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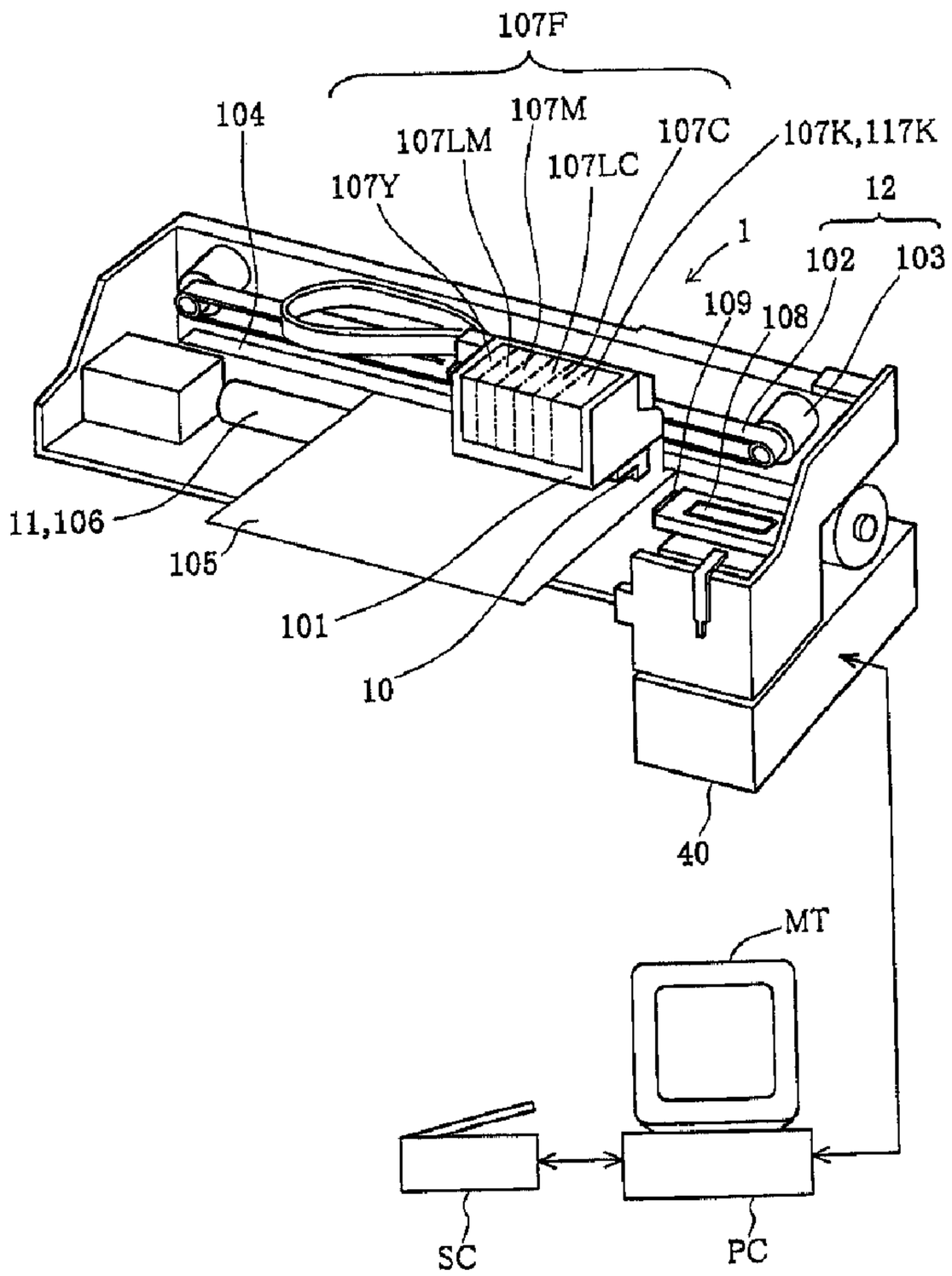

(57) Abrégé/Abstract:
An ink cartridge of the present invention has a storage element, in which plural pieces of specific information relating to an ink cartridge are stored at specific addresses that respectively occupy minimum bits required for storage. Namely the storage

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capacities required for storing the respective pieces of specific information are different from one another. For example, a piece of information on the year of manufacture is registered in a data length of 7 bits, a piece of information on the month of manufacture is registered in a data length of 4 bits, and a piece of information on the date of manufacture is registered in a data length of 5 bits. A piece of information on the time (hour) of manufacture is registered in a data length of 5 bits, and a piece of information on the time (minute) of manufacture is registered in a data length of 6 bits. A piece of information on the validity term of ink is registered in a data length of 6 bits, and a piece of information on the after-unsealed validity term is registered in a data length of 5 bits. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on the manufacture of the ink cartridge and those on remaining quantities of the respective inks, to be stored efficiently into the storage element, while reducing the manufacturing cost of the ink cartridge.

ABSTRACT OF THE DISCLOSURE

An ink cartridge of the present invention has a storage element, in which plural pieces of specific information relating to an ink cartridge are stored at specific addresses that respectively occupy minimum bits required for storage. Namely the storage capacities required for storing the respective pieces of specific information are different from one another. For example, a piece of information on the year of manufacture is registered in a data length of 7 bits, a piece of information on the month of manufacture is registered in a data length of 4 bits, and a piece of information on the date of manufacture is registered in a data length of 5 bits. A piece of information on the time (hour) of manufacture is registered in a data length of 5 bits, and a piece of information on the time (minute) of manufacture is registered in a data length of 6 bits. A piece of information on the validity term of ink is registered in a data length of 6 bits, and a piece of information on the after-unsealed validity term is registered in a data length of 5 bits. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on the manufacture of the ink cartridge and those on remaining quantities of the respective inks, to be stored efficiently into the storage element, while reducing the manufacturing cost of the ink cartridge.

TITLE OF THE INVENTION

INK CARTRIDGE AND PRINTER USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an ink cartridge detachably attached to a printing apparatus like an ink jet printer or an ink jet plotter. More specifically the invention pertains to a technique of processing information relating to the ink cartridge.

Description of the Related Art

The ink jet-type printing apparatus is arranged to cause the printer main body to calculate the remaining quantity of each ink in the ink cartridge based on the amount of ink ejected from the print head and to inform the user of a state of running out of the ink, in order to prevent the printing procedure from being interrupted by the out-of-ink.

One proposed ink cartridge has a storage element, in which various pieces of information relating to ink kept in the ink cartridge, for example, the type of ink and the quantity of ink, are stored. The ink cartridge has these pieces of information regarding ink, and the printer, to which the ink cartridge is attached, reads the stored information regarding ink and carries out the printing procedure suitable for the ink.

The ink cartridge is expendable and thereby required to have as low manufacturing cost as possible. A storage unit having a large storage capacity can thus not be

applied for the storage element of the ink cartridge. There is, however, a contradictory requirement of storing greater pieces of information relating to the ink cartridge into the storage element, in order to enable the user to obtain the detailed information relating to the ink cartridge.

SUMMARY OF THE INVENTION

The object of the present invention is thus to provide an ink cartridge that enables pieces of information relating to the ink cartridge, for example, information on a remaining quantity of each ink, to be stored efficiently in a storage element, while reducing the manufacturing cost of the ink cartridge including the storage element.

The object of the invention is also to provide a printer using such an ink cartridge, a method of writing information relating to the ink cartridge, and a storage unit included in the ink cartridge.

At least part of the above and the other related objects is actualized by an ink cartridge detachably attached to a printer. The ink cartridge includes a storage unit that stores plural pieces of specific information relating to the ink cartridge. The storage unit has a storage area that includes a plurality of memory divisions respectively having minimum storage capacities of bits required for storing the plural pieces of specific information.

In the ink cartridge of the present invention, the storage unit has a storage area including a plurality of

memory divisions, which respectively have minimum storage capacities of bits required for storing the plural pieces of specific information. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on remaining quantities of inks and pieces of information on the year, month, and day of month of manufacture of the ink cartridge, to be stored efficiently into the storage unit, while reducing the manufacturing cost of the ink cartridge.

In accordance with one preferable application of the present invention, the plural pieces of specific information include a piece of information relating to manufacture of the ink cartridge. In one preferable embodiment, the storage area includes a manufacture year memory division, which has a storage capacity of 7 bits and stores a piece of information regarding a year of manufacture of the ink cartridge, a manufacture month memory division, which has a storage capacity of 4 bits and stores a piece of information regarding a month of manufacture of the ink cartridge, and a manufacture day of month memory division, which has a storage capacity of 5 bits and stores a piece of information regarding a date of manufacture of the ink cartridge. In this configuration, the manufacture year memory division, the manufacture month memory division, and the manufacture day of month memory division may be arranged in this sequence in the storage area.

It is preferable that the storage area also includes a manufacture hour memory division, which has a storage capacity of 5 bits and stores a piece of information

regarding an hour of manufacture of the ink cartridge, and a manufacture minute memory division, which has a storage capacity of 6 bits and stores a piece of information regarding a minute of manufacture of the ink cartridge.

It is preferable that the storage area further has a validity term memory division, which has a storage capacity of 6 bits and stores a piece of information regarding a term of validity of ink kept in the ink cartridge, and an after-unsealed validity term memory division, which has a storage capacity of 5 bits and stores a piece of information regarding a term of validity of ink kept in the ink cartridge after unsealing the ink cartridge. In this configuration, the manufacture year memory division, the manufacture month memory division, the manufacture day of month memory division, the manufacture hour memory division, the manufacture minute memory division, the validity term memory division, and the after-unsealed validity term memory division may be arranged in this sequence in the storage area.

In accordance with another preferable application of the present invention, the storage area has an ink quantity information memory division, in which a piece of information relating to a quantity of the ink kept in the ink cartridge is stored, the ink quantity information memory division being located at a specific address that is accessed prior to the memory division in which the piece of information relating to the manufacture of the ink cartridge is stored.

In accordance with still another preferable application of the present invention, the storage unit

includes: an address counter that outputs a count in response to a clock signal output from the printer; and a storage element that has the storage area and is sequentially accessed based on the count output from the address counter.

The present invention is also directed to a method of writing plural pieces of specific information into a storage unit that is included in the ink cartridge having any one of the above configurations and being detachably attached to a printer. The method includes the steps of: generating the plural pieces of specific information, which include a piece of information relating to the ink cartridge; and writing the plural pieces of generated specific information into a plurality of memory divisions that are allocated in the storage unit and respectively have minimum storage capacities of bits required for storing the plural pieces of specific information.

The method of the present invention writes the plural pieces of specific information into a plurality of memory divisions that are allocated in the storage unit to respectively have minimum storage capacities of bits required for storing the plural pieces of specific information. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on remaining quantities of inks and pieces of information on the year, month, and day of month of manufacture of the ink cartridge, to be stored efficiently into the storage unit, while reducing the manufacturing cost of the ink cartridge.

The present invention is further directed to a

printer, to which the ink cartridge having any one of the arrangements discussed above is detachably attached.

The printer of the present invention uses the ink cartridge with the storage unit, which has a storage area including a plurality of memory divisions, which respectively have minimum storage capacities of bits required for storing the plural pieces of specific information. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on remaining quantities of inks and pieces of information on the year, month, and day of month of manufacture of the ink cartridge, to be stored efficiently into the storage unit, while reducing the manufacturing cost of the ink cartridge.

The present invention is also directed to a storage unit that is included in an ink cartridge. The ink cartridge is detachably attached to a printer and is read and written by the printer. The storage unit has a storage area that includes a plurality of memory divisions respectively having minimum storage capacities of bits required for storing a plural pieces of specific information.

The storage unit of the present invention included in an ink cartridge has a storage area including a plurality of memory divisions, which respectively have minimum storage capacities of bits required for storing the plural pieces of specific information. This arrangement enables the specific information relating to the ink cartridge, for example, pieces of information on remaining quantities of inks and pieces of information on

the year, month, and date of manufacture of the ink cartridge, to be stored efficiently into the storage unit, while reducing the manufacturing cost of the ink cartridge.

In accordance with one preferable application of the present invention, the plural pieces of specific information include a piece of information relating to manufacture of the ink cartridge. In one preferable embodiment, the storage area includes a manufacture year memory division, which has a storage capacity of 7 bits and stores a piece of information regarding a year of manufacture of the ink cartridge, a manufacture month memory division, which has a storage capacity of 4 bits and stores a piece of information regarding a month of manufacture of the ink cartridge, and a manufacture date memory division, which has a storage capacity of 5 bits and stores a piece of information regarding a date of manufacture of the ink cartridge. In this configuration, the manufacture year memory division, the manufacture month memory division, and the manufacture day of month memory division may be arranged in this sequence in the storage area.

It is preferable that the storage area also includes a manufacture hour memory division, which has a storage capacity of 5 bits and stores a piece of information regarding an hour of manufacture of the ink cartridge, and a manufacture minute memory division, which has a storage capacity of 6 bits and stores a piece of information regarding a minute of manufacture of the ink cartridge.

It is preferable that the storage area further has

a validity term memory division, which has a storage capacity of 6 bits and stores a piece of information regarding a term of validity of ink kept in the ink cartridge, and an after-unsealed validity term memory division, which has a storage capacity of 5 bits and stores a piece of information regarding a term of validity of ink kept in the ink cartridge after unsealing the ink cartridge. In this configuration, the manufacture year memory division, the manufacture month memory division, the manufacture day of month memory division, the manufacture hour memory division, the manufacture minute memory division, the validity term memory division, and the after-unsealed validity term memory division may be arranged in this sequence in the storage area.

In accordance with another preferable application of the present invention, the storage area has an ink quantity information memory division, in which a piece of information relating to a quantity of the ink kept in the ink cartridge is stored, the ink quantity information memory division being located at a specific address that is accessed prior to the memory division in which the piece of information relating to the manufacture of the ink cartridge is stored.

In accordance with still another preferable application of the present invention, the storage unit includes: an address counter that outputs a count in response to a clock signal output from the printer; and a storage element that has the storage area and is sequentially accessed based on the count output from the address counter.

These and other objects, features, aspects, and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiment with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view illustrating the structure of a main part of an ink jet printer in one embodiment according to the present invention;

Fig. 2 is a functional block diagram of the ink jet printer shown in Fig. 1;

Fig. 3 is a decomposed perspective view illustrating the structure of a carriage used in the ink jet printer of the embodiment;

Fig. 4 schematically illustrates a connection between a printer main body, a control IC, and storage elements;

Fig. 5 shows a layout of nozzle openings formed on the print head shown in Fig. 1;

Figs. 6A and 6B are perspective views schematically illustrating the structure of an ink cartridge and a cartridge attachment unit of the printer main body, respectively;

Fig. 7 is a sectional view illustrating an attachment state in which the ink cartridge shown in Fig. 6A is attached to the cartridge attachment unit shown in Fig. 6B;

Fig. 8 is a flowchart showing a processing routine executed at a time of power supply to the ink jet printer;

Fig. 9 is a flowchart showing a processing routine

executed at a power-off time of the ink jet printer;

Fig. 10 is a block diagram illustrating the internal structure of the storage elements shown in Fig. 3;

Fig. 11 shows addresses of the control IC seen from the printer main body and the internal data structure (memory map) of the storage element with regard to items of information on the black ink cartridge;

Fig. 12 shows addresses of the control IC seen from the printer main body and the internal data structure (memory map) of the storage element with regard to items of information on the color ink cartridge;

Fig. 13 shows the correlation between the addresses in memory cells of the storage elements and the addresses in the control IC (print controller);

Fig. 14 is a flowchart showing a processing routine executed by the control IC in the course of the reading process from the storage elements;

Fig. 15 is a timing chart on the occasion of the reading process shown in the flowchart of Fig. 14; and

Fig. 16 is a perspective view illustrating the appearance of another ink cartridge as one modification of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[First Embodiment]

(General Structure of Ink Jet-type Printing Apparatus)

Fig. 1 is a perspective view illustrating the structure of a main part of an ink jet printer 1 in one embodiment according to the present invention. The ink jet printer 1 of the embodiment is used in connection with

a computer PC, to which a scanner SC is also connected. The computer PC reads and executes an operating system and predetermined programs to function, in combination with the ink jet printer 1, as an ink jet-type printing apparatus. The computer PC executes an application program on a specific operating system, carries out processing of an input image, for example, read from the scanner SC, and displays a processed image on a CRT display MT. When the user gives a printing instruction after the required image processing, for example, retouching the image on the CRT display MT, is concluded, a printer driver incorporated in the operating system is activated to transfer processed image data to the ink jet printer 1.

