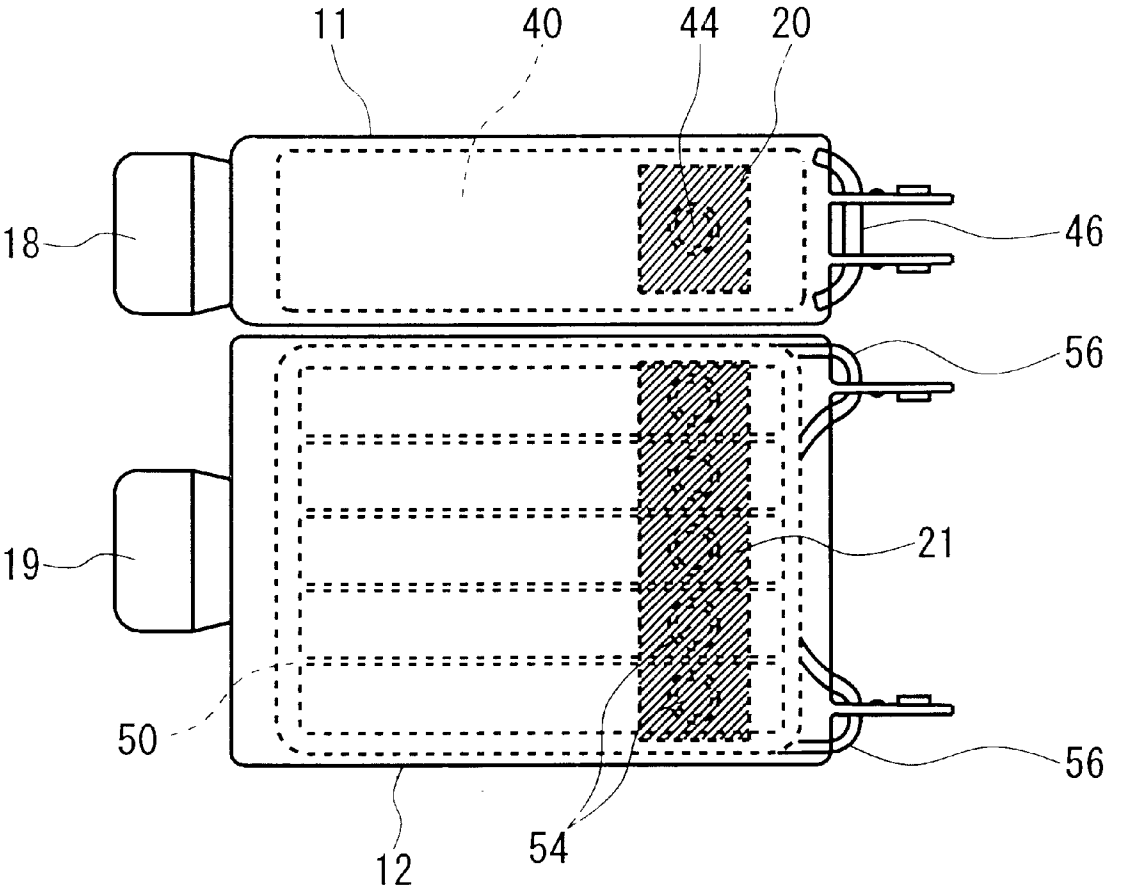
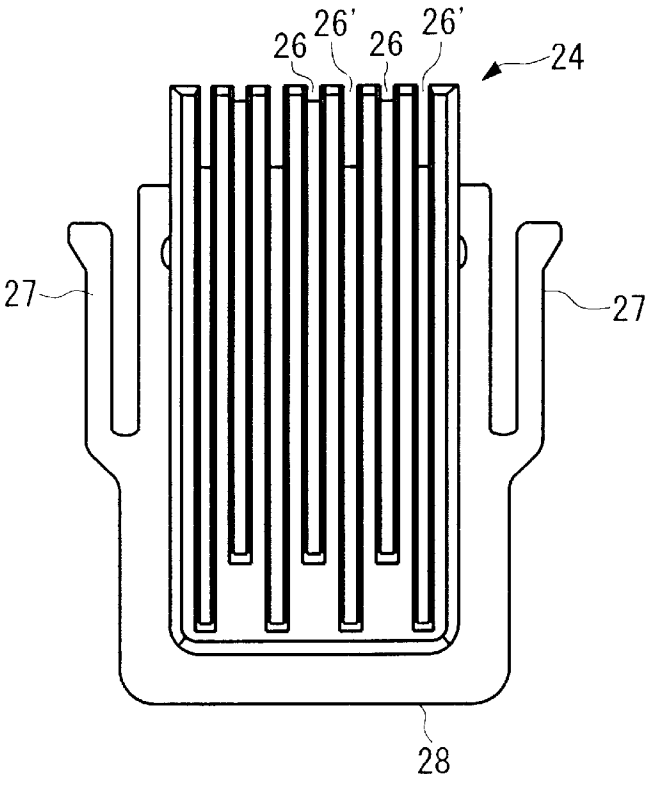
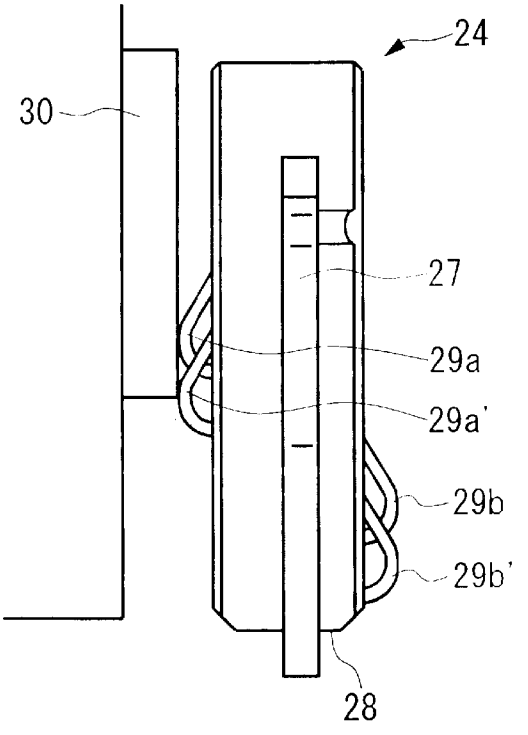


FIG. 4



(a)



(b)

FIG. 5

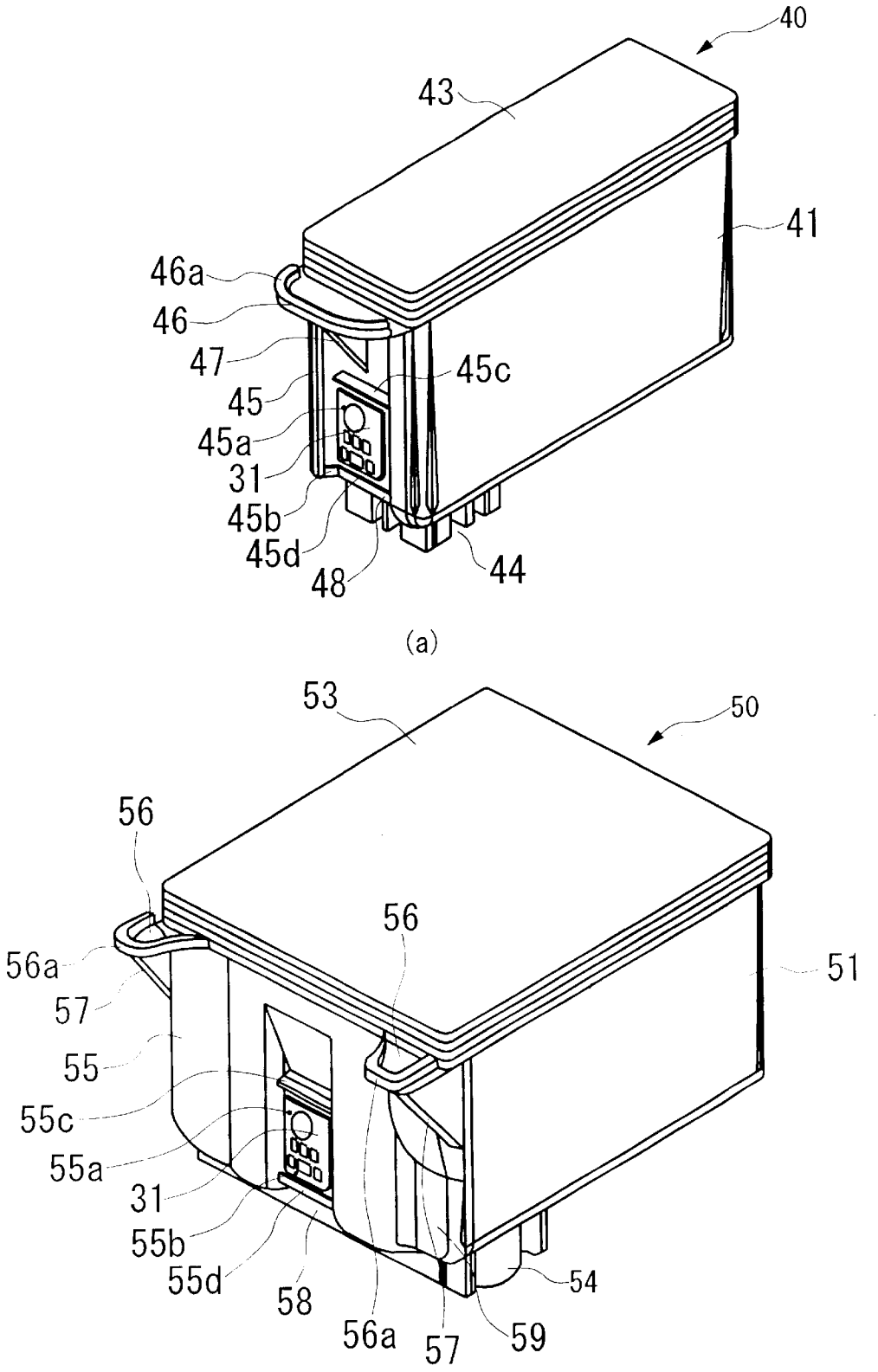

40
43
41
46a
46
47
45
45a
31
45b
45d
48
45c
44
(a)
53
50
56
56
56a
57
55
55c
55a
31
55b
55d
58
56a
57
59
54
51
(b)

FIG. 6

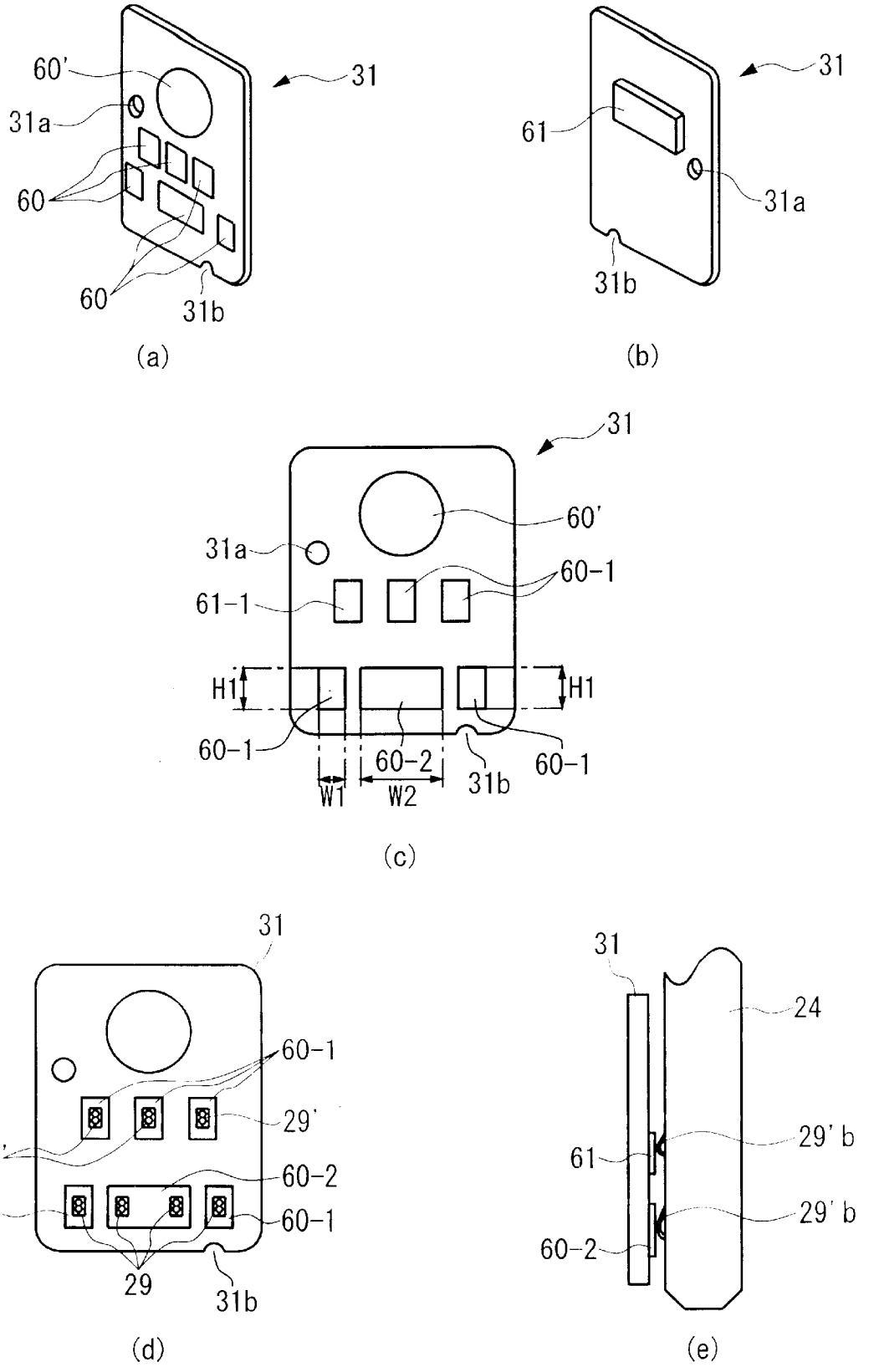

60'
31
31a
60
60
31b
(a)
31
61
31a
31b
(b)
31
60'
31a
60-1
61-1
H1
H1
60-1
60-2
31b
60-1
W1
W2
(c)
31
60-1
29'
29'
60-2
60-1
60-1
29
31b
(d)
31
24
29' b
61
29' b
60-2
(e)

