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United States Patent [19]

Edwards

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[45] **Date of Patent:** **Nov. 25, 1997**

[54] **INK LEVEL SENSING FOR DISPOSABLE INK JET PRINT HEAD CARTRIDGES**

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[73] Assignee: **Lexmark International, Inc.**, Lexington, Ky.

[21] Appl. No.: **980,847**

[22] Filed: **Nov. 24, 1992**

[51] **Int. Cl.**^{6} **B41J 2/195**; B41J 29/393

[52] **U.S. Cl.** **347/7**; 347/19

[58] **Field of Search** .... 346/140 R; 347/7, 347/9, 19; 73/295, 290 R; 340/618, 653

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Primary Examiner—David Yockey
Attorney, Agent, or Firm—John J. McArdle, Jr.; Ronald K. Aust

[57] **ABSTRACT**

A printer having a disposable print head which contains a consumable ink supply includes the capability of determining the level of ink in the print head without directly measuring the ink supply. The print head includes a number of resistors which can be driven to an open circuit condition by the printer. The printer includes a counter and memory for tracking the usage of the print head and a driver for selectively driving the print head resistors to an open circuit condition based upon such usage. The printer is also capable of detecting the condition of the resistors on the print head and producing a resultant visual display.

8 Claims, 10 Drawing Sheets

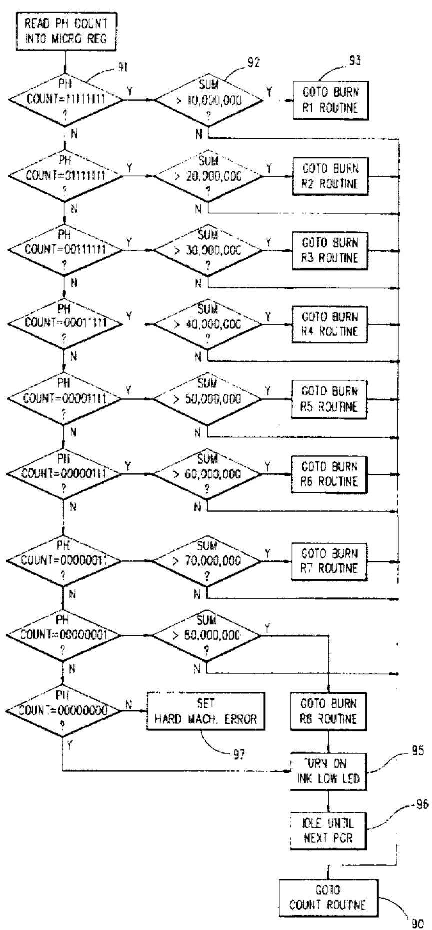


FIG. 1

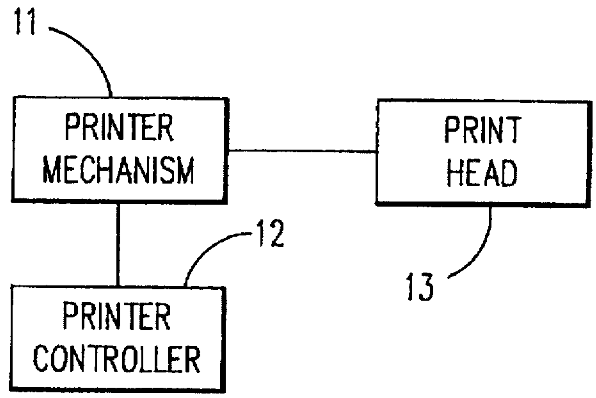

11
PRINTER MECHANISM
PRINT HEAD
12
13
PRINTER CONTROLLER

FIG. 4

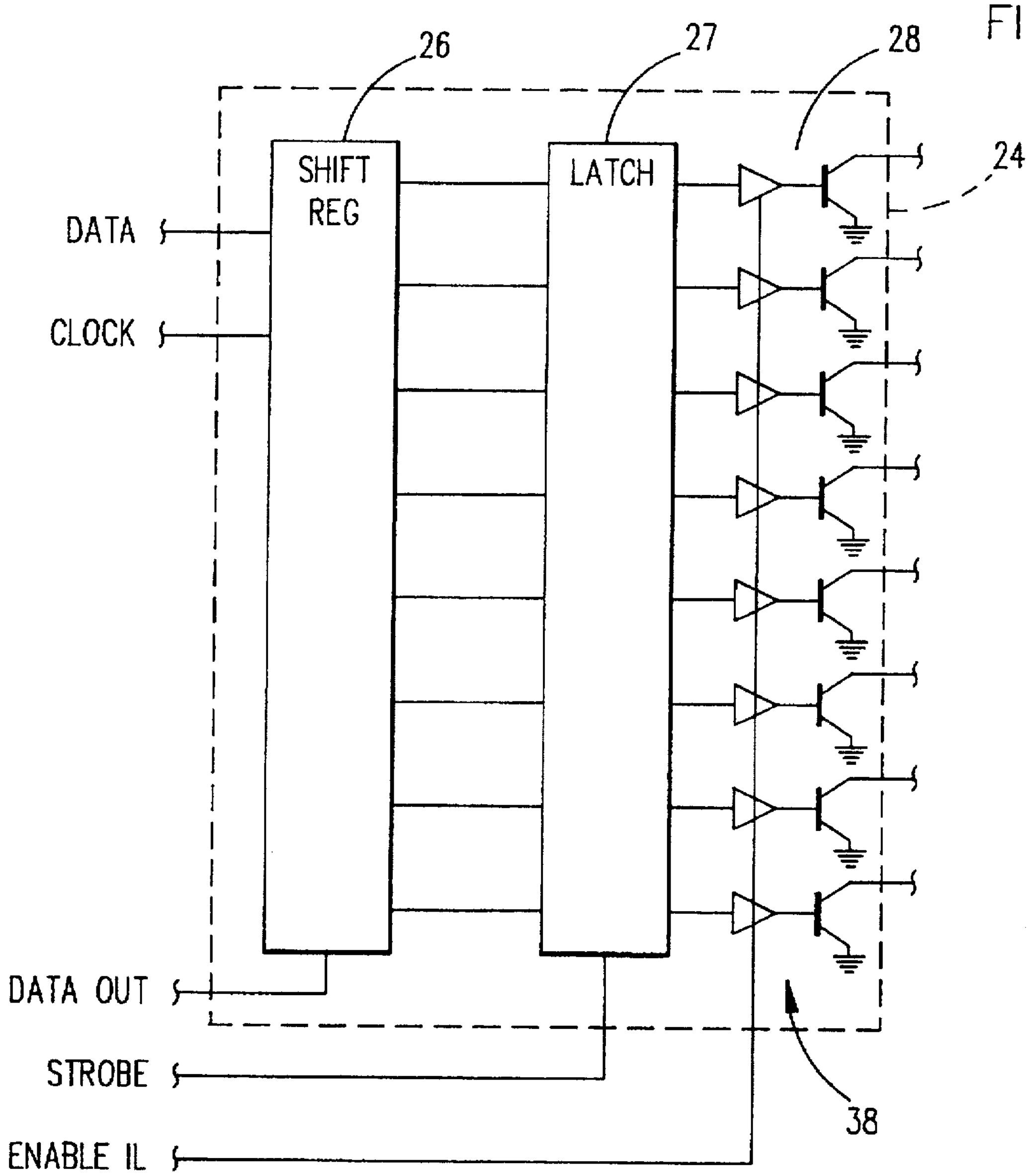

26
27
28
24
SHIFT REG
LATCH
DATA
CLOCK
DATA OUT
STROBE
ENABLE IL
38

FIG. 2

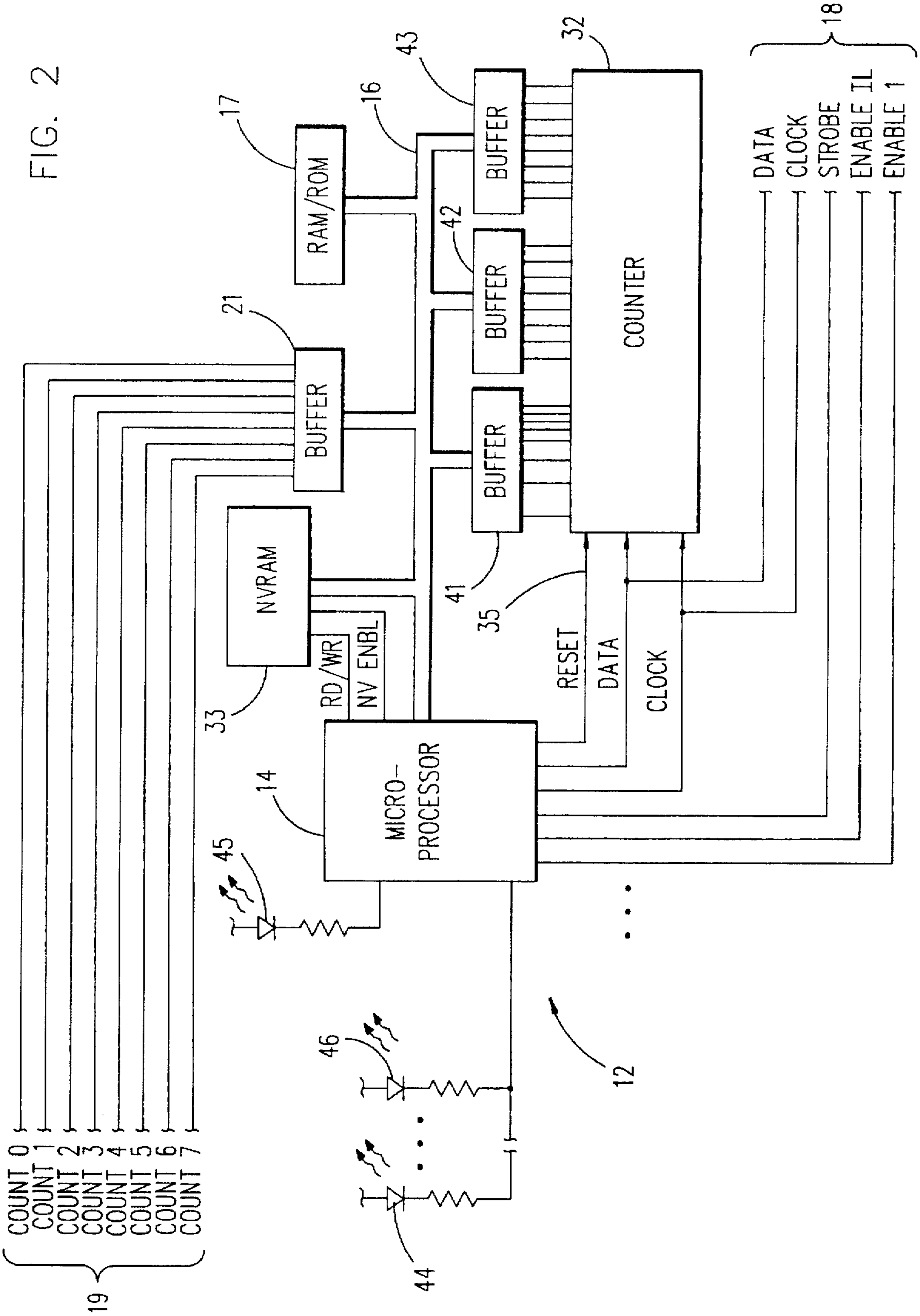

RAM/ROM
BUFFER
BUFFER
BUFFER
BUFFER
COUNTER
NVRAM
RD/WR
NV ENBL
MICRO-PROCESSOR
RESET
DATA
CLOCK
DATA
CLOCK
STROBE
ENABLE IL
ENABLE 1
COUNT 0
COUNT 1
COUNT 2
COUNT 3
COUNT 4
COUNT 5
COUNT 6
COUNT 7
12
14
16
17
18
19
21
32
33
35
41
42
43
44
45
46