The printer driver converts original color image data, which are input from the scanner SC and subjected to the required image processing, to color image data printable by the ink jet printer 1 in response to the printing instruction, and outputs the converted color image data to the ink jet printer 1. The original color image data consists of three color components, that is, red (R), green (G), and blue (B). The converted color image data printable by and output to the ink jet printer 1 consists of six color components, that is, black (K), cyan (C), light cyan (LC), magenta (M), light magenta (LA), and yellow (Y). The printable color image data are further subjected to binary processing, which specifies the on-off state of ink dots. These image processing and data conversion processes are known in the art and are thus not specifically described here. These processes may be carried out in the ink jet printer 1, in place of the printer

driver included in the computer PC.

In the ink jet printer 1, a carriage 101 is connected to a carriage motor 103 in a carriage mechanism 12 via a timing belt 102, and is guided by a guide member 104 to move forward and backward along a width of a sheet of printing paper (printing medium) 105. The ink jet printer 1 also has a sheet feed mechanism 11 with a sheet feed roller 106. An ink jet-type print head 10 is attached to a specific face of the carriage 101 that faces the printing paper 105, that is, a lower face in this embodiment. The print head 10 receives supplies of inks fed from ink cartridges 107K and 107F mounted on the carriage 101, and ejects ink droplets onto the printing paper 105 with a movement of the carriage 101, so as to create dots and print an image or letters on the printing paper 105.

The ink cartridge 107K has an ink chamber 117K, in which black ink (K) is kept. The ink cartridge 107F has a plurality of ink chambers 107C, 107LC, 107M, 107LM, and 107Y, which are formed independently of one another. Cyan ink (C), light cyan ink (LC), magenta ink (M), light magenta ink (LM), and yellow ink (Y) are respectively kept in the ink chambers 107C, 107LC, 107M, 107LM, and 107Y. The print head 10 receives the respective supplies of color inks fed from these ink chambers 107C, 107LC, 107M, 107LM, and 107Y. The print head 10 ejects these color inks in the form of ink droplets of the respective colors, so as to implement color printing.

A capping unit 108 is disposed in a non-printable area (non-storage area) of the ink jet printer 1 to close nozzle openings of the print head 10 while the printing

operation is not carried out. The capping unit 108 effectively prevents an increase in viscosity of ink and formation of an ink film due to vaporization of a solvent component from the ink while the printing operation is not performed. The capping unit 108 also collects ink droplets from the print head 10 occurring by a flushing process during the execution of the printing operation. A wiping unit 109 is disposed near the capping unit 108 to wipe the surface of the print head 10, for example, with a blade, so as to wipe out the ink residue or paper dust adhering to the surface of the print head 10.

Fig. 2 is a functional block diagram of the ink jet printer 1 of the embodiment. The ink jet printer 1 includes a printer main body 100 (main body of the printing apparatus) including a print controller 40 and a print engine 5. The print controller 40 has an interface 43 that receives print data including multi-tone information transmitted from a computer PC, a RAM 44 in which a variety of data, for example, the print data including the multi-tone information, are stored, and a ROM 45 in which routines for various data processing are stored. The print controller 40 further has a controller 46 including a CPU, an oscillator circuit 47, a driving signal generator circuit 48 that generates a driving signal COM given to the print head 10, and a parallel input-output interface 49 that transmits the print data developed to dot pattern data and the driving signal COM to the print engine 5.

Control lines of a panel switch 92 and a power source 91 are also connected to the print controller 40 via the parallel input-output interface 49. When a power OFF is

input from the panel switch 92, the print controller 40 outputs a power down instruction (NMI) to the power source 91, which then falls into a stand-by state. The power source 91 in the stand-by state supplies a stand-by electric power to the print controller 40 via a power line (not shown). Namely the standard power OFF process carried out via the panel switch 92 does not completely cut off the supply of electric power to the print controller 40.

The print controller 40 monitors whether a preset electric power is supplied from the power source 91. The print controller 40 also outputs the power down instruction (NMI) when a power plug is pulled out of a socket. The power source 91 has an auxiliary power unit (for example, a capacitor), in order to ensure a supply of electric power for a predetermined time period (for example, 0.3 sec) after the power plug is pulled out of the socket.

The print controller 40 further includes an EEPROM 90 that stores information regarding the black ink cartridge 107K and the color ink cartridge 107F mounted on the carriage 101 (see Fig. 1). Specific pieces of information including the pieces of information regarding quantities of inks in the black ink cartridge 107K and the color ink cartridge 107F (remaining quantities of inks or amounts of ink consumption) are stored in the EEPROM 90. The details of such information will be discussed later. The print controller 40 also has an address decoder 95 that converts an address in memory cells 81K and 81F (described later) of storage elements 80K and 80F (described later),

to which the controller 46 requires an access (read/write), into a number of clocks.

(Arrangement of Control IC 200)

The print controller 40 is connected to a control IC 200, which controls read and write operations from and to the respective ink cartridges 107K and 107F (storage elements 80K and 80F). The details of the control IC 200 are described with reference to Figs. 3 and 4. Fig. 3 is a decomposed perspective view illustrating the structure of the carriage 101 in the ink jet printer of the embodiment. Fig. 4 schematically illustrates a connection between the printer main body 100, the control IC 200, and the storage elements 80K and 80F.

Referring to Fig. 3, the control IC 200 is provided on and integrated with the print head 10. The control IC 200 comes into contact with the respective storage elements 80K and 80F mounted on the ink cartridges 107K and 107F via contact mechanisms 130 disposed on the carriage 101, and controls the writing operations of specific information according to the requirements. As shown in Figs. 2 and 4, the control IC 200 has a RAM 210, in which data are temporarily kept, and is connected to the print controller 40 via the parallel input-output interface 49 and further to the storage elements 80K and 80F. The control IC 200 is namely interposed between the print controller 40 and the respective storage elements 80K and 80F mounted on the ink cartridges 107K and 107F and controls the data transmission between the print controller 40 and the storage elements 80K and 80F. For convenience of illustration, the print head 10, the

carriage mechanism 12, and the control IC 200 are shown separately in Fig. 2.

The print controller 40 outputs an input signal RxD and a command selection signal SEL and carries out the writing operation of specific information into the control IC 200 at preset time intervals. The specific information are temporarily kept in the RAM 210. The preset time interval here represents every time the printing operation with regard to one page is completed, every time the printing operation with regard to several raster lines is completed, or every time the manual cleaning process is carried out. The specific information includes, for example, pieces of information regarding the remaining quantities of inks, the frequency of cleaning, the frequency of attachment of the ink cartridge, and the total time of attachment. The control IC 200 receives the input signal RxD and the command selection signal SEL and outputs a desired piece of information required by the print controller 40 among pieces of information, which are previously read from the respective storage elements 80K and 80F and stored in the control IC 200, as an output signal TxD to the print controller 40.

In the ink jet printer 1 of the embodiment, the quantity of ink ejection is calculated by multiplying the weight of ink droplets ejected from a plurality of nozzle openings 23 by the frequency of ejection of the ink droplets. The current remaining quantity of ink is determined by subtracting an amount of ink consumption from the previous remaining quantity of ink before the start of the current printing operation. The amount of

ink consumption is the sum of the calculated quantity of ink ejection and a quantity of ink suction. The ink suction is carried out, for example, when some abnormality occurs due to bubbles invading the print head 10. The procedure of ink suction causes the capping unit 108 to be pressed against the print head 10 and thereby close the nozzle openings 23, and sucks ink by means of a pump mechanism (not shown) linked with the capping unit 108 for the purpose of restoration. The controller 46 performs the calculation of the remaining quantity of ink from the data stored in the EEPROM 90 according to a program stored in advance in the ROM 45.

The ink jet printer 1 of the embodiment receives the binary data as described previously. The array of the binary data is, however, not coincident with the nozzle array on the print head 10. The control unit 46 accordingly divides the RAM 44 into three portions, that is, an input buffer 44A, an intermediate buffer 44B, and an output buffer 44C, in order to perform the rearrangement of the dot data array. The ink jet printer 1 may alternatively carry out the required processing for the color conversion and the binarization. In this case, the ink jet printer 1 registers the print data, which include the multi-tone information and are transmitted from the computer PC, into the input buffer 44A via the interface 43. The print data kept in the input buffer 44A are subjected to command analysis and then transmitted to the intermediate buffer 44B. The controller 46 converts the input print data into intermediate codes by supplying information regarding the printing positions of the

respective letters or characters, the type of modification, the size of the letters or characters, and the font address. The intermediate codes are kept in the intermediate buffer 44B. The controller 46 then analyzes the intermediate codes kept in the intermediate buffer 44B and decodes the intermediate codes into binary dot pattern data. The binary dot pattern data are expanded and stored in the output buffer 44C.

In any case, when dot pattern data corresponding to one scan of the print head 10 are obtained, the dot pattern data are serially transferred from the output buffer 44C to the print head 10 via the parallel input-output interface 49. After the dot pattern data corresponding to one scan of the print head 10 are output from the output buffer 44C, the process erases the contents of the intermediate buffer 44B to wait for conversion of a next set of print data.

The print engine 5 has the print head 10, the sheet feed mechanism 11, and the carriage mechanism 12. The sheet feed mechanism 11 successively feeds the printing medium, such as printing paper, to implement sub-scan, whereas the carriage mechanism 12 carries out main scan of the print head 10.

The print head 10 causes the respective nozzle openings 23 to eject ink droplets against the printing medium at a predetermined timing, so as to create an image corresponding to the generated dot pattern data on the printing medium. The driving signal COM generated in the driving signal generator circuit 48 is output to an element driving circuit 50 in the print head 10 via the parallel

input-output interface 49. The print head 10 has a plurality of pressure chambers 32 and a plurality of piezoelectric vibrators 17 (pressure-generating elements) respectively connecting with the nozzle openings 23. The number of both the pressure chambers 32 and the piezoelectric vibrators 17 is thus coincident with the number of the nozzle openings 23. When the driving signal COM is sent from the element driving circuit 50 to a certain piezoelectric vibrator 17, the corresponding pressure chamber 32 is contracted to cause the corresponding nozzle opening 23 to eject an ink droplet.

Fig. 5 shows a layout of the nozzle openings 23 formed on the print head 10. The nozzle openings 23 on the print head 10 are divided into six nozzle arrays of black (K), cyan (C), light cyan (LC), magenta (M), light magenta (LM), and yellow (Y).

(Structure of Ink Cartridge 107 and Cartridge Attachment Unit 18)

The black ink cartridge 107K and the color ink cartridge 107F, which are attached to the ink jet printer 1 having the above configuration, have a common basic structure. The following description regards the structure of the ink cartridges 107K and 107F, the black ink cartridge 107K as an example, and the structure of a cartridge attachment unit 18 of the printer main body 100, which receives and holds the ink cartridge, with reference to Figs. 6A, 6B, and 7.

Figs. 6A and 6B are perspective views schematically illustrating the structure of the ink cartridge 107K and the cartridge attachment unit 18 of the printer main body

100, respectively. Fig. 7 is a sectional view illustrating an attachment state in which the ink cartridge 107K is attached to the cartridge attachment unit 18.

Referring to Fig. 6A, the ink cartridge 107K has a cartridge main body 171 that is composed of a synthetic resin and defines the ink chamber 117K in which black ink is kept, and a storage element 80K incorporated in a side frame 172 of the cartridge main body 171. The storage element 80K carries out transmission of various data to and from the printer main body 100, when the ink cartridge 107K is attached to the cartridge attachment unit 18 of the printer main body 100 shown in Fig. 6B. The storage element 80K is received in a bottom-opened recess 173 formed in the side frame 172 of the ink cartridge 107K. The storage element 80K has a plurality of connection terminals 174 exposed to the outside. Alternatively the whole storage element 80K may be exposed to the outside.

Referring to Fig. 6B, the cartridge attachment unit 18 has an ink supply needle 181, which is disposed upward on a bottom 187 of a cavity, in which the ink cartridge 107K is accommodated. A recess 183 is formed about the ink supply needle 181 to receive an ink supply unit 175 (see Fig. 7) formed in the ink cartridge 107K. Three cartridge guides 182 are set on the inner wall of the recess 183. A connector 186 is placed on an inner wall 184 of the cartridge attachment unit 18. The connector 186 has a plurality of electrodes 185, which electrically connect with the plurality of connection terminals 174 of the storage element 80K when the ink cartridge 107K is attached

to the cartridge attachment unit 18.

The ink cartridge 107K is attached to the cartridge attachment unit 18 according to the following procedure. The procedure first places the ink cartridge 107K on the cartridge attachment unit 18. The procedure then presses down a lever 182, which is fixed to a rear wall 188 of the cartridge attachment unit 18 via a support shaft 191 as shown in Fig. 7, to be over the ink cartridge 107K. The press-down motion of the lever 182 presses the ink cartridge 107K downward, so as to make the ink supply unit 175 fitted into the recess 183 and make the ink supply needle 181 pierce the ink supply unit 175, thereby enabling a supply of ink. As the lever 192 is further pressed down, a clutch 193 disposed on a free end of the lever 192 engages with a mating element 189 disposed on the cartridge attachment unit 18. This fixes the ink cartridge 107K to the cartridge attachment unit 18. In this state, the plurality of connection terminals 174 on the storage element 80K in the ink cartridge 107K electrically connect with the plurality of electrodes 185 on the cartridge attachment unit 18. This enables transmission of data between the printer main body 100 and the storage element 80K via the control IC 200.

The color ink cartridge 107F basically has a similar structure to that of the ink cartridge 107K, and only the difference is described here. The color ink cartridge 107F has five ink chambers in which five different color inks are kept. It is required to feed the supplies of the respective color inks to the print head 10 via separate pathways. The color ink cartridge 107F accordingly has

five ink supply units 175, which respectively correspond to the five different color inks. The color ink cartridge 107F, in which five different color inks are kept, however, has only one storage element 80F incorporated therein. Pieces of information regarding the ink cartridge 107F and the five different color inks are collectively stored in this storage element 80F.

(Operation of Ink Jet Printer 1)

With reference to Figs. 8 and 9, the following describes a series of basic processing carried out by the ink jet printer 1 of the embodiment between a power-on time and a power-off time of the printer 1. Fig. 8 is a flowchart showing a processing routine executed at a time of power supply to the ink jet printer 1. Fig. 9 is a flowchart showing a processing routine executed at a power-off time of the ink jet printer 1.

The controller 46 executes the processing routine of Fig. 8 immediately after the start of power supply. When the power source 91 of the ink jet printer 1 is turned on, the controller 46 first determines whether or not the ink cartridge 107K or 107F has just been replaced at step S30. The decision of step S30 is carried out, for example, by referring to an ink cartridge replacement flag in the case where the EEPROM 90 stores the ink cartridge replacement flag, or in another example, based on data regarding the time (hour and minute) of manufacture or production serial number data with regard to the ink cartridge 107K or 107F. In the case where the power is on without replacement of any ink cartridges 107K and 107F, that is, in the case of a negative answer at step S30, the

controller 46 reads the data from the respective storage elements 80K and 80F of the ink cartridges 107K and 107F at step S31.

