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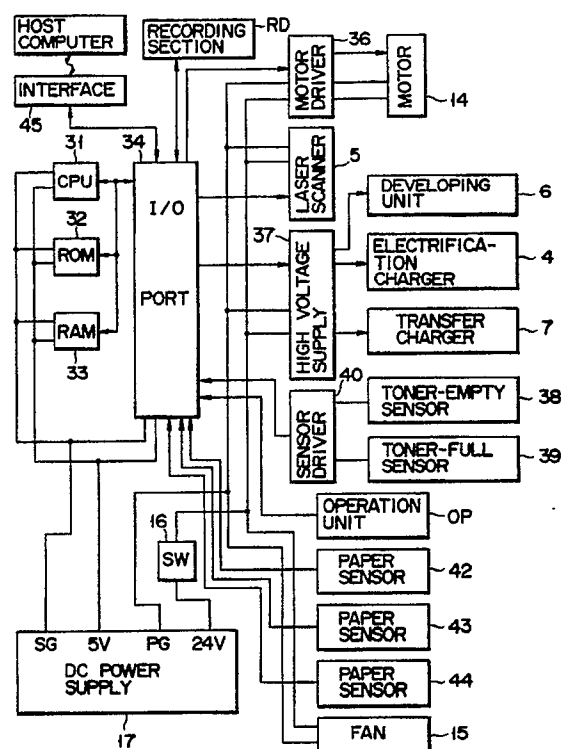
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(54) **Electrophotographic apparatus.**

(57) An electrophotographic apparatus comprises a printing section, having a photosensitive drum to be replaced when its service life expires, for forming an electrostatic latent image on the photosensitive drum, developing the electrostatic latent image by applying developer to the photosensitive drum, and transferring the developed image on a sheet of print paper, a nonvolatile recording section (RD) for storing at least print number data representing the number of prints made by the photosensitive drum, and a display (OP) for informing that the print number data stored in the recording section (RD) reaches an allowable print number determined in accordance with the service life of the photosensitive drum. The electrophotographic apparatus further comprises a control circuit (31, 32, 33) for setting the print number data stored in the recording section (RD) to a value close to the allowable print number when the operation of the display (87) is checked.



**FIG. 3**

**EP 0 438 160 A2**

## ELECTROPHOTOGRAPHIC APPARATUS

The present invention relates to a dry type electrophotographic apparatus such as a laser printer.

Recently, a drum unit is used in laser printers. This drum unit includes a photosensitive drum, an electrifying section, a developing section and a transfer section, for example, and is detachably mounted to the printer cabinet. Particularly, the photosensitive drum wears out with frequent usage and needs replacing when its service life expires. The laser printer is designed to permit replacement of the drum unit when the service life of the photosensitive member expires, thus facilitating the maintenance work.

There is known a conventional technique which counts the number of prints as the history of usage of the photosensitive drum for each printer operation in order to check if the service life of the photosensitive drum has expired, and uses a memory device to display the count value (see Published Unexamined Japanese Patent Application No. 62-75468). The use of this technique allows an operator to know how much the photosensitive drum has worn out or the degree of degradation of this drum more accurately from the current print number, compared with the case of checking the use period. Upon confirming the print number having reached an allowable print number by means of an alarm indicator, the user has only to replace the drum unit. In this manner, it is possible to prevent the print quality from lowering due to degradation of the photosensitive drum.

At the time of shipping laser printers of this type, manufacturers normally check the print quality, etc. by actually making prints several times. In this checking, the number of prints made is counted and the count value is stored in the memory device. It is not desirable that the products be shipped in this state. Conventionally, therefore, the memory device is detached from each printer after the checking, the print number data stored in this memory device is cleared to "0" using an exclusive read/write device. The initialized memory device is reinstalled in the laser printer, which will then be shipped. Further, in maintenance inspection of the printer, it may be checked whether or not an alarm indication is made when the print number reaches the allowable print number. The check is executed in such a manner that another memory device having the desired print number data close to the allowable print number preset by the exclusive read/write device is temporarily installed in the printer and printing is actually done under this condition until the allowable print number is reached.

In short, according to the prior art, when data of the printing history of the photosensitive drum needs to be temporarily changed in checking printers at the manufacturing stage, maintenance, etc., an exclusive read/write device should be used, thus reducing the working efficiency.

It is therefore an object of the present invention to provide an electrophotographic apparatus capable of facilitating inspection at shipment and maintenance.

To achieve this object, there is provided an electrophotographic apparatus comprising: a printing section, having a photosensitive member to be replaced when its service life expires, for forming an electrostatic latent image on the photosensitive member, developing the electrostatic latent image by applying developer to the photosensitive member, and transferring the developed image on a sheet of print paper; a nonvolatile recording section for storing at least print number data representing the number of prints made by the photosensitive member; an indicating section for informing that the print number data stored in the recording section reaches an allowable print number determined in accordance with the service life of the photosensitive member; and an update section for setting the print number data stored in the recording medium to a value close to the allowable print number when the operation of the indicating section is checked.

According to this electrophotographic apparatus, the print number data stored in the nonvolatile recording section can be set to a value close to the allowable print number in checking at the time of shipment and maintenance. It is therefore possible to easily check if the indicating section properly functions by repeating the printing operation several times following the value setting, without requiring a particular device for this checking.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagram illustrating the internal structure of a laser printer according to one embodiment of the present invention;

Fig. 2 is a diagram showing the structure of a laser scanner unit shown in Fig. 1;

Fig. 3 is a block diagram showing a control circuit of the laser printer;

Fig. 4 is a circuit diagram specifically illustrating part of the control circuit shown in Fig. 3;

Fig. 5 is a diagram illustrating the contents of a process condition data table provided in a ROM shown in Fig. 3;

Fig. 6 is a diagram illustrating the main memory structure of a RAM shown in Fig. 3;

Fig. 7 is a diagram showing an operation section shown in Fig. 4; and

Figs. 8 to 10B are diagrams for explaining the operation of the control circuit shown in Fig. 3.

A laser printer according to one preferred embodiment of the present invention will now be described referring to the accompanying drawings.