FIG. 7

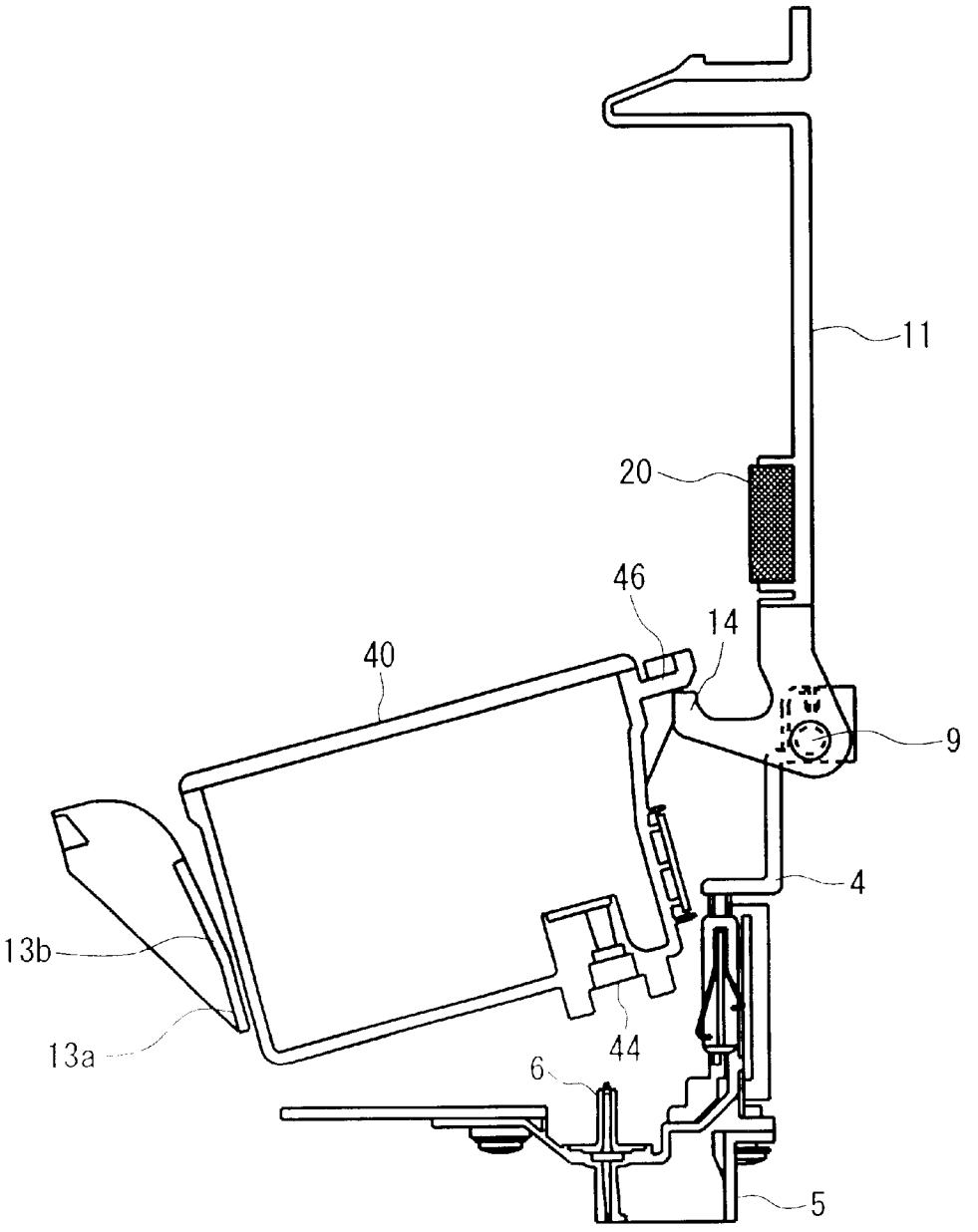


FIG. 8

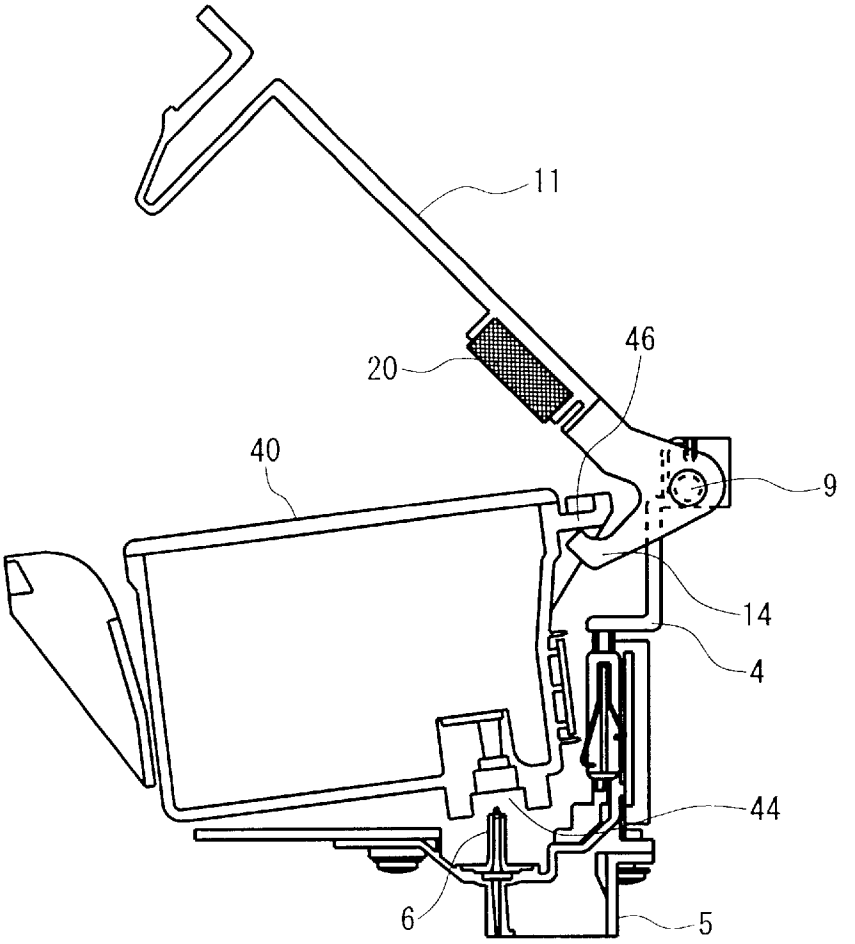


FIG. 9

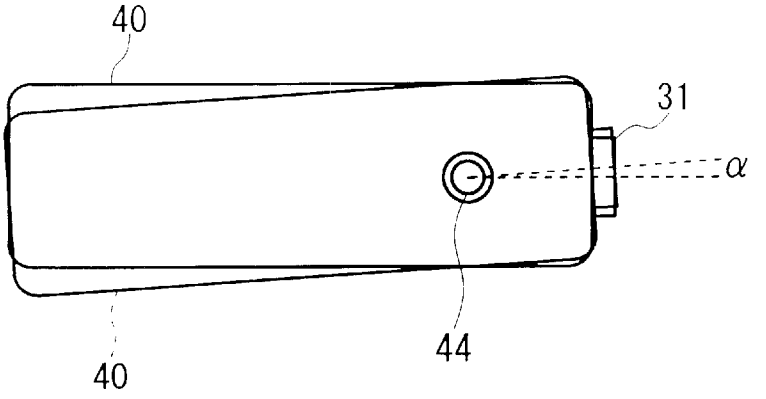


FIG. 10

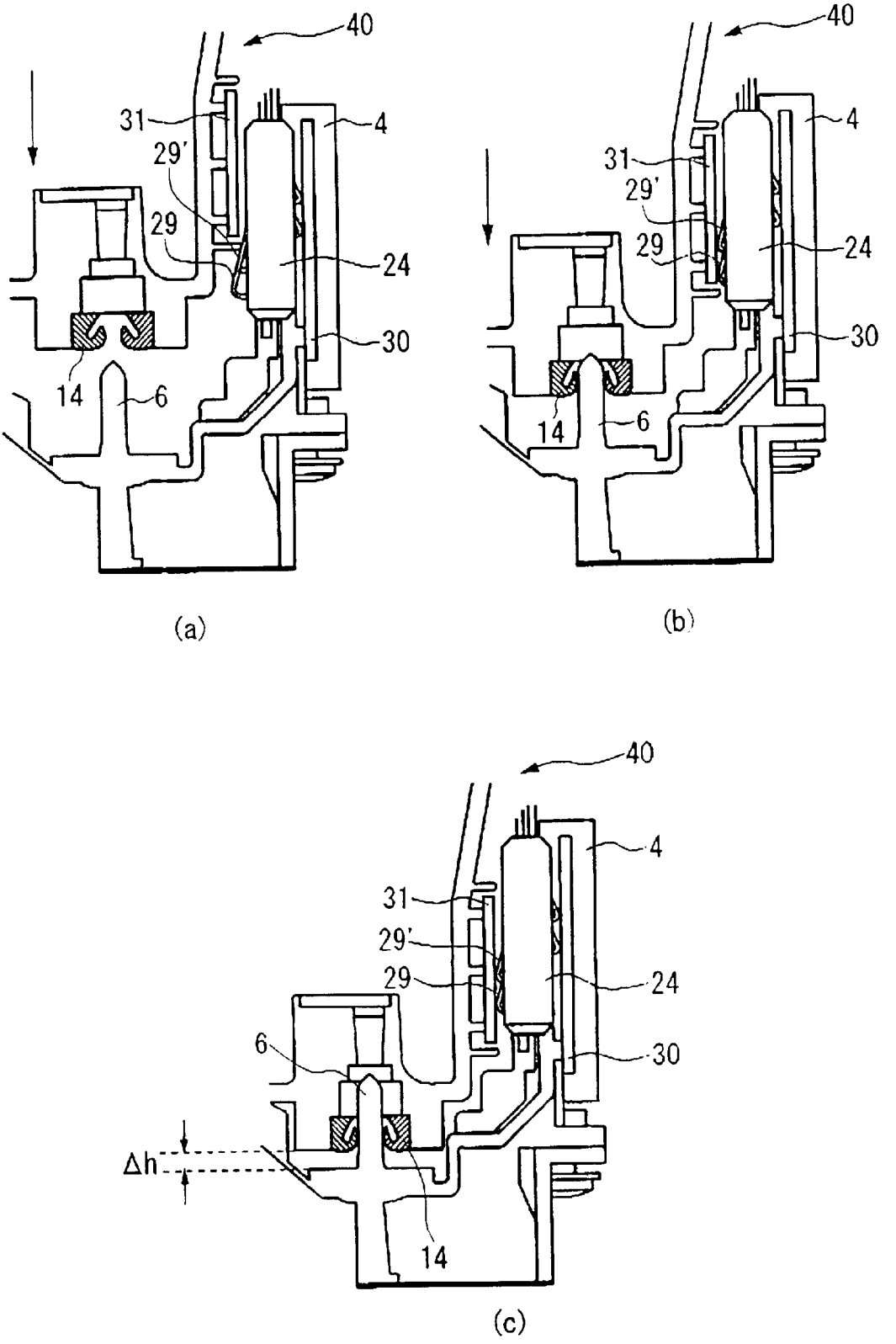
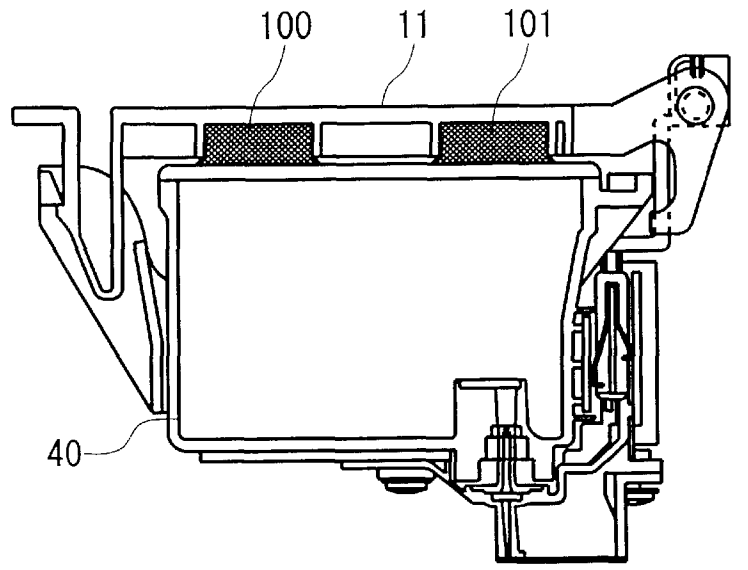
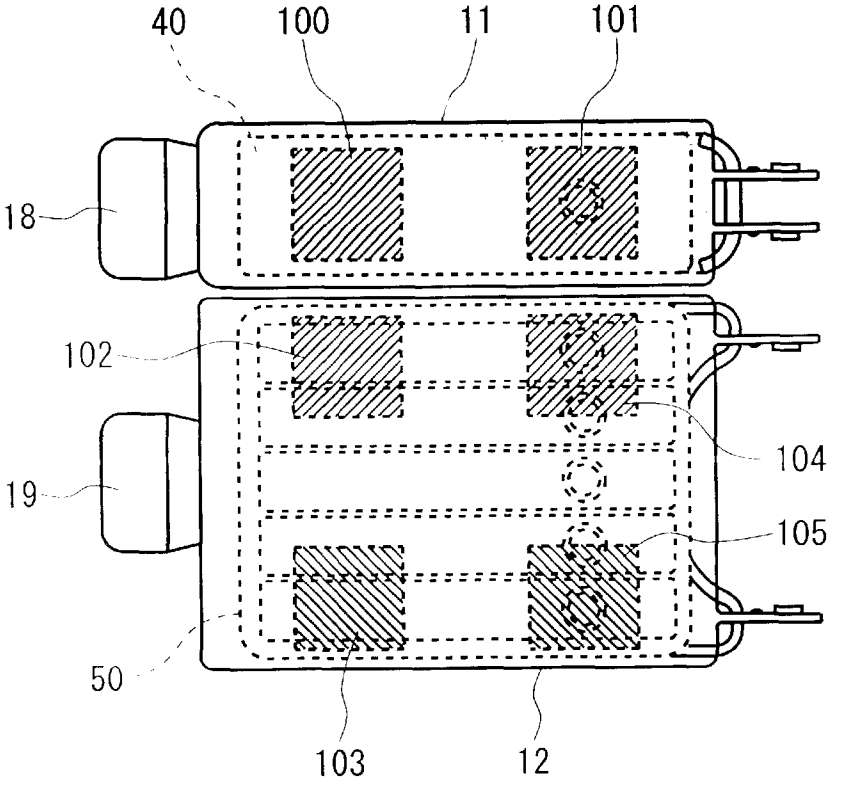

40
31
29'
29
4
24
30
14
6
(a)
40
31
29'
29
4
24
30
14
6
(b)
40
4
31
29'
29
24
6
30
Δh
14
(c)

FIG. 11

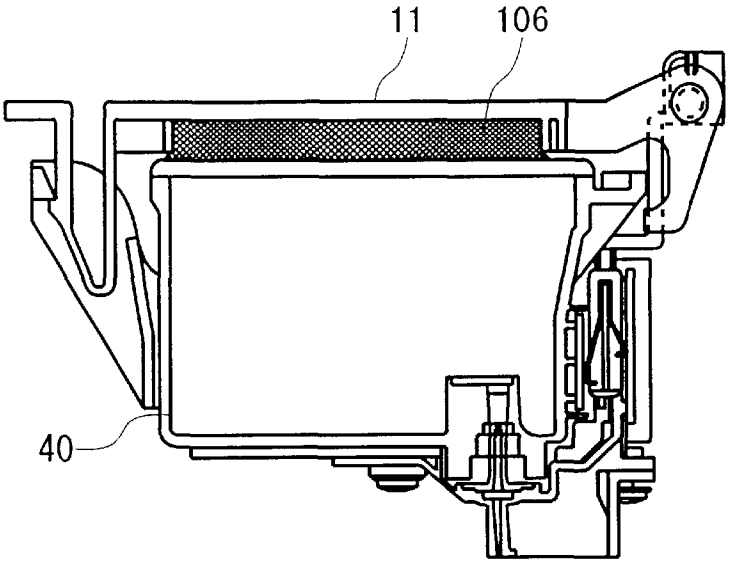


(a)

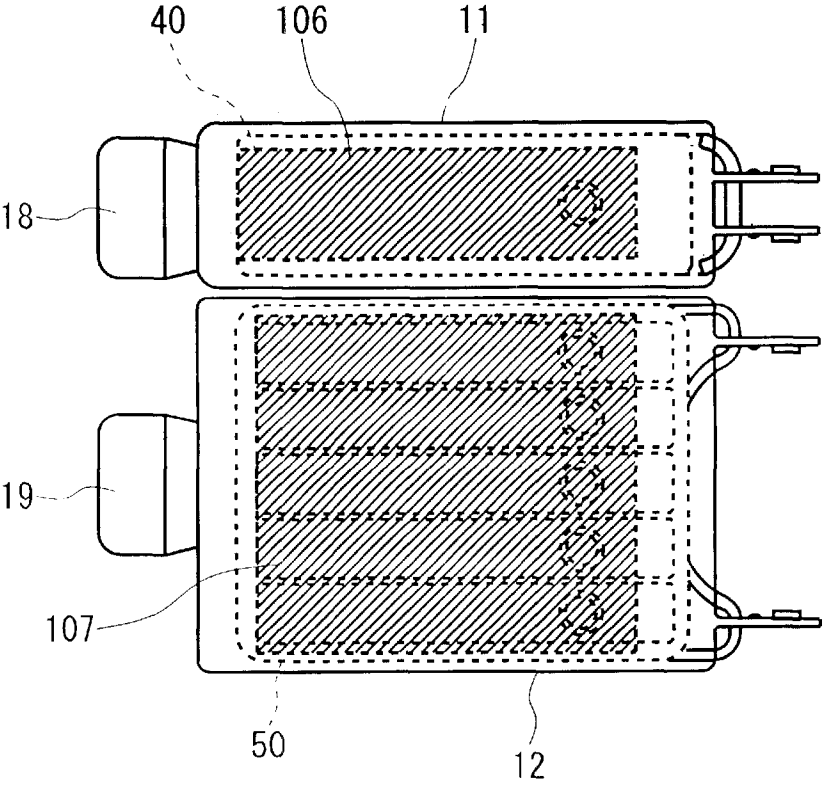


(b)

FIG. 12

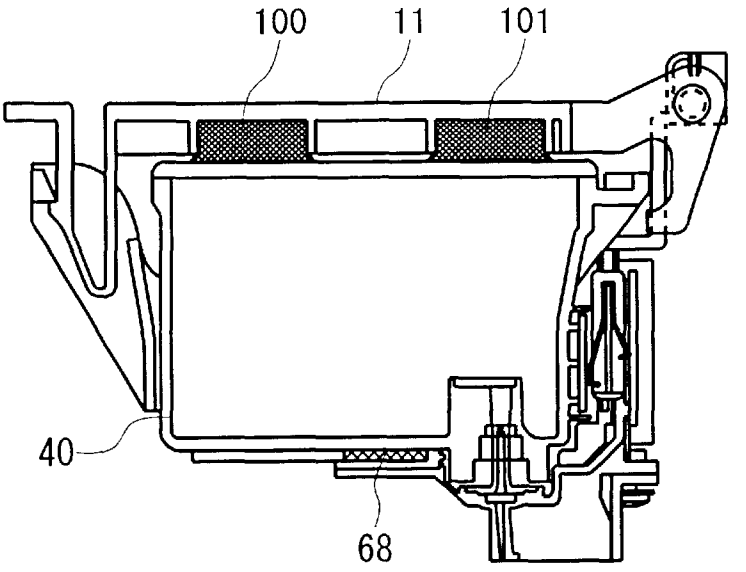


(a)

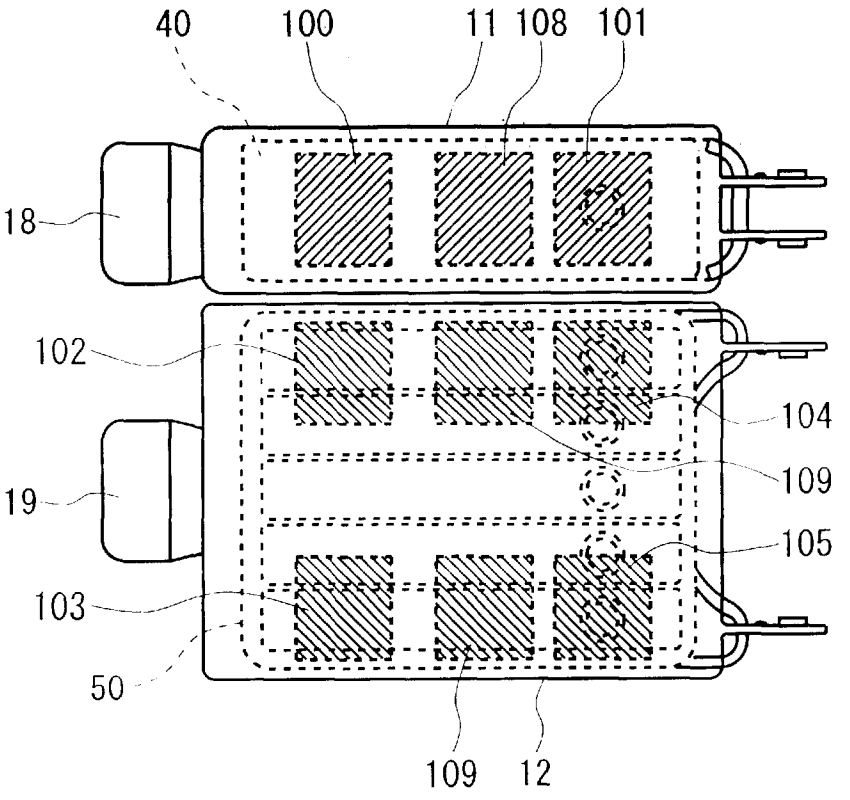


(b)

FIG. 13


100
11
101
40
68

(a)


40
100
11
108
101
18
102
104
109
19
105
103
50
109
12

(b)

FIG. 14

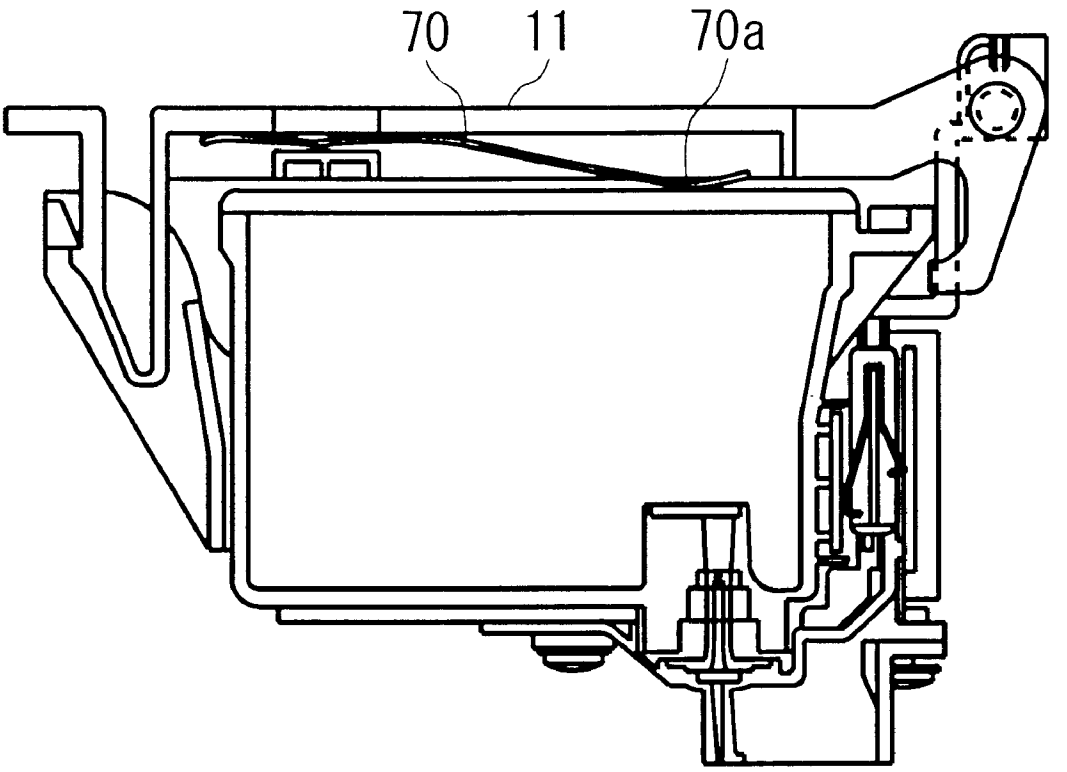


FIG. 15

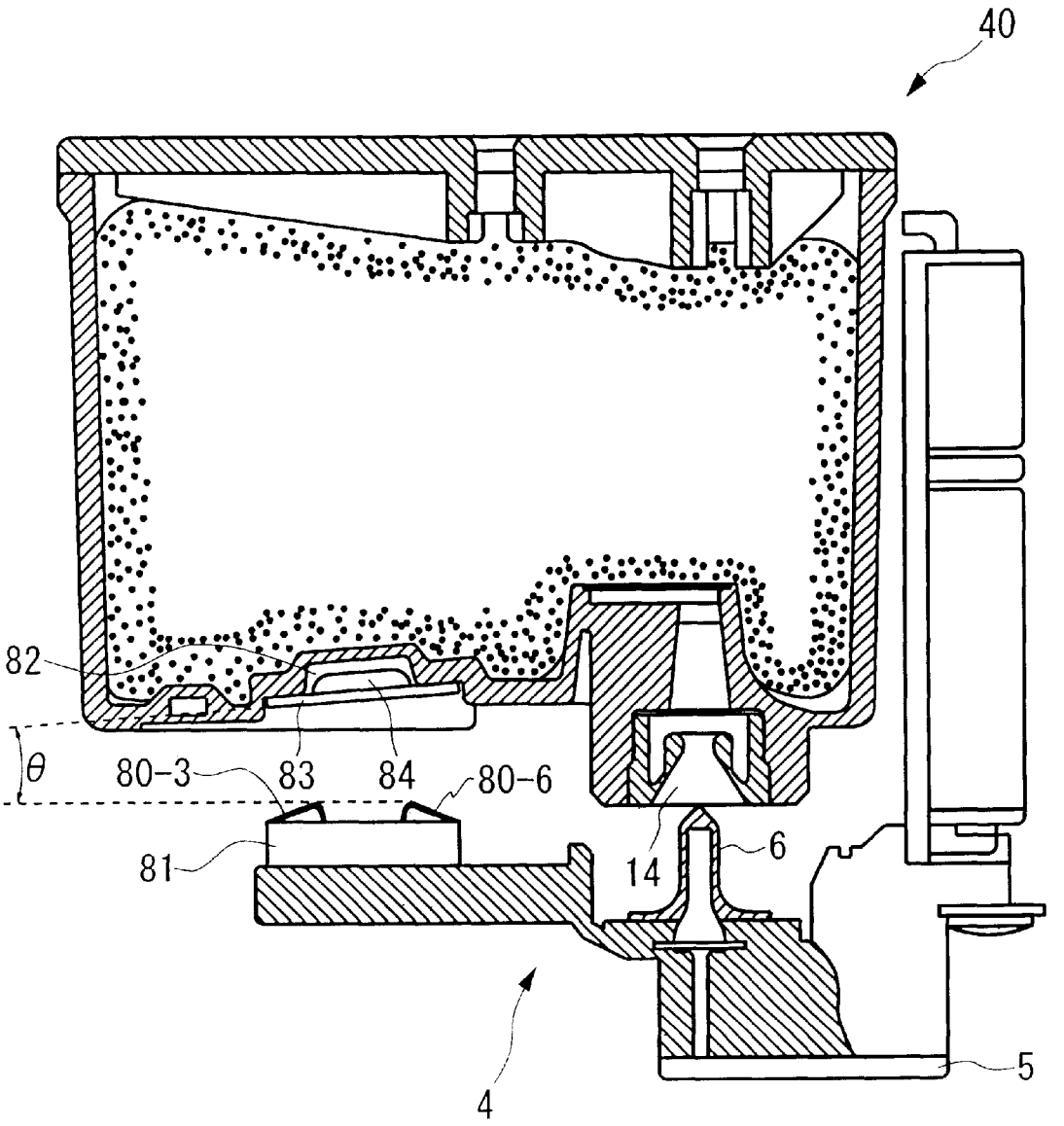
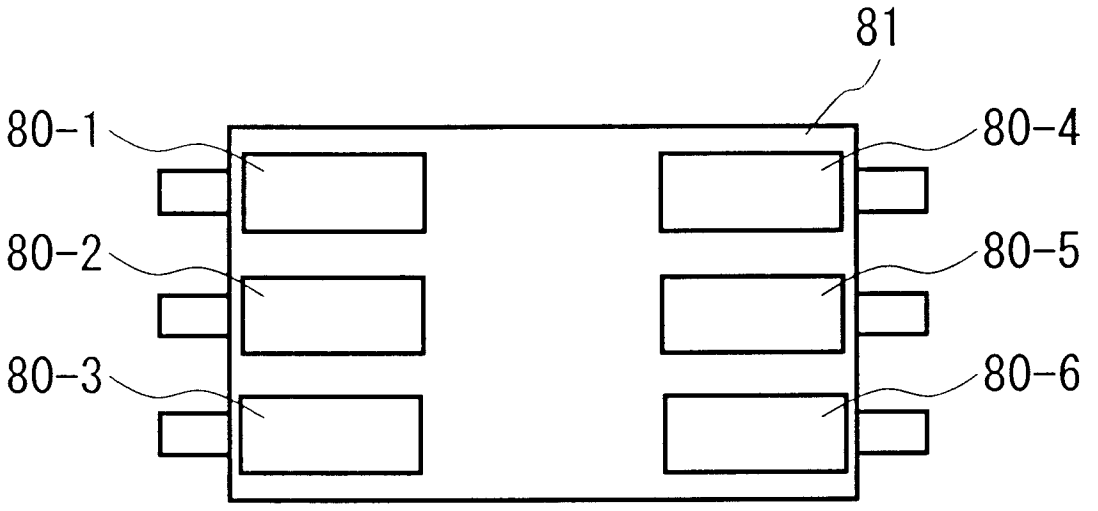
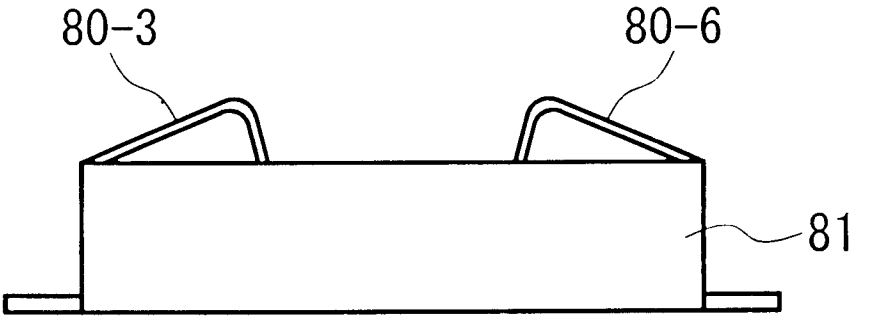


FIG. 16

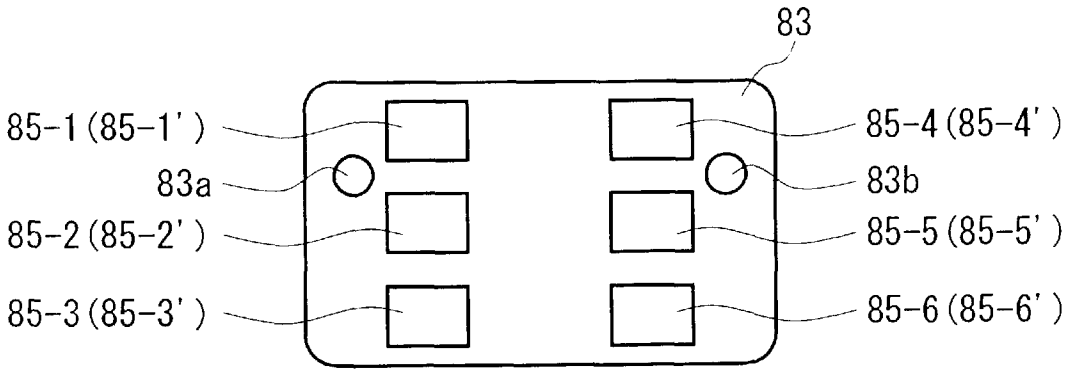


(a)