When it is determined that the ink cartridge 107K or 107F has just been replaced, that is, in the case of an affirmative answer at step S30, on the other hand, the controller 46 increments the frequency of attachment by one and writes the incremented frequency of attachment into the storage element 80K or 80F of the ink cartridge 107K or 107F at step S32. The controller 46 then reads the data from the respective storage elements 80K and 80F of the ink cartridges 107K and 107F at step S31. The data read out here are those required by the print controller 40 and include, for example, data regarding the year of manufacture, data regarding the month of manufacture, data regarding the validity term, and data regarding the after-unsealed validity term. The control IC 200 actually executes the reading operation from the storage elements 80K and 80F, which will be described later in detail.

The controller 46 subsequently writes the read-out data at preset addresses in the EEPROM 90 or in the RAM 44 at step S33. At subsequent step S34, the controller 46 determines whether or not the ink cartridges 107K and 107F attached to the ink jet printer 1 are suitable for the ink jet printer 1, based on the data stored in the EEPROM 90. When suitable, that is, in the case of an affirmative answer at step S34, a printing operation is allowed at step S35. This completes the preparation for printing, and the program exits from the processing routine of Fig. 8. When

not suitable, that is, in the case of a negative answer at step S34, on the contrary, the printing operation is not allowed, and information representing the prohibition of printing is displayed on either the panel switch 92 or the display MT at step S36.

The ink jet printer 1 carries out a predetermined printing process in the case where the printing operation is allowed. The controller 46 calculates the remaining quantities of the respective black and color inks in the course of the predetermined printing process. The current remaining quantity of each ink is determined by subtracting an amount of ink consumption, which is due to a current printing operation, from the previous remaining quantity of ink before the start of the current printing operation. The amount of ink consumption with regard to each ink is the sum of the quantity of ink ejection and the quantity of ink suction consumed by the sucking action described previously. The quantity of ink ejection is calculated, for example, by multiplying the weight of an ink droplet by the frequency of ejection of the ink droplets. The controller 46 writes the calculated latest remaining quantities of the respective inks as the data on the remaining quantities of inks into the EEPROM 90.

The updated remaining quantities of inks are written into the respective storage elements 80K and 80F of the ink cartridges 107K and 107F after the power switch is turned off on the panel switch 92 in the ink jet printer 1.

Referring to the flowchart of Fig. 9, in response to an off-operation of the power switch on the panel switch

92 in the ink jet printer 1, the program first determines whether or not the ink jet printer 1 is in a stand-by state at step ST11. In the case where the ink jet printer 1 is not in the stand-by state at step ST11, the program stops the sequence in progress at step ST12 and returns to step ST11. In the case where the ink jet printer 1 is in the stand-by state at step ST11, on the other hand, the program drives the capping unit 108 to cap the print head 10 at step ST13, and stores the driving conditions of the print head 10 into the EEPROM 90 at step ST14. The driving conditions here include a voltage of the driving signal to compensate for the individual difference of the print head and a condition of correction to compensate for the difference between the respective colors. The program subsequently stores counts on a variety of timers into the EEPROM 90 at step ST15, and stores the contents of a control panel, for example, an adjustment value to correct the misalignment of hitting positions in the case of bi-directional printing, into the EEPROM 90 at step ST16. The program then stores the remaining quantities of the respective black and color inks, which are written in the EEPROM 90, into the respective storage elements 80K and 80F of the black and color ink cartridges 107K and 107F at step ST17. After that, the program cuts the power supply off at step ST18.

(Structure of Storage Elements 80K and 80F)

The internal structure of the storage elements 80K and 80F is described in detail with reference to Figs. 10 through 13. Fig. 10 is a block diagram illustrating the internal structure of the storage elements 80K and 80F

shown in Fig. 3. Fig. 11 shows addresses of the control IC 200 seen from the printer main body 100 and the internal data structure (memory map) of the storage element 80K with regard to items of information on the black ink cartridge 107K. Fig. 12 shows addresses of the control IC 200 seen from the printer main body 100 and the internal data structure (memory map) of the storage element 80F with regard to items of information on the color ink cartridge 107F. Fig. 13 shows the correlation between the addresses in the storage elements 80K and 80F and the addresses in the control IC 200 (the print controller 40).

The black ink cartridge 107K and the color ink cartridge 107F have cavities formed therein to function as the ink chambers and keep black and color inks, and include the storage elements 80K and 80F, respectively. In this embodiment, EEPROMs are applied for the storage elements 80K and 80F. The EEPROMs used for the storage elements 80K and 80F respectively include the memory cells 81K and 81F, read/write controllers 82K and 82F that control reading and writing operations of data from and into the memory cells 81K and 81F, and address counters 83K and 83F that count up on the occasions of the reading and writing operations of data between the printer main body 100 and the memory cells 81K and 81F via the read/write controllers 82K and 82F in response to a clock signal CLK, as shown in the block diagram of Fig. 10. The addresses in the storage elements 80K and 80F are specified by the bit unit. In the specification hereof, the addresses in the storage elements 80K and 80F represent the head addresses or the head bits, in which the corresponding

pieces of information are to be stored.

The data structure of the memory cell 81K of the storage element 80K included in the black ink cartridge 107K is described in detail with reference to Fig. 11. The memory cell 81K (storage element 80K) has addresses 00 through 18, which are allocated to a readable and writable storage area 650, and addresses 28 through 66, which are allocated to a read only storage area 660. In this embodiment, a piece of information on the remaining quantity of black ink is registered at the address 00 in the memory cell 81K having a data length of 8 bits. A piece of information on the frequency of cleaning the print head 10 and a piece of information on the frequency of attachment of the black ink cartridge 107K are registered respectively at the addresses 08 and 10, both having a data length of 8 bits. A piece of information on a total time period of attachment of the ink cartridge 107K is registered at the address 18 having a data length of 16 bits. The data regarding the remaining quantity of black ink is allocated to the head address 00 among the readable and writable addresses 00 through 18. This arrangement enables the data regarding the remaining quantity of black ink to be written preferentially.

The data on the remaining quantity of black ink has an initial value of 100 (expressed by percentage) and gradually decreases to 0 with a progress of execution of the printing process. The remaining quantity of black ink may be replaced by the amount of ink consumption. In the latter case, the amount of ink consumption has an initial value of 0 (expressed by percentage) and gradually

increases to 100 with a progress of execution of the printing process. The printer main body 100 has data regarding the maximum ink capacities in the black and color ink cartridges 107K and 107F. The calculation of the percentage is based on the maximum ink capacity data and actual amounts of ink consumption. Alternatively the maximum ink capacities may be stored in the storage elements 80K and 80F of the respective ink cartridges 107K and 107F.

In the case where the amounts of ink consumption are used in place of the remaining quantities of inks, data on the amount of ink consumption may take an initial value in a range of 0 to 90%. Data with no initial values written therein are generally indefinite. Writing the initial value in the range of 0 to 90% into the data ensures the accurate monitor of ink consumption. This arrangement also enables the secure determination of whether or not the quantity of ink kept in the ink cartridge is measured on the assumption that adequate correction is carried out during the use of the ink cartridge. Setting the maximum value of the data on the amount of ink consumption equal to 90% effectively prevents ink from running out in the course of the printing procedure.

In the case of a half-sized ink cartridge, which has half the ink capacity of a standard-sized ink cartridge, data on the remaining quantity of ink or data on the amount of ink consumption may take an initial value of 50 (expressed by percentage). An alternative technique sets 100 to the initial value of the data on the remaining quantity of ink or 0 to the initial value of the data on

the amount of ink consumption, and doubles the decreasing rate or the increasing rate. The latter technique enables the remaining quantities of inks to be monitored on the identical scale when both the standard-sized ink cartridge and the half-sized ink cartridge are attachable to the printer.

Pieces of information relating to the manufacture of the black ink cartridge 107K are stored at specific addresses that respectively occupy minimum bits required for storage (storage capacities). Namely the storage capacities required for storing the respective pieces of information are different from one another. For example, a piece of information on the year of manufacture is registered at the address 28 having a data length of 7 bits, a piece of information on the month of manufacture is registered at the address 2F having a data length of 4 bits, and a piece of information on the day of manufacture is registered at the address 33 having a data length of 5 bits. A piece of information on the time (hour) of manufacture is registered at the address 38 having a data length of 5 bits, a piece of information on the time (minute) of manufacture is registered at the address 3D having a data length of 6 bits, and a piece of information on the production serial number is registered at the address 43 having a data length of 8 bits. A piece of information on the frequency of recycle, a piece of information on the validity term of ink, and a piece of information on the after-unsealed validity term are respectively registered at the address 4B having a data length of 3 bits, at the address 60 having a data length of 6 bits, and at the address

66 having a data length of 5 bits.

The data structure of the memory cell 81F of the storage element 80F included in the color ink cartridge 107F is described in detail with reference to Fig. 12. The memory cell 81F (storage element 80F) has addresses 00 through 38, which are allocated to a readable and writable storage area 750, and addresses 48 through 86, which are allocated to a read only storage area 760. Pieces of information on the remaining quantities of cyan ink, magenta ink, yellow ink, light cyan ink, and light magenta ink are registered at the addresses 00, 08, 10, 18, and 20 in the memory cell 81F, each having a data length of 8 bits.

A piece of information on the frequency of cleaning the print head 10 and a piece of information on the frequency of attachment of the color ink cartridge 107F are registered respectively at the addresses 28 and 30, both having a data length of 8 bits. A piece of information on a total time period of attachment of the ink cartridge 107F is registered at the address 38 having a data length of 16 bits. The data regarding the remaining quantities of the respective color inks are allocated to the head addresses 00 through 20 among the readable and writable addresses 00 through 38. This arrangement enables the data regarding the remaining quantities of the respective color inks to be written preferentially. The pieces of information regarding the remaining quantities of cyan, magenta, and yellow inks are allocated to the first 3 bytes (24 bits), and the pieces of information regarding the remaining quantities of light cyan and light magenta inks

are allocated to the following 2 bytes (16 bits). This data structure is thus applicable to a color ink cartridge having only three colors, cyan, magenta, and yellow.

The data on the remaining quantity of each color ink has an initial value of 100 (expressed by percentage) and gradually decreases to 0 with a progress of execution of the printing process. The remaining quantity of each color ink may be replaced by the amount of ink consumption. In the latter case, the amount of ink consumption has an initial value of 0 (expressed by percentage) and gradually increases to 100 with a progress of execution of the printing process. The arrangement of the data on the remaining quantities of the respective color inks are similar to the arrangement of the data on the remaining quantity of black ink and is thus not specifically described here.

Pieces of information relating to the manufacture of the color ink cartridge 107F are stored at specific addresses that respectively occupy minimum bits required for storage (storage capacities). Namely the storage capacities required for storing the respective pieces of information are different from one another. For example, a piece of information on the year of manufacture is registered at the address 48 having a data length of 7 bits, a piece of information on the month of manufacture is registered at the address 4F having a data length of 4 bits, and a piece of information on the day of month of manufacture is registered at the address 53 having a data length of 5 bits. A piece of information on the time (hour) of manufacture is registered at the address 58 having a data length of

5 bits, a piece of information on the time (minute) of manufacture is registered at the address 5D having a data length of 6 bits, and a piece of information on the production serial number is registered at the address 63 having a data length of 8 bits. A piece of information on the frequency of recycle, a piece of information on the validity term of inks, and a piece of information on the after-unsealed validity term are respectively registered at the address 6B having a data length of 3 bits, at the address 80 having a data length of 6 bits, and at the address 86 having a data length of 5 bits.

Referring to Figs. 11 and 12, among the lower 8-bit addresses of the control IC 200 seen from the printer main body 100, addresses 00 through 10 are allocated to the information relating to the storage element 80K of the black ink cartridge 107K, and addresses 20 through 34 are allocated to the information relating to the storage element 80F of the color ink cartridge 107F. The data length of 1 or 2 bytes is allocated to each address.

The correlation between the addresses in the storage elements 80K and 80F and the addresses in the control IC 200 (the print controller 40) are described briefly with reference to Fig. 13. Data are stored by the unit of 1 byte in the control IC 200, whereas data are stored by the unit of 1 bit in the storage elements 80K and 80F. In the control IC 200, the area of 1 byte is accordingly allocated to even the data having the length of less than 1 byte. In the storage elements 80K and 80F, on the other hand, only the required minimum bits are allocated to the respective data, so that there is no vacancy in the data

area.

(Reading Operation from Storage Elements 80K and 80F)

The following describes a decoding process carried out in the course of the reading operation from the storage elements 80K and 80F, which is performed by the control IC 200 in response to an instruction from the printer main body 100 (the print controller 40), with reference to Figs. 14 and 15. Fig. 14 is a flowchart showing a processing routine executed by the control IC 200 in the course of the reading process from the storage elements 80K and 80F, and Fig. 15 is a timing chart on the occasion of the reading process shown in the flowchart of Fig. 14.

When the program enters the processing routine of Fig. 14, the control IC 200 first makes a CS signal in a low level and resets the address counters 83K and 83F in the storage elements 80K and 80F at step S200. The control IC 200 then makes the CS signal in a high level and sets the storage elements 80K and 80F in the active state at step S210. The control IC 200 subsequently makes a R/W signal in a low level and thereby specifies a reading operation from the storage elements 80K and 80F at step S220. The control IC 200 then outputs a specific number of clock pulses to the storage elements 80K and 80F at step S230. The specific number of clock pulses corresponds to a desired address, which is output from the print controller 40 and at which the print controller 40 requires to gain an access for reading data. In this address conversion process, the control IC 200 converts a first address *Adf and an end address *Ade in a desired range of addresses (bit data) in the memory cells 81K and 81F,

at which the controller 46 requires to gain an access for the reading operation, into the corresponding numbers of clock pulses. The control IC 200 successively outputs (*Adf-1) clock pulses and (*Ade-*Adf) clock pulses to the storage elements 80K and 80F.

The address counters 83K and 83F in the storage elements 80K and 80F increment the address by the bit unit at a timing of a fall of the clock signal CLK. The control IC 200 thereby specifies a desired address at step S240. The data stored in the storage elements 80K and 80F are output to a data bus at the timings of the fall of the clock pulse. The control IC 200 controls the desired count on the address counter required for the reading operation in the above manner, and temporarily stores the output data corresponding to the desired address, for example, the data on the year of manufacture, the data on the month of manufacture, the data on the validity term, and the data on the after-unsealed validity term, at step S250.

The read-out data are serial data expressed by the bit unit, so that the control IC 200 converts the bit data to the byte data, as well as the serial data to the parallel data at step S260. The control IC 200 then outputs the converted parallel byte data to the print controller 40 at step S270. This completes the decoding process and the program exits from the processing routine of Fig. 14. As described previously, the address is specified and incremented by the bit unit in this embodiment.

(Effects of First Embodiment)

In the embodiment discussed above, pieces of information relating to the manufacture of the ink

cartridge are stored in succession at specific addresses that respectively occupy minimum bits required for storage. This arrangement enables the limited storage capacities of the storage elements 80K and 80F to be utilized effectively. The arrangement of the embodiment enables a vacant memory division, which is allocated to data in the case of a fixed data length but is kept unused, to be allocated to another storage area and effectively used for the storage of another piece of information. This arrangement ensures the efficient storage of more pieces of information in a fixed storage capacity.

In the embodiment discussed above, the inexpensive EEPROM, which carries out only the sequential access, is applied for the storage elements 80K and 80F of the black and color ink cartridges 107K and 107F, where the data on the remaining quantities of inks are stored. Such application desirably reduces the cost of the expendable ink cartridges 107K and 107F.

In the arrangement of the embodiment discussed above, the readable and writable storage areas 650 and 750 are located at addresses that are sequentially accessed prior to the read only storage areas 660 and 760 in the respective storage elements 80K and 80F. Even in the structure that carries out the writing operation of data into the readable and writable storage areas 650 and 750 after the off operation of the power switch on the panel switch 92, this arrangement ensures completion of the writing operation of data before the power plug is pulled out of the socket. The configuration of the embodiment, which applies the inexpensive storage elements 80K and 80F enabling only the

sequential access to decrease the cost of the ink cartridges 107K and 107F, thus advantageously reduces the possible failure in the process of rewriting the data.