Fig. 1 schematically illustrates the internal structure of the laser printer. This laser printer comprises a printer cabinet 1, and also comprises a drum unit 2, a laser scanner unit 5, a transfer charger 7, a paper storage 10, a paper pickup roller 11, a fixing unit 12, paper discharge rollers 13, a feed motor 14, a fan 15, an interlock switch 16 and a DC power supply 17 which are disposed in the cabinet 1. The drum unit 2 includes a photosensitive drum 3, an electrification charger 4, a developing unit 6, a cleaning unit 8, and a deelectrifying lamp 9, and is detachably mounted to the center portion of the cabinet 1. The photosensitive drum 3 has a photosensitive surface and is driven to rotate in one direction in the printing operation. When the drum unit 2 is mounted to the cabinet 1, the electrification charger 4, the laser scanner unit 5, the developing unit 6, the transfer charger 7, the cleaning unit 8, and the deelectrifying lamp 9 are positioned around the photosensitive drum 3 so as to execute a sequence of electrophotograph processes. The electrification charger 4 electrifies the photosensitive surface of the photosensitive drum 3, and the laser scanner unit 5 selectively exposes the electrified photosensitive surface using a laser beam emitted according to print data to thereby form an electrostatic latent image. The developing unit 6 supplies toner or a developer to the photosensitive surface of the drum 3 to make the latent image visible as a toner image by the toner sticking on the photosensitive surface in accordance with the latent image. The transfer charger 7 electrifies a sheet of print paper and transfers the toner image on the print paper due to electrostatic attraction. The cleaning unit 8 clears off the unnecessary toner remaining on the photosensitive surface of the drum 3, and the deelectrifying lamp 9 deelectrifies charges on this photo-sensitive surface. The paper storage 10 is disposed at the preceding stage of the transfer charger 7, and the fixing unit 12 and discharge rollers 13 are disposed in order at the subsequent stage of the transfer charger 7. Sheets of print paper stored in the paper storage 10 are picked up one at a time by the pickup roller 11 in each print operation, and the print paper is fed to the transfer charger 7 at a given timing. The fixing unit 12 applies heat and pressure to the print paper to fix the transferred toner image on the paper.

As shown in Fig. 2, the laser scanner unit 5 comprises a laser diode assembly 21 for producing a laser beam, a laser controller 22 for driving this laser diode assembly 21, a start sensor 23 formed of PIN diodes which detects the irradiation start position of the laser beam, a polygon motor 24 for rotating a polygon mirror, a polygon motor driver 25 for driving the motor 24, and a PLL controller 26 for controlling the rotation of the motor 24.

Fig. 3 schematically illustrates the control circuit of the laser printer. This control circuit includes a CPU (Central Processing Unit) 31 which executes various data processing required to control the printing operation, a ROM (Read only Memory) 32 which stores control program for the CPU 31, various data tables, and the like, a RAM (Random Access Memory) 33 which temporarily stores data input to and output from the CPU 31 such as print data supplied from an external host computer, an I/O port 34 and a bus line 35 for interconnecting these components.

The I/O port 34 is connected to the laser scanner unit 5, the fan 15, a motor driver 36, a high voltage supply circuit 37, a sensor driver 40, an operation unit OP, paper sensors 42 to 44, an interface 45, and a recording section RD. The motor driver 36 controls the driving of the feed motor 14. The high voltage supply circuit 37 supplies a high voltage to the electrification charger 4, developing unit 6 and transfer charger 7. The sensor driver 40 drives a toner-empty sensor 38 and a toner-full sensor 39, both provided in the developing unit 6. The paper sensors 42 to 44 are distributed to detect paper jamming. The interface 45 receives at least a print start command and print data from the host computer. The nonvolatile recording section RD stores print number data A representing the number of prints made by the photosensitive drum 3 and allowable print number data B representing the allowable print number which is determined in accordance with the service life of the photosensitive drum 3 and at which the drum unit 2 should be replaced. These data A and B are not erased when the power supply for the printer is cut off. The interlock switch 16 is inserted in the power supply line which supplies a voltage of +24 V from the DC power supply 17 to the motor driver 36, laser scanner unit 5, high voltage supply circuit 37 and fan 15. This interlock switch cuts off the power supply when the upper part of the printer cabinet 1 is rocked open. The CPU 31, ROM 32, RAM 33, I/O port 34, and the other components operate on a voltage of +5 V supplied from the DC power supply 17.

Fig. 4 illustrates the specific structure of part of the control circuit. In this circuit, the CPU 31 accesses a memory card 51 via a card interface 52, directly accesses the ROM 32 and RAM 33, and

accesses the operation section 41 via an operation section interface 53. The memory card 51 serves as a nonvolatile data storage medium detachable to the interface 52, and has areas in which the print number data A and allowable print number data B. The CPU 31 sets a reference voltage of an electrification voltage supply 54 for the electrification charger 4 in a D/A (Digital/Analog) converter 55 and sets a reference voltage of a transfer voltage supply 56 for the transfer charger 7 in a D/A converter 57. The CPU 31 also sets a reference voltage of a bias voltage supply 58 for the developing unit 6 in a D/A converter 59 and sets the laser output of the laser controller 22 in a D/A converter 60. In an initial state, the memory card 51 has the print number data A of "0" and the allowable print number B of "10000". The print number data A stored in the memory card 51 is incremented by the print number in each printing operation. The ROM 32 has an area that constitutes a process condition data table 70 as shown in Fig. 5. This table 70 includes the electrophotograph process condition data #1 and #2 associated with different print numbers A and selectively used to compensate for degradation of the print quality caused by the deterioration of the photosensitive drum 3. These electrophotograph process condition data #1 and #2 each consist of reference voltage data of the electrification voltage supply 54, transfer voltage supply 56 and bias voltage supply 58, and the laser output data of the laser controller 22. As shown in Fig. 6, the RAM 33 has areas that constitute a print number memory 71 for storing the print number data A retrieved from the memory card 51 as process data A', a flag memory 72 for a data set flag F which is set to "1" when a data set mode is selected, and an allowable print number memory 88 for storing the allowable print number data B retrieved from memory card 51 as process data B'. The operation section 41 is provided with a power switch 81, a data set mode select switch 82, a set key 83, a reset key 84, an UP key 85, a DOWN key 86 and a liquid crystal display 87. This display 87 displays message or numeral data such as the print number data A stored in the memory card 51.

The operation of the thus constituted laser printer will be explained below.

The CPU 31 is programmed to perform the operation shown in Fig. 8 when the power switch 81 is operated to activate the laser printer. When this operation starts, the CPU 31 first executes the initialization to clear the data in the RAM 33 and reset the I/O port 34, for example. Then, the CPU 31 checks the status of the set mode select switch 82. When the switch 82 is set ON for the set mode, the data set flag F in the flag memory 72 is set to "1." When the switch 82 is not set ON, the data set

flag F in the flag memory 72 is reset to "0". After the flag F is set or reset, the CPU 31 sequentially executes a print preparation process and a print process.

In this print preparation process, the CPU 31 periodically executes a print discrimination process shown in Fig. 9 and a key discrimination process shown in Figs. 10A and 10B.

When the print discrimination process starts, the CPU 31 first checks if a print start command is received from the host computer and set in RAM 33. This print discrimination process is immediately terminated when the print start command is not set. When it is detected that the print start command is set, the CPU 31 accesses the memory card 51 to read out the print number data A and allowable print number data B from the card 51.