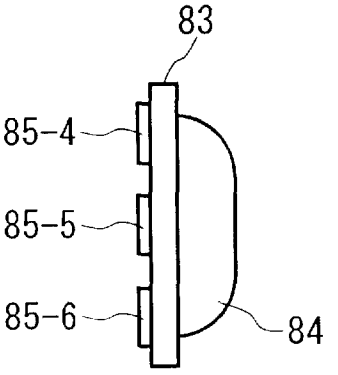


(b)

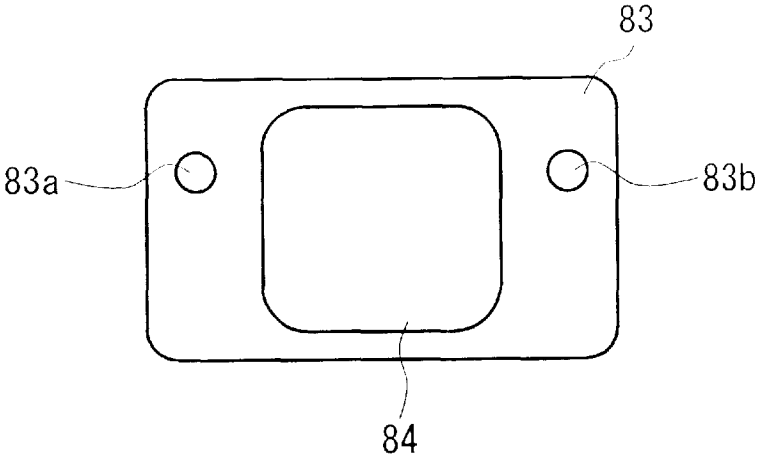
FIG. 17


83
85-1 (85-1')
83a
85-2 (85-2')
85-3 (85-3')
85-4 (85-4')
83b
85-5 (85-5')
85-6 (85-6')

(a)


83
85-4
85-5
85-6
84

(b)


83
83a
83b
84

(c)

FIG. 18

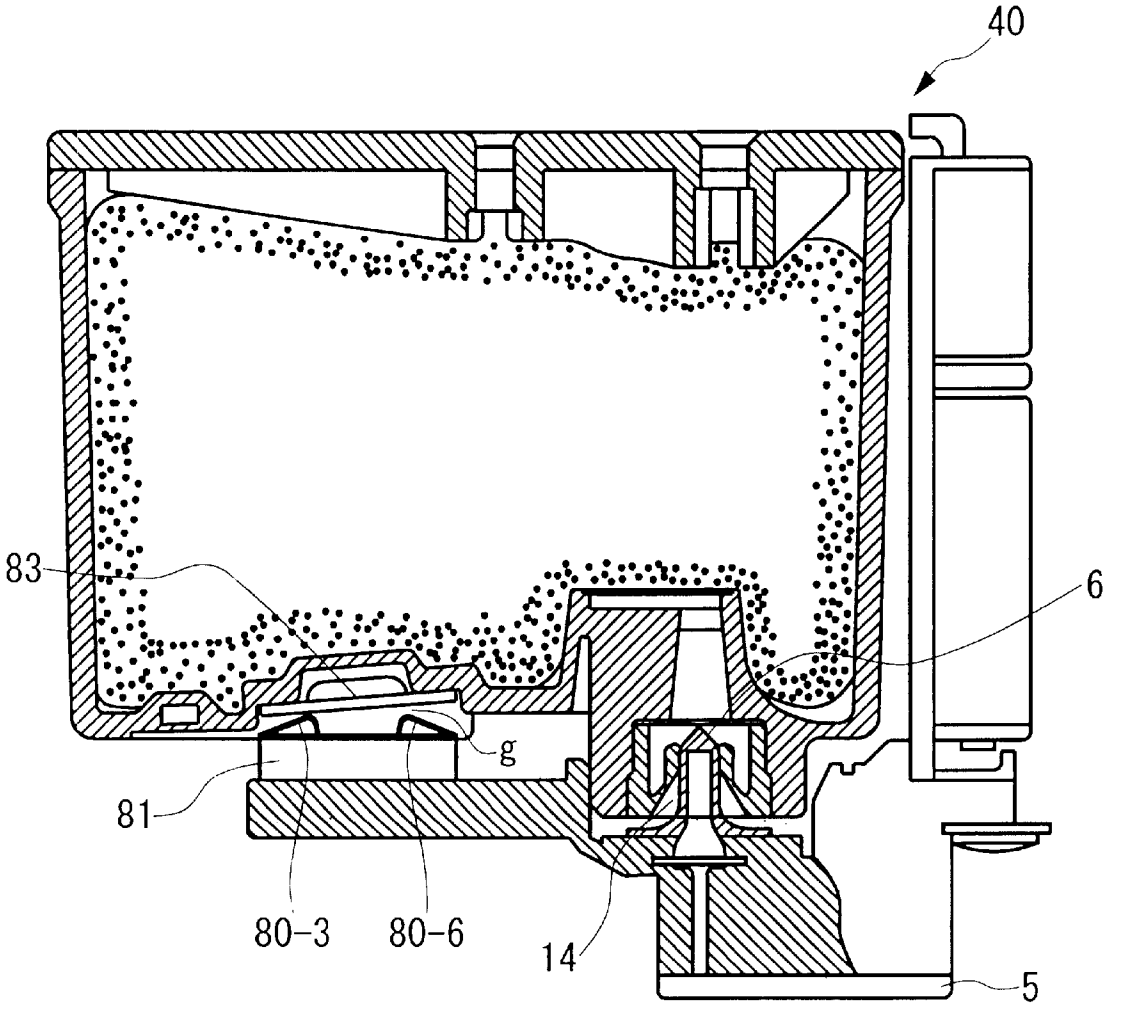
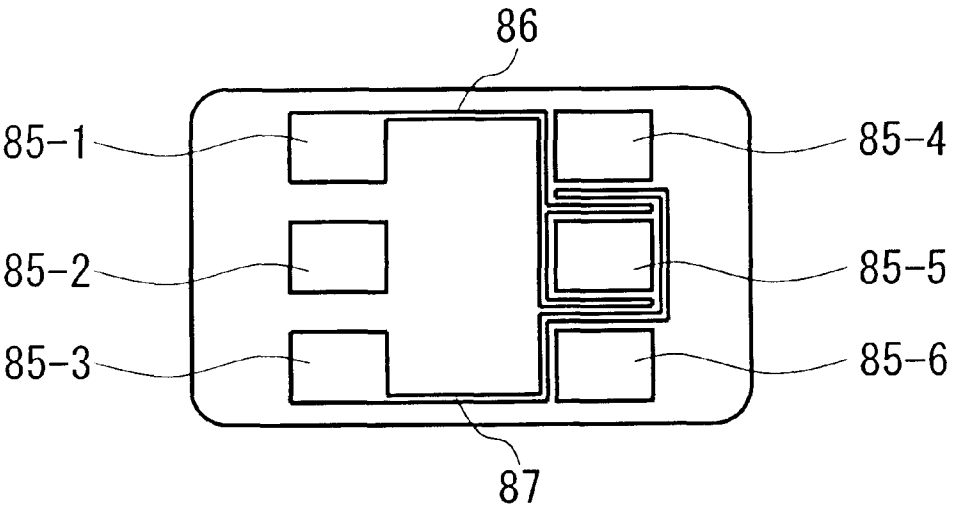
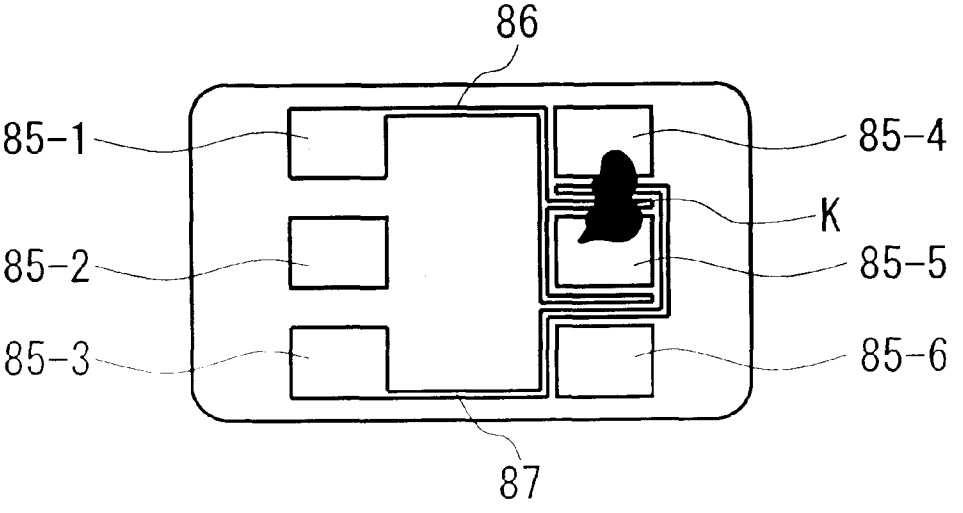


FIG. 19



(a)



(b)

FIG. 20

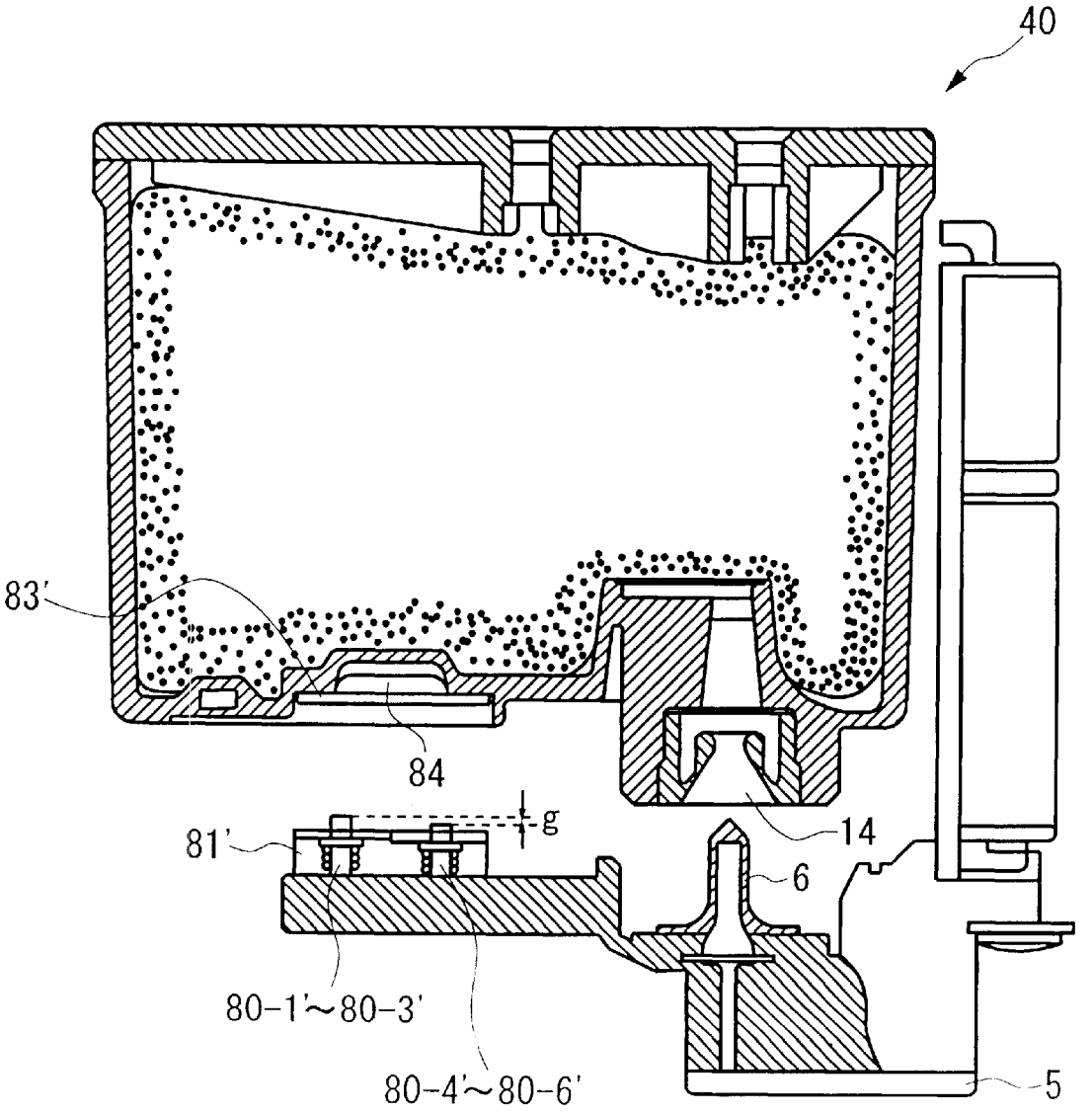


FIG. 21

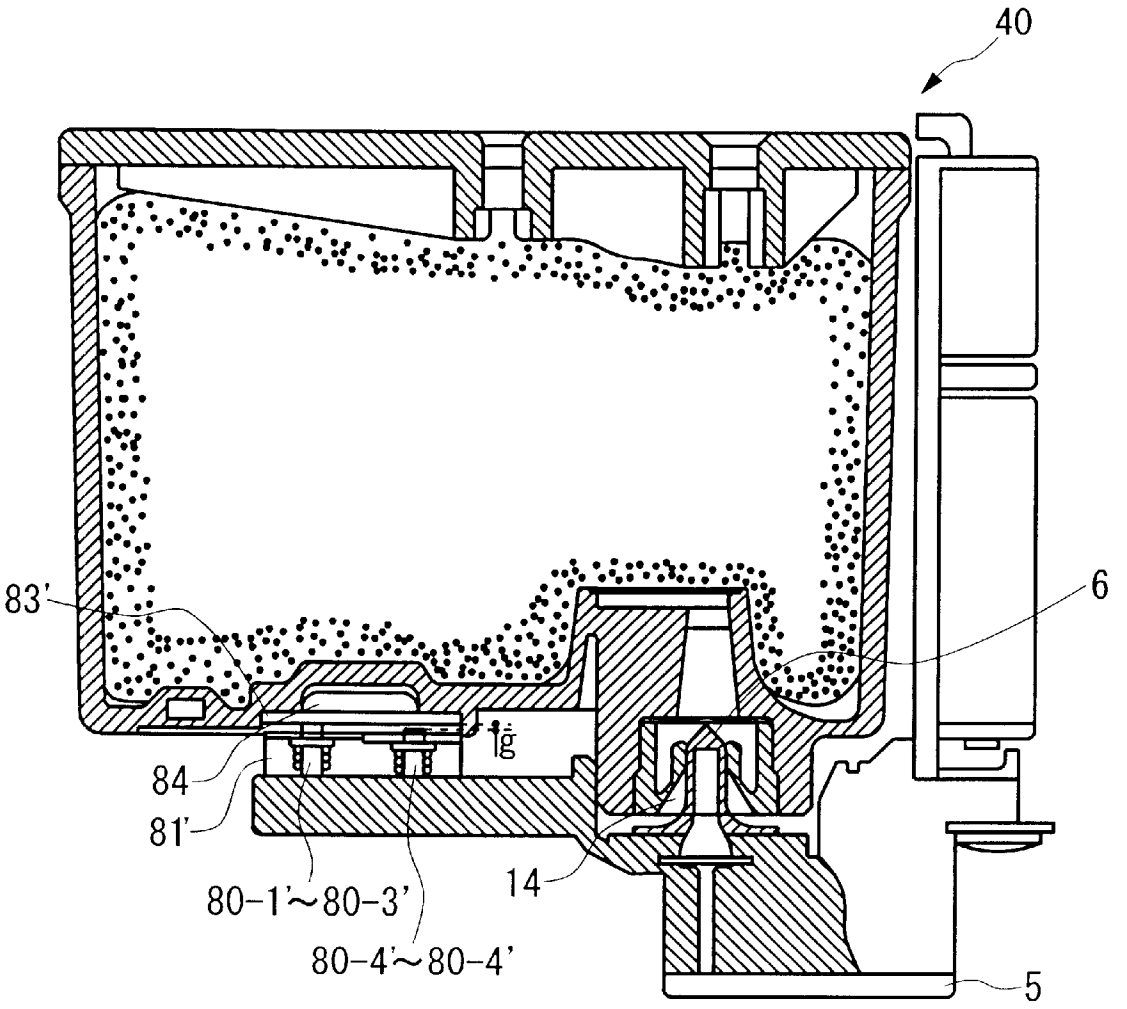


FIG. 22

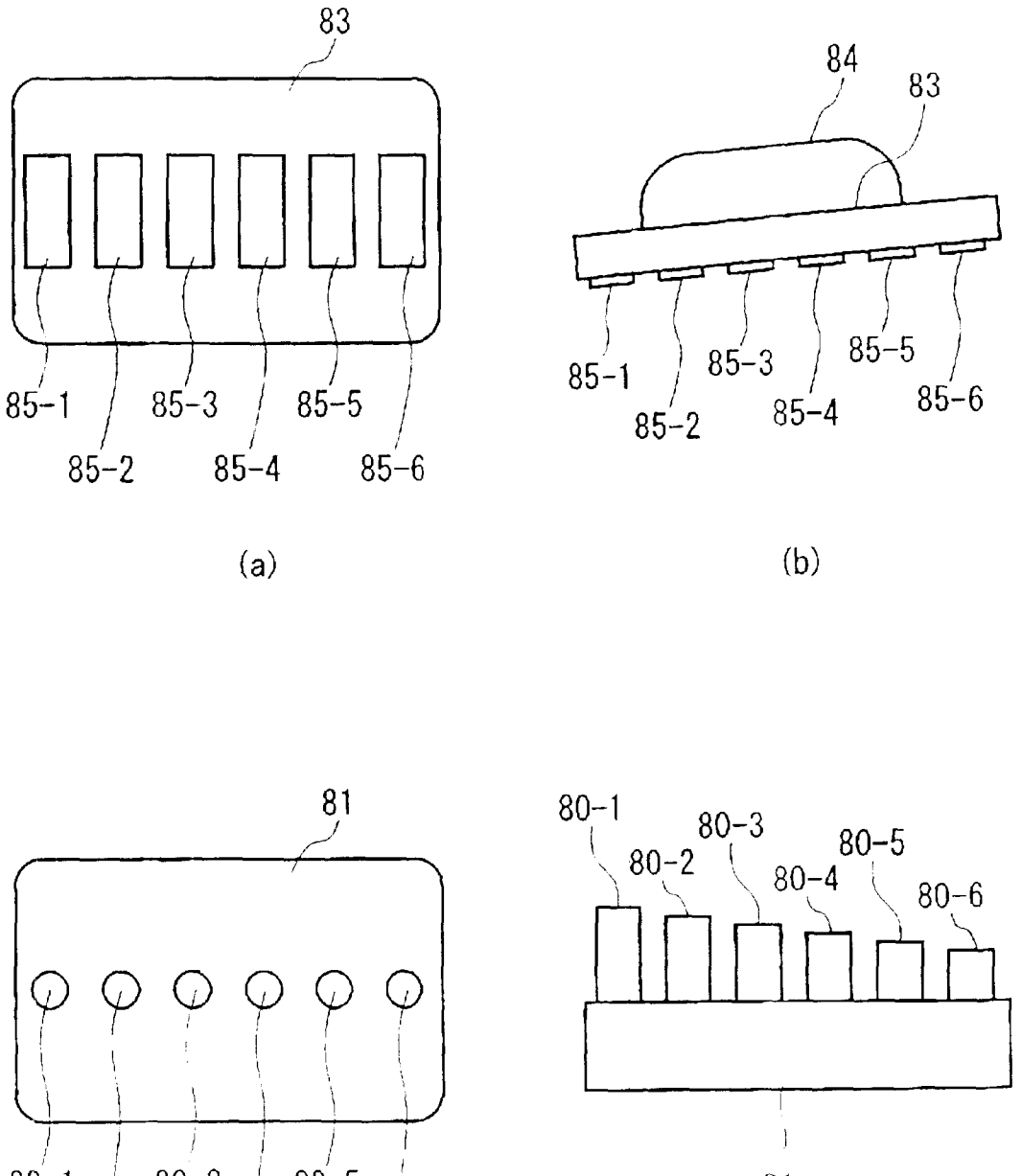
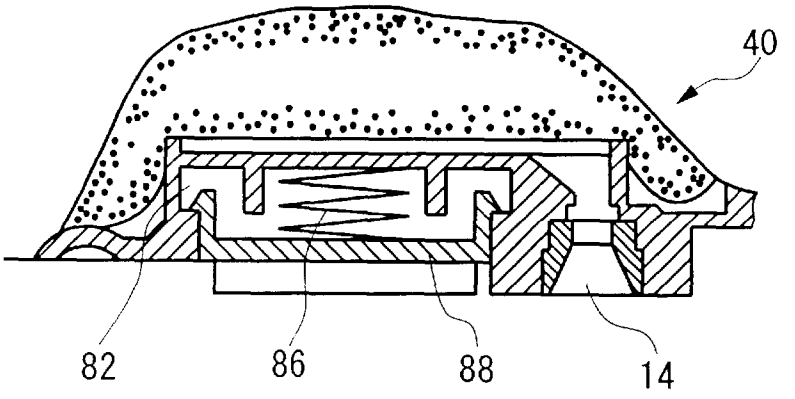
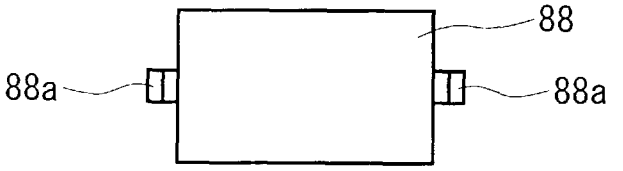

83
85-1
85-2
85-3
85-4
85-5
85-6
(a)
84
83
85-1
85-2
85-3
85-4
85-5
85-6
(b)
81
80-1
80-2
80-3
80-4
80-5
80-6
(c)
80-1
80-2
80-3
80-4
80-5
80-6
81
(d)

FIG. 23



(a)



(b)