[Modifications of First Embodiment]

In the embodiment discussed above, the address counters 83K and 83F used are the count-up type. The count-down type may alternatively be used for the address counters 83K and 83F. In this case, the data array should be changed in such a manner that the readable and writable storage areas 650 and 750 are accessed prior to the read only storage areas 660 and 760. Namely the readable and writable storage areas 650 and 750 are located at the higher addresses than those of the read only storage areas 660 and 760. More concretely, the pieces of information regarding the remaining quantities of inks allocated to the head addresses should be registered at the end addresses.

The principle of the present invention is applicable to the off-carriage type printer, in which the ink cartridges are not mounted on the carriage, as well as to the on-carriage type printer, in which the ink cartridges are mounted on the carriage as described in the above embodiment.

In the above embodiment, the EEPROM is applied for the storage elements 80K and 80F. A dielectric memory of the sequential access type FEROM may be used instead of the EEPROM. The EEPROM includes flash memories.

In the above embodiment, the remaining quantities of inks are used as the information relating to the quantities of inks. The cumulative amounts of ink

consumption may, however, be used instead of the remaining quantities of inks.

The ink cartridges 107K and 107F used in the above embodiment may be replaced with another ink cartridge 500 shown in Fig. 16. Fig. 16 is a perspective view illustrating the appearance of the ink cartridge 500 as one modification of the present invention.

The ink cartridge 500 includes a vessel 51 substantially formed in the shape of a rectangular parallelepiped, a porous body (not shown) that is impregnated with ink and accommodated in the vessel 51, and a cover member 53 that covers the top opening of the vessel 51. The vessel 51 is parted into five ink chambers (like the ink chambers 107C, 107LC, 107M, 107LM, and 107Y in the ink cartridge 107F discussed in the above embodiment), which separately keep five different color inks. Ink supply inlets 54 for the respective color inks are formed at specific positions on the bottom face of the vessel 51. The ink supply inlets 54 at the specific positions face ink supply needles (not shown here) when the ink cartridge 500 is attached to a cartridge attachment unit of a printer main body (not shown here). Pair of extensions 56 are integrally formed with the upper end of an upright wall 55, which is located on the side of the ink supply inlets 54. The extensions 56 receive projections of a lever (not shown here) fixed to the printer main body. The extensions 56 are located on both side ends of the upright wall 55 and respectively have ribs 56a. A triangular rib 57 is also formed between the lower face of each extension 56 and the upright wall 55. The vessel 51 also has a check recess 59, which prevents the

ink cartridge 500 from being attached to the unsuitable cartridge attachment unit mistakenly.

The upright wall 55 also has a recess 58 that is located on the substantial center of the width of the ink cartridge 500. A circuit board 31 is mounted on the recess 58. The circuit board 31 has a plurality of contacts, which are located to face contacts on the printer main body, and a storage element (not shown) mounted on the rear face thereof. The upright wall 55 is further provided with projections 55a and 55b and extensions 55c and 55d for positioning the circuit board 31.

In the above embodiment, the five color inks, that is, magenta, cyan, yellow, light cyan, and light magenta, are applied for the plurality of different color inks. The present invention is also applicable to any combination of an arbitrary number of color inks, for example, a combination of three different color inks of magenta, cyan and yellow, a combination of six different color inks including other than above five color inks in addition to the above five color inks.

The present invention is not restricted to the above embodiment or its modifications, but there may be many other modifications, changes, and alterations without departing from the scope or spirit of the main characteristics of the present invention.

The scope and spirit of the present invention are limited only by the terms of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An ink cartridge configured to be detachably mountable on a printer, the ink cartridge comprising:

an ink reservoir for containing an ink; and

a storage unit storing plural pieces of specific information relating to the ink cartridge, and including an input-output terminal and an input-output control unit;

wherein the input-output control unit inputs or outputs a serial data signal via the input-output terminal, and wherein the serial data signal contains data that is updated according to use of the ink cartridge and which has a data size that is an integral multiple of eight bits, and data that is not updated according to use of the ink cartridge, and at least a part of which has a data size that is a non-integral multiple of eight bits.

2. An ink cartridge in accordance with claim 1, wherein the plural pieces of specific information include a piece of information relating to manufacture of the ink cartridge.

3. An ink cartridge in accordance with claim 1, wherein the storage unit further comprises a manufacture year memory area, which has a storage capacity of 7 bits and stores a piece of information regarding a year of manufacture of the ink cartridge, a manufacture month memory area, which has a storage capacity of 4 bits and stores a piece of information regarding a month of manufacture of the ink cartridge, and a manufacture date memory area, which has a storage capacity of 5 bits and stores a piece of information regarding a date of manufacture of the ink cartridge.

4. An ink cartridge in accordance with claim 3, wherein the storage unit further comprises a manufacture hour memory area, which has a storage capacity of 5 bits and stores a piece of information regarding an hour of manufacture of the ink cartridge, and a

manufacture minute memory area, which has a storage capacity of 6 bits and stores a piece of information regarding a minute of manufacture of the ink cartridge.

5. An ink cartridge in accordance with claim 4, wherein the storage unit further comprises a validity term memory area, which has a storage capacity of 6 bits and stores a piece of information regarding a term of validity of the ink kept in the ink cartridge.

6. An ink cartridge in accordance with claim 3, wherein the storage unit further comprises:

an address counter outputting a count in response to a clock signal output from the printer; and

a storage element having the memory areas and which is sequentially accessed based on the count output from the address counter.

7. A printer comprising the ink cartridge in accordance with claim 1, wherein the ink cartridge is detachably attached to the printer.

8. A storage unit provided with an ink cartridge that is configured to be detachably mountable on a printer, the storage unit being written or read specific information by the printer, the storage unit comprising:

an input-output terminal via which a serial data signal is input or output; and

an input-output control unit that inputs or outputs the serial data signal via the input-output terminal, and wherein the serial data signal contains data that is updated according to use of the ink cartridge and which has a data size that is an integral multiple of eight bits and is to be updated according to use of the ink cartridge, and data that is not updated according to use of the ink cartridge and at least a part of which has a data size of a non-integral multiple of eight bits and which is not updated accordance to use of the ink cartridge.

9. A storage unit in accordance with claims 8, wherein the plural pieces of specific information include a piece of information relating to manufacture of the ink cartridge.

10. A storage unit provided with an ink cartridge that is configured to be detachably mountable on a printer, the storage unit being written or read specific information by the printer, the storage unit comprising:

an input-output terminal via which a serial data signal is input or output; and

an input-output control unit that inputs or outputs the serial data signal by eight bits via the input-output terminal, and wherein the serial data signal contains data that is updated according to use of the ink cartridge and which has a data size that is an integral multiple of eight bits and which is updated according to use of the ink cartridge, and data that is not updated according to use of the ink cartridge and at least a part of which has a data size that is a non-integral multiple of eight bits and which is not updated according to the use of the ink cartridge.

11. A storage unit in accordance with claim 10, wherein the storage unit further comprises a manufacture hour memory area, which has a storage capacity of 5 bits and stores a piece of information regarding an hour of manufacture of the ink cartridge, and a manufacture minute memory area, which has a storage capacity of 6 bits and stores a piece of information regarding a minute of manufacture of the ink cartridge.

12. A storage unit in accordance with claim 11, wherein the storage unit further comprises a validity term memory area, which has a storage capacity of 6 bits and stores a piece of information regarding a term of validity of an ink kept in the ink cartridge.

13. A storage unit in accordance with claim 10, wherein the storage unit further comprises:

an address counter outputting a count in response to a clock signal output from the printer; and

a storage element having memory areas and which is sequentially accessed based on the count output from the address counter.

14. A printer used with an ink cartridge, the ink cartridge having a storage unit that stores plural pieces of specific information relating to the ink cartridge and an input-output terminal, the printer comprising:

a read out mechanism reading out data this is not updated according to use of the ink cartridge by eight bits, wherein at least a part of the data has a data size that is a non-integral multiple of eight bits;

an acquisition mechanism acquiring, from the read out data by eight bits, the data not to be updated according to use of the ink cartridge and having the data size that is a non-integral multiple of eight bits; and

a writing mechanism which writes the data that is updated according to use of the ink cartridge and having a data size that is an integral multiple of eight bits in the storage unit by eight bits.

15. A printer used with an ink cartridge, the ink cartridge having a storage unit that stores plural pieces of data relating to the ink cartridge, and has an input-output terminal, the printer comprising:

a read out mechanism reading out the plural pieces of data relating to the ink cartridge from the storage unit via the input-output terminal;

an acquisition mechanism acquiring, from the read out data, data which is not updated according to use of the ink cartridge and at least a part of which has a data size that is a non-integral multiple of eight bits, and data to be updated according to use of the ink cartridge and having a data size that is an integral multiple of eight bits, respectively; and

a writing mechanism which writes the data that is updated according to use of the ink cartridge and having a data size that is an integral multiple of eight bits in the storage unit by eight bits.

16. An ink cartridge for mounting on a printer, comprising:

an cartridge body defining an ink chamber to hold an ink;

a storage element mounted on the cartridge body and comprising;

a memory cell for storing data;

a read/write controller that controls reading of data from and writing of data to the memory cell;

an address counter that counts, in response to a received clock signal, when data is read from or written to the memory cell; and

a plurality of electrical contacts in electrical communication with the storage element, the electrical contacts being arranged for the transfer of data in serial fashion between the storage element and the printer.

17. A method of storing data in an ink cartridge having a data storage device with plural storage regions, comprising the step of:

storing, in succession, a plurality of data records in the data storage regions, each said data record having a number of bits and being stored in a portion of the data storage regions, the portion having a size measured in bits and which size is equal to the number of bits, so that a minimum required number of bits are allocated to each said data record and each said data record occupies a location in the data storage device immediately after a preceding data record without vacancy therebetween.

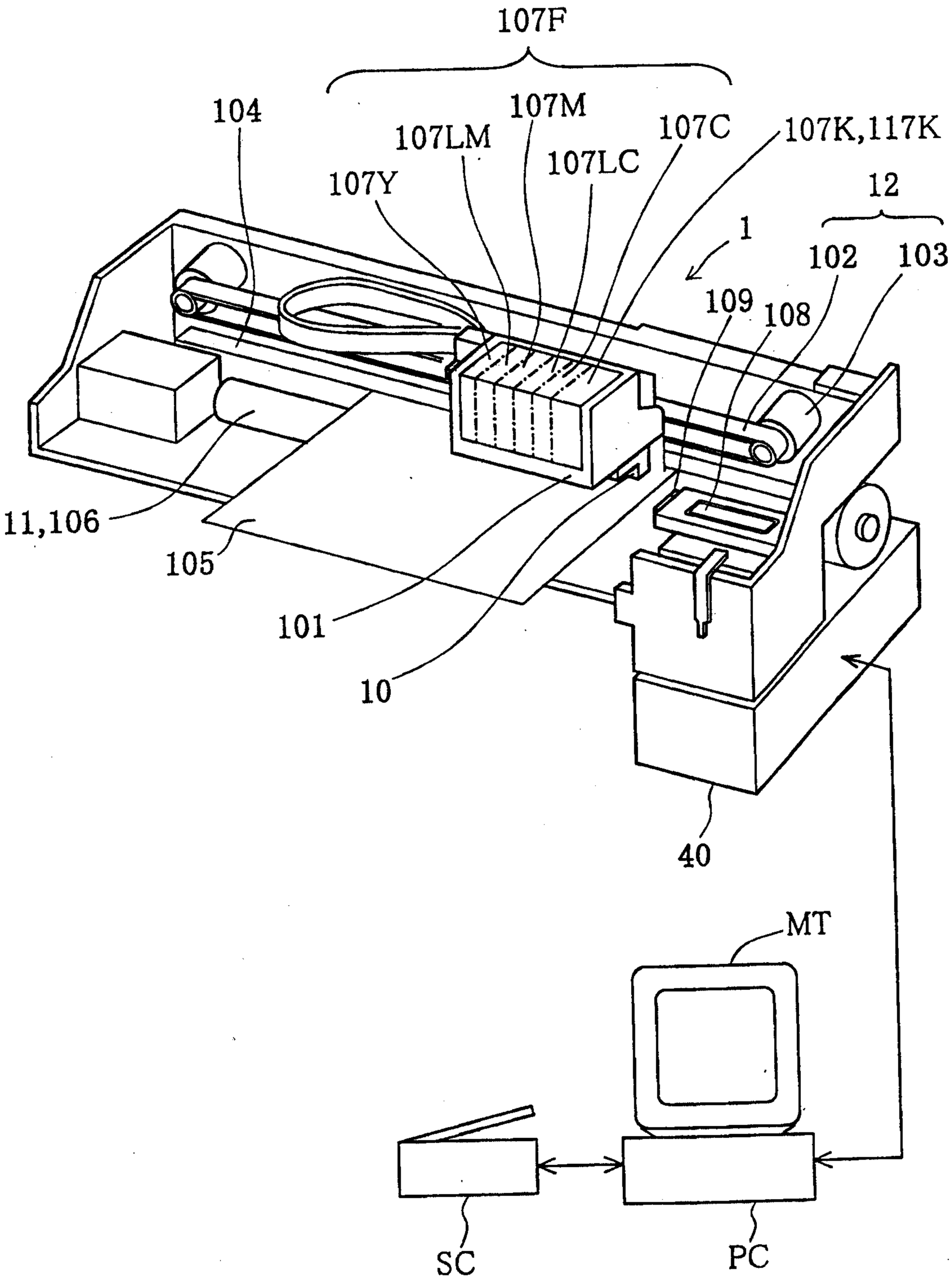
18. A method of reading data from a ink cartridge, comprising the steps of:

providing a printer having mounted thereon an ink cartridge having a data storage device having plural storage regions that contain a plurality of data records in succession, each said data record having a number of bits and being stored in a portion of the data storage regions, the portion having a size measured in bits, and which size is equal to the number of bits, so that a minimum required number of bits are allocated to each said data record and each said data record occupies a location in the data storage device immediately after a preceding data record without vacancy therebetween;

obtaining a read-out data by reading at least one of the data records contained in the data storage device, by bit unit, from a beginning address to an end address, the read-out data being serial data expressed by the bit unit; and

converting the read-out data to byte data which is parallel data.