When the print number A is equal to or greater than zero and less than B/2, the electrophotograph process condition data #1 is read out from the condition data table 70 in the ROM 32 and various data included in this data #1 are respectively set in the D/A converters 55, 57, 59 and 60. More specifically, "-6000 V" is set as the reference voltage of the electrification voltage supply 54 in the D/A converter 55, "-5000 V" as the reference voltage of the transfer voltage supply 56 in the D/A converter 57, "-300 V" as the reference voltage of the bias voltage supply 58 in the D/A converter 59, and "3 mW" as the laser output of the laser controller 22 in the D/A converter 60.

When the print number A is equal to or greater than B/2 and less than B, the electrophotograph process condition data #2 is read out from the condition data table 70 in the ROM 32 and various data included in this data #2 are respectively set in the D/A converters 55, 57, 59 and 60. More specifically, "-7000 V" is set this time as the reference voltage of the electrification voltage supply 54 in the D/A converter 55, "-6000 V" as the reference voltage of the transfer voltage supply 56 in the D/A converter 57, "-400 V" as the reference voltage of the bias voltage supply 58 in the D/A converter 59, and "4 mW" as the laser output of the laser controller 22 in the D/A converter 60.

The CPU 31 terminates the print discrimination process after data are set in the D/A converters 55, 57, 59 and 60, so as to execute the print process. In this print process, the electrification charger 4, laser controller 22, developing unit 6, and transfer charger 7 are activated in order to execute a sequence of electrophotograph processes based on the values set in the associated D/A converters 55, 57, 59 and 60, printing an image corresponding to print data set from the host computer on the print paper. Upon completion of one printing operation, the print number data A is incremented by "1" in the memory card 51.

When the print number A reaches the allowable print number B, the CPU 31 causes the operation section interface 53 to display a message requesting replacement of the photosensitive drum 3 on the liquid crystal display 87, and inhibits the following printing operation. When the print number A is over the allowable print number B, the CPU 31 causes the operation section interface 53 to display a message, indicating that the data stored in the memory card 51 is inaccurate, on the display 87 and disables the following printing operation.

When the key discrimination process starts, the CPU 31 checks in step ST1 whether or not the data set keys, namely, the set key 83, reset key 84, UP key 85 and DOWN key 86, have been operated. Upon detection of the key operations in step ST1, the CPU 31 selectively performs an initializing of data A and B, an updating of data A, or an updating of data B.

The initializing of data A and B is performed when it is confirmed that the reset key 84 has been operated, the data set flag F has been set to "1", and the set key 83 has not been operated. In this initializing, the print number data A of "0" and the allowable print number data B of "10000" are written in the memory card 51. The CPU 31 terminates the key discrimination process after the writing.

The updating of data A is performed when it is confirmed that the reset key 84 has not been operated, the set key 83 has been operated, and the data set flag F has been set to "1". In this updating, print number data A is read out from the memory card 51, and written as process data A' in the print number memory 71. This process data A' is read out from the memory 71 and is displayed, blinking, on the liquid crystal display 87. Then the CPU 31 repeats steps ST2 to ST4 and waits for any of the data set keys 83, 85 or 86 excluding the reset key 84 to be operated. If the operation of the UP key 85 is detected in step ST2, "100" is added to the data A' stored in the memory 71. The resultant data A' is read out from the memory 71 and is displayed, blinking, on the display 87. After the display operation, the CPU 31 waits for the next key operation. If the operation of the DOWN key 86 is detected in step ST3, "100" is subtracted from the data A' stored in the memory 71. The resultant data A' is read out from the memory 71 and is displayed, blinking, on the display 87. After the display operation, the CPU 31 waits for the next key operation. If the operation of the set key 83 is detected in step ST4, the data A' stored in the memory 71 is written as the print number data A in the memory card 51 and is displayed without blinking on the display 87. After the display operation, the CPU 31 terminates the key discrimination process.

The updating of data B is performed when it is

confirmed that the reset key 84 and set key 83 have been operated, and the data set flag F has been set to "1". In this updating, allowable print number data B is read out from the memory card 51, and written as process data B' in the allowable print number memory 88. This process data B' is read out from the memory 88 and is displayed, blinking, on the liquid crystal display 87. Then the CPU 31 repeats steps ST5 to ST7 and waits for any of the data set keys 83, 85 or 86 excluding the reset key 84 to be operated. If the operation of the UP key 85 is detected in step ST5, "100" is added to the data B' stored in the memory 88. The resultant data B' is read out from the memory 88 and is displayed, blinking, on the display 87. After the display operation, the CPU 31 waits for the next key operation. If the operation of the DOWN key 86 is detected in step ST6, "100" is subtracted from the data B' stored in the memory 88. The resultant data B' is read out from the memory 88 and is displayed, blinking, on the display 87. After the display operation, the CPU 31 waits for the next key operation. If the operation of the set key 83 is detected in step ST7, the data B' stored in the memory 88 is written as the allowable print number data B in the memory card 51 and is displayed without blinking on the display 87. After the display operation, the CPU 31 terminates the key discrimination process.

If it is detected that no key operation is detected in step ST1, the operation of a key other than the set key 83 and reset key 84 is detected, or the flag F has been reset to "0", the CPU 31 will terminate the key discrimination process without doing anything.

In the above-described laser printer, when power is given using the power switch 81 with the data set mode select switch 82 set ON, the data set flag F is set to "1" to select the data set mode. After that, when the reset key 84 is operated, the print number data A stored in the memory card 51 connected to the card interface 52 is reset to "0."

If the manufacturer operates the laser printer to check the print quality or the like prior to its shipment, therefore, the print number data A in the memory card 51 installed in the printer can be cleared to "0" by setting the power switch 81 ON after the checking with the data set mode select switch 82 rendered ON followed by the operation of the reset key 84. In other words, this printer can permit initialization of the memory card 51 by a simple operation without requiring a particular read/write device, and can thus improve the working efficiency in checking before shipment.

In this laser printer, if the set key 83 is operated under the condition that the data set mode has been selected, the print number data A stored in the memory card 51 connected to the card

interface 52 is read out and temporarily stored as process data A' in the print number memory 71, and the process data A' is displayed blinking on the liquid crystal display 87. When the UP key 85 is operated in this state, "100" is added to the process data A' stored in the memory 71, and the resultant process data A' is displayed blinking on the display 87. When the DOWN key 86 is operated, "100" is subtracted from the process data A' stored in the memory 71, and the resultant process data A' is displayed blinking on the display 87. When the set key 83 is operated again, the process data A' stored in the memory 71 at that point of time is written as the print number data A in the memory card 51 connected to the card interface 52. This print number data A is also displayed without blinking on the display 87.