FIG. 24

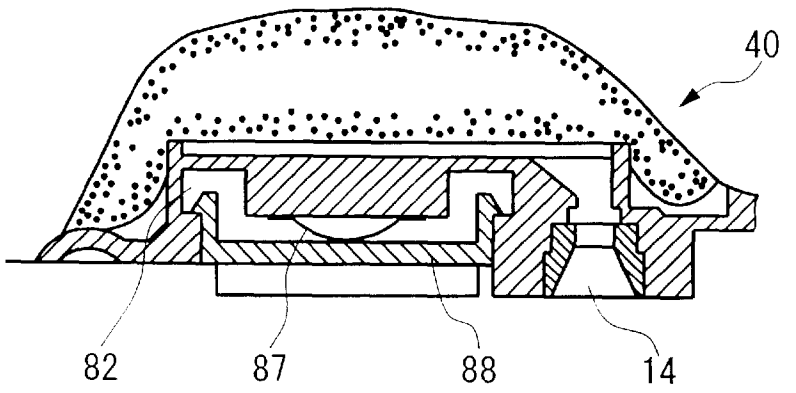
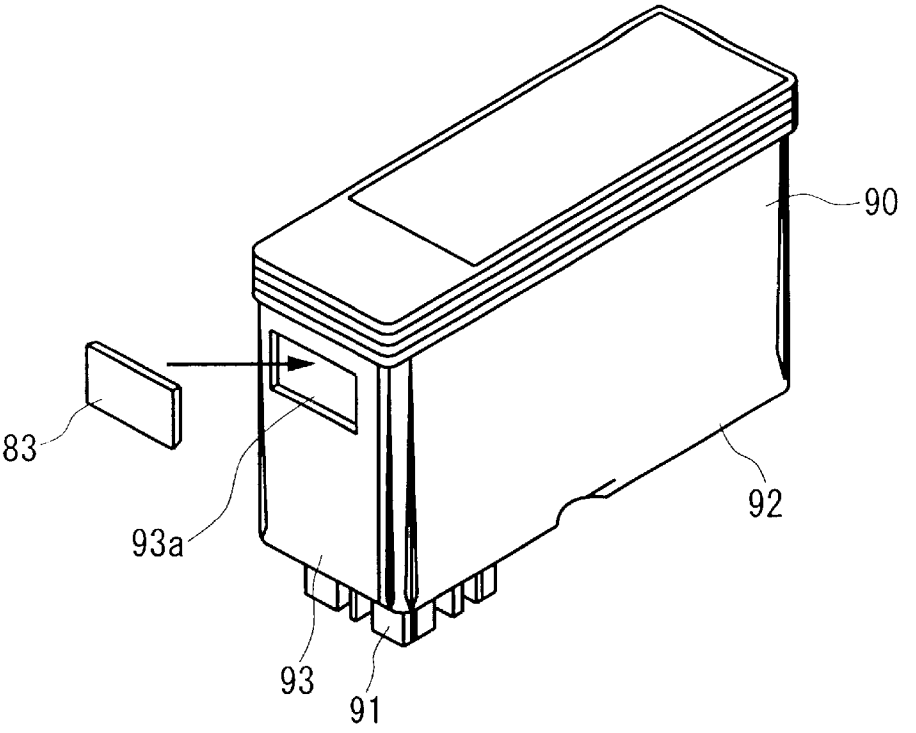
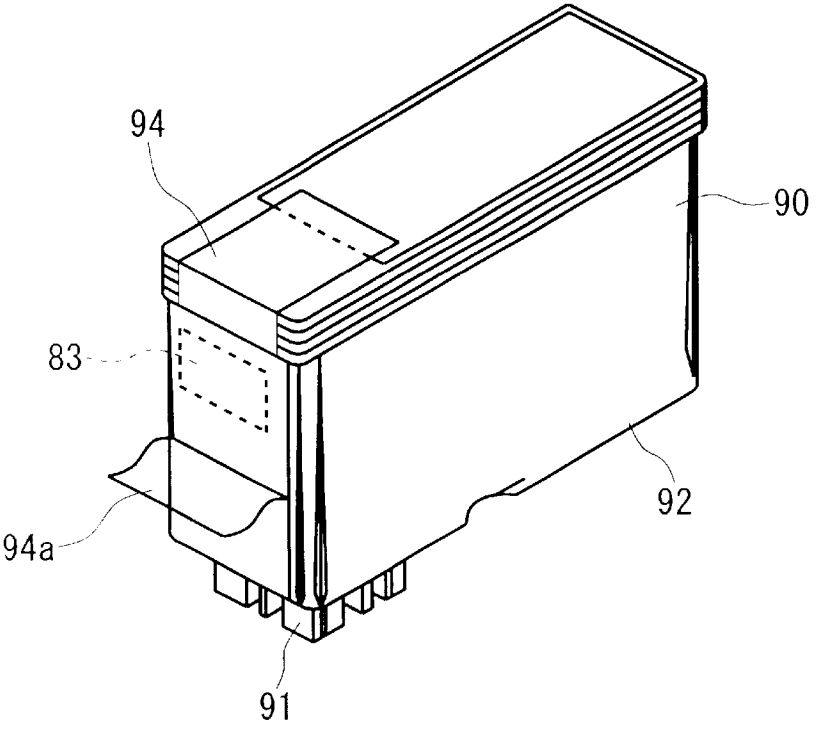


FIG. 25



(a)



(b)

FIG. 26

INK-JET PRINTING APPARATUS AND INK CARTRIDGE THEREFOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of PCT Application No. PCT/JP99/02579, filed May 18, 1999, which claims benefit of priority based on Japanese and PCT Application Ser. 10-151883, filed May 18, 1998, 10-151882, filed May 18, 1998, 10-180519, filed Jun. 26, 1998, 10-266109, filed Sep. 21, 1998, 10-301782, filed Oct. 23, 1998, and 11-78843, filed Mar. 24, 1999.

This is a Continuation-in-Part of PCT Application No. PCT/JP99/02579, filed May 18, 1999, which claims benefit of priority based on Japanese and PCT Application No. 10-151883, filed May 18, 1998, 10-151882, filed May 18, 1998, 10-180519, Jun. 26,1998, 10-266109, Sep. 21, 1998, 10-301782, Oct. 23, 1998, 11-78843, Mar. 24,1999.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a printing apparatus to which ink is supplied from a replaceable ink cartridge for printing on a recording medium, ejecting an ink droplet from nozzle apertures and an ink cartridge suitable for the above printing apparatus.

2. Conventional Art

An ink-jet printing apparatus is known in which there is provided with a print head for supplying a driving signal to a piezoelectric vibrator or heating means to print data, pressurizing ink by energy generated by the piezoelectric vibrator or the heating means and thereby ejecting ink droplets from nozzle apertures and an ink cartridge housing ink for supplying ink to the above print head.

As the print quality depends upon the resolution of the print head and greatly depends upon the viscosity of ink, the degree of bleeding on a recording medium or the like, the characteristics of ink are improved to enhance the print quality. Even if the same ink is used, a driving method of a print head suitable for the characteristics of ink is improved to enhance the print quality. Further, a maintenance condition such as the cycle of no-medium-ejection or forced ejection in a capping state is improved to prevent the nozzle apertures from clogging.

As described above, the print quality of a printing apparatus can be enhanced when the ink characteristics and the driving method for a print head work together, not only by the ink characteristics. Although a result by such technical development can be applied to a newly manufactured ink-jet printing apparatus, the application to a printing apparatus already shipped from a manufacturer would be practically impossible when taking into consideration the cost, labor and others. This is because that the printing apparatus has to be carried to the manufacturer and storing means in which control data is recorded must be exchanged.

To cope with such a problem, as disclosed in Japanese Patent Publication No. 2594912 for example, there has been proposed a printing apparatus in which semiconductor storage means and an electrode connecting to the storage means are arranged on an ink cartridge, a group of electrodes is also arranged on the body of the printing apparatus, data stored in the semiconductor storage means is read, and recording operation is controlled in accordance with the data.

However, there is a problem that contact with the semiconductor storage means is failed because of rough operation for attaching or detaching an ink cartridge by a user or play between a carriage and an ink cartridge, the reading of data is disabled because of electrification or the application of a signal at unsuitable timing and, in the worst case, data is lost and recording operation is disabled.

The present invention is made in view of such a problem and an object of which is to provide an ink-jet printing apparatus wherein data stored in semiconductor storage means can be prevented from being lost independent of unsuitable operation for attaching or detaching an ink cartridge.

Another object of the present invention is to provide an ink cartridge suitable for the above printing apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an embodiment of a printing apparatus according to the present invention mainly in relation to its recording mechanism, and

FIG. **2** is an assembly perspective drawing showing an embodiment of a carriage in the above printing apparatus.

FIG. **3** shows an embodiment of the carriage in the above printing apparatus in a state in which an ink cartridge is installed,

FIG. **4** is a top view showing an embodiment of the carriage in the above printing apparatus in a state in which an ink cartridge is installed, and

FIGS. **5**(*a*) and **5**(*b*) show an embodiment of a contact mechanism of the above carriage.

FIGS. **6**(*a*) and **6**(*b*) show an embodiment of an ink cartridge suitable for the above printing apparatus,

FIGS. **7**(*a*) to **7**(*c*) show an embodiment of a circuit board mounted on the ink cartridge in relation to its superficial and rear structure and the size of an electrode and

FIGS. **7**(*d*) and **7**(*e*) show a state of contact with a contact,

FIGS. **8** and **9** show a process in which the above ink cartridge is installed,

FIG. **10** shows the quantity of the movement of mainly an ink supply port where an ink supply needle is inserted of the ink cartridge, and

FIGS. **11**(*a*) to **11**(*c*) show a process of contact between the circuit board of the ink cartridge and a contact of a holder.

FIGS. **12**(*a*), **12**(*b*) to FIGS. **14**(*a*) and **14**(*b*) are respectively sectional views and top views showing another embodiment of the present invention in a state in which the ink cartridge is installed, and

FIG. **15** is a sectional view showing another embodiment of the present invention in a state in which the ink cartridge is installed.

FIG. **16** is a sectional view showing another embodiment of the head holder and the ink cartridge respectively in the above printing apparatus,

FIGS. **17**(*a*) and **17**(*b*) are respectively a plan and a side view showing an embodiment of the contact provided to the above head holder, and

FIGS. **18**(*a*) to **18**(*c*) are respectively a front view, a side view and a rear view showing a contact board mounted on the above ink cartridge.

FIG. **19** is a sectional view showing first conduction in a process for inserting the ink cartridge, and

FIG. **20**(*a*) is a plan showing the other embodiment of the contact mounted on the above ink cartridge and FIG. **20**(*b*) shows a state in which ink adheres.

FIG. **21** is a sectional view showing the other embodiment of the head holder and the ink cartridge respectively in the printing apparatus according to the present invention, and

FIG. **22** is a sectional view showing first conduction in the process for inserting the ink cartridge in the above printing apparatus.

FIGS. **23**(*a*) to **23**(*d*) are respectively plans and side views showing the other embodiment of the present invention in relation to the arrangement of the contacts, and

FIGS. **24**(*a*) and **24**(*b*) are respectively sectional views showing another embodiment of the mounting of the circuit board on the ink cartridge and a top view showing the structure of a mounting plate.

FIG. **25** is a sectional view showing another embodiment of the mounting of the circuit board on the ink cartridge.

FIGS. **26**(*a*) and **26**(*b*) show the other embodiment of the mounting of the circuit board.

THE BEST MODE FOR EMBODYING THE PRESENT INVENTION

FIG. **1** shows one embodiment of an ink-jet printing apparatus according to the present invention with respect to a printing mechanism. A holder **4** for installing a black ink cartridge **40** housing black ink described later and a color ink cartridge **50** housing color ink is disposed on an upper surface of a carriage **3** connecting to a driving motor **2** via a timing belt **1**. A print head **5** to which ink is supplied from each ink cartridge is provided on the lower surface of the carriage **3**.

FIG. **2** shows an embodiment of the carriage in a state in which the carriage is disassembled into a holder part and a head part and FIG. **3** is a sectional structural view sectioned at an ink supply port **44** of the black ink cartridge **40**.

Ink supply needles **6** and **7** communicating with the print head **5** are vertically penetrated in the bottom of the carriage **3** so that they are located on the back side of the device, that is, on the side of the timing belt **1**. Levers **11** and **12** are respectively mounted at the upper end of a vertical wall **8** opposite to each vicinity of the ink supply needles **6** and **7** out of the vertical wall forming the holder **4** so that the levers are respectively rotatable along shafts **9** and **10**. A wall **13** located on the side of each free end of the levers **11** and **12** is composed of a vertical part **13***a* near the bottom and a sloped part **13***b* sloped outward in its upper area.

The levers **11** and **12** respectively extend from the vicinity of the shafts **9** and **10** so that projections **14** and **15** respectively fitted to overhangs **46** and **56** described later at the upper end of the ink cartridges **40** and **50** are approximately perpendicular to each body of the respective levers **11** and **12**, and hook portions **18** and **19** elastically fitted to hooks **16** and **17** formed in the sloped part **13***b* of the holder **4** are respectively formed.

Elastic members **20** and **21** for elastically pressing at least the area opposite to the ink supply port **44** or **54** of each ink cartridge **40** or **50**, as shown in FIG. **4**, when the ink cartridge **40** is set in a normal position are provided to the back of each lever **11** or **12**, that is, the face opposite to a cover **43** of the ink cartridge **40**.

For these elastic members **20** and **21**, material having the coefficient of friction of 0.5 or more for the respective covers **43** and **53** of the ink cartridges **40** and **50**, for example, rubber the hardness of which is 10° to 70°, foamed material and a felt member and, further, gelled material are employed.

Windows **22** and **23** each upper part of which is open are respectively formed on the vertical wall **8** located near the

ink supply needle. Further, continuous grooves **22***c* and **23***c* are respectively formed on vertical walls **22***a* and **23***a* and at the bottoms **22***b* and **23***b* to respectively form each window, and contact mechanisms **24** and **25** are respectively inserted into these grooves **22***c* and **23***c* and fixed therein.

As the contact mechanisms **24** and **25** are composed so that they have approximately the same structure, one contact mechanism **24** will be described below. As shown in FIGS. **5**(*a*) and **5** (*b*), two types of slits **26** and **26'** different in depth are formed approximately at fixed pitch, the contact forming members **29** and **29'** provided with conductivity and elasticity are fitted into each slit **26** or **26'** of the body **28** provided with an elastically transformable pawl **27** on both sides. These contact forming members **29** and **29'** are respectively located unevenly and fixed so that they are exposed on the superficial and rear sides of the body **28**.

Areas **29***a* and **29'***a* exposed from each one face of the contact forming members **29** and **29'** respectively elastically come in contact with the contact of a circuit board **30** by composing the contact mechanisms **24** and **25** as described above and fitting the circuit board **30** in front of a vertical wall **34** of a base **32**, areas **29***b* and **29'***b* exposed from the other face respectively elastically come in contact with the contact of a circuit board **31** described later of the ink cartridges **40** and **50**, and conduction is acquired.

In the meantime, the print head **5** is fixed to the bottom of the holder **4** via a horizontal part **33** of the base **32** composed together with the ink supply needles **6** and **7** so that the base is approximately L-type. Windows **35** and **36** are respectively formed in areas opposite to the contact mechanism **24** and **25** on the vertical wall **34** of the base **32** and the above circuit board **30** is held on its front side.

The circuit board **30** is connected to control means **38** via a flexible cable **37** shown in FIG. **1**, supplies a driving signal for instructing the print head **5** to jet an ink droplet and comes in contact with the circuit board **31** of the ink cartridges **40** and **50** respectively via the contact mechanisms **24** and **25**.

FIGS. **6**(*a*) and **6**(*b*) show an embodiment of the black ink cartridge **40** and the color ink cartridge **50**, a porous number **42** impregnated with ink is respectively housed in containers **41** and **51** formed so that they are substantially parallelopiped and the respective upper faces are respectively sealed by the covers **43** and **53**.

The ink supply ports **44** and **54** are respectively formed in positions opposite to the ink supply needles **6** and **7** when the ink cartridges are respectively installed in the holder **4** at the bottom of the respective containers **41** and **51**, and overhang portions **46**, **56** and **56** for fitting in the respective projections **14** and **15** of the levers **11** and **12** are integrated with the respective upper ends of the vertical walls **45** and **55** on the side of the ink supply ports. As shown in FIGS. **6**(*a*) and **6**(*b*), the overhang portions **46**, **56** protrude from the housing of the ink cartridges **40**, **50**, respectively, in a direction perpendicular to a plane of the circuit board **31**. The overhang portion **46** of the black ink cartridge **40** is continuously formed from one end to the other end, the overhang portion **56** of the color ink cartridge **50** are individually formed so that they are located on both sides and, further, triangular ribs **47** and **57** are respectively formed between each lower surface and the wall **45** or **55**. A reference number **59** denotes a concave portion for preventing wrong insertion.

Concave portions **48** and **58** are respectively formed on the vertical walls **45** and **55** on the side of the ink supply ports so that the concave portions are respectively located in the center of the width of the ink cartridges **40** and **50** and

the circuit boards **31** are respectively installed in the above concave portions.

As best shown in FIGS. **6**(*a*) and **6**(*b*), the circuit boards **31** is attached on a side wall having the shorter width than the other side wall of the ink cartridges **40** and **50** and located on a central line of the ink supply ports **44** and **54**, respectively. The circuit board **31** is disposed substantially in parallel with the side wall. In addition, as shown in FIG. **6**(*b*), the ink cartridge **50** is provided with a plurality of ink chambers for different ink, and the circuit board **31** is disposed substantially at a center of the total width of the plurality of the ink chambers. Because the circuit boards **31** are located as described above, the accurate positional relationship of the circuit boards **31** with the contact member of the printing apparatus can be assured when the ink cartridges **40** and **50** are mounted on the printing apparatus.

Further, it is preferable that the height or depth of the concave portions in which the circuit boards **31** are to be installed is higher than that of the circuit board **31**. Alternately, a plane of the circuit boards **31** is aligned with a surface of the side wall of the ink cartridge **40**, **50** on which the circuit boards **31** are disposed. Because of these arrangement, the circuit boards **31** can be prevented from being touched by a user's finger when the ink cartridge is mounted on the printing apparatus.

Contacts **60** in plural rows in a direction in which the cartridge is inserted, in two rows in this embodiment, are formed in a position respectively opposite to the contact forming members **29** and **29'** of the above contact mechanism **24** on the side of the surface when the circuit board is attached to the ink cartridge of the circuit board **31** as shown in FIG. **7**(*a*). A semiconductor storage means **61** may be mounted at the rear surface of the circuit board **31** so that the semiconductor storage means is connected to these contacts **60** and, if necessary, is molded by ink-resistant material and is kept unexposed. The semiconductor storage means **61** may store data of the quantity of ink housed in the ink cartridge **40** or **50** to which the semiconductor storage means is provided, the manufacturing date of the ink, its trademark and the like. If required, the semiconductor storage means **61** stores data such as a maintenance status transmitted from the body of the printing apparatus. A reference number **60'** denotes an electrode used for a check during its manufacturing process. The electrode **60'** is grounded when used.

As shown in FIG. **7**, the electrodes **60** are distanced from an edge of the circuit board **31** or from a position of the circuit board where a contact member of the printing apparatus first comes into abutment when the ink cartridge is mounted on the printing apparatus. Such arrangement is advantageous in that the electrodes **60** on the circuit board **31** can be protected from a damage which might be given to the electrodes **60** when the circuit board **31** comes into abutment with the contact member of the printing apparatus. Further, since the electrodes **60** are distanced from the edge of the circuit board **31**, it is easy to control the position of the circuit board **31** with respect to the contact member of the printing apparatus.

Out of electrodes **60** formed on the circuit board **31**, for a small electrode **60-1** shown in FIG. **7**(*c*), the height H1 may be 1.8 mm and the width W1 1 mm, for a large electrode **60-2**, the height H2 may be 1.8 mm and the width W2 is 3 mm. Particularly, contact with the contact forming members **29** can be secured by forming the small electrode **60-1** in a rectangle in which the length in the inserted direction of the ink cartridge **40** or **50** is longer than that in the other direction, minimizing the width W1 of the electrode even if there is a lift Δh between the ink cartridge **40** or **50** and the holder **4** as shown in FIG. **11**(*c*).

On the circuit board **31** on which the semiconductor storage means **61** is mounted as described above, at least one through hole **31** a and a concave portion **31***b* are formed, and projections **45***a*, **45***b*, **55***a* and **55***b* for positioning together with the through hole **31***a* and the concave portion **31***b* and overhangs **45***c*, **45***d*, **55***c* and **55***d* which are elastically in contact with the side of the circuit board **31** such as a rib and a pawl are respectively formed near the ink supply ports **44** and **45** in a direction in which the cartridge is inserted in the vertical direction of the circuit board **31** on the vertical walls **45** and **55** which are respectively the mounting faces of the ink cartridges **40** and **50**. In another arrangement, if desired, the circuit board **31** may be provided with at least one projection which engages with a concave portion or through-hole for positioning the circuit board **31** with respect to the ink cartridge.

Hereby, the circuit board can be readily installed, respectively fitting to the ribs **45***c*, **45***d*, **55***c* and **55***d* by pressing the semiconductor storage means **61** on the respective walls **45** and **55** of the cartridges **40** and **50**, regulating the position of the semiconductor storage means according to the projection. Hereby, the cartridge is not required to be thickened uselessly for forming a hole for a screw, filling ink of sufficient quantity is enabled, not screwing fastening in which work is relatively troublesome but not riveting in which work is easy can be applied and a manufacturing process can be simplified. The height of the ribs **45***c*, **45***d*, **55***c* and **55***d* may preferably be higher than a plane of the circuit board **31** when the circuit board is disposed on the ink cartridge, so that the circuit board **31** my be prevented from touching user's finger when he or she mounts the ink cartridge on the printing apparatus.

In this embodiment, when the cartridge **40** is installed with the lever **11** lifted up to an approximately vertical position, the overhang **46** formed on the side of the ink supply port is caught by the projection **14** of the lever **11**, the side of the other end is supported by the sloped part **13***b* of the holder **4** and held in a state in which the side of the ink supply port is lifted as shown in FIG. **8**. In the above installation, if the ink cartridge **40** comes in abutment against the body of the printing apparatus, the circuit board **31** is protected by the overhang portion **46** in the upper part, as the circuit board **31** is also housed in the concave portion **48**, no shock directly operates on the circuit board **31** and damage is prevented.

When the lever **11** is closed in this state, the projection **14** is turned downward, the ink cartridge **40** is lowered, approximately keeping the posture when it is installed and the ink supply port **44** comes in contact with the tip end of the ink supply needle **6** as shown in FIG. **9**. As shown in FIG. **9**, the circuit board **31** is located at an opposite position of a fulcrum of the ink cartridge **40** when it is mounted on or removed from the holder of the printing apparatus. Further, as best shown in FIGS. **6**, **8** and **9**, the circuit board **31**, the ink supply port **44**, **54** and the overhang members **46**, **56** are located at the same side of the ink cartridges **41**, **51**, respectively. Owing to such structure, the positioning of the circuit board **31** with respect to the contact member of the printing apparatus is not largely affected by the quantity a of a turn when the ink cartridge **40** is mounted on the holder of the printing apparatus.

As a part over the ink supply port **44** of the cartridge **40** is pressed by the elastic member **20** when the lever **11** is further turned in this state, the ink supply port **44** is pressed

on the ink supply needle **6** by pressure amplified based upon the ratio of the length of the lever **11** and distance between the shaft **9** and the elastic member **20**. When the lever **11** is pressed to the end, it is fixed by the hook **16** with the lever **11** always elastically pressing the cover **43** of the ink cartridge **40** on the side of the ink supply needle via the elastic member **20** as shown in FIG. **3**.

Hereby, the ink cartridge **40** is elastically pressed under fixed pressure with the ink supply port **44** fitted to the ink supply needle **6** and a state in which the ink supply port **44** is fitted to the ink supply needle **6**, holding them airtight is maintained independent of vibration in printing, shock and vibration due to the movement of a printing apparatus and others.

As the circuit board **31** is located in the center in the width of the cartridge **40** on the vertical wall **45** in the vicinity of the ink supply port, the vertical wall **45** on which the circuit board **31** is fixed is moved possibly in parallel with a locus on which the ink supply port **44** is regulated by the ink supply needle **6**.

In the meantime, as the circuit board **31** is located in the vicinity of the ink supply needle **6** even if the cartridge **40** rattles when it is installed and a turn is caused with the ink supply needle **6** in the center, the quantity a of a turn is extremely small as shown in FIG. **10**.

For the arrangement set forth above, the circuit board **31** is moved according to a preset path as shown in FIGS. **11**(*a*) to **11**(*c*), comes in contact with the contacts **29** and **29'** of the contact mechanism **24** in defined order and in order grouped vertically, prevents data from being lost in the semiconductor storage means **61** due to the application of signals in unprepared order, the contact forming members **29** and **29'** elastically come in contact with the contact **60** of the circuit board **31** in a state in which the ink cartridge **40** is securely installed, and the reading of data stored in the semiconductor storage means **61** and the writing of data on the side of the printing apparatus are enabled.