Fig. 1


107F
104
107M
107LM
107C
107K,117K
107LC
107Y
12
1
102
103
109
108
11,106
105
101
10
40
MT
SC
PC

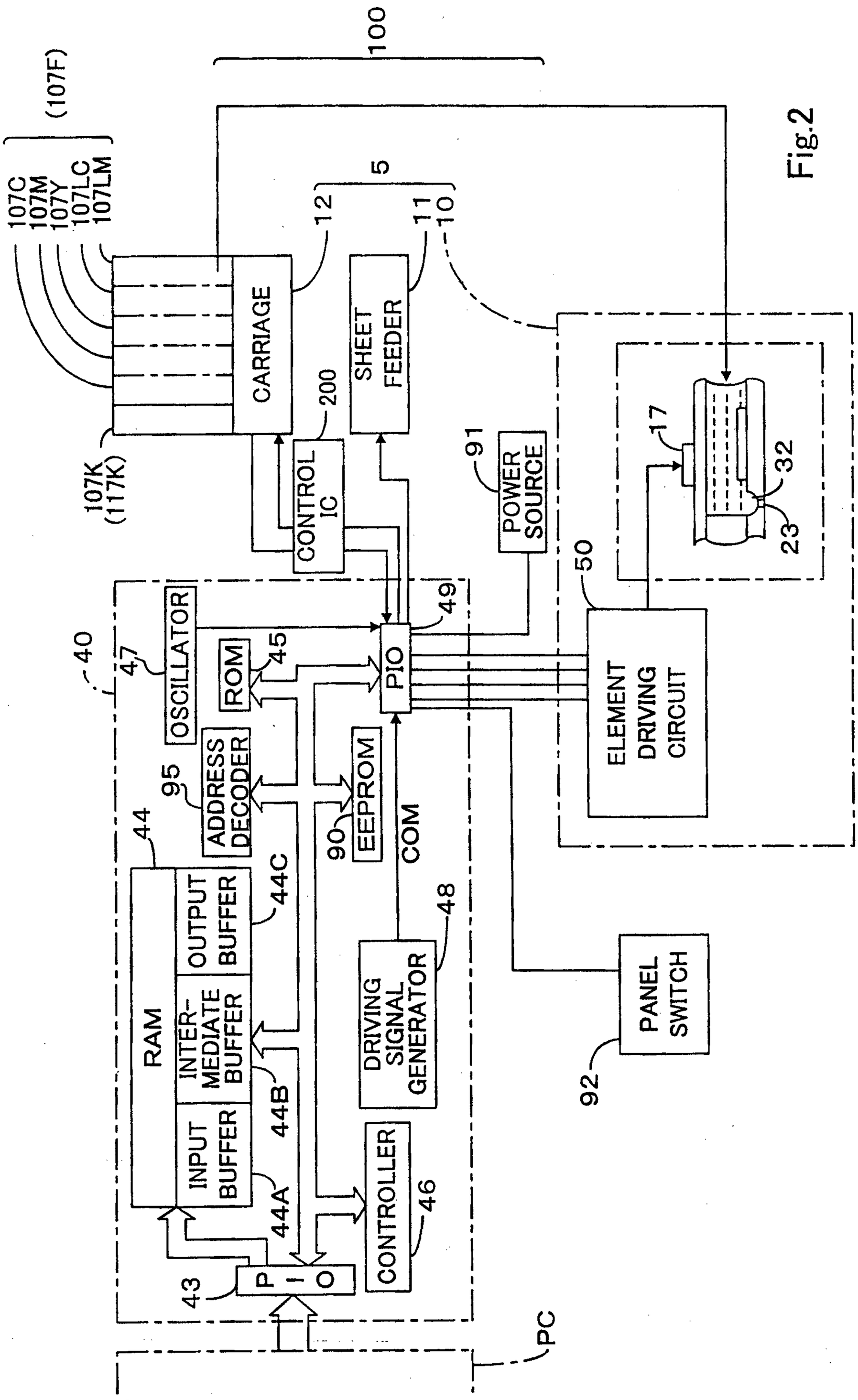
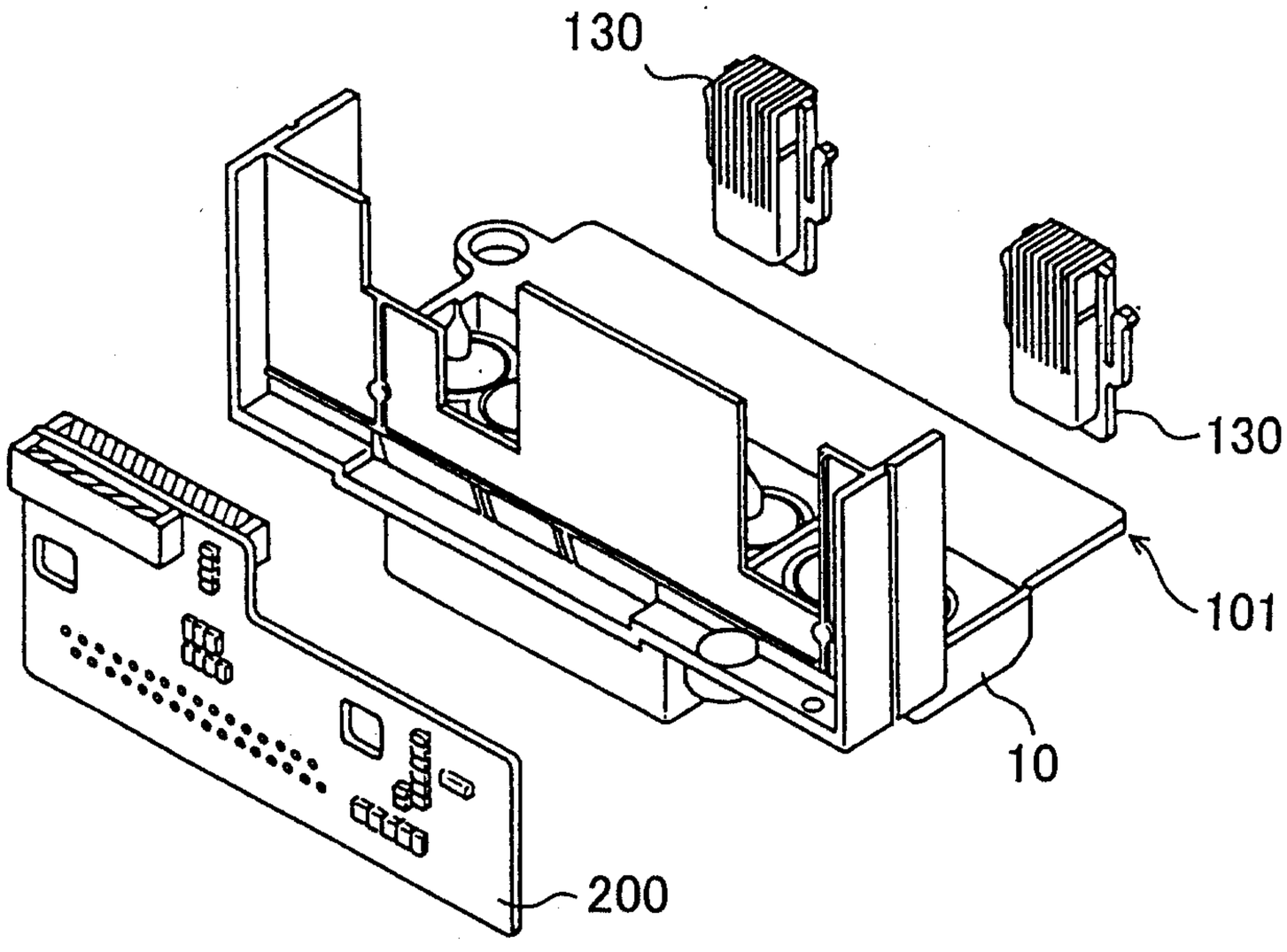

100
5
12
11
10
107C
107M
107Y
107LC
107LM
(107F)
107K
(117K)
CARRIAGE
SHEET FEEDER
200
CONTROL IC
91
POWER SOURCE
17
32
23
50
49
40
47
OSCILLATOR
ROM
45
PIO
ELEMENT DRIVING CIRCUIT
95
ADDRESS DECODER
44
RAM
INPUT BUFFER
INTER-MEDIATE BUFFER
OUTPUT BUFFER
44C
44B
44A
90
EEPROM
COM
DRIVING SIGNAL GENERATOR
48
CONTROLLER
46
43
P I O
PANEL SWITCH
92
PC

Fig.2

Fig.3



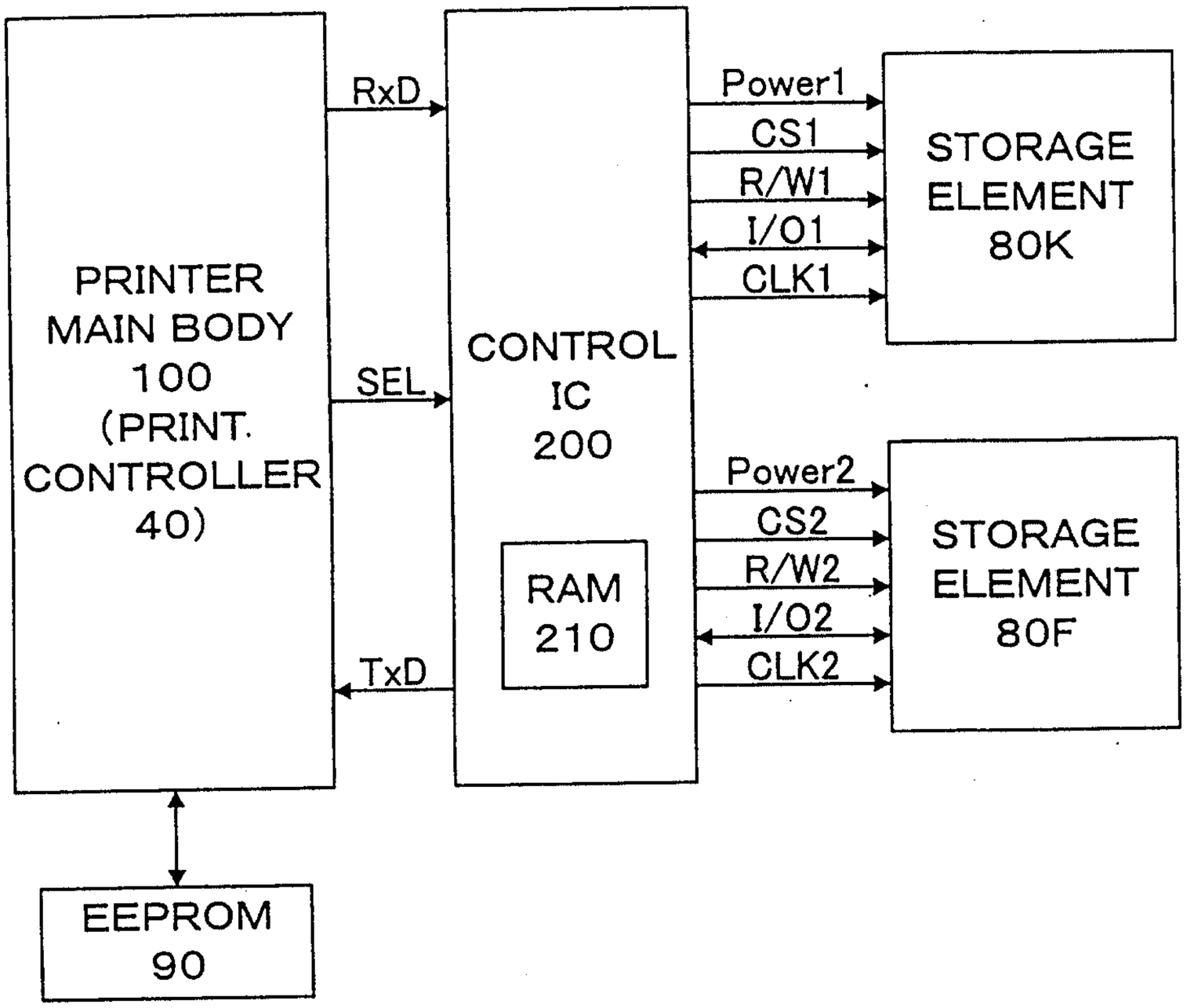

PRINTER MAIN BODY 100 (PRINT. CONTROLLER 40)
RxD
SEL
TxD
CONTROL IC 200
RAM 210
Power1
CS1
R/W1
I/O1
CLK1
STORAGE ELEMENT 80K
Power2
CS2
R/W2
I/O2
CLK2
STORAGE ELEMENT 80F
EEPROM 90