FIG. 3

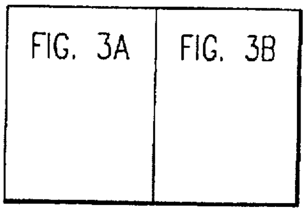


FIG. 3A
FIG. 3B

FIG. 3A

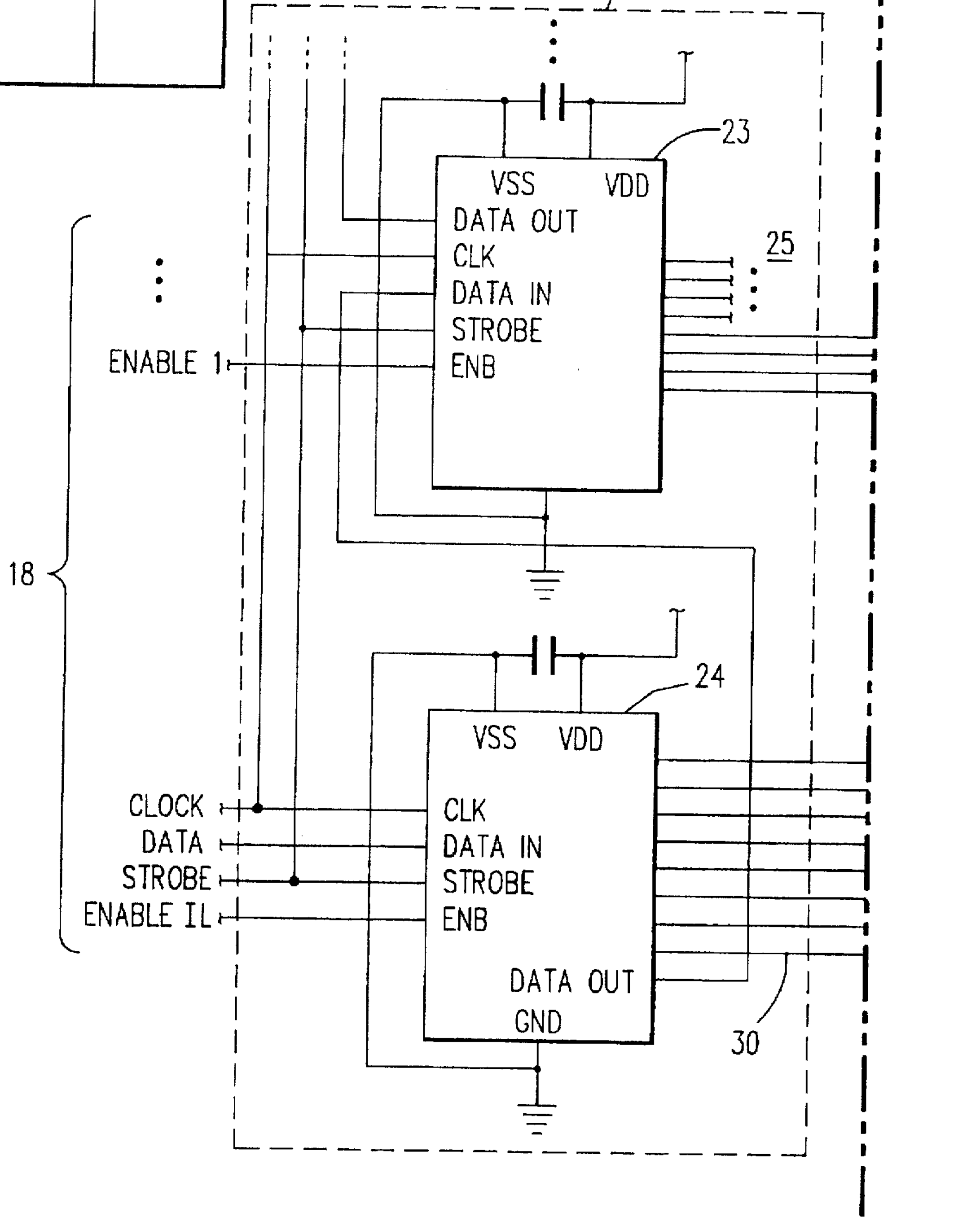

22
23
VSS
VDD
DATA OUT
CLK
DATA IN
STROBE
ENB
25
ENABLE 1
18
24
VSS
VDD
CLOCK
DATA
STROBE
ENABLE IL
CLK
DATA IN
STROBE
ENB
DATA OUT
GND
30