When the installation of the ink cartridge **40** or **50** is finished, the contact forming member **29***a* of the contact mechanism **24** comes in contact with the electrodes in the upper row out of the electrodes shown in FIGS. **7**(*d*) and **7**(*e*) and the contact forming member **29'***a* comes in contact with the electrodes in the lower row. Two contact forming members **29** are in contact with the electrode **60-2** arranged in the center in the lower row. The two contact forming members **29** touched to the electrodes **60-2** are grounded and it can be judged by detecting conduction between these on the side of the printing apparatus whether the ink cartridge **40** or **50** is installed or not. Further, as the width W2 of the electrode **60-2** is larger than that of the other electrode **60-1** and the electrode **60-2** is located on the central line of the ink supply port, the electrode **60-2** securely comes in contact with the contact forming member **29'**. As the electrodes **60-1** and **60-2** are exposed and a user can check them easily in case the failure of contact is verified, the electrodes are simply wiped by cloth and others and conduction can be recovered. As shown in FIG. **7**, the electrode **60-2** is disposed on the same side of the circuit board **31** as the other electrodes **60-1**, **61-1** are formed.

When fitting to the hook **16** is released and the lever **11** is turned upward in case ink in the ink cartridge **40** is consumed, the projection **14** of the lever **11** is fitted to the lower part of the overhang portion **46** of the ink cartridge in the process as shown in FIG. **9**. When the lever **11** is further turned in this state, the ink cartridge **40** is lifted by the lever **11** and fitting to the ink supply needle **6** is released. As the upper half of the ink cartridge **40** is exposed from the holder with the overhang **46** on the side of the ink supply port supported by the projection **14** of the lever **11** as shown in FIG. **8** when the turn of the lever **11** up to an approximately vertical position is finished, the ink cartridge can be easily extracted.

In the above embodiment, only the side of the ink supply port is pressed, however, it is more effective that elastic members **100**,**101** are provided in two locations in the longitudinal direction of the lever **11** as shown in FIGS. **12**(*a*) and **12**(*b*) and in the case of the wider cartridge **50** for color ink, elastic members **102** to **105** are provided in four locations, dispersing the elastic members in the direction of the width of the lever **12**.

As shown in FIG. **13**, when elastic members **106** and **107** in size covering the approximately overall face are mounted, the cartridges **40** and **50** can be more securely held by large frictional force. In this case, it is desirable that thickness and elastic modules are selected so that pressure on the side of the ink supply port is larger than that in the other area.

Further, as shown in FIG. **14**, if elastic members **108** and **109** similar to the elastic members elastically pressing the upper surface are laid approximately in the center of the bottom of the holder **4**, airtight capability between the ink supply port **44** or **54** and the ink supply needle **6** or **7** of the ink cartridge **40** or **50** can be maintained independent of vibration and shock.

Further, even if at least one plate spring **70** protruded at least on the side of the ink supply port is fixed to the side of a free end at the back of the lever **11** as shown in FIG. **15**, the ink cartridge **40** can be fixed in the holder. In this case, it is more effective that non-slip and others are stuck on the side of the free end **70***a* of the plate spring **70** or on the cover of the ink cartridge.

FIG. **16** shows an embodiment in case a circuit board is arranged at the bottom in the vicinity of an ink supply port or an ink cartridge, an ink supply needle **6** communicating with a print head **5** is planted at the bottom of a carriage and a board **81** on which elastically transformable contacts **80-1**, **80-2**, . . . **80-6** formed by a spring are formed is provided in a position possibly adjacent to the ink supply needle **6** as shown in FIGS. **17**(*a*) and **17**(*b*).

In the meantime, an ink supply port **14** which can be fitted to the ink supply needle **6** is provided at the bottom of an ink cartridge **40**, a concave portion **82** is formed in a position possibly close to the ink supply port **14** and in a position opposite to the contact board **81** and a circuit board **83** is fixed diagonally so that the circuit board has an angle θ with each vertex of the contacts **80-1** to **80-6**. It is preferable that the circuit board **83** may be diagonal with respect to a plane perpendicular to a direction in which the ink cartridge is mounted on the printing apparatus.

Through holes **83***a* and **83***b* for a positioning are formed on the circuit board **83** as shown in FIG. **18**(*a*), semiconductor storage means **84** is mounted on the surface on the side of an ink housing chamber, that is, at the back as shown in FIGS. **18**(*b*) and **18**(*c*) and contacts **85-1**, **85-2**, . . . **85-6** connected to the data input terminal and the driving power supply terminal of the semiconductor storage means **84** for acquiring conduction to the contacts **80-1** to **80-6** on the side of the carriage, are formed on the side of the exposed surface.

As the semiconductor storage means **84** is mounted at the rear surface of the circuit board **83** as described above, the degree of freedom in arranging the contacts is enhanced. The surface and the rear of the circuit board **83** can be effectively

utilized and electrodes to be the contacts **85-1**, **85-2**, . . . **85-6** can be formed in area to the extent that the reliability of connection can be secured. A molding agent can be readily applied to the surface on which the semiconductor storage means **84** is formed without considering whether application precision is high or not to prevent from adhering to the contacts **85-1**, **85-2**, . . . **85-6** and the manufacturing process can be simplified.

Further, because the semiconductor storage means **84** is mounted on the cartridge with the status hidden by the circuit board **83**, a user can be prevented from touching to the storage means unintentionally, liquid such as ink can be prevented from adhering to the storage means, and electrostatic destruction and an accident caused by a short circuit can be also prevented.

The semiconductor storage means **84** is connected to control means not shown of the printing apparatus via the contacts **85-1**, **85-2**, . . . **85-6** and the contacts **80-1** to **80-6**, data stored in the semiconductor storage means is read and data such as the quantity of ink consumed by printing operation is written to the means.

In another arrangement, the circuit board **83** may be diagonal with respect to a direction in which the ink cartridge **40** is mounted on the printing apparatus.

In this embodiment, when the ink cartridge **40** reaches the vicinity of the bottom of the carriage in case the ink cartridge **40** is installed, the ink supply needle **6** enters the ink supply port **14** as shown in FIG. **19**, forms a passage, the contacts **80-1** to **80-3** near one side of the circuit board **83** having an angle θ with a horizontal plane first come in contact with the contacts **85-1** to **85-3** and conduction is acquired.

When the cartridge **40** further is further lowered, the contacts **80-4** to **80-6** near the other side of the circuit board **83** come into contact with the contacts **85-4** to **85-6** and all contacts become conduction.

Therefore, power is supplied to the semiconductor storage means **84** through the contacts **80-1** to **80-3** and the contacts **85-1** to **85-3** by which conduction is first acquired so as to initialize the semiconductor storage means **84**. Data can be prevented from being lost by accessing to data stored in the semiconductor storage means **84** via the contacts **80-4** to **80-6** and the contacts **85-4** to **85-6** which become conduction after the above conduction is acquired.

In the meantime, when the ink cartridge **40** is pulled out from the carriage, termination processing can be executed by power still supplied by the contacts **80-1** to **80-3** and the contacts **85-1** to **85-3** and afterward, power can be turned off through the contacts **80-4** to **80-6** and the contacts **85-4** to **85-6** are first disconnected. When processing for the semiconductor storage means **84** finishes as described above, the ink supply needle **6** is pulled out from the ink supply port **14**.

FIG. **20**(*a*) shows the other embodiment of contacts **85-1** to **85-5** formed in an ink cartridge **40**. Conductive patterns **86** and **87** are formed between a column of contacts **85-1** to **85-3** by which conduction is first acquired when the ink cartridge **40** is inserted and a column of contacts **85-4** to **85-5** by which conduction is afterward acquired.

For example, the contacts **85-1** and **85-3** are selected as a detection terminal and two of the contacts **854** to **85-5**, that is, **85-4** and **85-5** may be selected as a power supply terminal.

In the arrangement described above, if ink K adheres across the terminals **85-4** and **85-5**, serving as a power supply terminal as shown in FIG. **20**(*b*), resistance between the terminals **85-4** and **85-5** is detected by the contacts **85-1** and **85-3**, by which conduction is first acquired together with the contacts **80-1** and **80-3** of the holder **4** when the ink cartridge is inserted. If the detected resistance is lower than a predetermined value, the supply of power to **80-4** and **80-5** by which conduction is next acquired together with the power supply terminals **85-4** and **85-5** is stopped and an accident caused by a short circuit due to the adhesion of ink K can be precluded.

FIG. **21** shows another preferred embodiment of the present invention in which a circuit board **83'** on which contacts **85-1'** to **85-6'** formed such as to be secured horizontally at the bottom of an ink cartridge **40** while the circuit board is always pressed upward by a spring or the like. A board **81'** on which two columns of contacts **80-1'** to **80-3'** and contacts **80-4'** to **80-6'** are formed is formed in such a manner that difference g in a level is made between the tip ends of the two columns is provided.

Also in this embodiment, as shown in FIG. **22**, as the first column of contacts **85-1'** to **85-3'** and the contacts **80-1'** and **80-3'** first become conduction. Next, the second column of contacts **80-4'** to **80-6'** respectively short in a stroke come in contact with the contacts **85-4'** and **85-6'** and conduction is acquired, so that the similar action and effect to those in the above embodiments are produced.

In the above embodiment, the contacts **80-1** to **80-6** and **85-1** to **85-6** are divided into plural columns and difference in time until conduction is acquired is provided between the columns. However, it is clear that the similar effect may be realized even if the contacts **80-1** to **80-6** and the contacts **85-1** to **85-6** are respectively arranged in one row as shown in FIGS. **23**(*a*) and **23**(*b*), and a board **83** on which the contacts **85-1** to **85-6** are formed is angled as shown in FIGS. **23**(*c*) and **23**(*d*) so that the conducting time becomes different between the contact **80-1** and **85-1** on one side and the contact **80-6** and **85-6** on the other side. Similarly, if the position of each end of the contacts **80-1** to **80-6** is designed to be differentiated, so that the same function may be achieved.

In the above embodiments, the mode according to which the ink cartridge is mounted on the carriage is described as an example. However, it is apparent that a similar effect may be obtained even if the present invention is applied to a printing apparatus of a type in which an ink cartridge is housed in a cartridge housing area of the apparatus body and is connected to a print head via an ink supply tube.

That is, contacts have only to be formed in required positions on the exposed face of the ink cartridge and the above contacts **85-1** to **85-6** have only to be formed in touchable positions opposite to the contacts of the ink cartridge when the ink cartridge is installed.

In addition, the same effect may be accomplished even in an arrangement in which the board **83** is mounted at the bottom of the ink cartridge **40** via a mounting plate **88** having elastically transformable pawls **88***a* protruding therefrom at least at both ends on the open sides of the mounting plate, after inserting a coil spring **86** or an arcuate plate spring **87** into a concave portion as shown in FIGS. **24** and **25**. Alternatively, the same effect may be obtained if the semiconductor storage means **84** is mounted on the mounting plate **88** thereby to form the contacts **85-1**, **85-2**, . . . **85-6**. According to this arrangement, if merely a jig is prepared, the pawls **88**a can be removed by the jig and the board **83** can be detached from the cartridge **40** in a factory while precluding unnecessary detachment by user.

Further, in the above embodiments, projections for positioning may be formed on the ink cartridge and the circuit

board is positioned. However, the similar effect can be achieved in another arrangement in which a concave portion **93***a* is formed on a wall of an ink cartridge **90**, a wall **93** adjacent to the bottom **92** on which an ink supply port **91** is formed, in this embodiment as shown in FIG. **26**(*a*), a circuit board **83** is housed and fixed in the concave portion **93***a*.

If necessary, a film **94** which can be peeled from one end **94***a* may be also applied as shown in FIG. **26**(*b*) and may be also sealed till the start of use.

According to the present invention, as the ink supply needle is located near one side in a direction perpendicular to the direction of the reciprocation of the carriage, the circuit board is mounted on the wall in the vicinity of the side on which the ink supply port is formed of the ink cartridge, the plural contacts for connecting to external control means are formed on the exposed surface of the circuit board and the semiconductor storage means is accessed from the external control means via the contacts, the circuit board is located on the side of the ink supply port and the face on which the circuit board is fixed is moved along the ink supply needle. Therefore, even if there is play between the carriage and the cartridge, the cartridge is moved according to a locus defined by the ink supply needle and the ink supply port, the contacts are connected to the external control means in a defined order and data stored in the semiconductor storage means can be securely prevented from being lost by the application of signals in an unprepared order.

What is claimed is:

1. An ink cartridge for mounting on a carriage of an inkjet printing apparatus and for supplying ink to a printhead of said ink jet printing apparatus through an ink supply needle, the ink cartridge comprising:

a plurality of external walls, including a first wall and a second wall, defining at least some of a chamber;

an ink supply port for receiving said ink supply needle, the ink supply port having a centerline and communicating with the chamber,

a semiconductor storage device storing information about the ink carried by said cartridge; and

a plurality of contacts for connecting the semiconductor storage device to the ink jet printing apparatus, the contacts being formed in a plurality of rows lying essentially in a plane parallel to the centerline of the ink supply port, each said row being centered relative to the centerline of said ink supply port.

2. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall of said housing.

3. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall of said housing in the vicinity of said ink supply port.

4. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall which is perpendicular to said first wall of said housing.

5. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are disposed on a substrate which is substantially rectangular, and said semiconductor storage device is disposed on said second wall which is substantially perpendicular to said first wall, and said second wall has a shorter width than the other wall of said housing.

6. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are disposed substantially in parallel with said second wall which is perpendicular to said first wall of said housing.

7. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are located at an opposite position of a fulcrum of the ink cartridge when it is mounted on or removed from the printing apparatus.

8. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are disposed on a substrate which is substantially rectangular and directs in a vertical orientation.

9. An ink cartridge for mounting on a cartridge of an ink jet printing apparatus and for supplying ink to a printhead of said ink jet printing apparatus through an ink supply needle, the ink cartridge comprising:

a plurality of external walls defining at least some of a chamber;

an ink supply port for receiving said ink supply needle, the ink supply port having an exit opening and a centerline and communicating with the chamber;

a semiconductor storage device storing information about the ink carried by said cartridge; and

a plurality of contacts for connecting said semiconductor storage device to the ink jet printing apparatus, the contacts being formed in a plurality of rows so that one of said rows is closer to said exit opening of said ink supply port than an other of said rows, the row of said contacts which is closest to said exit opening of said ink supply port being longer than the row of said contacts which is furthest from said exit opening of said ink supply port.

10. The ink cartridge according to claim **9**, wherein the electrical contacts are arranged so that at least one contact is spaced apart from the central line of the ink supply port.

11. The ink cartridge according to claim **9**, wherein said contacts, viewing the ink cartridge in a direction perpendicular to a plane of the contacts, lie on a centerline of said ink supply port.

12. The ink cartridge according to claim **9**, wherein said wall on which said semiconductor storage device is disposed is located in the vicinity of said ink supply port.

13. The ink cartridge according to claim **12**, wherein said semiconductor storage device is located on a center line of said wall of said housing on which said semiconductor storage device is disposed.

14. The ink cartridge according to claim **1**, wherein, viewing the ink cartridge in a direction perpendicular to a plane of the contacts, the electrical contacts of each row are symmetrically disposed about the centerline of the ink supply port.

15. The ink cartridge according to claim **1**, wherein the contact in the first row is narrower than the contact in the second row.

16. The ink cartridge according to claim **1**, wherein the ink cartridge comprises a plurality of ink supply ports.

17. An ink cartridge for an ink jet printing apparatus having a printhead which ejects ink droplets onto recording medium, the ink cartridge comprising:

a housing containing ink therein, said housing having a first wall and a second wall,

an ink supply port formed on said first wall for directing ink in said housing to the printhead;

a memory device storing information about the ink disposed on said housing; and

a plurality of contacts disposed at a predetermined angle relative to a wall plane on a wall of said housing, the contacts allowing electrical communication between the memory device and the ink jet printing apparatus.

18. The ink cartridge according to claim **17**, wherein said memory device is disposed on the same wall as said ink supply port is formed.

19. The ink cartridge according to claim **17**, wherein said semiconductor storage device is intersected by a plane passing through a center line of said ink supply port.

20. The ink cartridge according to claim **17**, wherein said memory device is disposed substantially at a center in the widthwise direction of said wall in the vicinity of said ink supply port.

21. The ink cartridge according to claim **17**, wherein said memory device is disposed on a side wall of said housing.

22. The ink cartridge according to claim **17**, wherein said housing is substantially rectangular, and said wall on which said memory device is disposed is a side wall having a shorter width than the other side wall of said housing.

23. The ink cartridge according to claim **17**, wherein said memory device is diagonal with respect to a direction in which the ink cartridge is mounted on the printing apparatus.

24. The ink cartridge according to claim **17**, wherein said memory device is diagonal with respect to a plane perpendicular to a direction in which the ink cartridge is mounted on the printing apparatus.

25. The ink cartridge according to claim **17**, wherein said memory device comprises a storage device and a plurality of terminals which is grouped into at least two groups.

26. The ink cartridge according to claim **25**, wherein said memory device comprises a first group of said terminals connect to said storage device and a second group of said terminals connect to contact members of the printing apparatus.

27. The ink cartridge according to claim **25**, wherein said two groups of terminals come into contact with the contact members of the printing apparatus at a time interval.

28. A contact forming device formed on an ink cartridge holder, which contacts a memory device storing information of ink contained in an ink cartridge for an ink jet printing apparatus, the contact forming device comprising:

a support member; and

a plurality of elastic contact members formed on said support, each of said contact member contacts a respective terminal of the memory device of the ink cartridge when the ink cartridge is mounted on the printing apparatus, at least two of said plurality of contact members contact a single terminal of the memory device when the ink cartridge is mounted.

29. An ink jet printing apparatus, comprising:

a printhead for ejecting ink droplets onto a recording medium;

an ink container having an ink supply port for supplying ink contained therein to said printhead; and

at least one elastic member formed at a predetermined portion of the printing apparatus, said elastic member elastically engaging with said ink container when said ink container is mounted on the printing apparatus.

30. The printing apparatus according to claim **29**, wherein said ink container comprises a memory device for storing information of ink disposed at a predetermined position of said ink container.

31. The printing apparatus according to claim **29**, wherein said elastic member comprises two separate elastic materials disposed at different positions.

32. The printing apparatus according to claim **29**, wherein said elastic member comprises a single elastic material covering a surface of said ink container substantially entirely.

33. The printing apparatus according to claim **29**, wherein said elastic member comprises at least one elastic material which elastically engages with a bottom surface of said ink container.

34. The printing apparatus according to claim **29**, wherein said elastic member comprises a plate spring.

35. The printing apparatus according to claim **29**, wherein said elastic member comprises a porous member.

36. The printing apparatus according to claim **29**, wherein said elastic member is disposed at a position confronting said ink supply port of said ink container.

37. The printing apparatus according to claim **29**, wherein said elastic member comprises a first elastic material and a second elastic material disposed at an opposite side of said first elastic material.

38. The printing apparatus according to claim **29**, wherein said elastic material is disposed on a lever member of an ink container holder.

* * * * *

US006502917C1

(12) EX PARTE REEXAMINATION CERTIFICATE (6643rd)

United States Patent

Shinada et al.

(10) Number: US 6,502,917 C1

(45) Certificate Issued: Feb. 3, 2009

(54) **INK-JET PRINTING APPARATUS AND INK CARTRIDGE THEREFOR**

(75) Inventors: **Satoshi Shinada**, Nagano (JP); **Fujio Akahane**, Nagano (JP); **Minoru Usui**, Nagano (JP); **Takao Kobayashi**, Nagano (JP); **Makoto Matsuzaki**, Nagano (JP)

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

Reexamination Request:
No. 90/008,791, Aug. 3, 2007

Reexamination Certificate for:

Patent No.:	**6,502,917**
Issued:	**Jan. 7, 2003**
Appl. No.:	**09/484,458**
Filed:	**Jan. 18, 2000**

(51) **Int. Cl.**
B41J 29/393 (2006.01)
B41J 2/175 (2006.01)

(52) **U.S. Cl.** **347/19**; 347/86

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,119,115	A		6/1992	Buat et al.
5,442,386	A	*	8/1995	Childers et al. 347/50
5,488,401	A		1/1996	Mochizuki et al.
5,610,635	A		3/1997	Murray et al.
5,706,040	A		1/1998	Reid et al.
5,975,677	A		11/1999	Marler et al.
6,102,517	A		8/2000	Kobayashi et al.

FOREIGN PATENT DOCUMENTS

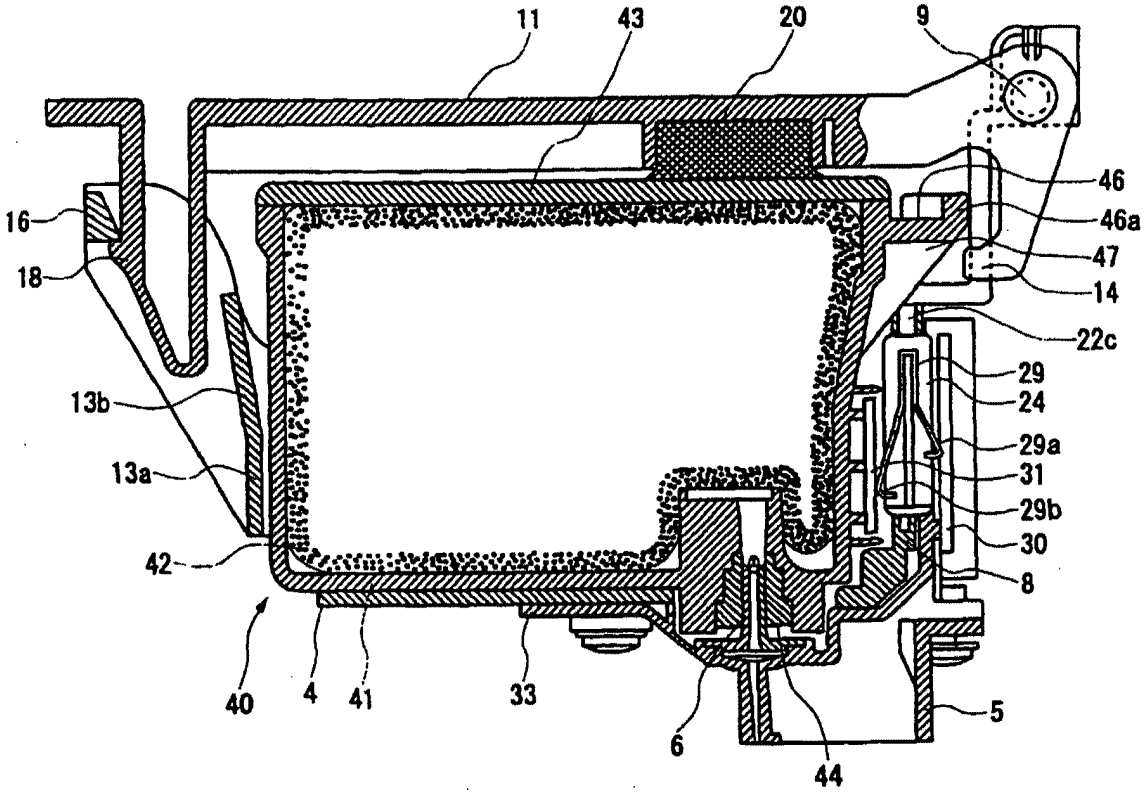
JP	03-227629 A		10/1991
JP	WO 97/23352	*	7/1997
WO	WO-98/04414 A1		2/1998

* cited by examiner

Primary Examiner—Minh T Nguyen

(57) **ABSTRACT**

An ink jet type printing apparatus in which an ink supply needle is located near one side in a direction perpendicular to the reciprocated directions of a carriage, a circuit board is mounted on a wall of an ink cartridge in the vicinity of the side on which an ink supply port is formed and plural contacts for connecting to external control means are formed on the exposed surface of the circuit board.



EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1, 8** is confirmed.

Claims **17–22** are cancelled.

Claims **2–6, 9** and **13** are determined to be patentable as amended.

Claims **10–12, 14** and **16**, dependent on an amended claim, are determined to be patentable.

Claims **7, 15** and **23–38** were not reexamined.

2. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall of said [housing] *chamber*.

3. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall of said [housing] *chamber* in the vicinity of said ink supply port.

4. The ink cartridge according to claim **1**, wherein said semiconductor storage device is disposed on said second wall which is perpendicular to said first wall of said [housing] *chamber*.

5. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are disposed on a substrate which is substantially rectangular, and said semiconductor storage device is disposed on said second wall which is substantially perpendicular to said first wall, and said second wall has a shorter width than the other wall of said [housing] *chamber*.

6. The ink cartridge according to claim **1**, wherein said contacts connecting said semiconductor storage device are disposed substantially in parallel with said second wall which is perpendicular to said first wall of said [housing] *chamber*.

9. An ink cartridge for mounting on a [cartridge] *carriage* of an ink jet printing apparatus and for supplying ink to a printhead of said ink jet printing apparatus through an ink supply needle, the ink cartridge comprising:

a plurality of external walls defining at least some of a chamber;

an ink supply port for receiving said ink supply needle, the ink supply port having an exit opening and a centerline and communicating with the chamber;

a semiconductor storage device storing information about the ink carried by said cartridge; and

a plurality of contacts for connecting said semiconductor storage device to the ink jet printing apparatus, the contacts being formed in a plurality of rows so that one of said rows is closer to said exit opening of said ink supply port than an other of said rows, the row of said contacts which is closest to said exit opening of said ink supply port being longer than the row of said contacts which is furthest from said exit opening of said ink supply port.

13. The ink cartridge according to claim **12**, wherein said semiconductor storage device is located on a center line of said wall of said [housing] *chamber* on which said semiconductor storage device is disposed.

* * * * *

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.

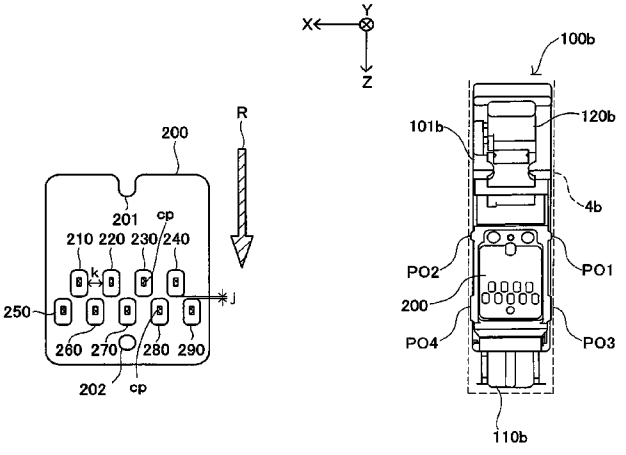
(Continued)

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.

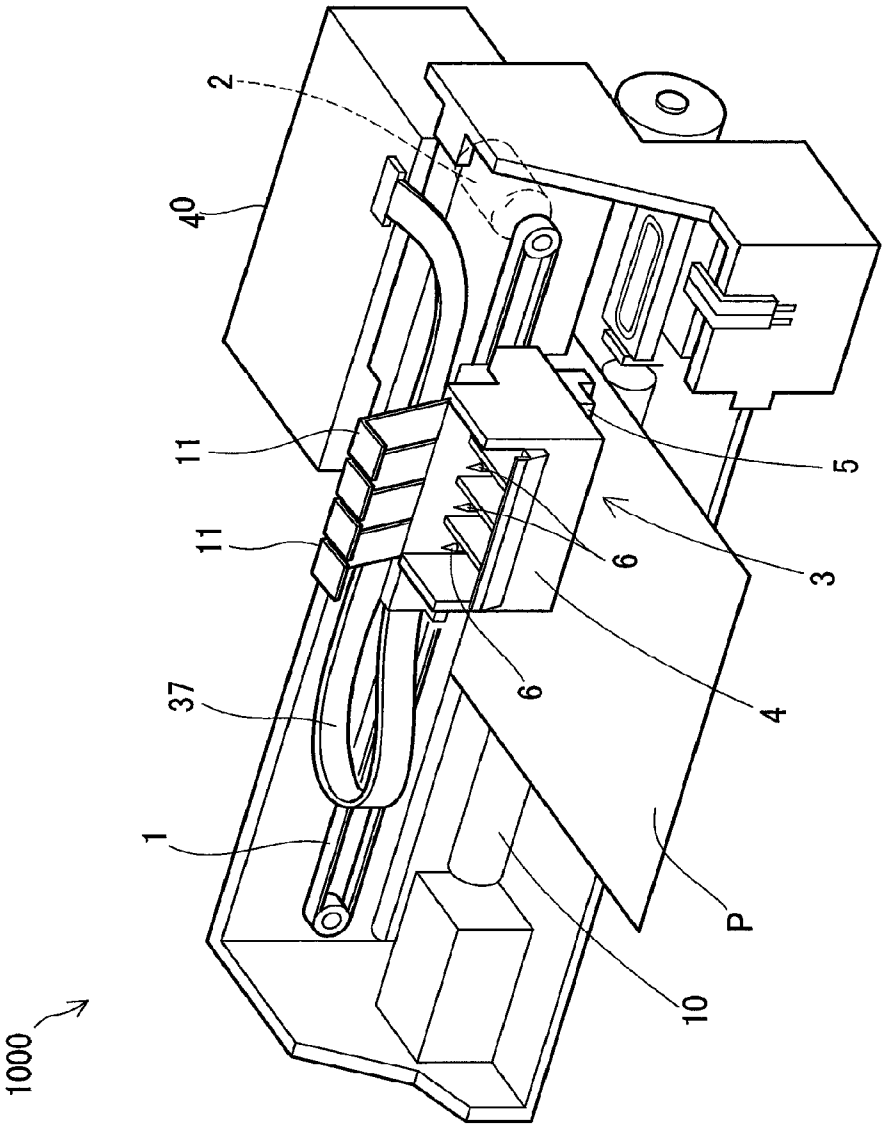


Fig.1

Fig.2

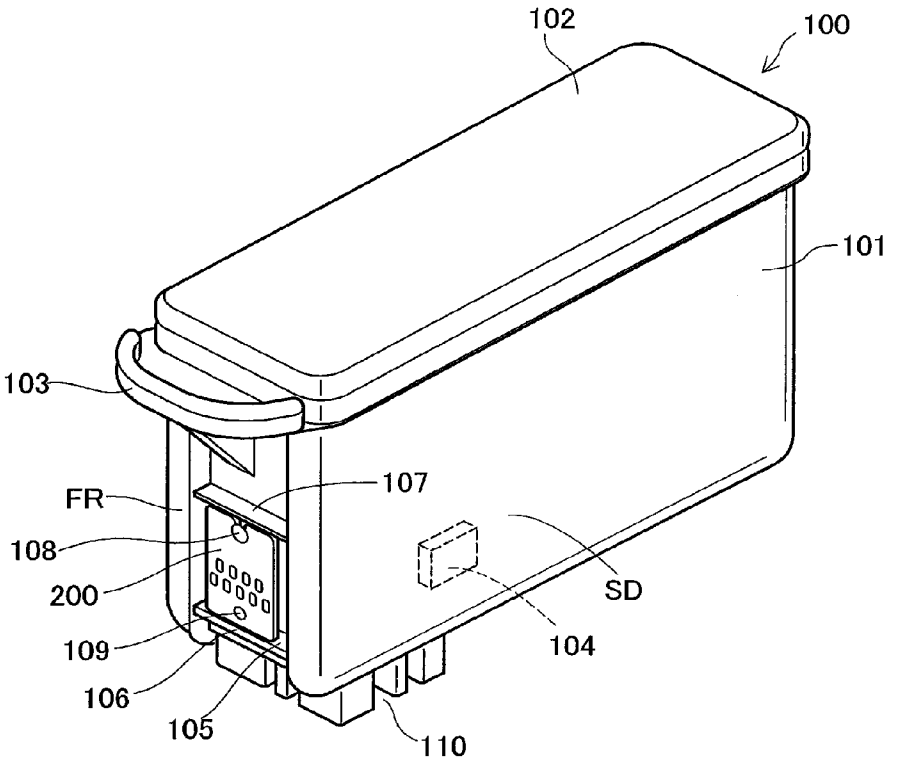


Fig.3A

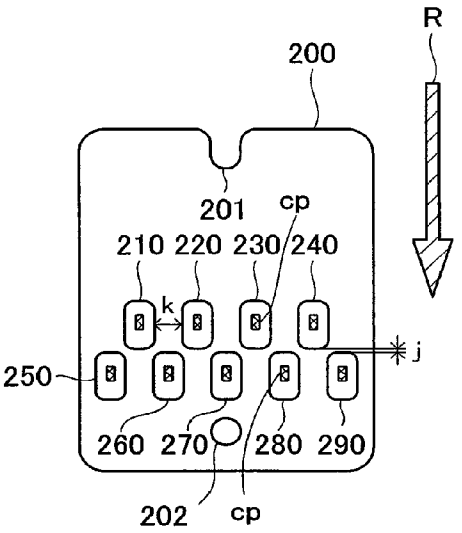


Fig.3B

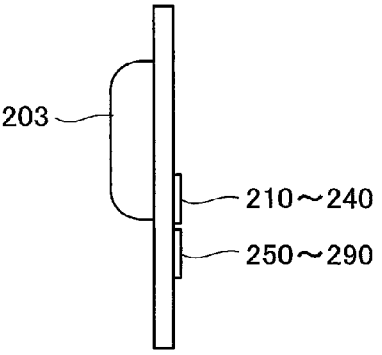
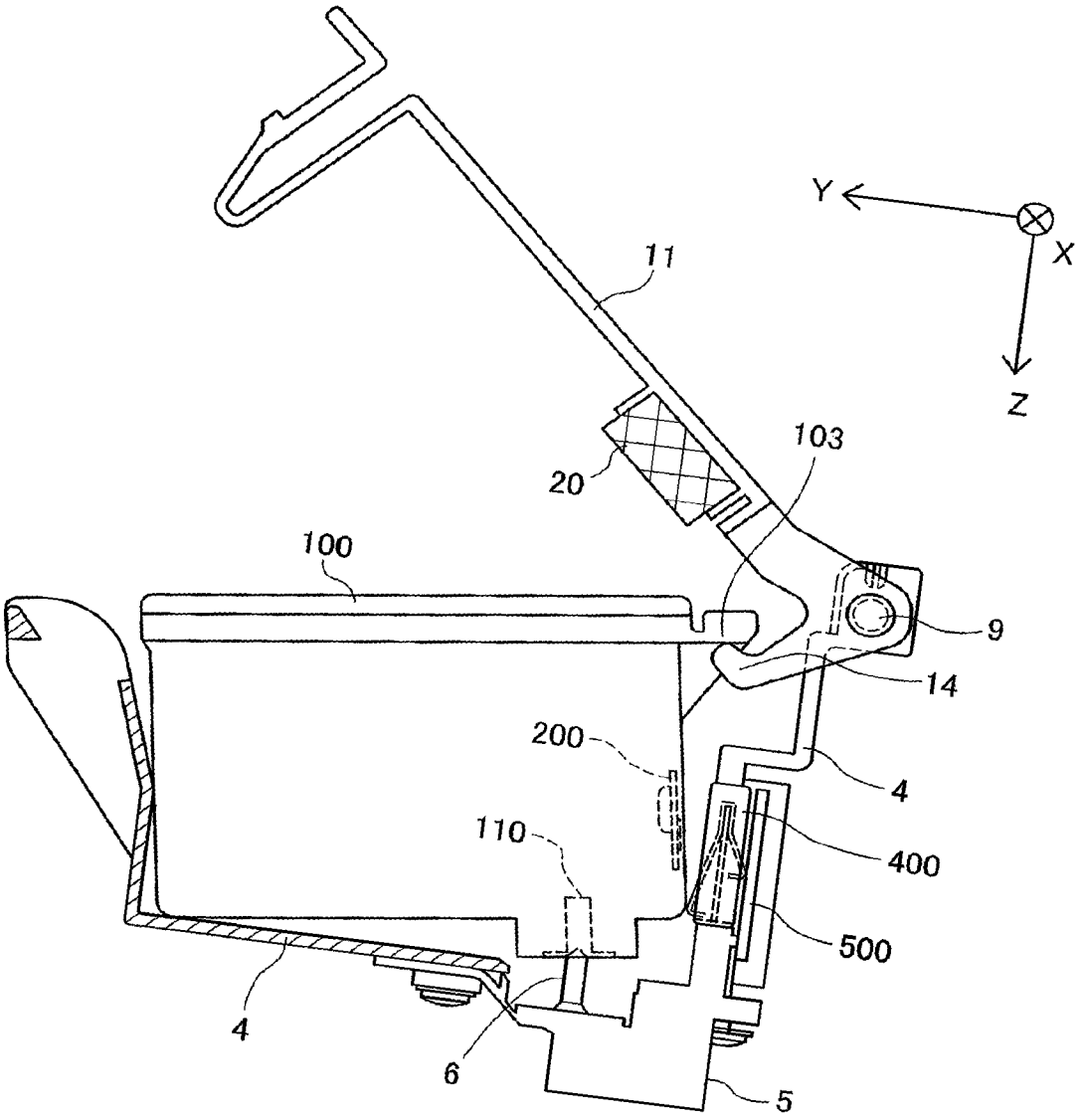


Fig.4



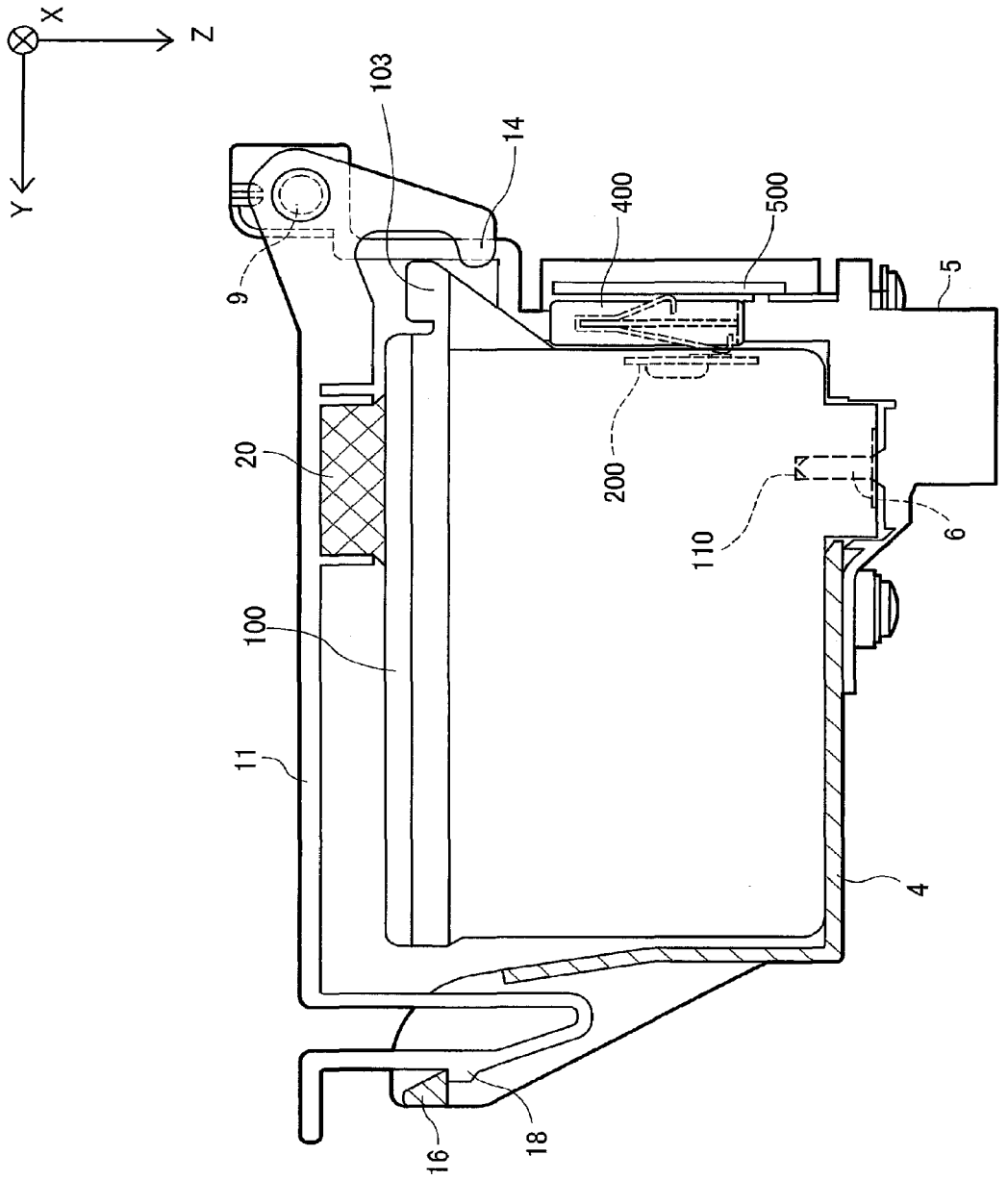


Fig.5

Fig.6A

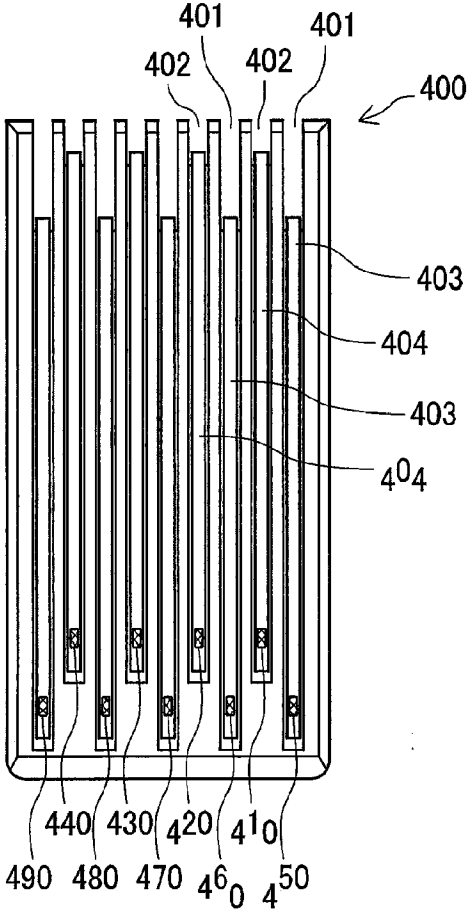

401
401
402
402
400
403
404
403
404
440
430
420
410
490
480
470
460
450

Fig.6B

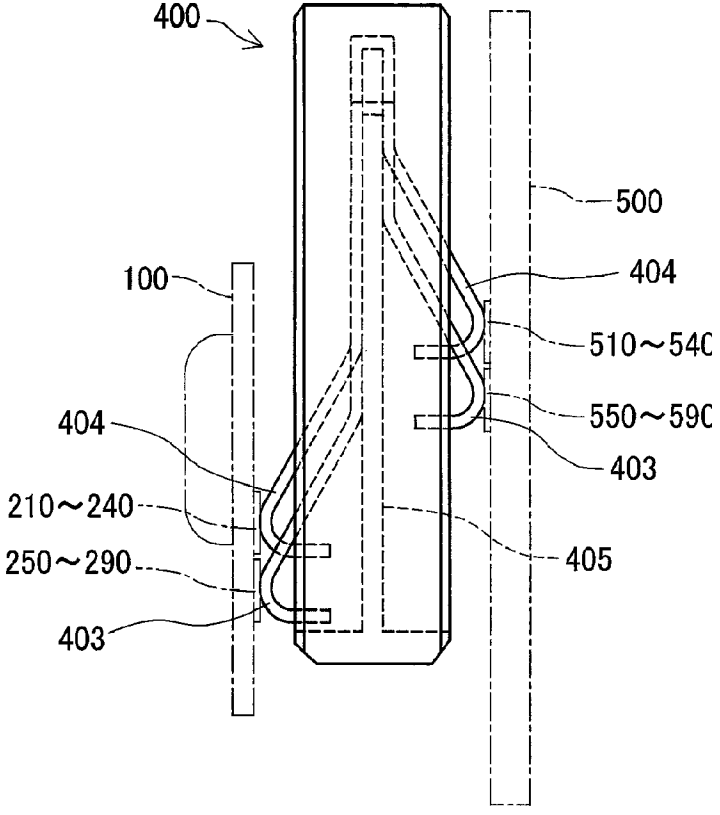

400
500
100
404
510~540
404
550~590
403
210~240
405
250~290
403

Fig.7

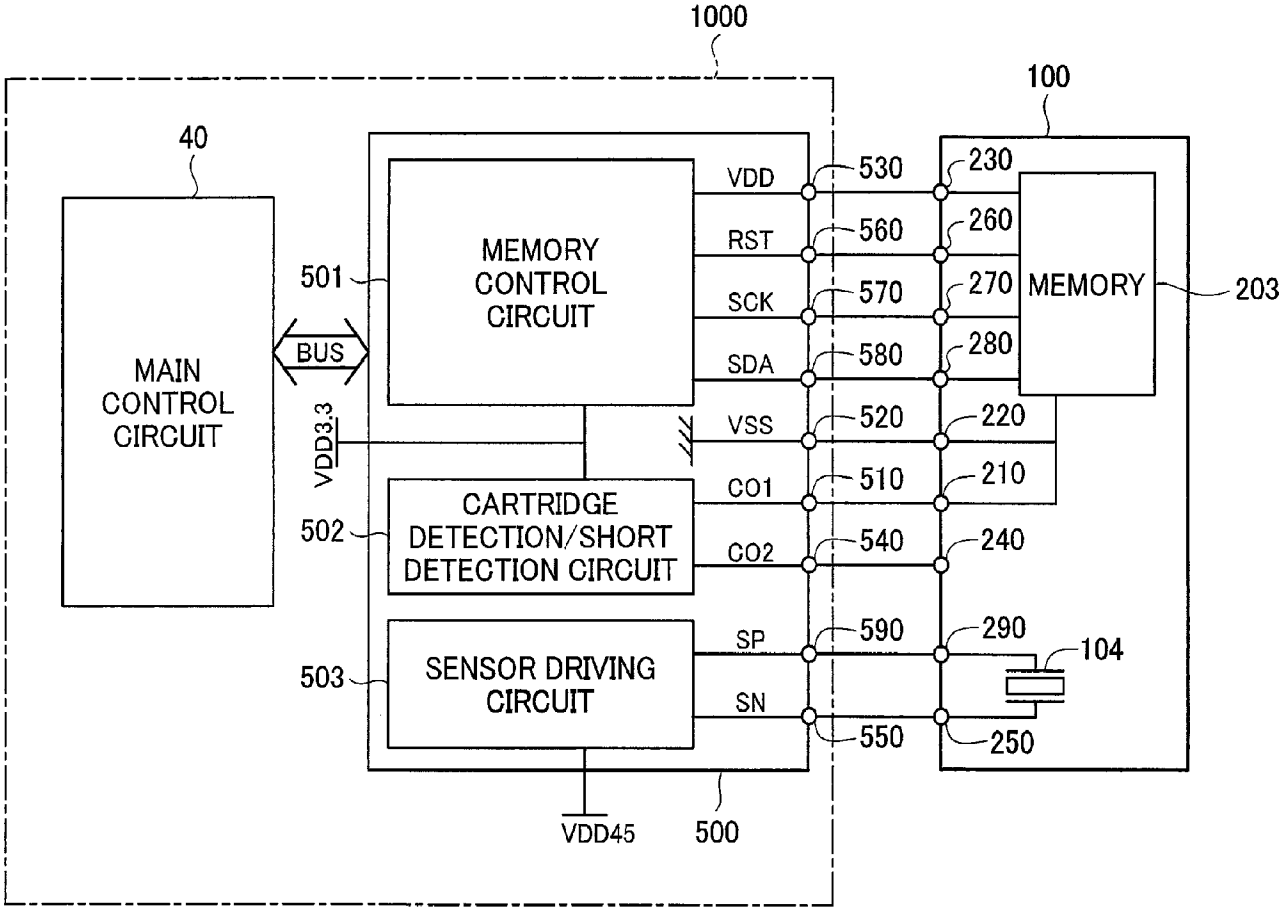

1000
100
40
MAIN CONTROL CIRCUIT
BUS
501
MEMORY CONTROL CIRCUIT
VDD3.3
502
CARTRIDGE DETECTION/SHORT DETECTION CIRCUIT
503
SENSOR DRIVING CIRCUIT
VDD
RST
SCK
SDA
VSS
CO1
CO2
SP
SN
530
560
570
580
520
510
540
590
550
230
260
270
280
220
210
240
290
250
MEMORY
203
104
VDD45
500