Fig. 4

Fig. 5

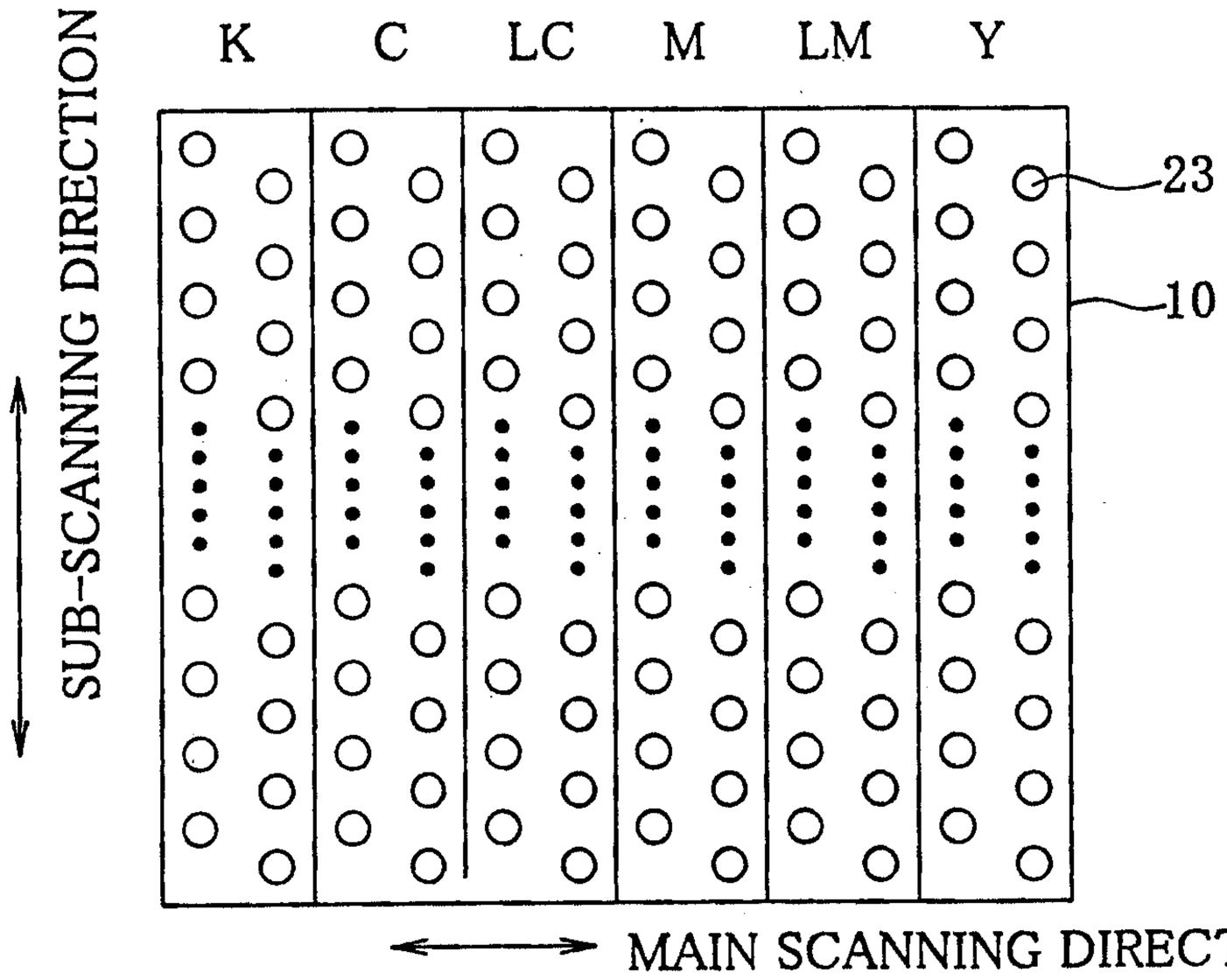

K
C
LC
M
LM
Y
SUB-SCANNING DIRECTION
23
10
MAIN SCANNING DIRECTION

Fig. 6A

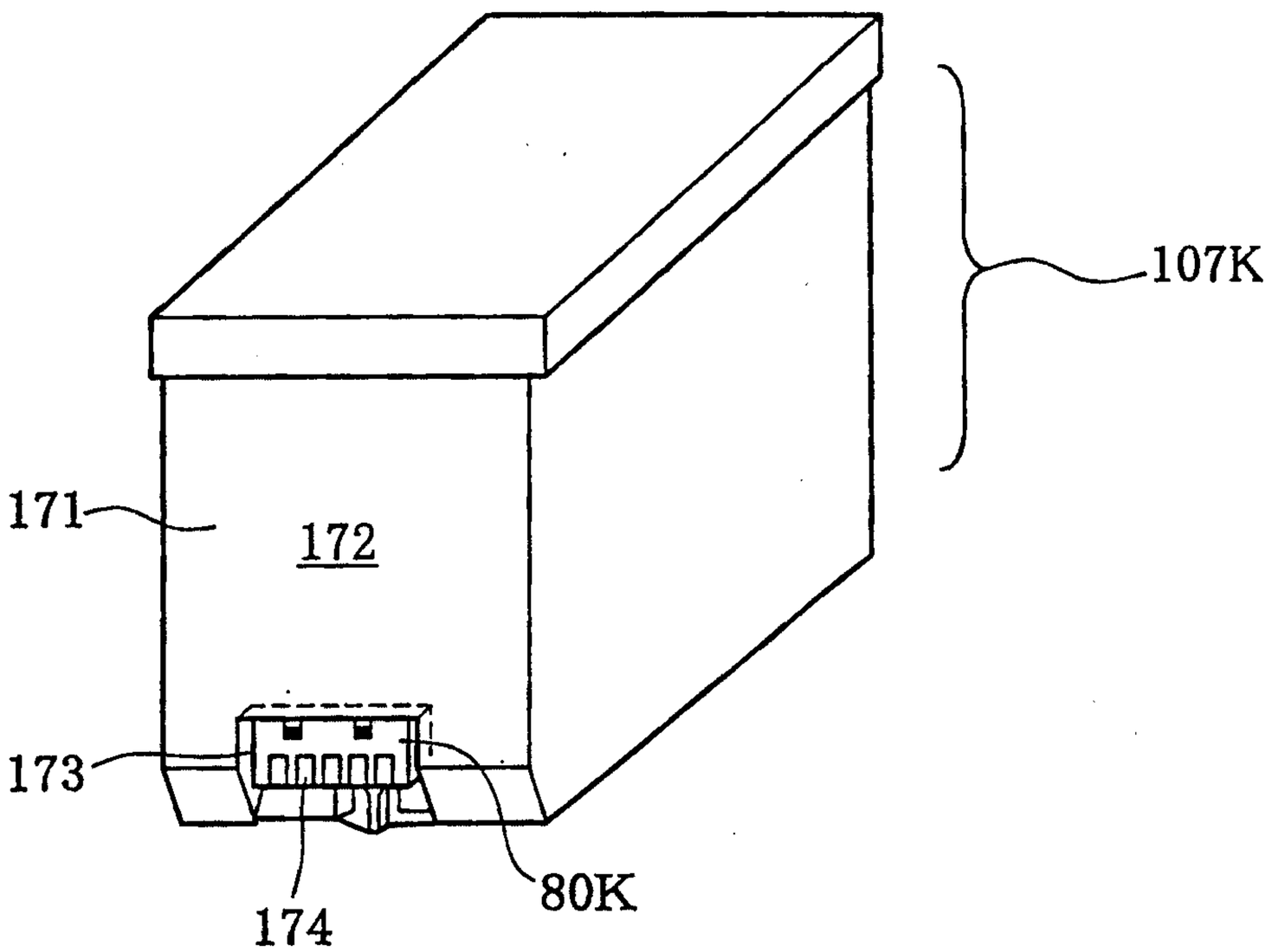


Fig. 6B

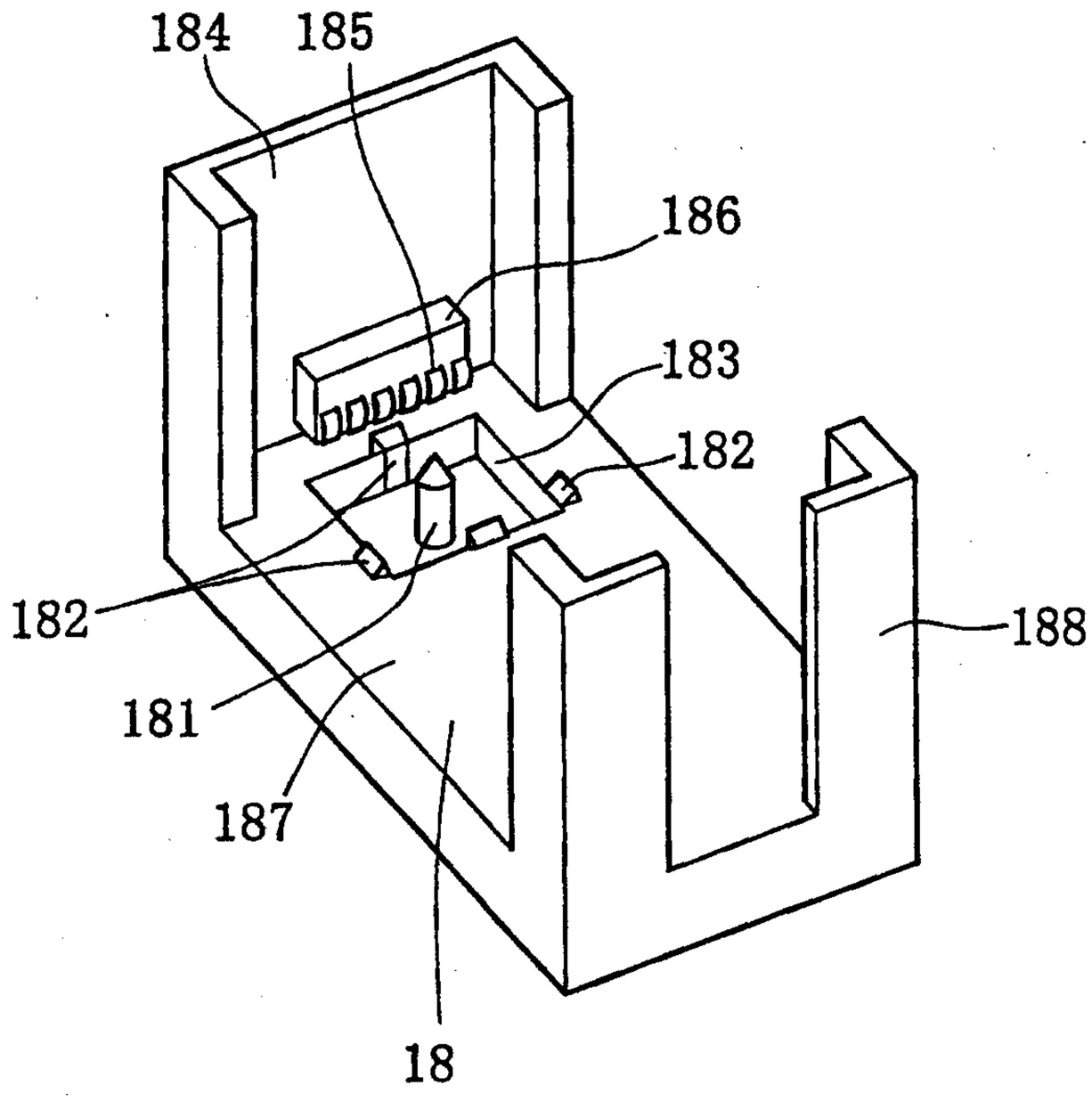
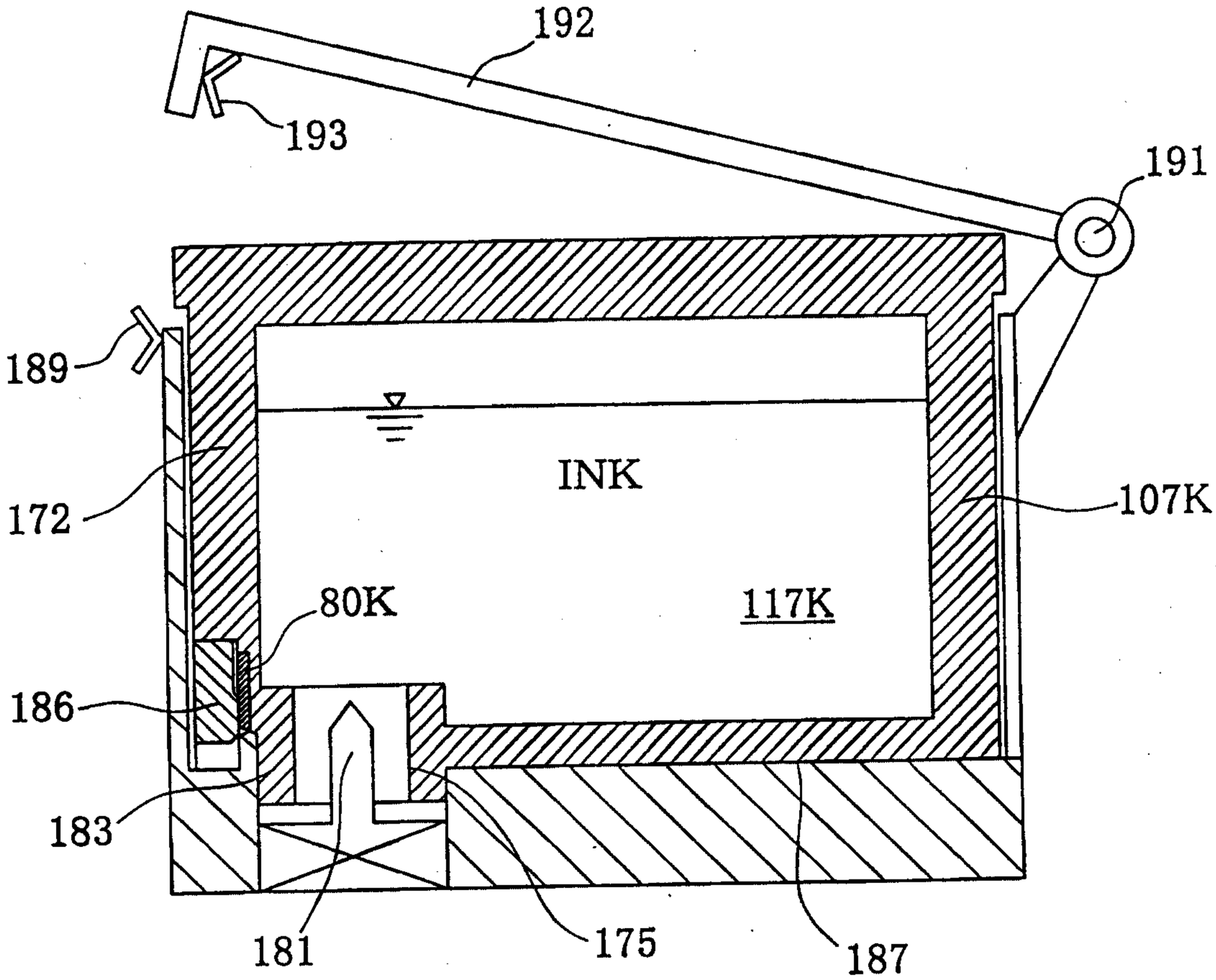


Fig. 7



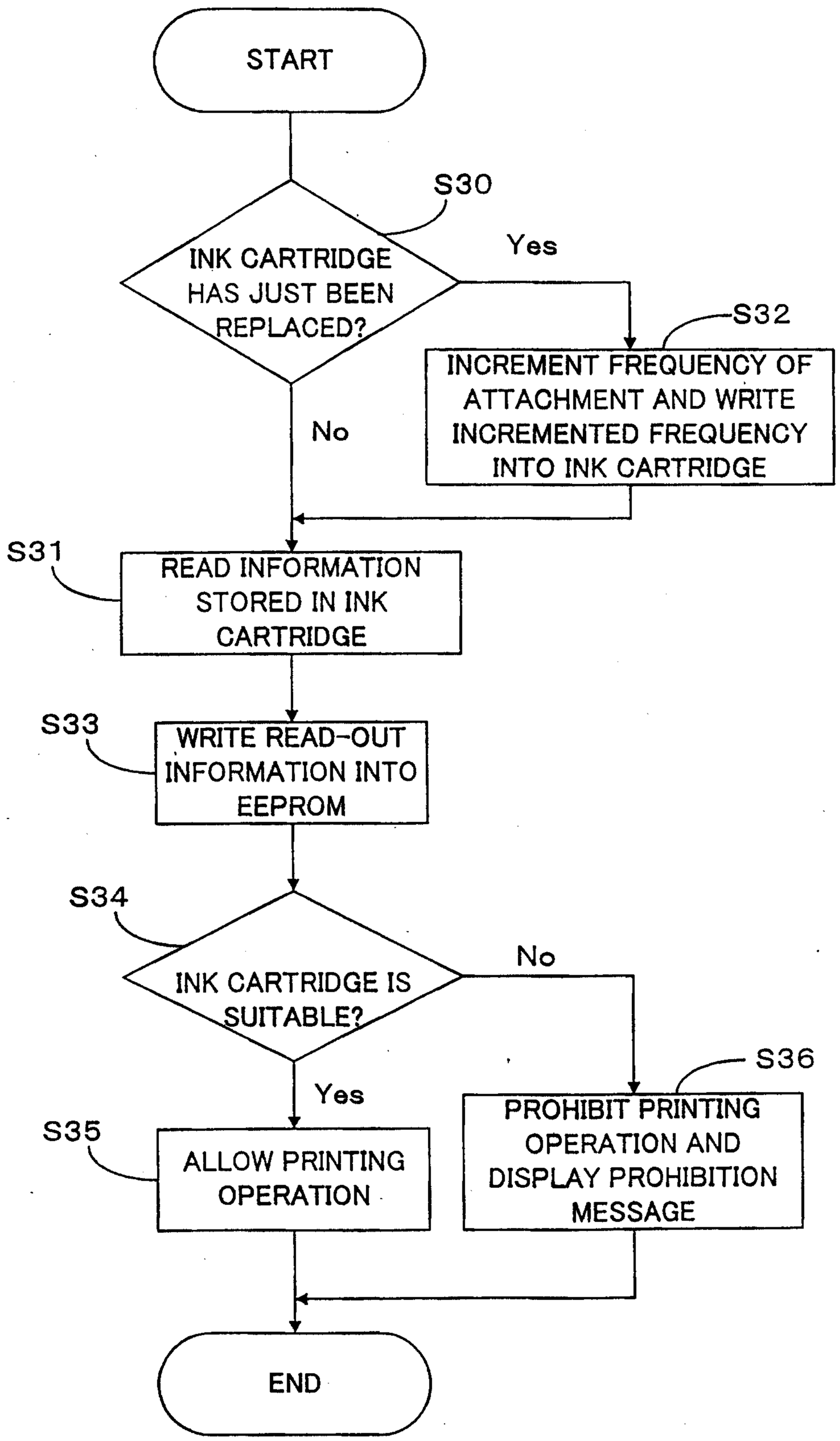

START
S30
INK CARTRIDGE HAS JUST BEEN REPLACED?
Yes
No
S32
INCREMENT FREQUENCY OF ATTACHMENT AND WRITE INCREMENTED FREQUENCY INTO INK CARTRIDGE
S31
READ INFORMATION STORED IN INK CARTRIDGE
S33
WRITE READ-OUT INFORMATION INTO EEPROM
S34
INK CARTRIDGE IS SUITABLE?
No
Yes
S36
PROHIBIT PRINTING OPERATION AND DISPLAY PROHIBITION MESSAGE
S35
ALLOW PRINTING OPERATION
END