FIG. 3B

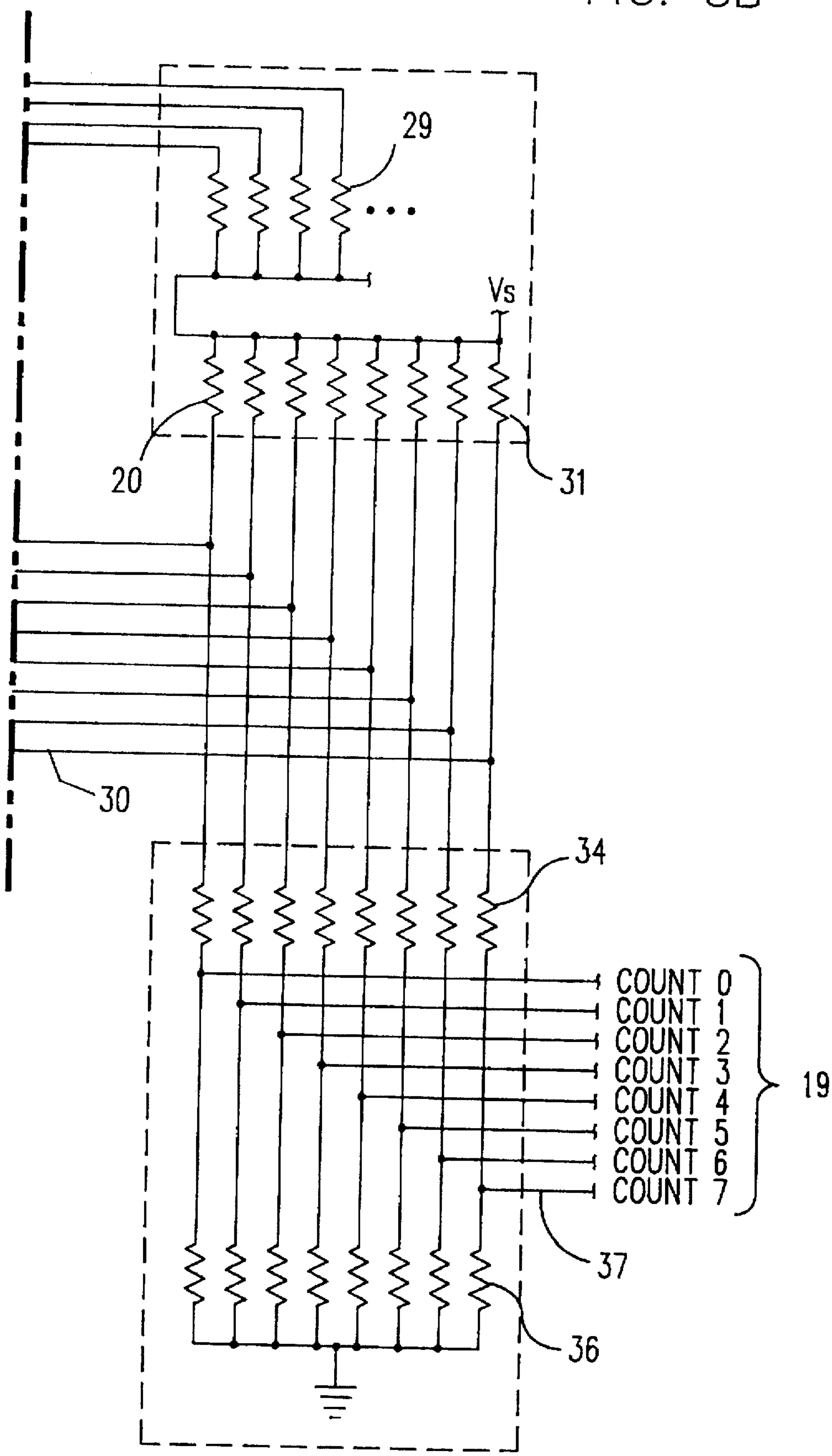

29
Vs
20
31
30
34
COUNT 0
COUNT 1
COUNT 2
COUNT 3
COUNT 4
COUNT 5
COUNT 6
COUNT 7
19
37
36

FIG. 5

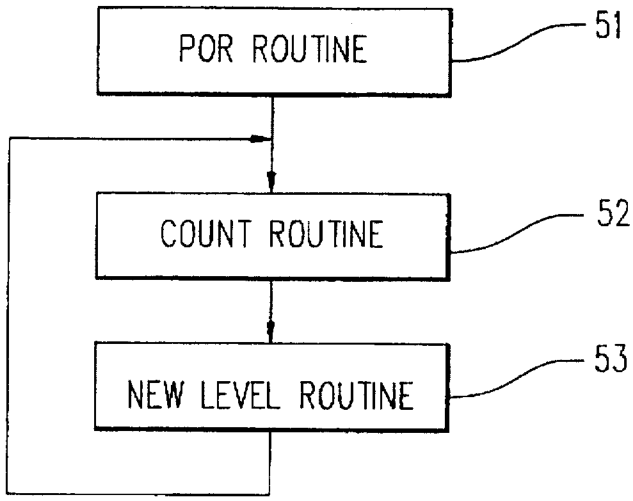
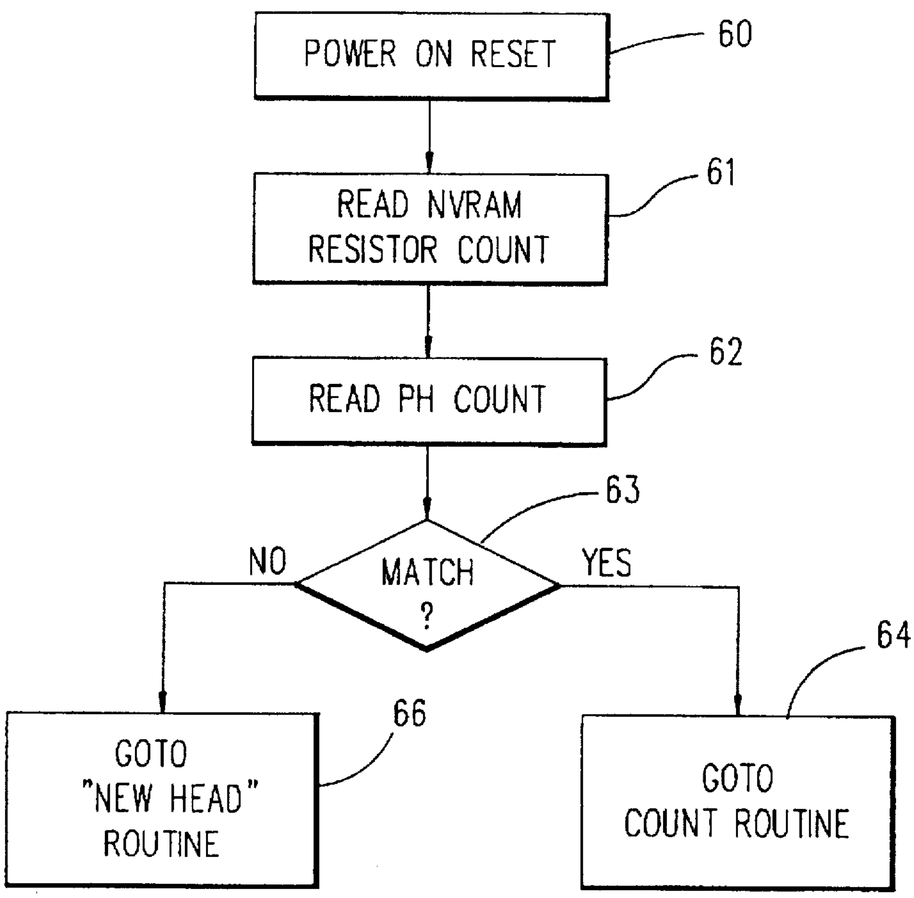

POR ROUTINE
51
COUNT ROUTINE
52
NEW LEVEL ROUTINE
53

FIG. 6


POWER ON RESET
60
READ NVRAM RESISTOR COUNT
61
READ PH COUNT
62
63
MATCH ?
NO
YES
64
66
GOTO "NEW HEAD" ROUTINE
GOTO COUNT ROUTINE