When it becomes necessary to check if an alarm indication is made when the print number reaches the allowable print number determined in accordance with the service life of the photosensitive drum in the maintenance inspection of the present laser printer, therefore, first the data set mode select switch 82 is rendered ON, then the power switch 81 is set ON in this state followed by the operation of the set key 83. As a result, the print number data A stored in the memory card 51 in association with the presently mounted drum unit 2 is displayed blinking on the display 87 so that the operator writes down this number on a memo or the like. Then, the UP key 85 is repeatedly operated to decrease the displayed print number by the units of "100". When this number approaches to the allowable print number, the set key 83 is operated again. Consequently, the print number close to this allowable print number is written in the memory card 51. It is therefore possible to check if a message requesting the drum replacement is displayed by actually making prints until the print number reaches the allowable print number.

When the maintenance inspection is completed in this manner, the set key 83 is operated again with the set mode selected. Then the DOWN key 86 is repeatedly operated to decrement the displayed print number by the units of "100". When the resultant print number becomes the print number taken down on the memo plus the number of the prints actually made in this inspection, the set key 83 is operated again to write the present print number data in the memory card 51. Therefore, the printing history of the photosensitive drum in the laser printer can be set back to the correct value as before the maintenance inspection. Accordingly, it is possible to check if an alarm indication is made when the print number reaches the allowable print number in the maintenance inspection or the like by a simple key operation without requiring a read/write device. This can therefore ensure easier

maintenance inspection. To execute this type of maintenance inspection, the presently installed memory card may be replaced with another memory card and the print number data recorded in the new memory card may be arbitrarily altered.

In this laser printer, if the set key 83 and reset key 84 are operated under the condition that the data set mode has been selected, the allowable print number data B stored in the memory card 51 connected to the card interface 52 is read out and temporarily stored as process data B' in the allowable print number memory 88, and the process data B' is displayed blinking on the liquid crystal display 87. When the UP key 85 or DOWN key 86 is repeatedly operated in this state, the process data B' stored in the memory 88 increases or decreases by the units of "100", and the resultant process data B' is displayed blinking on the display 87. When the set key 83 is operated again, the process data B' stored in the memory 88 at that point of time is written as the allowable print number data B in the memory card 51 connected to the card interface 52. This allowable print number data B is also displayed without blinking on the display 87. Since the allowable print number B can be updated, it is possible to cope with the case where the service life of the photosensitive drum is changed by replacement of the drum unit.

The present invention is not limited to the above-described embodiment, and can be modified in other various manners without departing from the scope and spirit thereof. In the embodiment, the UP key 85 and DOWN key 86 are provided to increase and decrease the number data stored in the memory card 51 by the units of "100". Instead, numerical keys may be provided to directly set the desired number, for example. Although the memory card 51 is used as an example of the data recording medium in the above embodiment, a magnetic tape or other types of recording media may be employed as well. The recording medium may also be a semiconductor memory such as E<sup>2</sup> PROM or RAM with power backup. Further, the present invention is not restricted to a laser printer, but may also be applied to a copying machine in which a drum unit having a photosensitive member is detachably mounted to the cabinet.

## Claims

1. An electrophotographic apparatus comprising: printing means (2, 5, 12), having a photosensitive member (3) to be replaced when its service life expires, for forming an electrostatic latent image on said photosensitive member (3), developing the electrostatic latent image by applying developer to said photosensitive member (3), and transferring the developed

image on a sheet of print paper;  
nonvolatile recording means (RD) for storing at  
least print number data representing the num-  
ber of prints made by said photosensitive  
member (3); and 5  
indicating means (87) for informing that the  
print number data stored in said recording  
means reaches an allowable print number de-  
termined in accordance with the service life of  
said photosensitive member (3); 10  
characterized in that  
said electrophotographic apparatus further  
comprises update means (31, 32, 33, 81 -86)  
for setting the print number data stored in said  
recording means (RD) to a value close to the 15  
allowable print number when the operation of  
said indicating means (87) is checked.

2. An electrophotographic apparatus according to  
claim 1, characterized in that said recording  
means (RD) further stores allowable print num-  
ber data representing said allowable print num-  
ber, and said update means (31, 32, 33, 81 -  
86) includes means for changing said allowa-  
ble print number data when said photosensitive 25  
member (3) is replaced.
3. An electrophotographic apparatus according to  
claim 1 or 2, characterized in that said update  
means (31, 32, 33, 81 - 86) includes means for 30  
setting said print number data stored in said  
recording means (RD) to zero when the re-  
cording means (RD) is initialized.
4. An electrophotographic apparatus according to 35  
claim 1, characterized in that said update  
means (31, 32, 33, 81 - 86) includes an input  
section (81 - 86), a memory (33), and data  
processing means (31) for transferring data  
stored in said recording means to said mem-  
ory, changing the data stored in said memory  
(33) in accordance with the operation of said  
input section (81 - 86), and transferring the  
data stored in said memory (33) to said re-  
cording means (RD). 45
5. An electrophotographic apparatus according to  
claim 1 characterized in that said elec-  
trophotographic apparatus further comprises a  
cabinet (1), and in that said printing means (2, 50  
5, 12) includes a unit (2) detachably mounted  
to said cabinet (1) and constituted by at least  
said photosensitive member (3).