Fig.8

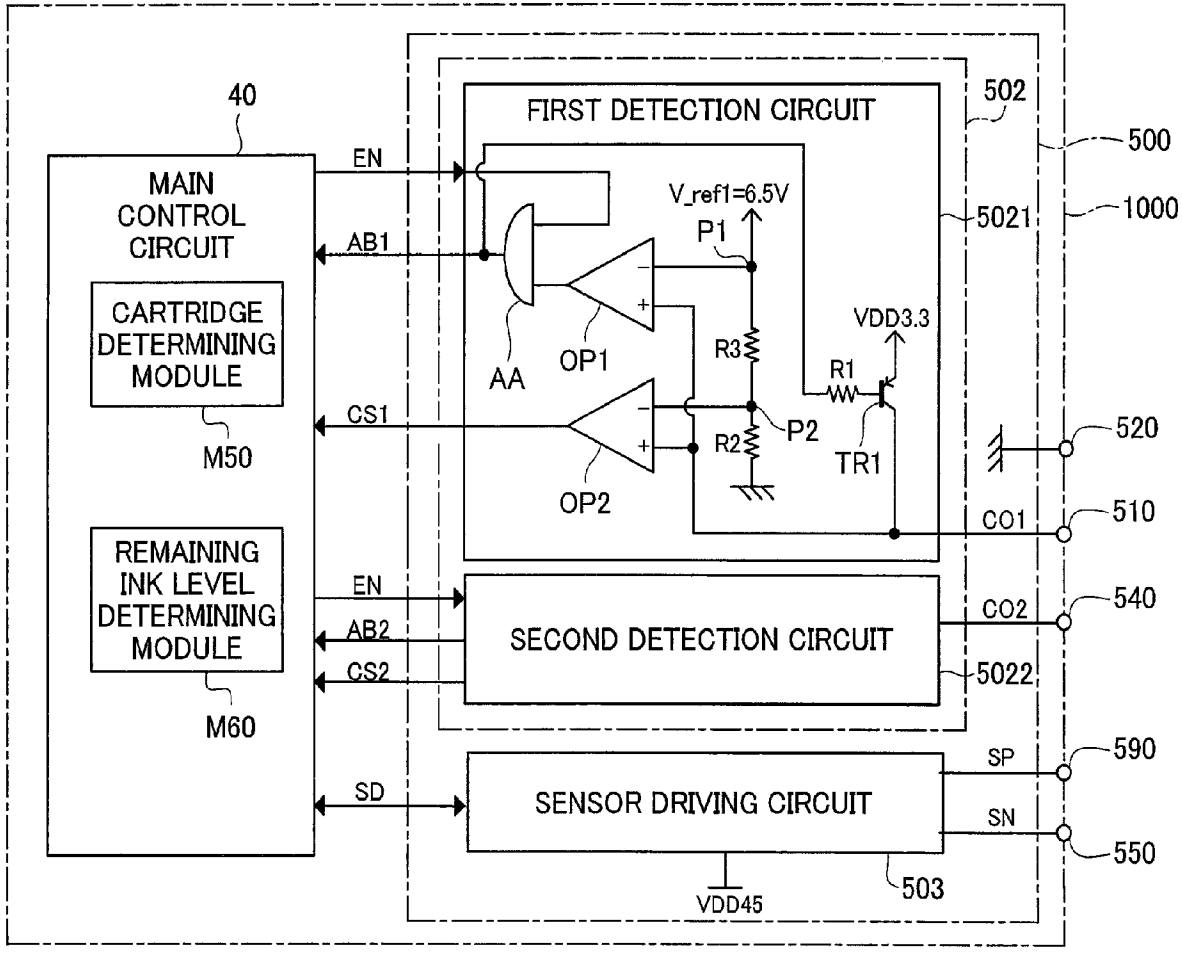

40
MAIN CONTROL CIRCUIT
CARTRIDGE DETERMINING MODULE
M50
REMAINING INK LEVEL DETERMINING MODULE
M60
EN
AB1
CS1
EN
AB2
CS2
SD
FIRST DETECTION CIRCUIT
502
500
1000
5021
V_ref1=6.5V
P1
VDD3.3
R3
R1
AA
OP1
CS1
R2
P2
TR1
OP2
520
CO1
510
SECOND DETECTION CIRCUIT
CO2
540
5022
SP
590
SENSOR DRIVING CIRCUIT
SN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

Fig.9

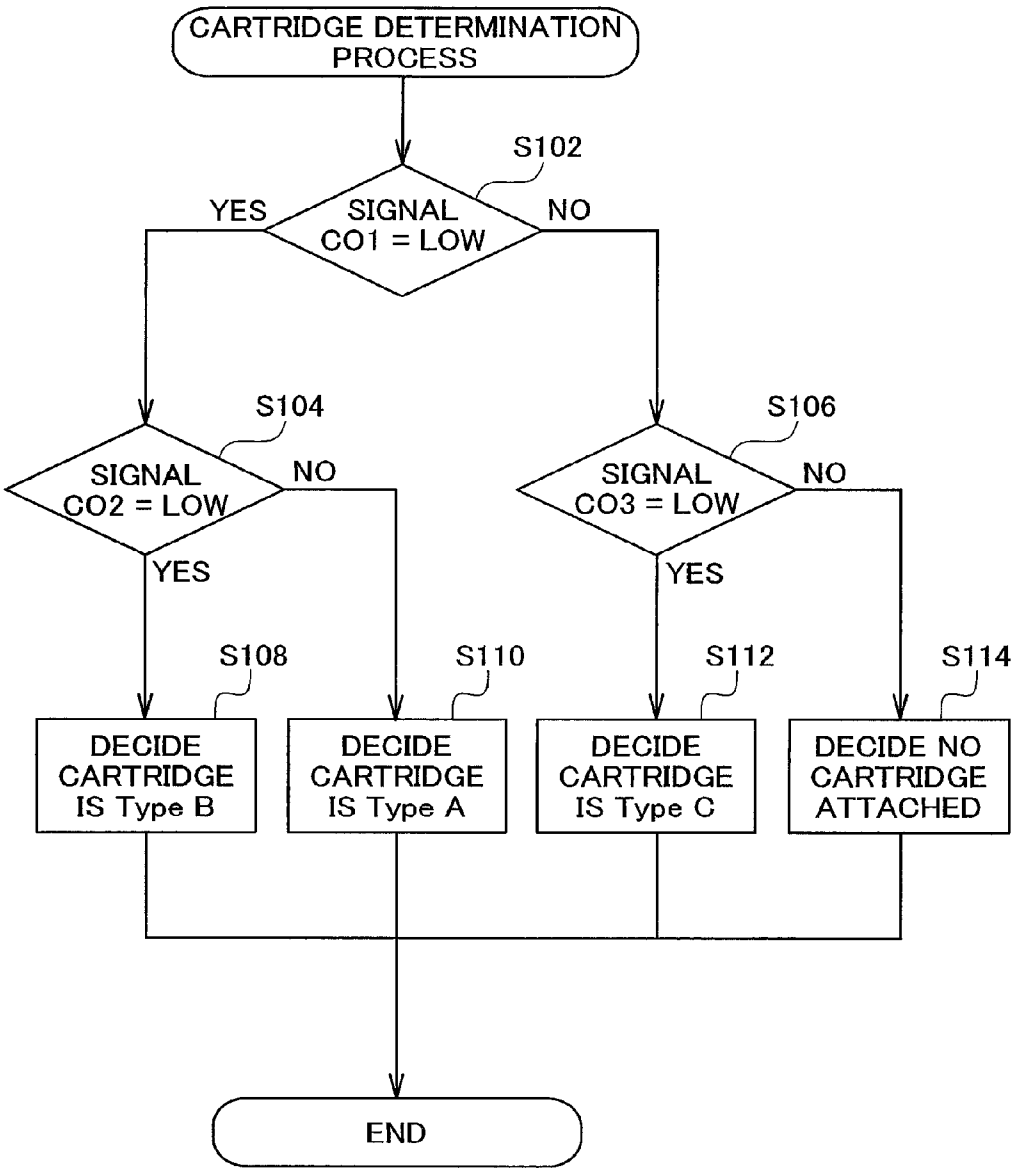
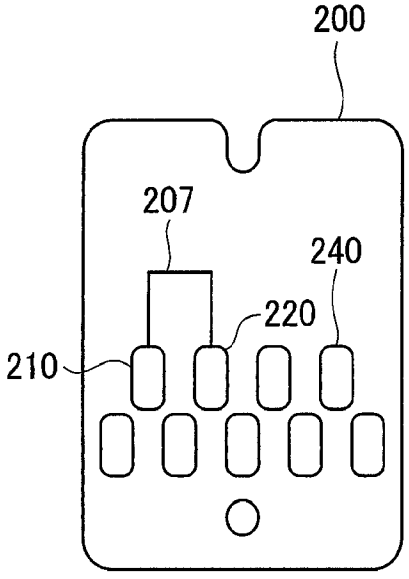
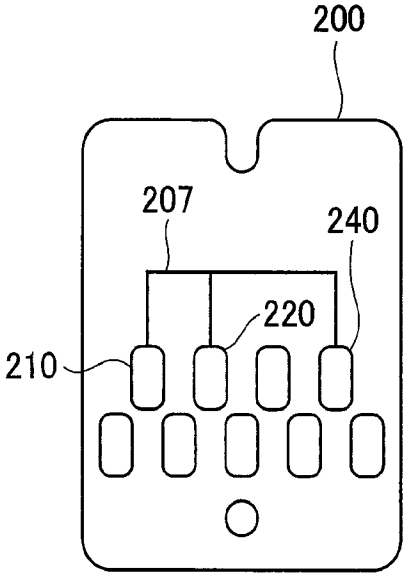

CARTRIDGE DETERMINATION PROCESS
S102
SIGNAL CO1 = LOW
YES
NO
S104
SIGNAL CO2 = LOW
NO
YES
S106
SIGNAL CO3 = LOW
NO
YES
S108
DECIDE CARTRIDGE IS Type B
S110
DECIDE CARTRIDGE IS Type A
S112
DECIDE CARTRIDGE IS Type C
S114
DECIDE NO CARTRIDGE ATTACHED
END

Fig.10A



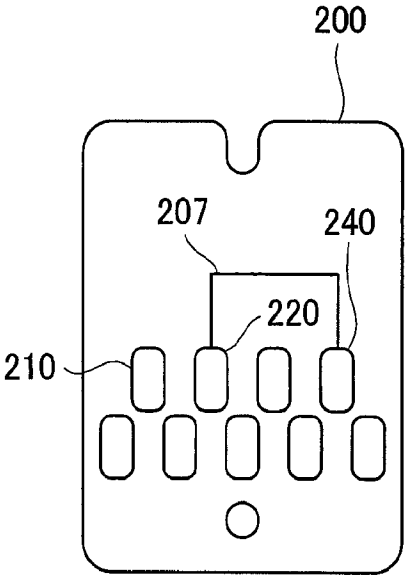
typeA

Fig.10B



typeB

Fig.10C



typeC

Fig.11

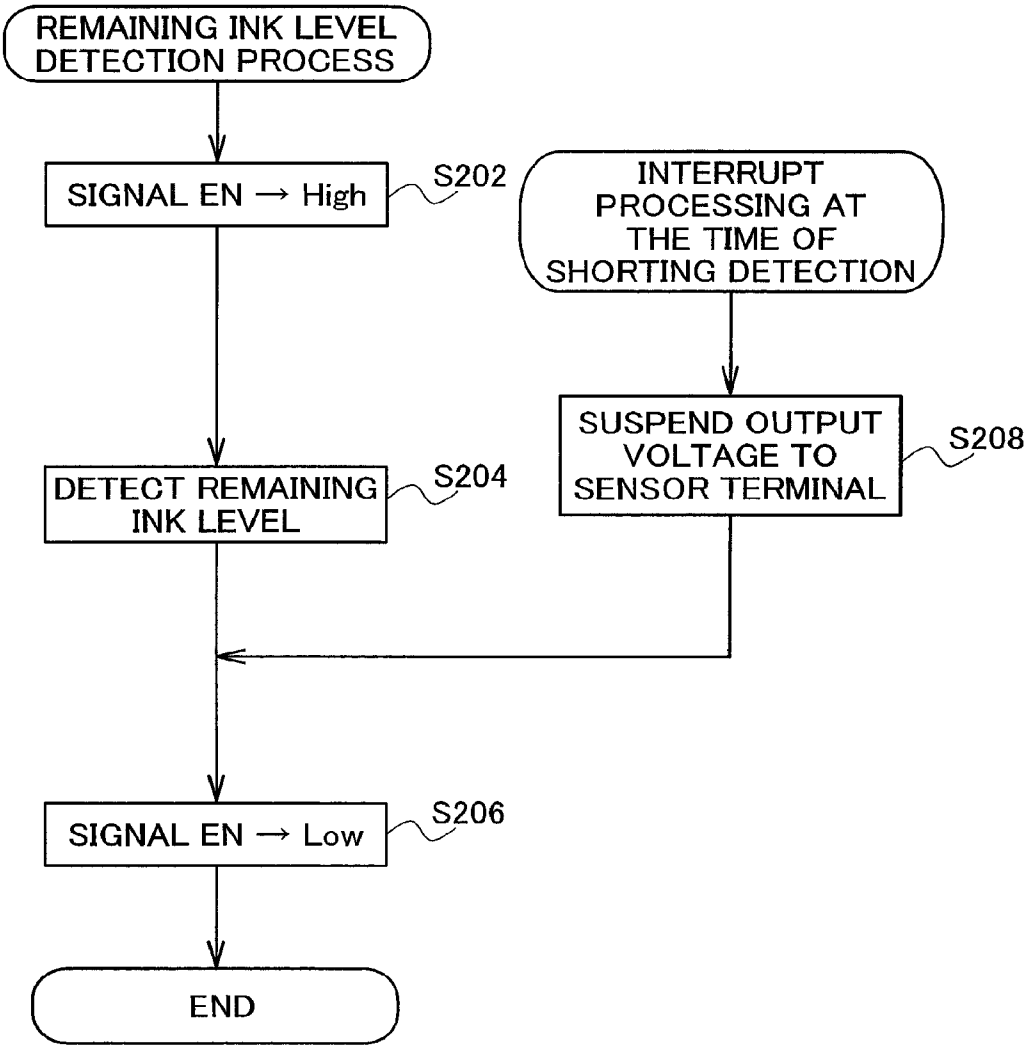

REMAINING INK LEVEL DETECTION PROCESS
SIGNAL EN → High
S202
INTERRUPT PROCESSING AT THE TIME OF SHORTING DETECTION
SUSPEND OUTPUT VOLTAGE TO SENSOR TERMINAL
S208
DETECT REMAINING INK LEVEL
S204
SIGNAL EN → Low
S206
END