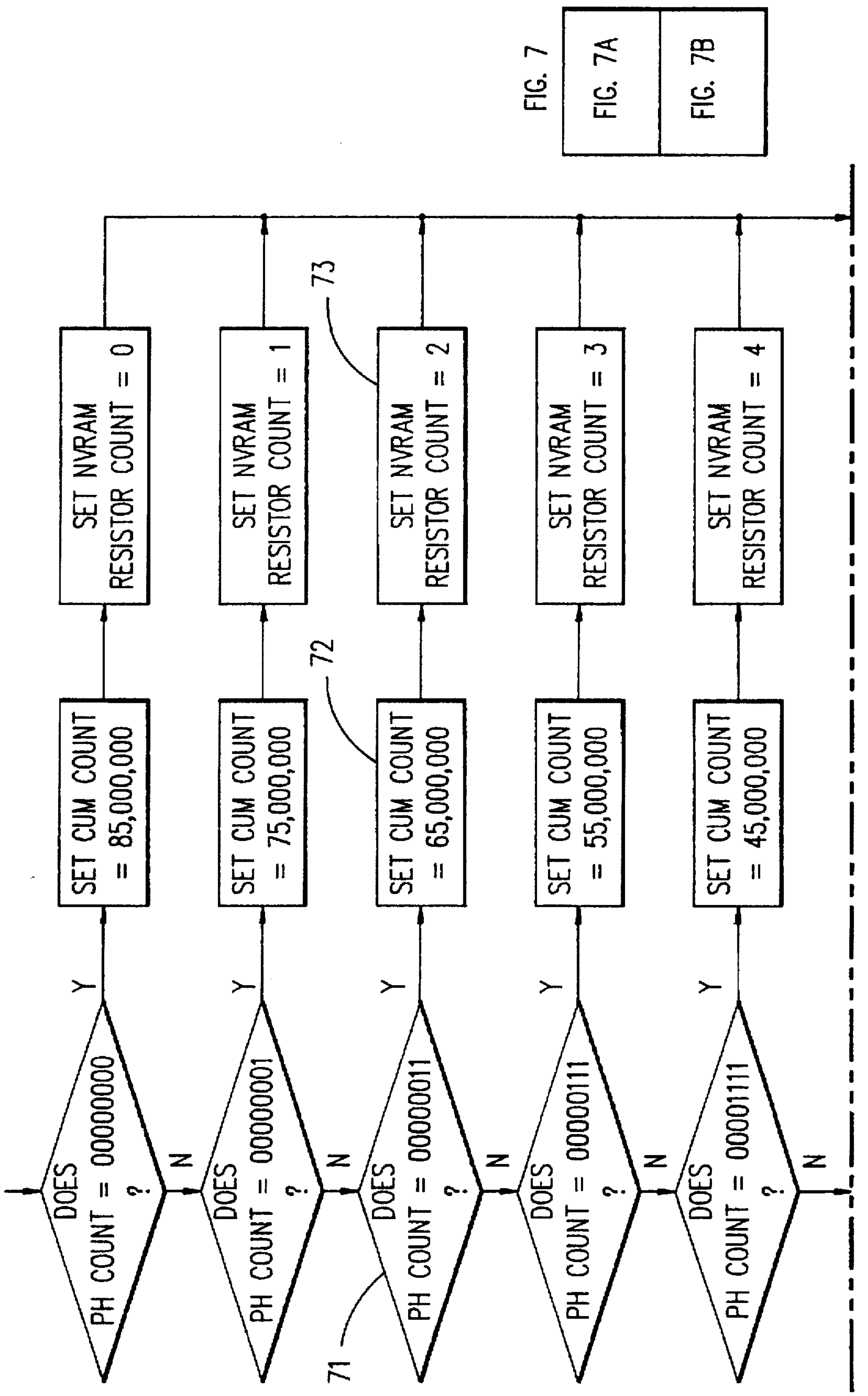


FIG. 7
FIG. 7A
FIG. 7B
DOES PH COUNT = 00000000 ?
DOES PH COUNT = 00000001 ?
DOES PH COUNT = 00000011 ?
DOES PH COUNT = 00000111 ?
DOES PH COUNT = 00001111 ?
Y
N
SET CUM COUNT = 85,000,000
SET CUM COUNT = 75,000,000
SET CUM COUNT = 65,000,000
SET CUM COUNT = 55,000,000
SET CUM COUNT = 45,000,000
SET NVRAM RESISTOR COUNT = 0
SET NVRAM RESISTOR COUNT = 1
SET NVRAM RESISTOR COUNT = 2
SET NVRAM RESISTOR COUNT = 3
SET NVRAM RESISTOR COUNT = 4
71
72
73