Fig. 8

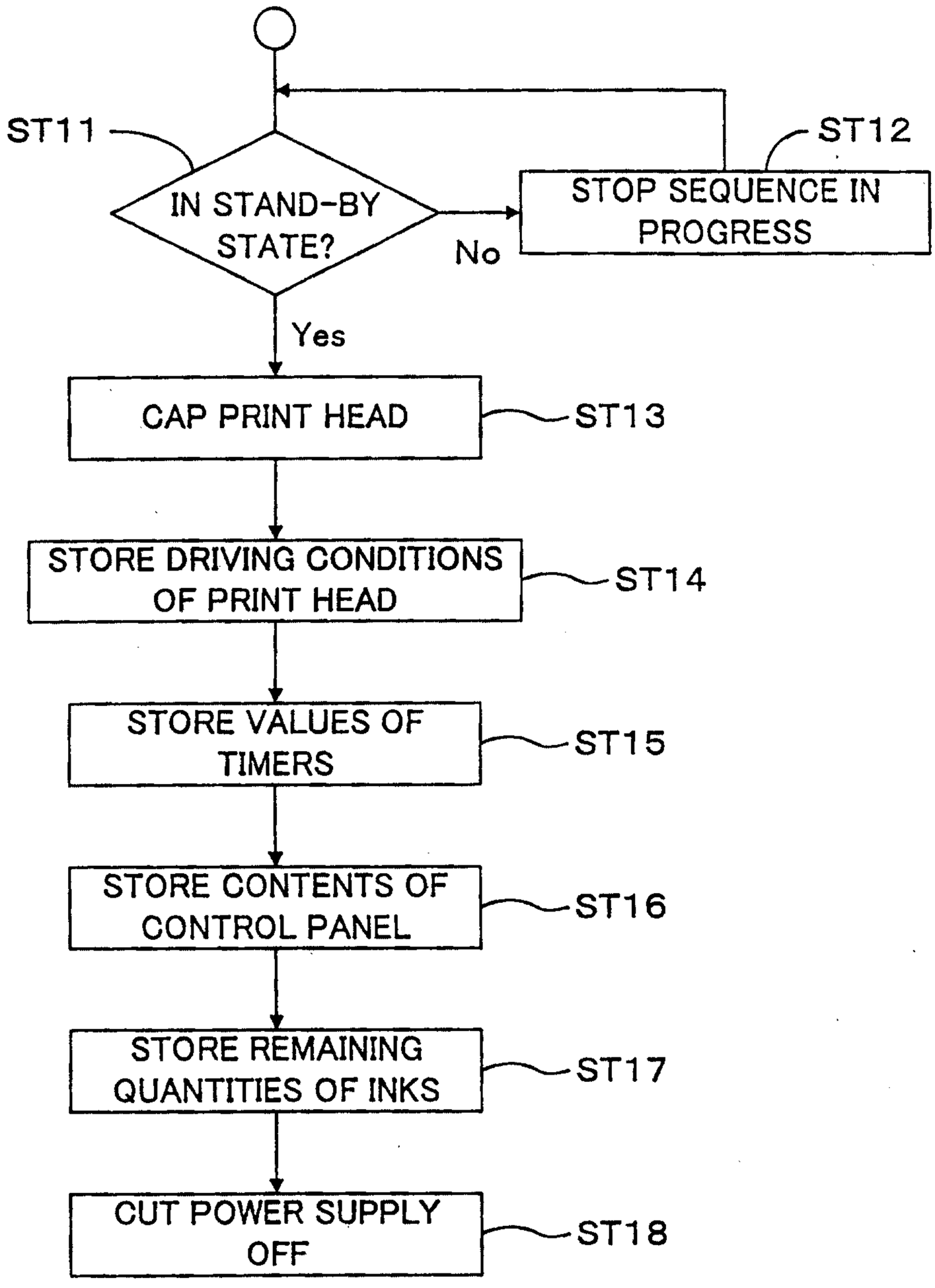

ST11
IN STAND-BY STATE?
No
ST12
STOP SEQUENCE IN PROGRESS
Yes
CAP PRINT HEAD
ST13
STORE DRIVING CONDITIONS OF PRINT HEAD
ST14
STORE VALUES OF TIMERS
ST15
STORE CONTENTS OF CONTROL PANEL
ST16
STORE REMAINING QUANTITIES OF INKS
ST17
CUT POWER SUPPLY OFF
ST18

Fig. 9

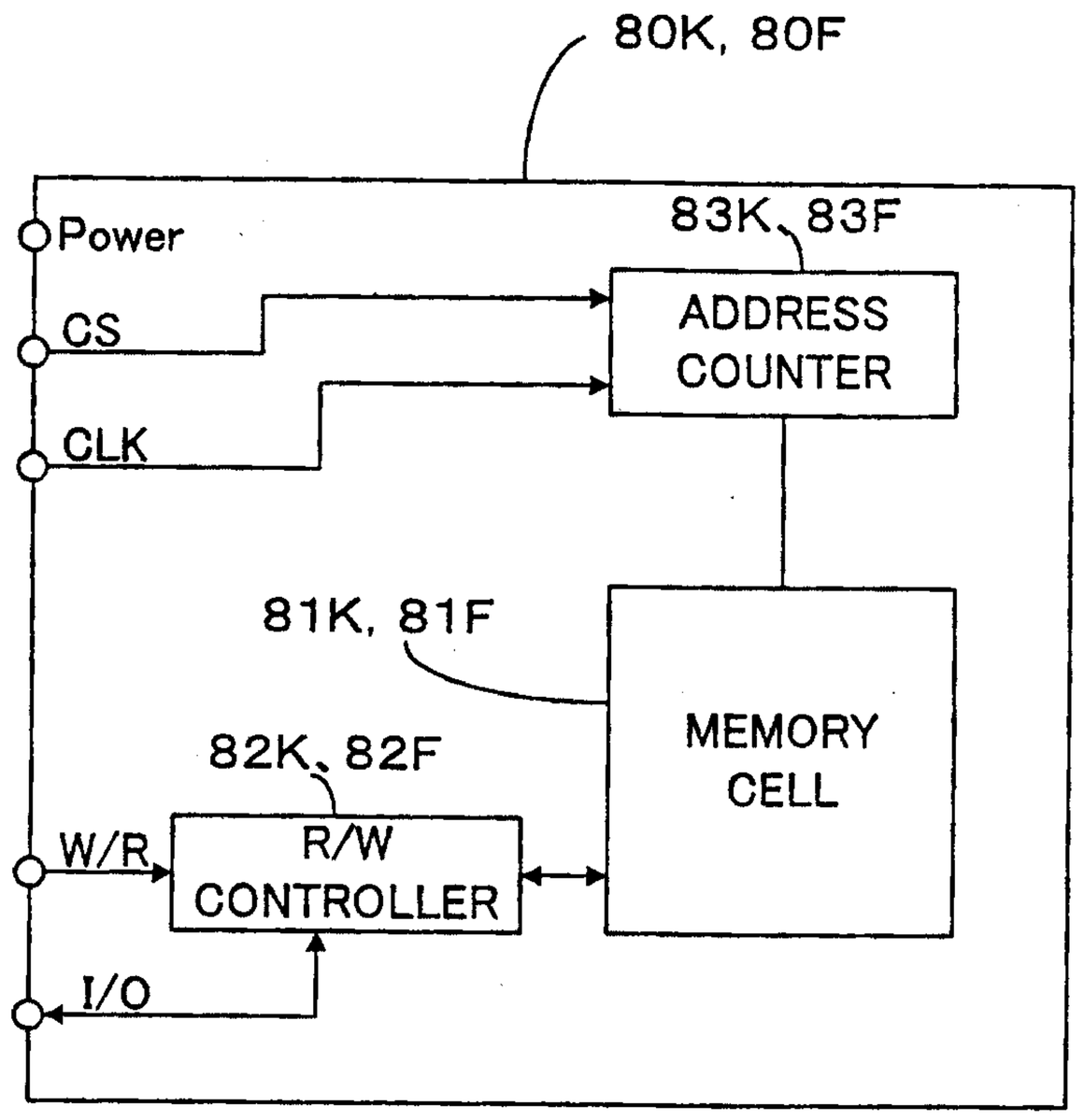

80K, 80F
Power
CS
CLK
83K, 83F
ADDRESS COUNTER
81K, 81F
MEMORY CELL
82K, 82F
W/R
R/W CONTROLLER
I/O

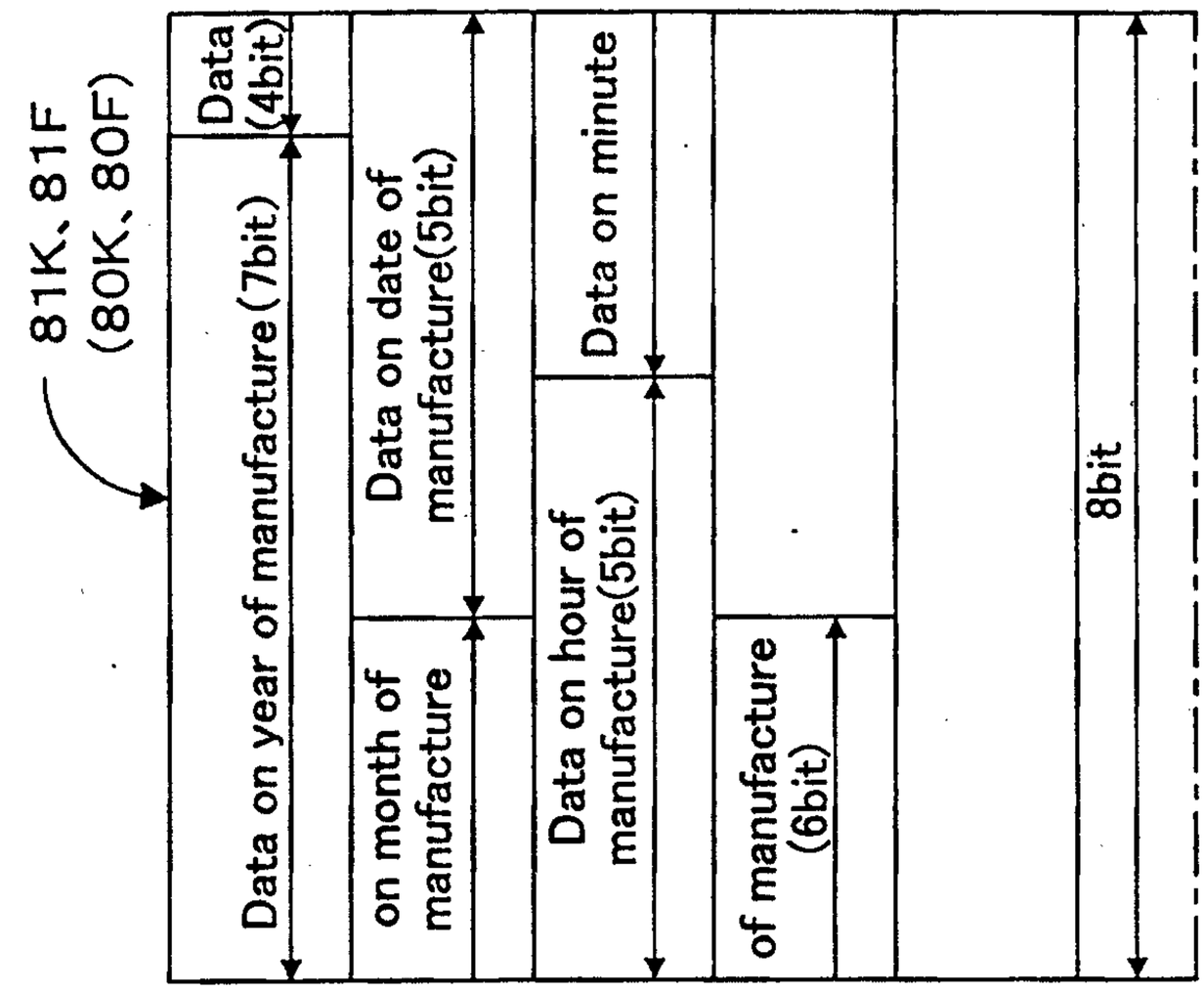
Fig. 10

Address of Control IC 200	Data Length (byte)	Items of Information	Address of Storage Element 80K	Capacity (bit) in Storage Element	
00	1	Remaining quantity of black ink	00	8	650
01	1	Frequency of cleaning	08	8	
02	1	Frequency of attachment	10	8	
03	2	Total time period of attachment	18	16	
05	1	Year of manufacture	28	7	660
06	1	Month of manufacture	2F	4	
07	1	Date of manufacture	33	5	
08	1	Hour of manufacture	38	5	
09	1	Minute of manufacture	3D	6	
0A	1	Production serial No.	43	8	
0B	1	Frequency of recycle	4B	3	
0C	2	Ink cartridge name	4E	10	
0E	1	Ink type	58	8	
0F	1	Term of validity	60	6	
10	1	Term of validity after unsealed	66	5	

Fig.11

Address of Control IC 200	Data Length (byte)	Items of Information	Address of Storage Element 80F	Capacity (bit) in Storage Element	
20	1	Remaining quantity of cyan ink	00	8	750
21	1	Remaining quantity of magenta ink	08	8	
22	1	Remaining quantity of yellow ink	10	8	
23	1	Remaining quantity of light cyan ink	18	8	
24	1	Remaining quantity of light magenta	20	8	
25	1	Frequency of cleaning	28	8	
26	1	Frequency of attachment	30	8	
27	2	Total time period of attachment	38	16	
29	1	Year of manufacture	48	7	760
2A	1	Month of manufacture	4F	4	
2B	1	Date of manufacture	53	5	
2C	1	Hour of manufacture	58	5	
2D	1	Minute of manufacture	5D	6	
2E	1	Production serial No.	63	8	
2F	1	Frequency of recycle	6B	3	
30	2	Ink cartridge name	6E	10	
32	1	Ink type	78	8	
33	1	Term of validity	80	6	
34	1	Term of validity after unsealed	86	5	

Fig. 12


81K、81F
(80K、80F)
Data on year of manufacture(7bit)
Data (4bit)
on month of manufacture
Data on date of manufacture(5bit)
Data on hour of manufacture(5bit)
Data on minute
of manufacture (6bit)
8bit

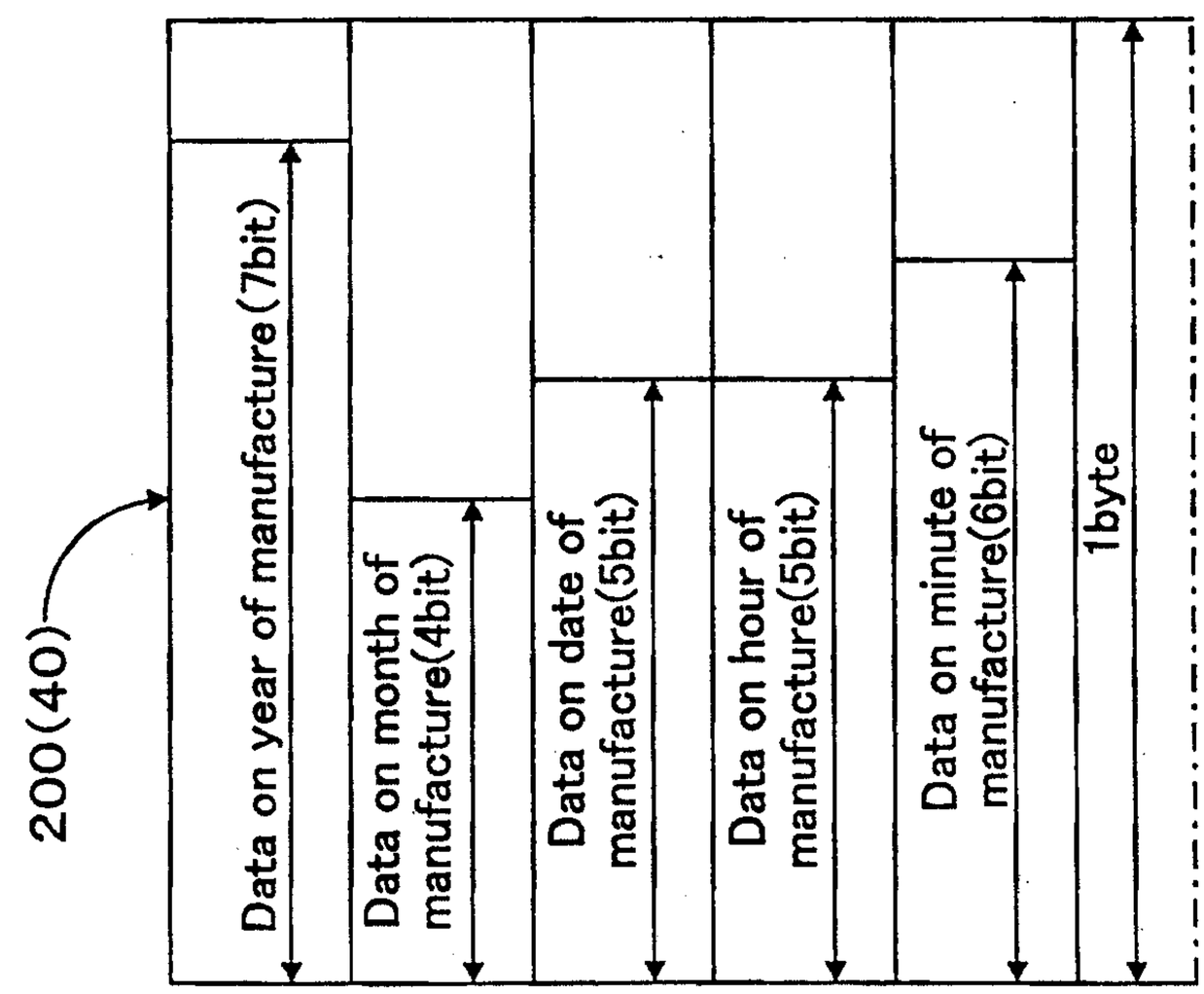

200(40)
Data on year of manufacture(7bit)
Data on month of manufacture(4bit)
Data on date of manufacture(5bit)
Data on hour of manufacture(5bit)
Data on minute of manufacture(6bit)
1byte