Fig.12A

Fig.12B

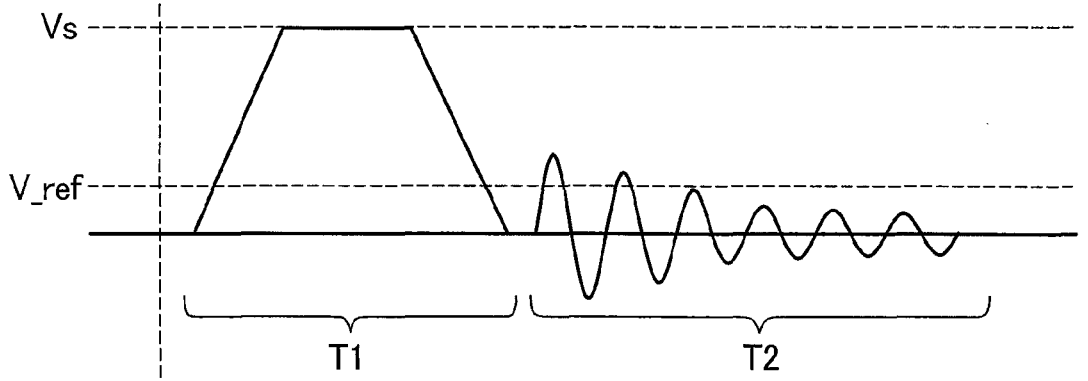


Fig.12C

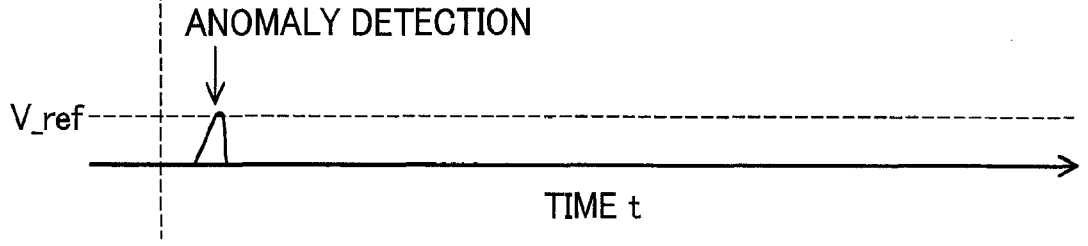


Fig.13

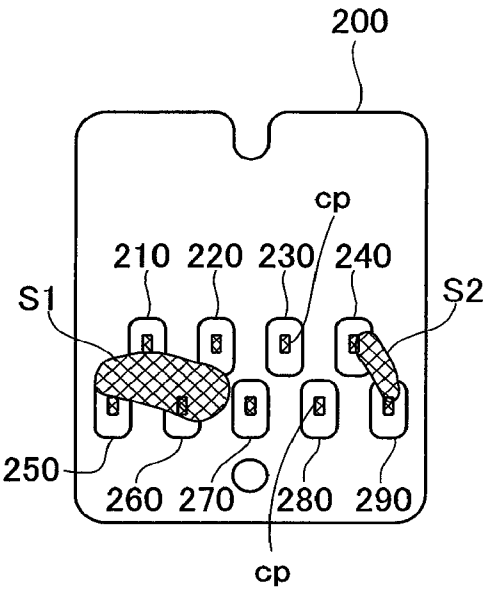


Fig.14A

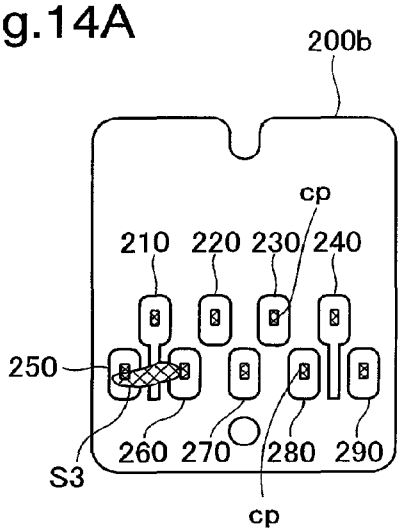


Fig.14B

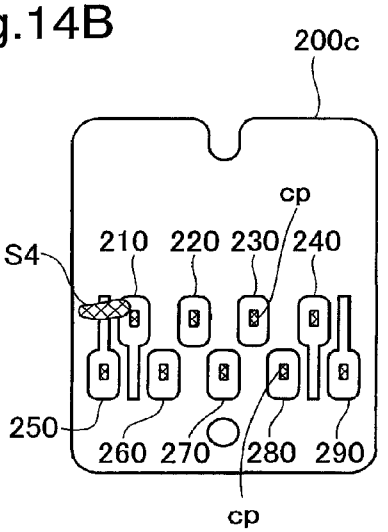


Fig.14C

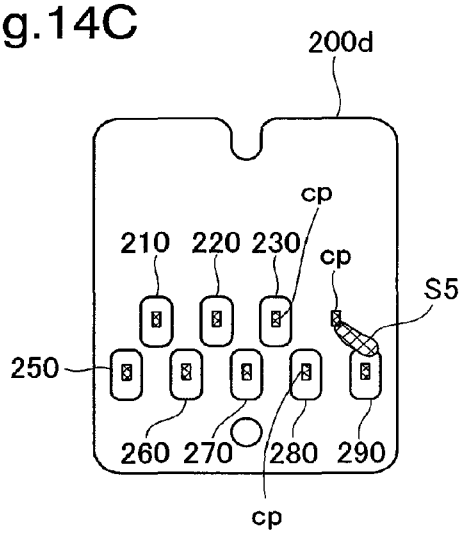


Fig.14D

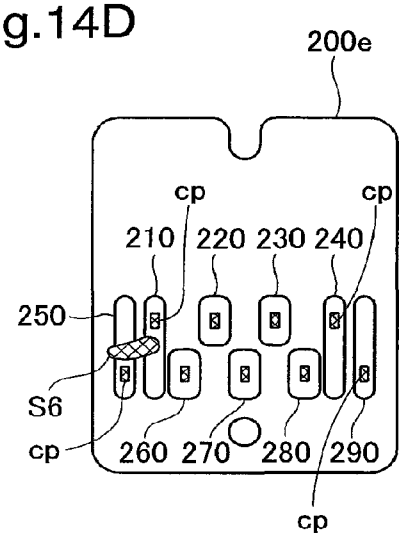


Fig.15A

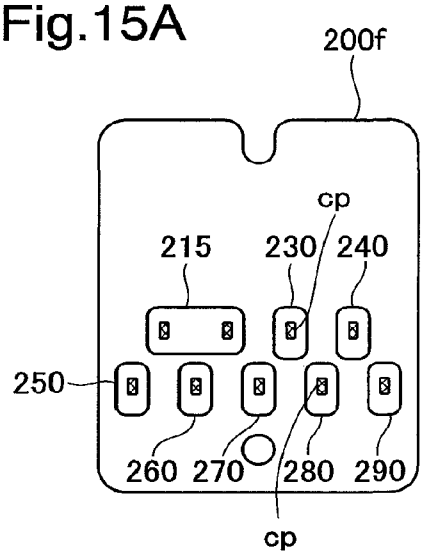


Fig.15B

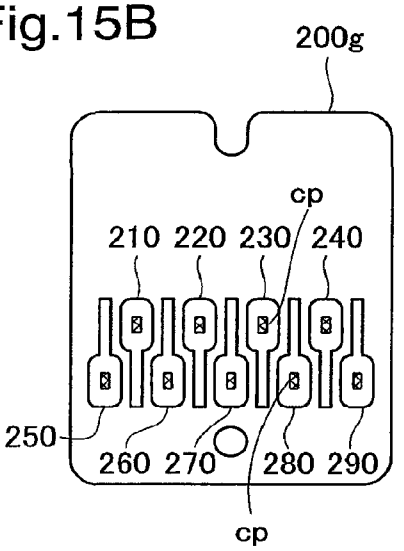


Fig.15C

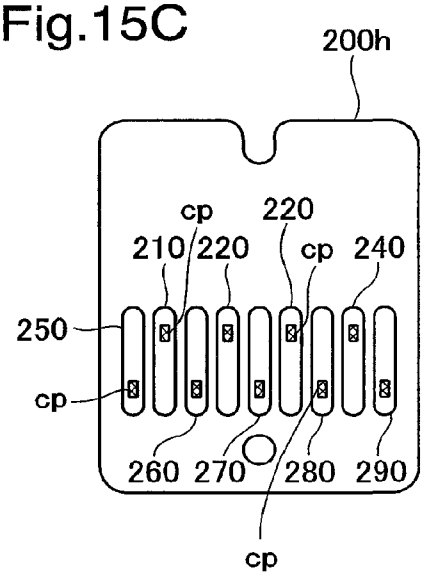


Fig.16A

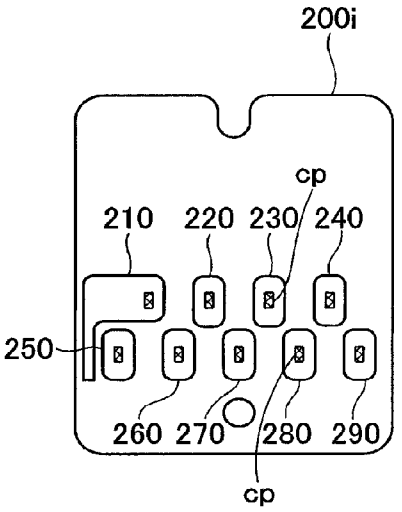


Fig.16B

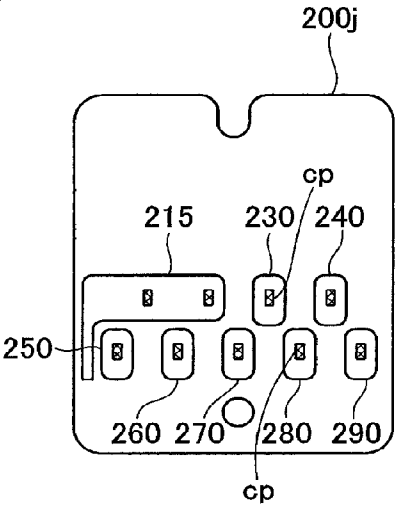


Fig.16C

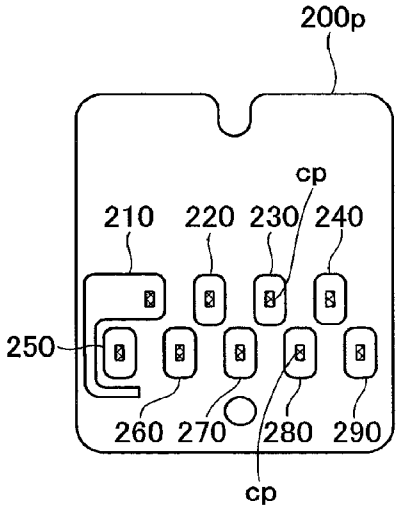


Fig.16D

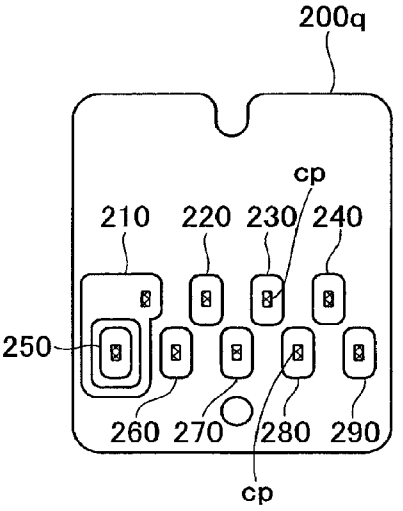


Fig.17A

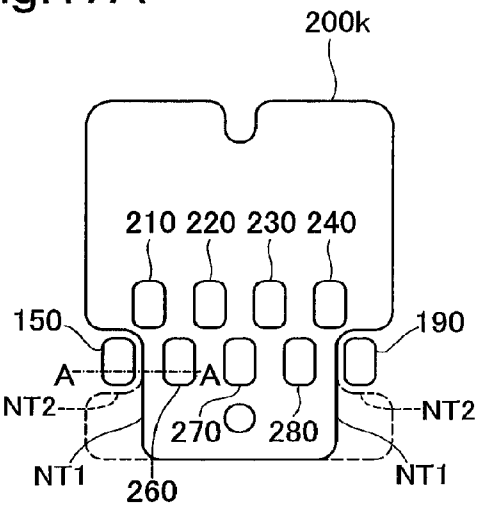


Fig.17B

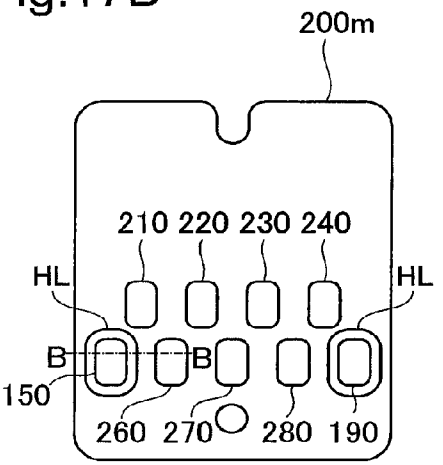


Fig.17C

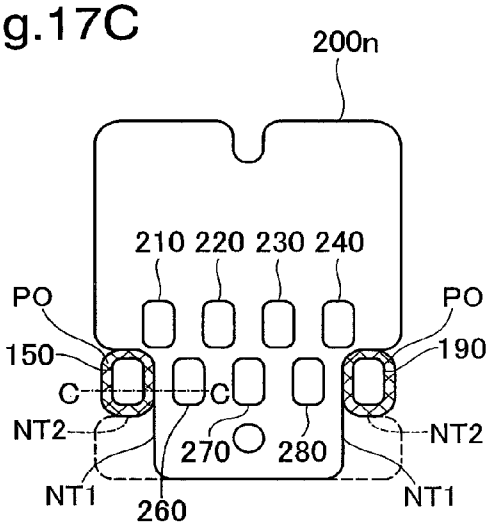


Fig.17D

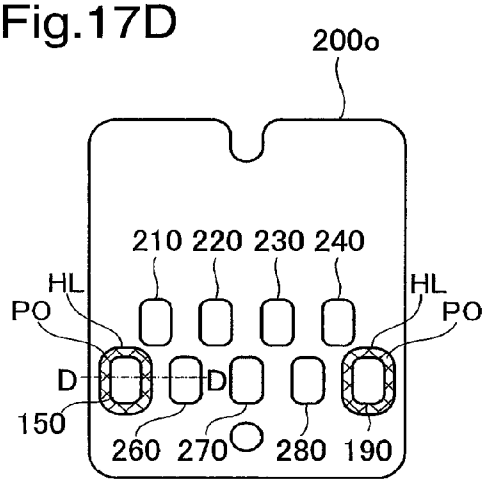


Fig.18A

A-A CROSS SECTION

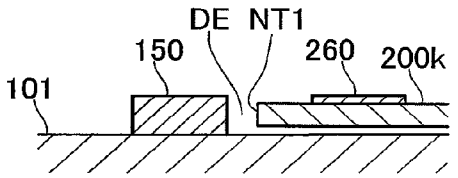


Fig.18B

B-B CROSS SECTION

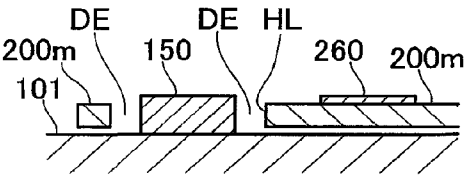


Fig.18C

C-C CROSS SECTION

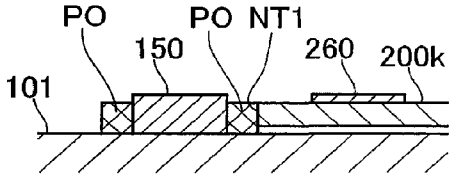


Fig.18D

D-D CROSS SECTION

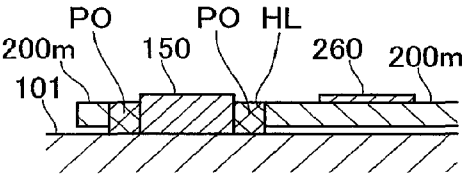


Fig.19A

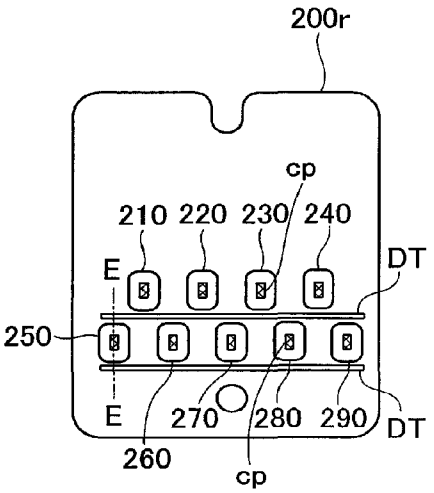


Fig.19B

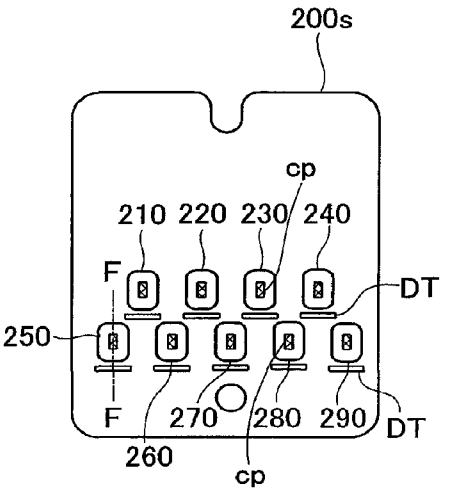


Fig.19C

E-E CROSS SECTION

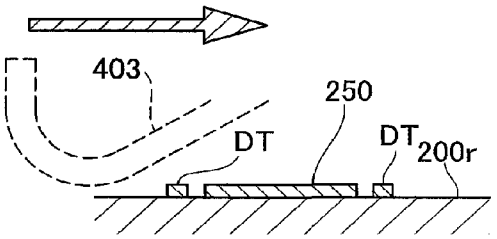
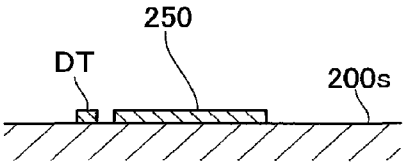


Fig.19D

F-F CROSS SECTION



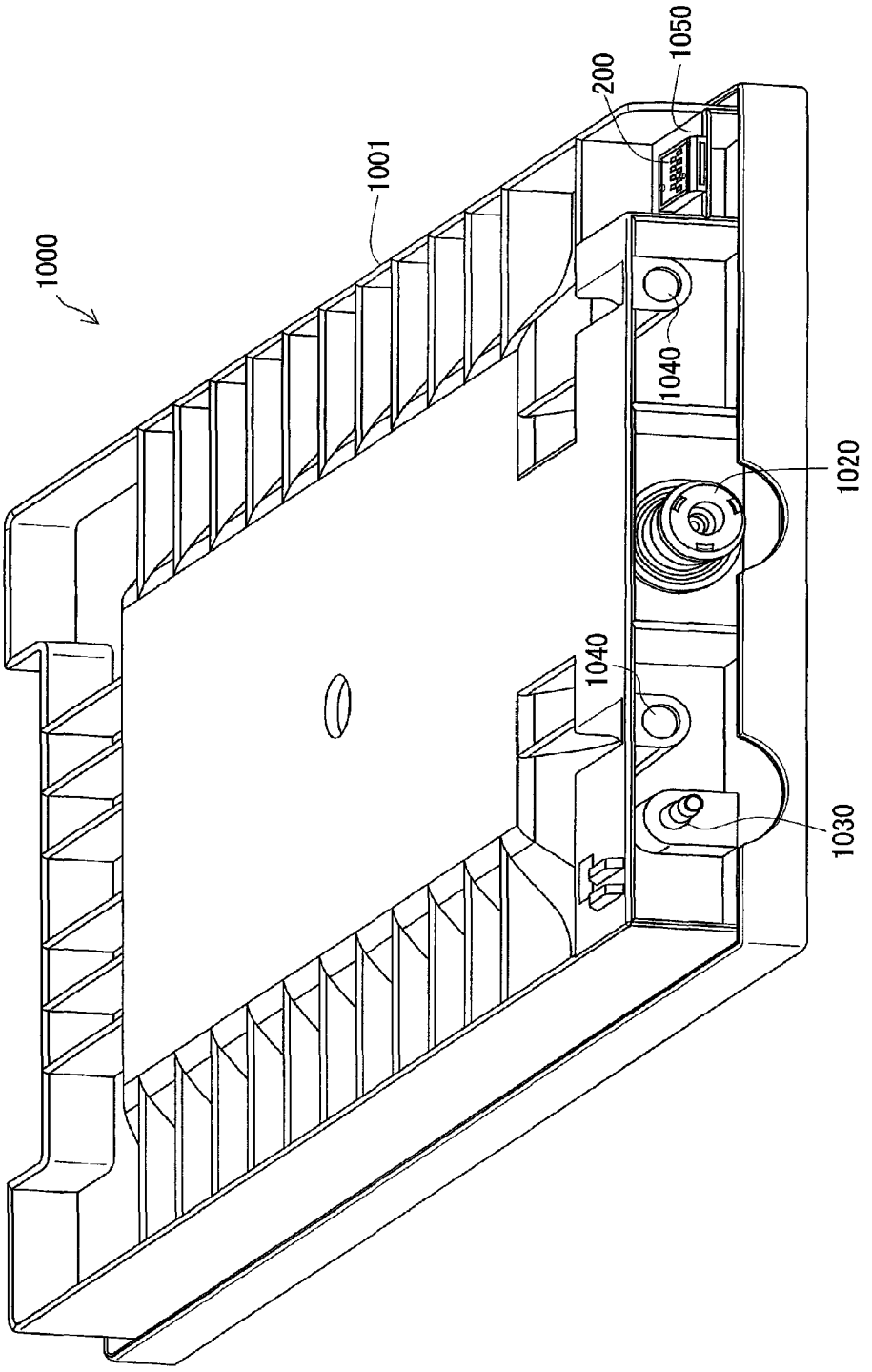


Fig.20

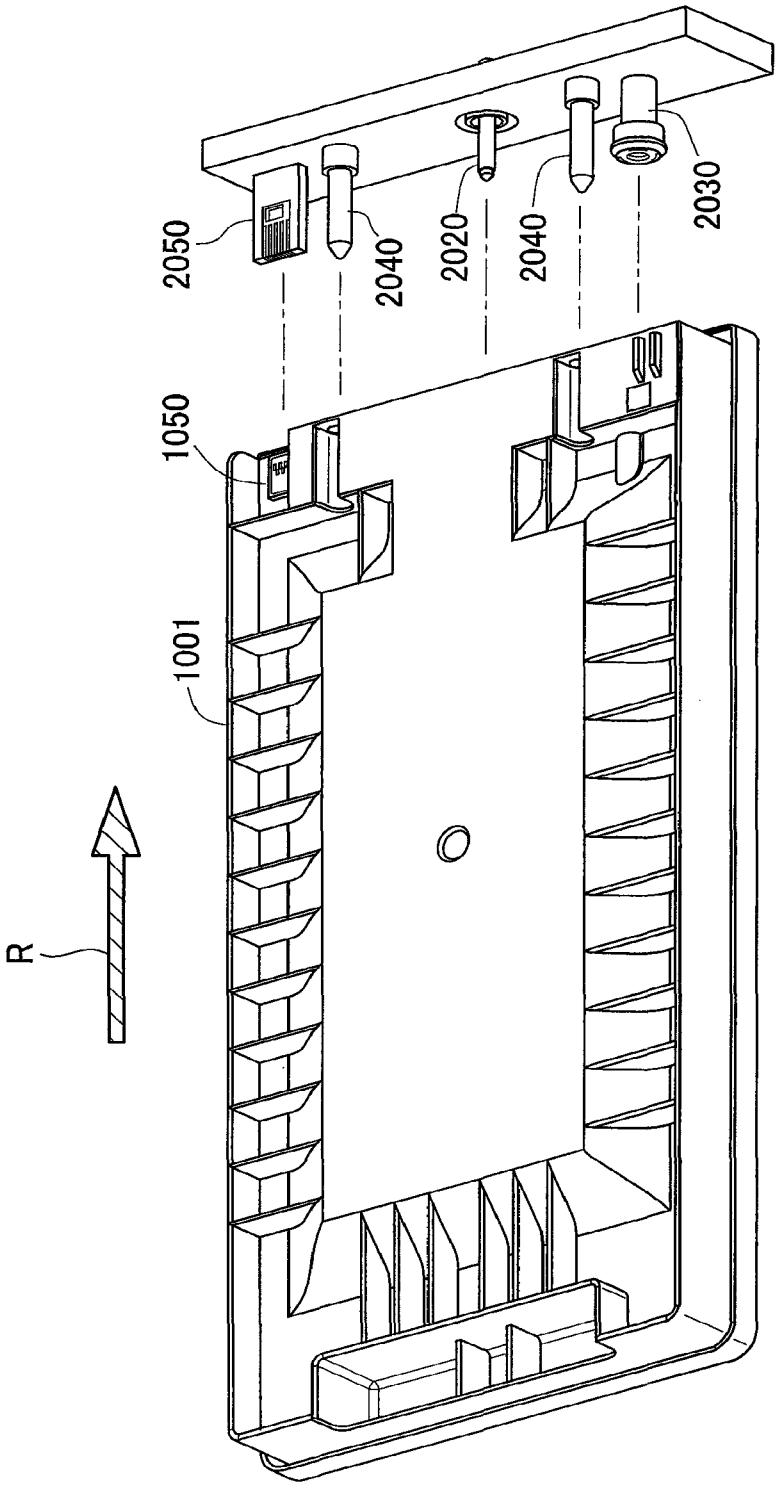


Fig.21

Fig.22

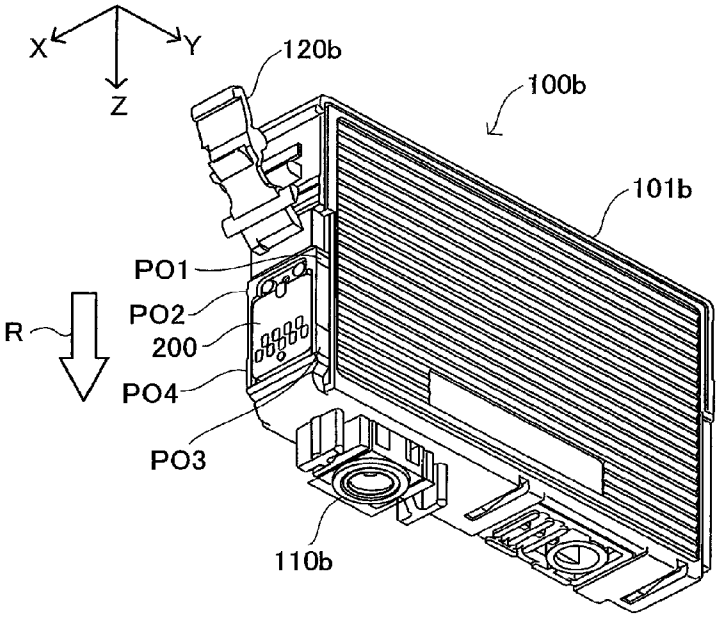

X
Y
Z
120b
100b
101b
PO1
PO2
200
PO4
PO3
R
110b

Fig.23

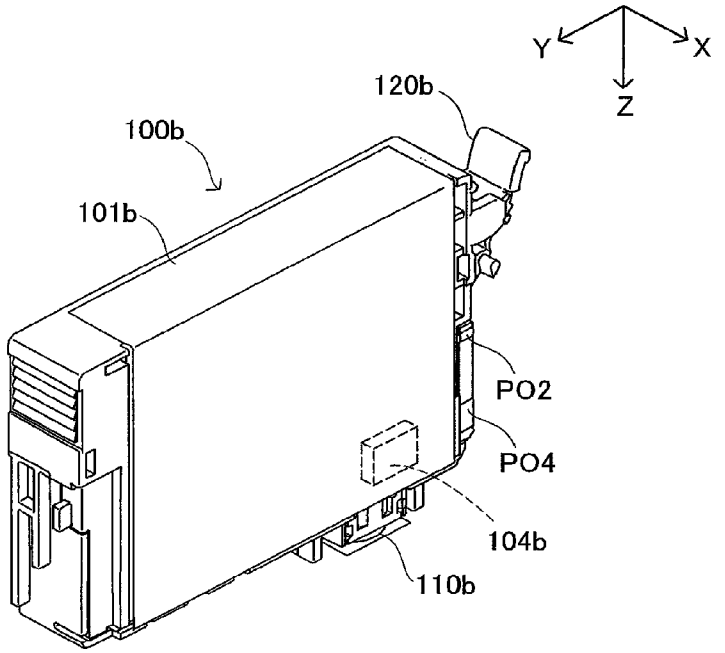
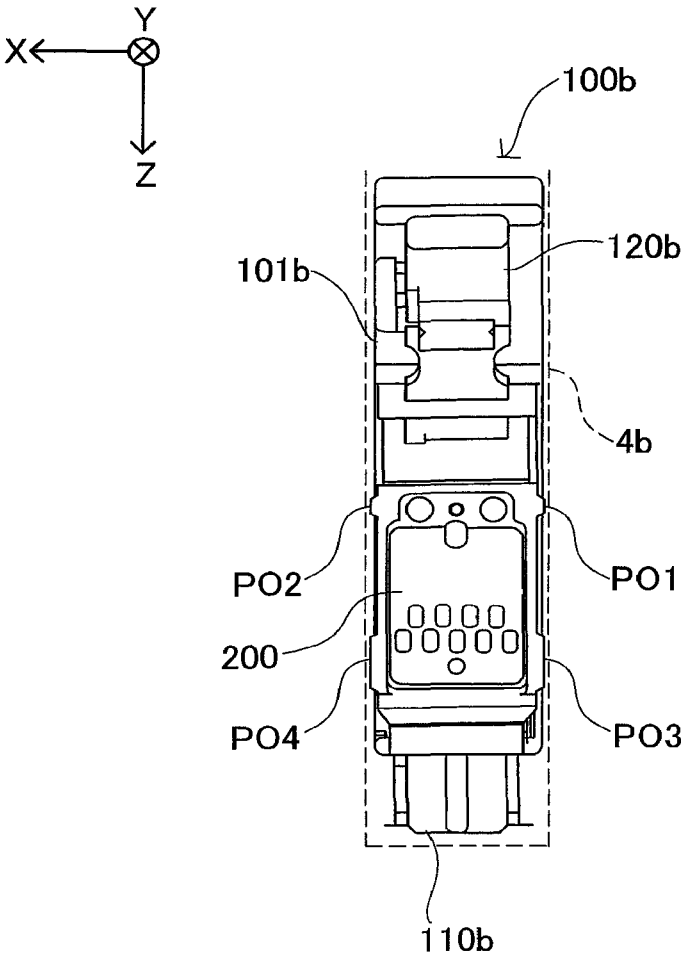

Y
X
Z
120b
100b
101b
PO2
PO4
104b
110b

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.

* * * * *