FIG. 7A

FIG. 7B

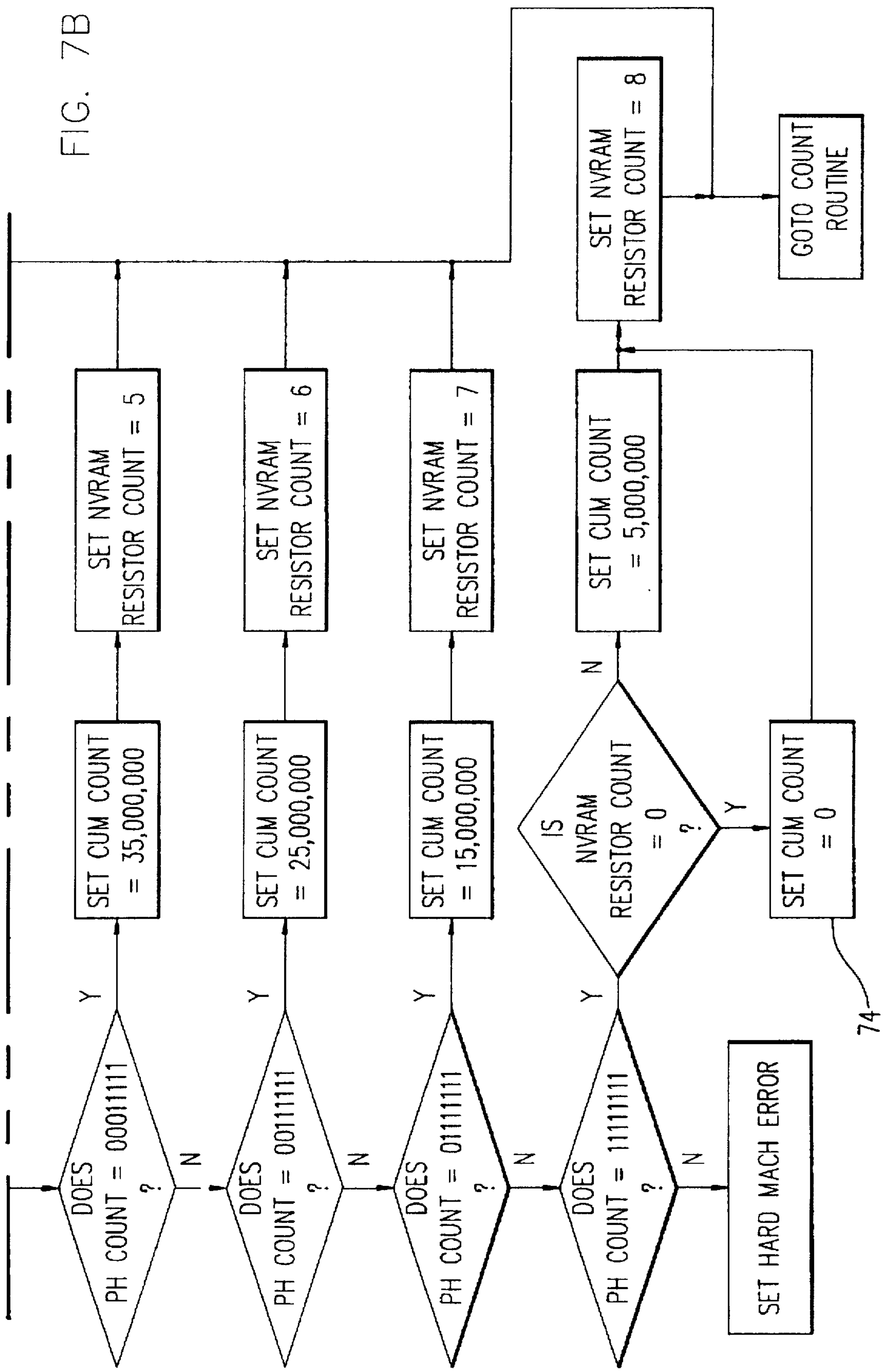

DOES PH COUNT = 00011111 ?
Y
N
SET CUM COUNT = 35,000,000
SET NVRAM RESISTOR COUNT = 5
DOES PH COUNT = 00111111 ?
SET CUM COUNT = 25,000,000
SET NVRAM RESISTOR COUNT = 6
DOES PH COUNT = 01111111 ?
SET CUM COUNT = 15,000,000
SET NVRAM RESISTOR COUNT = 7
DOES PH COUNT = 11111111 ?
IS NVRAM RESISTOR COUNT = 0 ?
SET CUM COUNT = 5,000,000
SET CUM COUNT = 0
SET NVRAM RESISTOR COUNT = 8
GOTO COUNT ROUTINE
SET HARD MACH ERROR
74