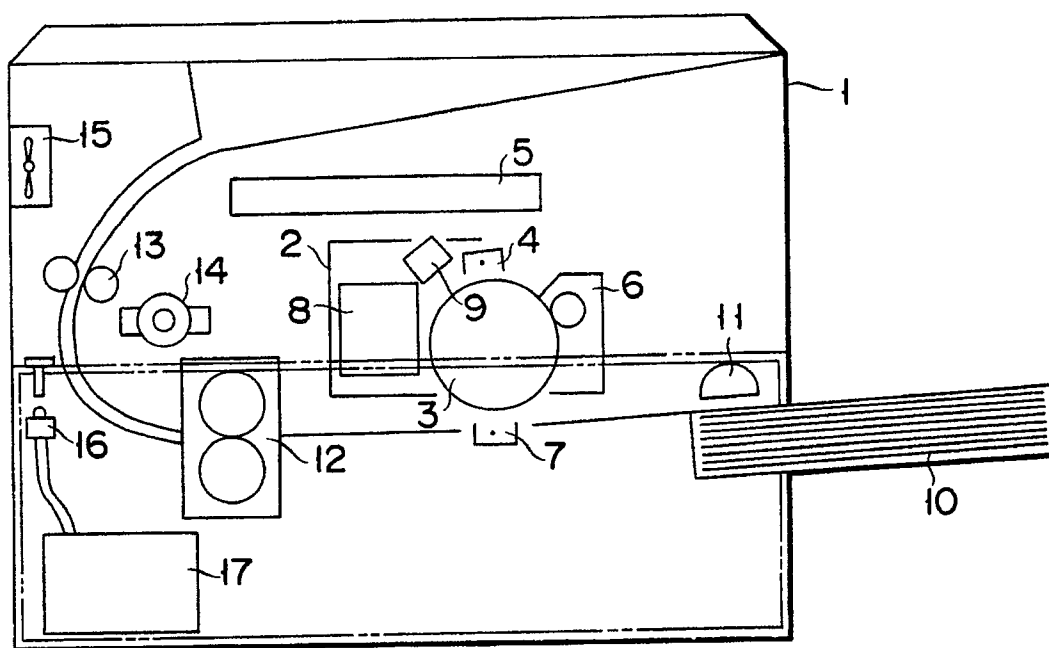


FIG. 1

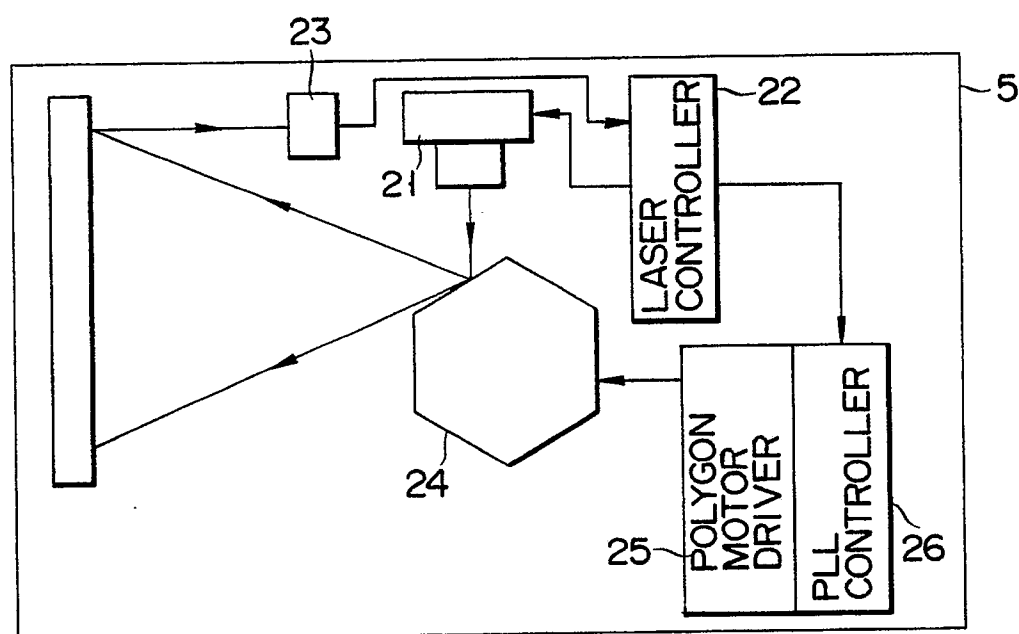


FIG. 2



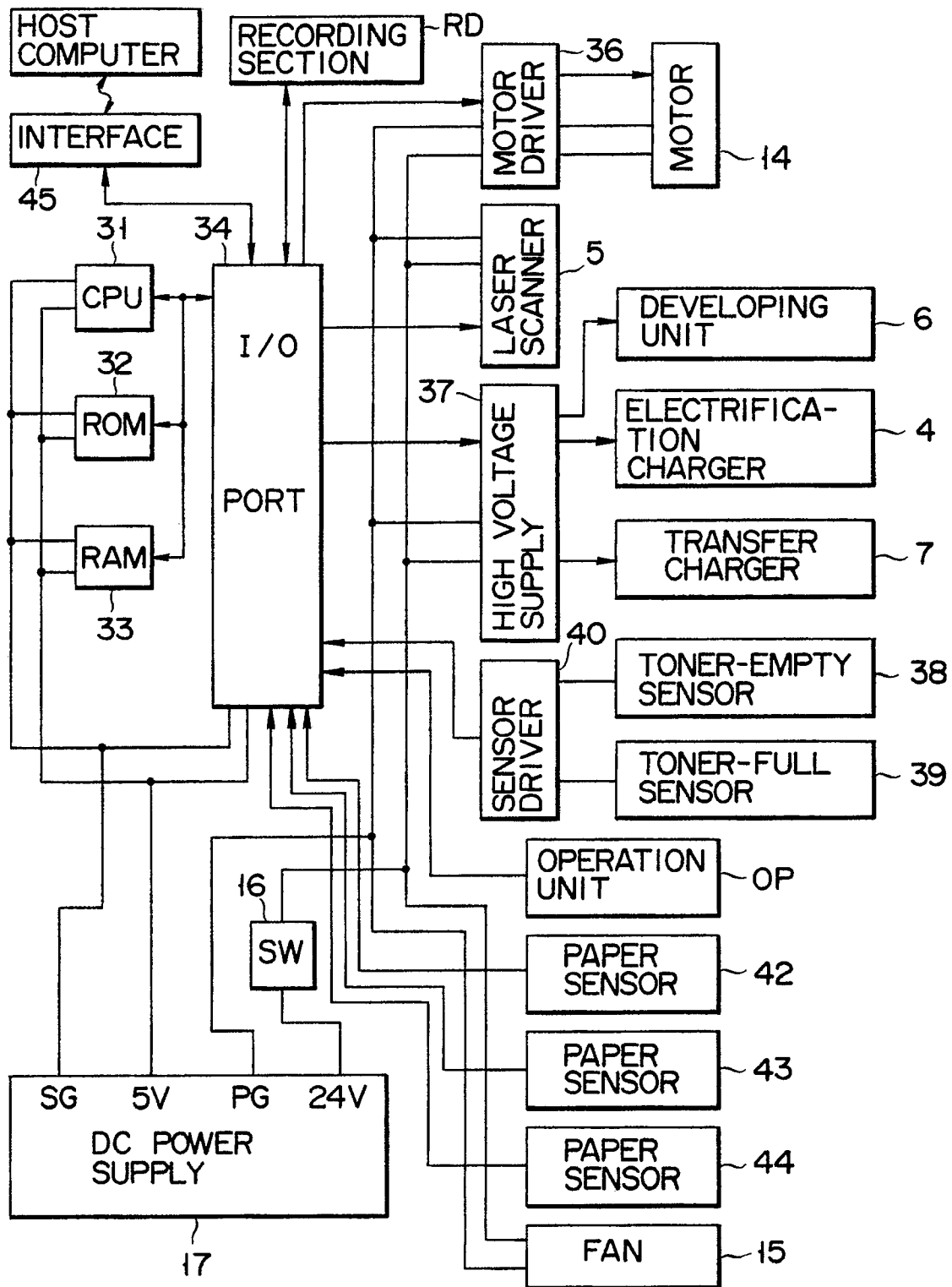


FIG. 3

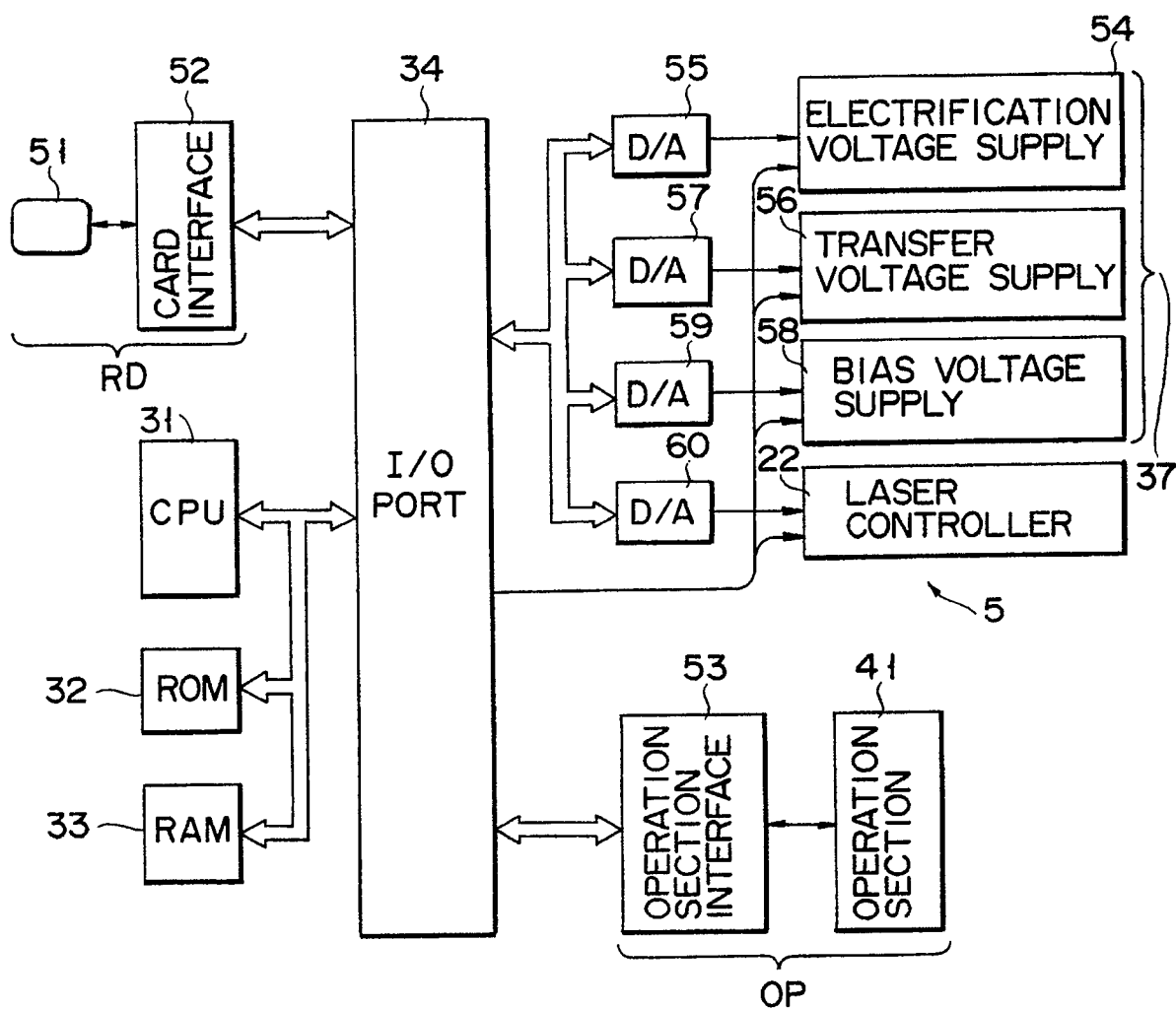


FIG. 4

|    | PRINT<br>NUMBER A | ELECTRI-<br>FICATION<br>VOLTAGE | TRANSFER<br>VOLTAGE | BIAS<br>VOLTAGE | LASER<br>OUTPUT |
|----|-------------------|---------------------------------|---------------------|-----------------|-----------------|
| #1 | $0 \leq A < B/2$  | -6000V                          | -5000V              | -300V           | 3mW             |
| #2 | $B/2 \leq A < B$  | -7000V                          | -6000V              | -400V           | 4mW             |