Fig. 13

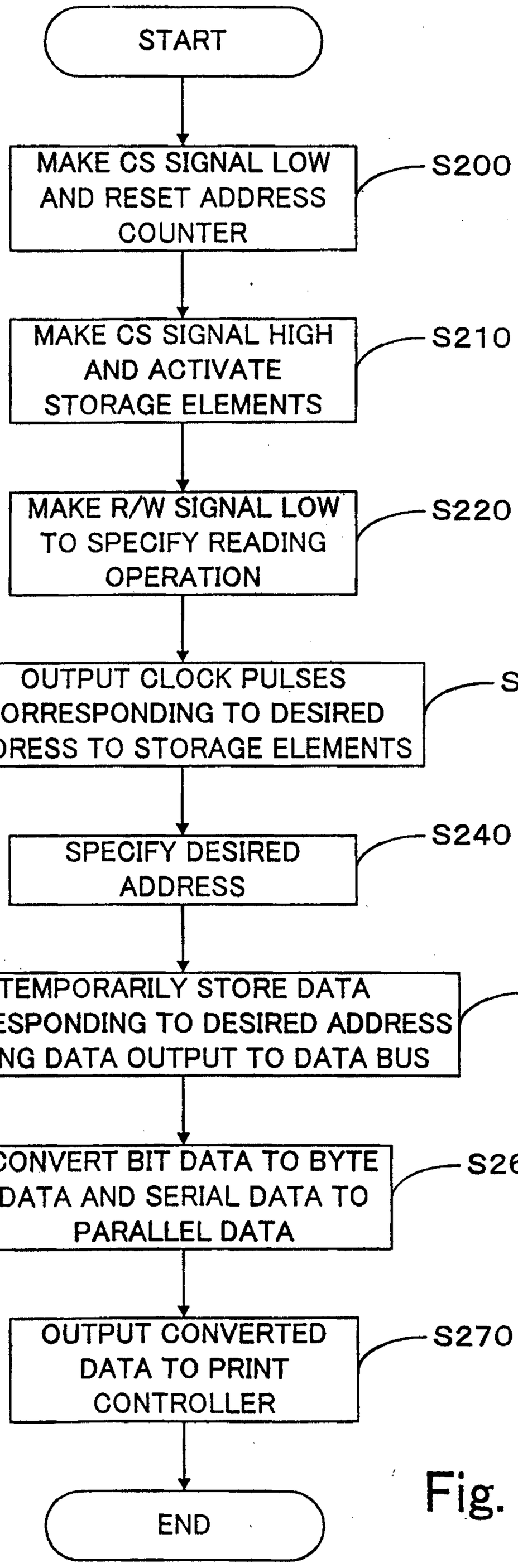

START
MAKE CS SIGNAL LOW AND RESET ADDRESS COUNTER
S200
MAKE CS SIGNAL HIGH AND ACTIVATE STORAGE ELEMENTS
S210
MAKE R/W SIGNAL LOW TO SPECIFY READING OPERATION
S220
OUTPUT CLOCK PULSES CORRESPONDING TO DESIRED ADDRESS TO STORAGE ELEMENTS
S230
SPECIFY DESIRED ADDRESS
S240
TEMPORARILY STORE DATA CORRESPONDING TO DESIRED ADDRESS AMONG DATA OUTPUT TO DATA BUS
S250
CONVERT BIT DATA TO BYTE DATA AND SERIAL DATA TO PARALLEL DATA
S260
OUTPUT CONVERTED DATA TO PRINT CONTROLLER
S270
END

Fig. 14

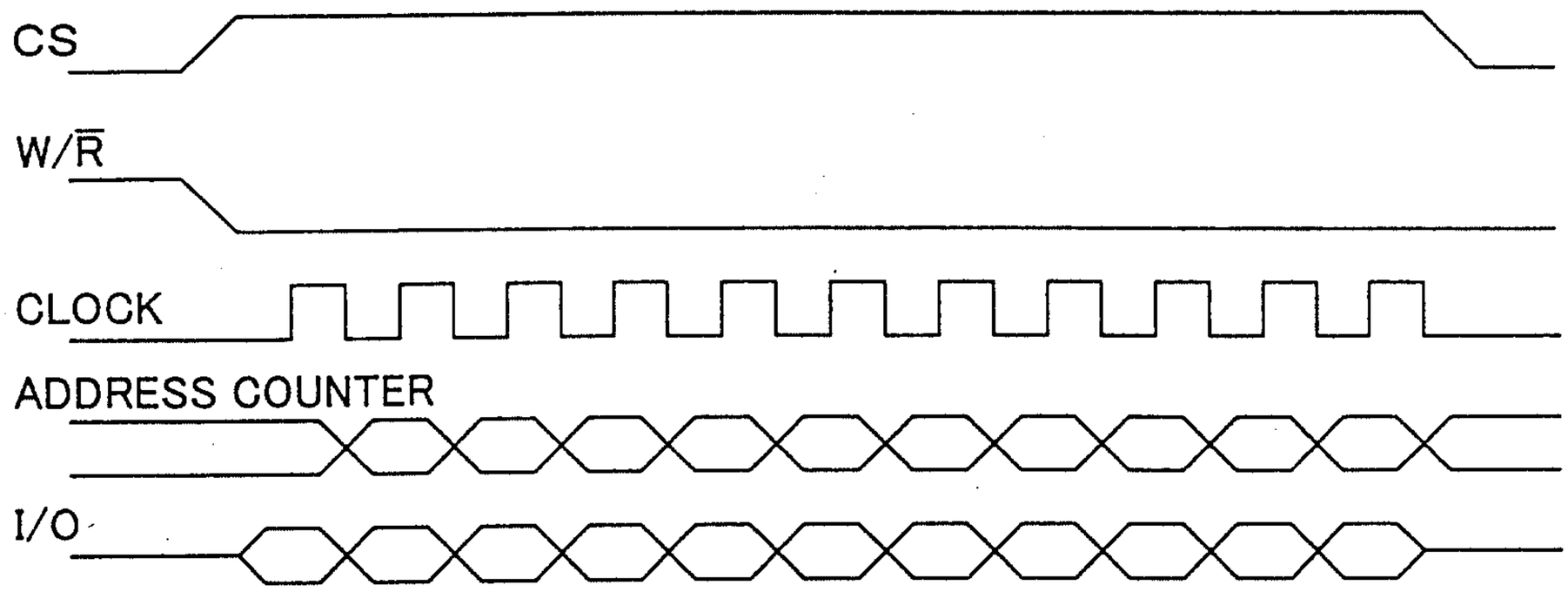
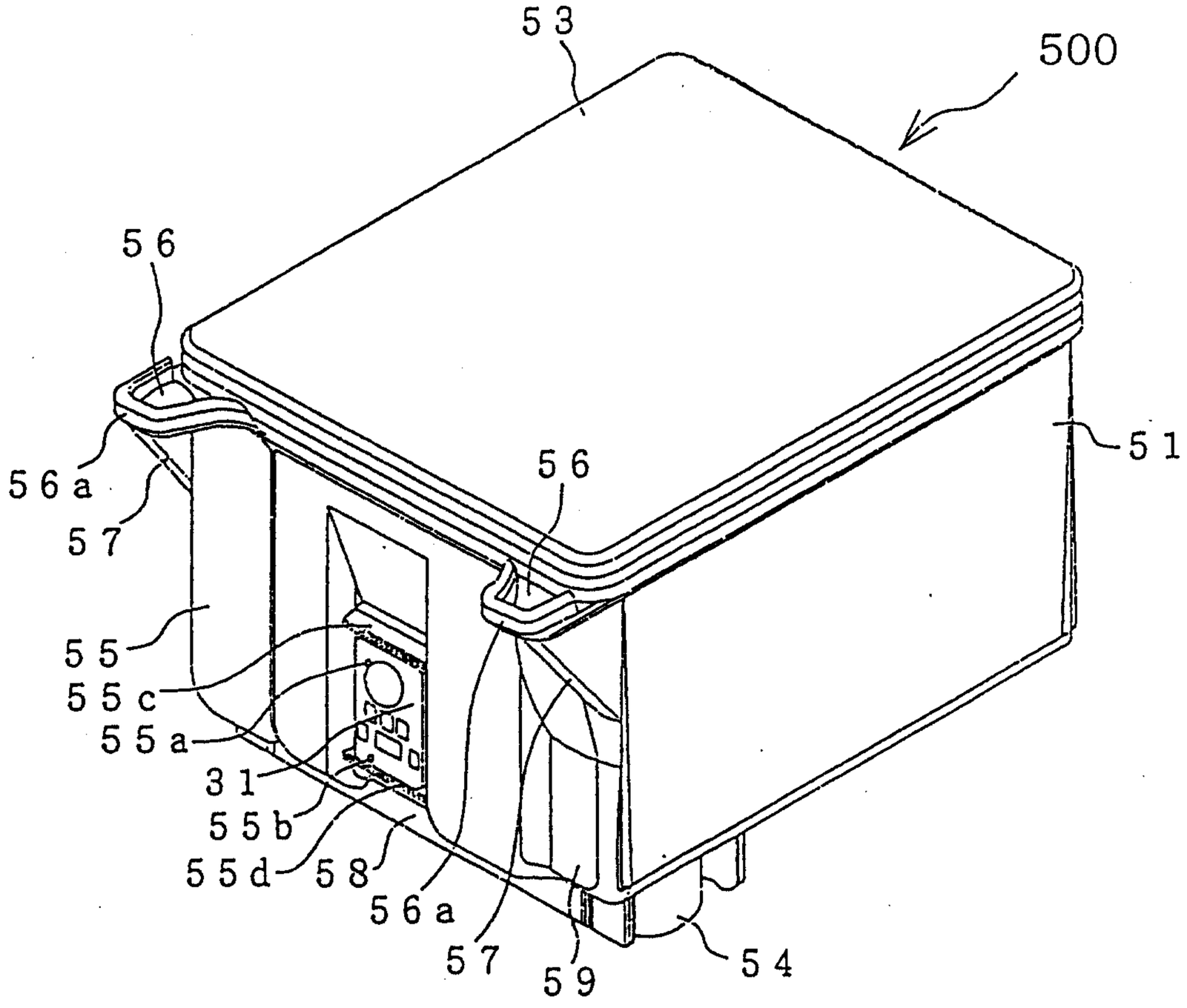
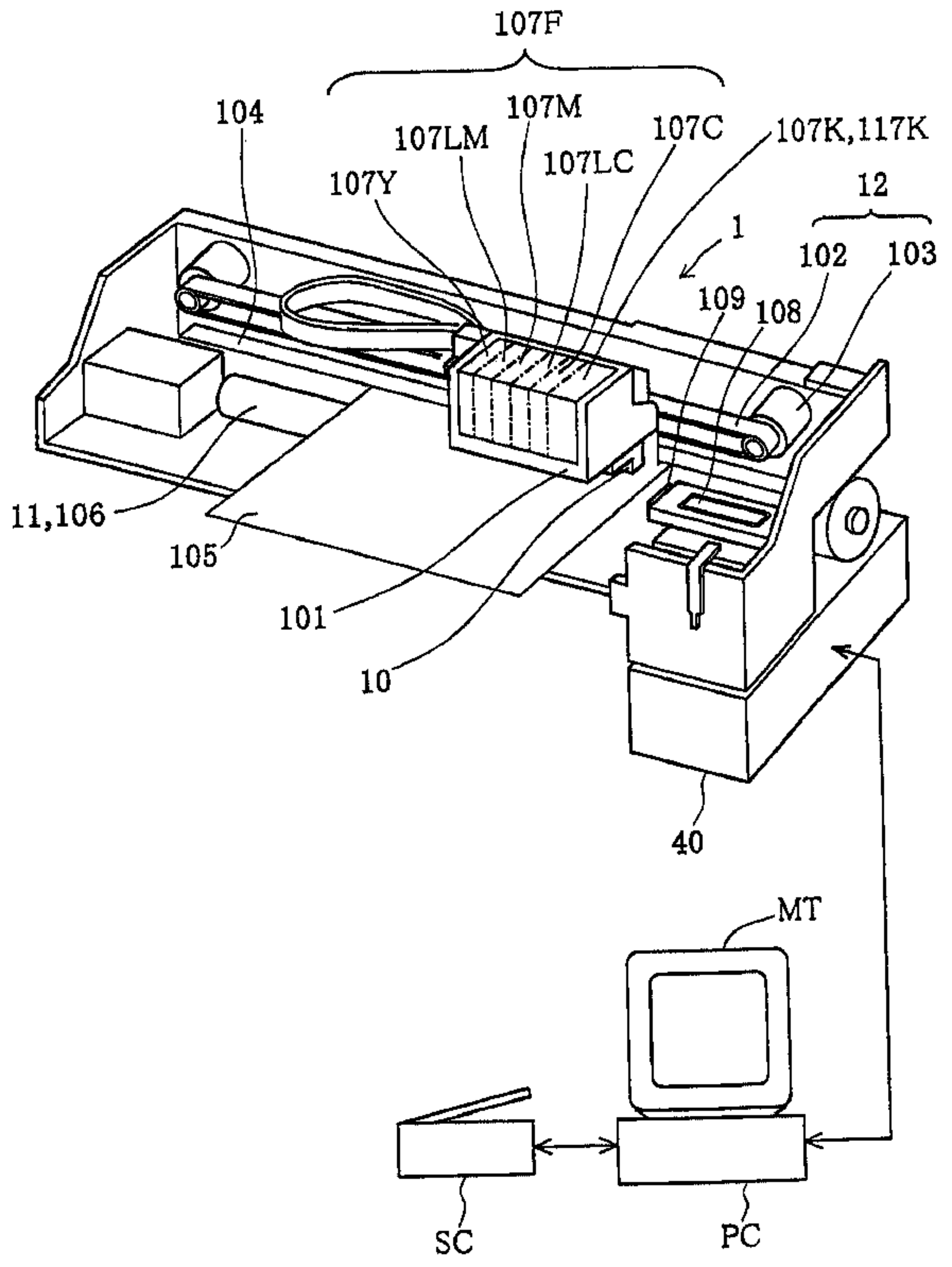


Fig. 15

Fig.16




107F
104
107M
107LM
107C
107K,117K
107Y
107LC
12
1
102
103
109
108
11,106
105
101
10
40
MT
SC
PC