FIG. 5

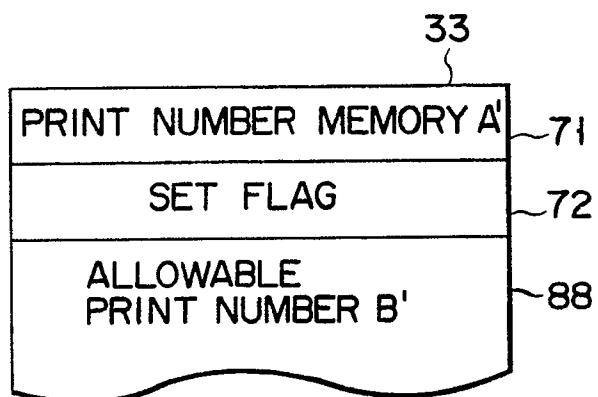


FIG. 6

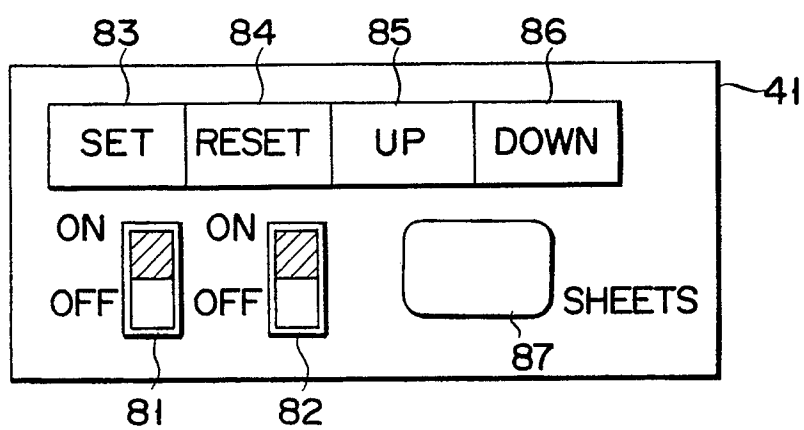


FIG. 7

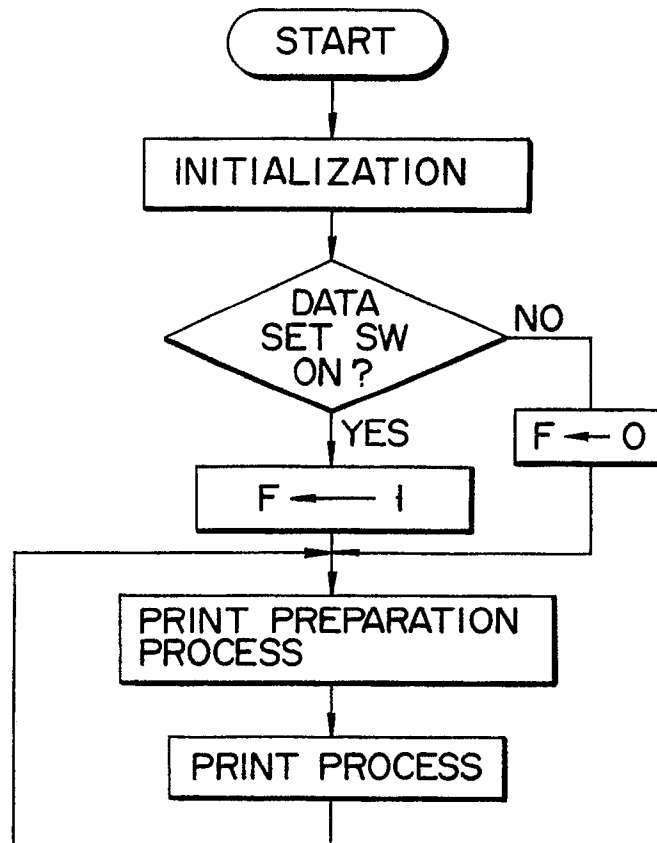


FIG. 8

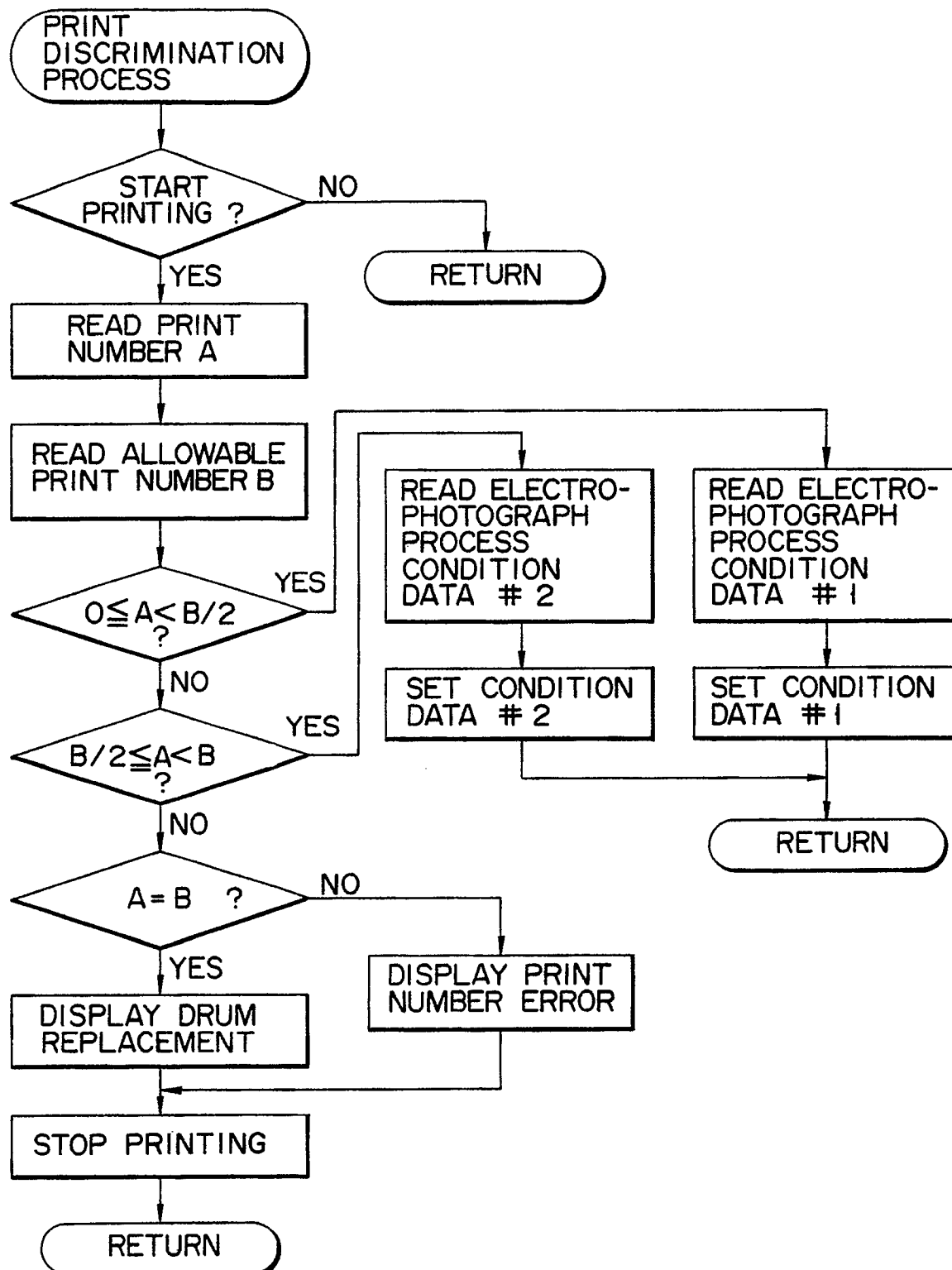
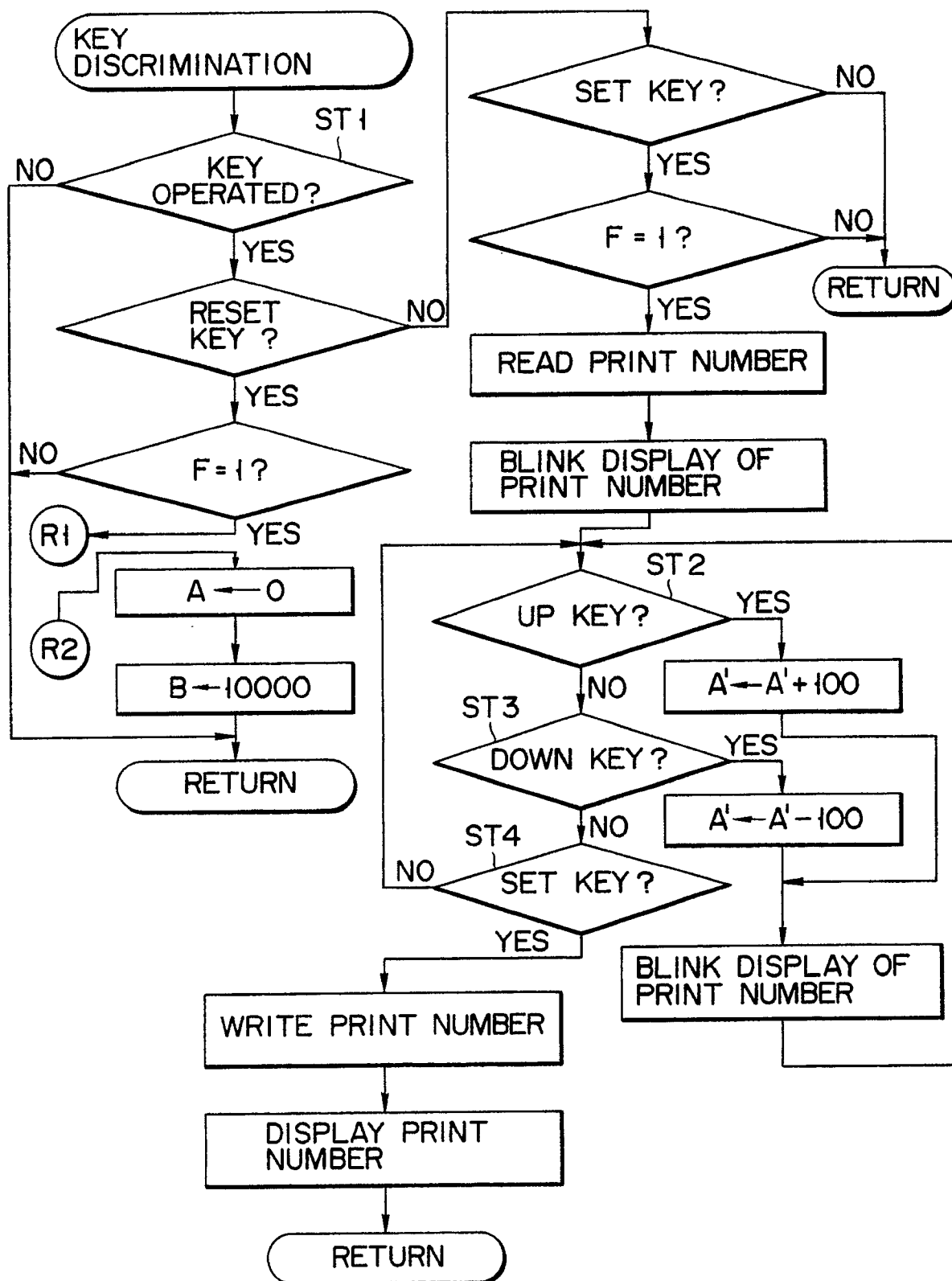
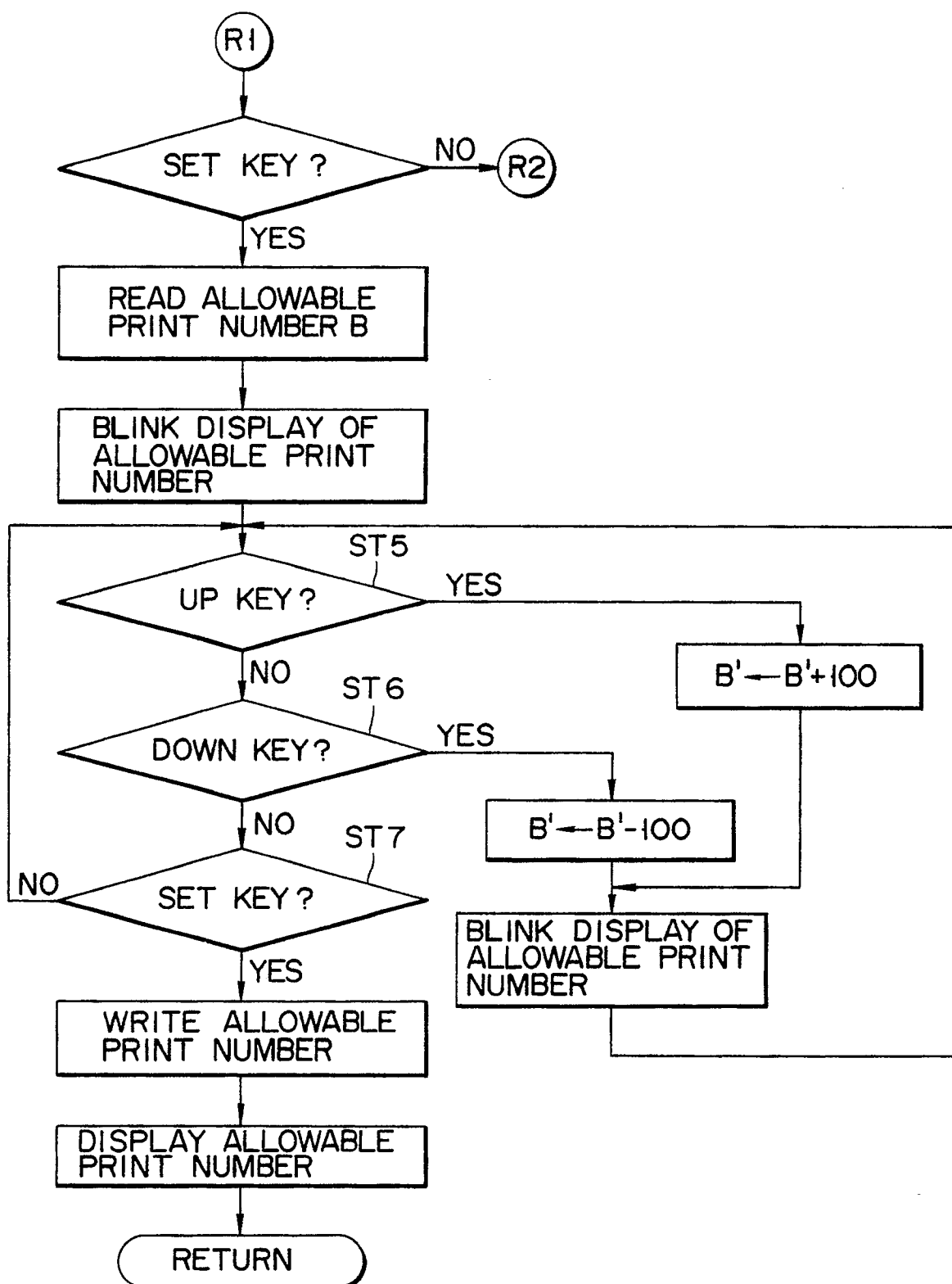


FIG. 9



F I G. 10A



F I G. 10B