FIG. 8

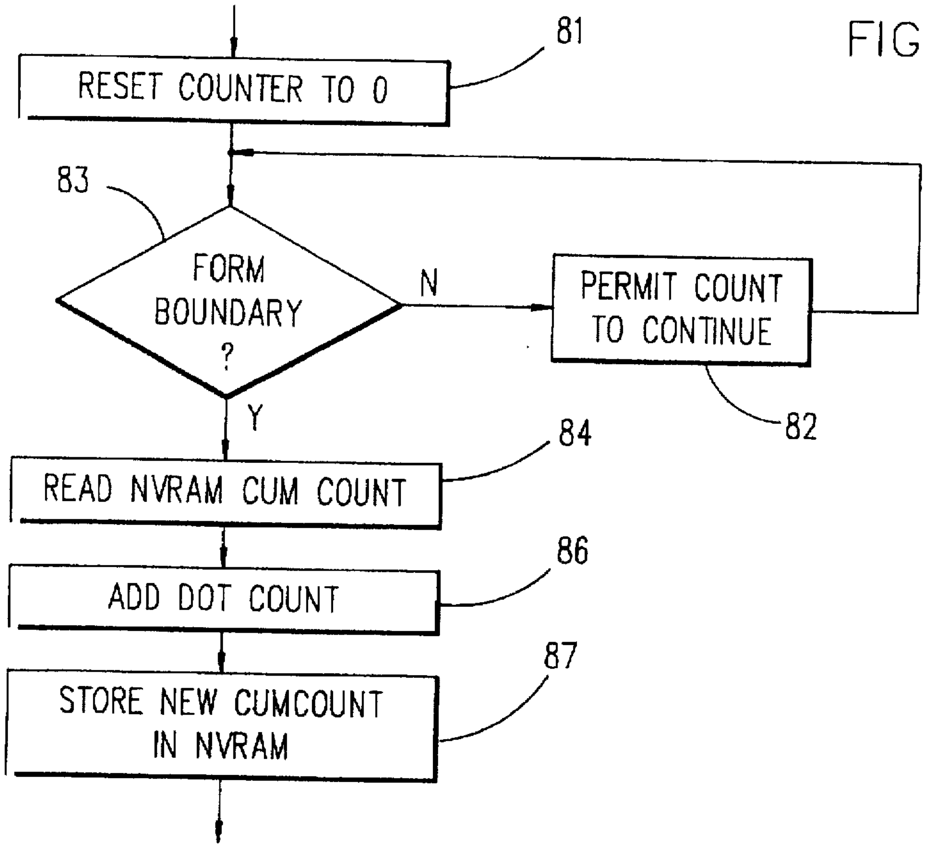

RESET COUNTER TO 0
81
83
FORM BOUNDARY ?
N
PERMIT COUNT TO CONTINUE
82
Y
READ NVRAM CUM COUNT
84
ADD DOT COUNT
86
STORE NEW CUMCOUNT IN NVRAM
87

FIG. 10

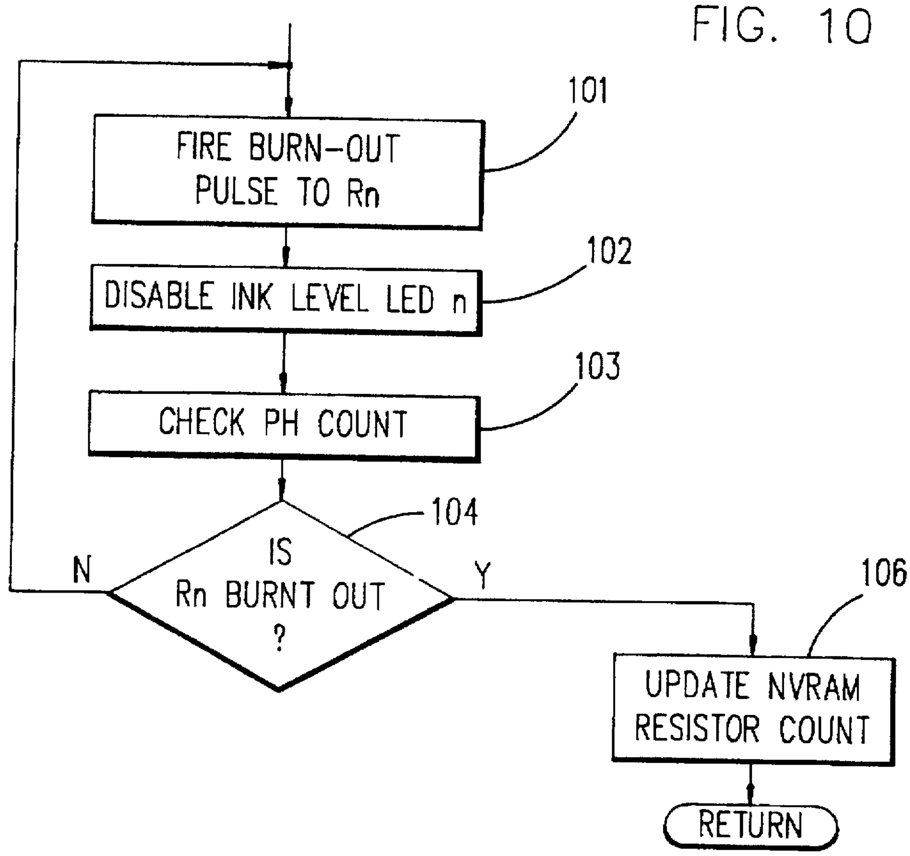

FIRE BURN-OUT PULSE TO Rn
101
DISABLE INK LEVEL LED n
102
CHECK PH COUNT
103
104
IS Rn BURNT OUT ?
N
Y
106
UPDATE NVRAM RESISTOR COUNT
RETURN

FIG. 9A

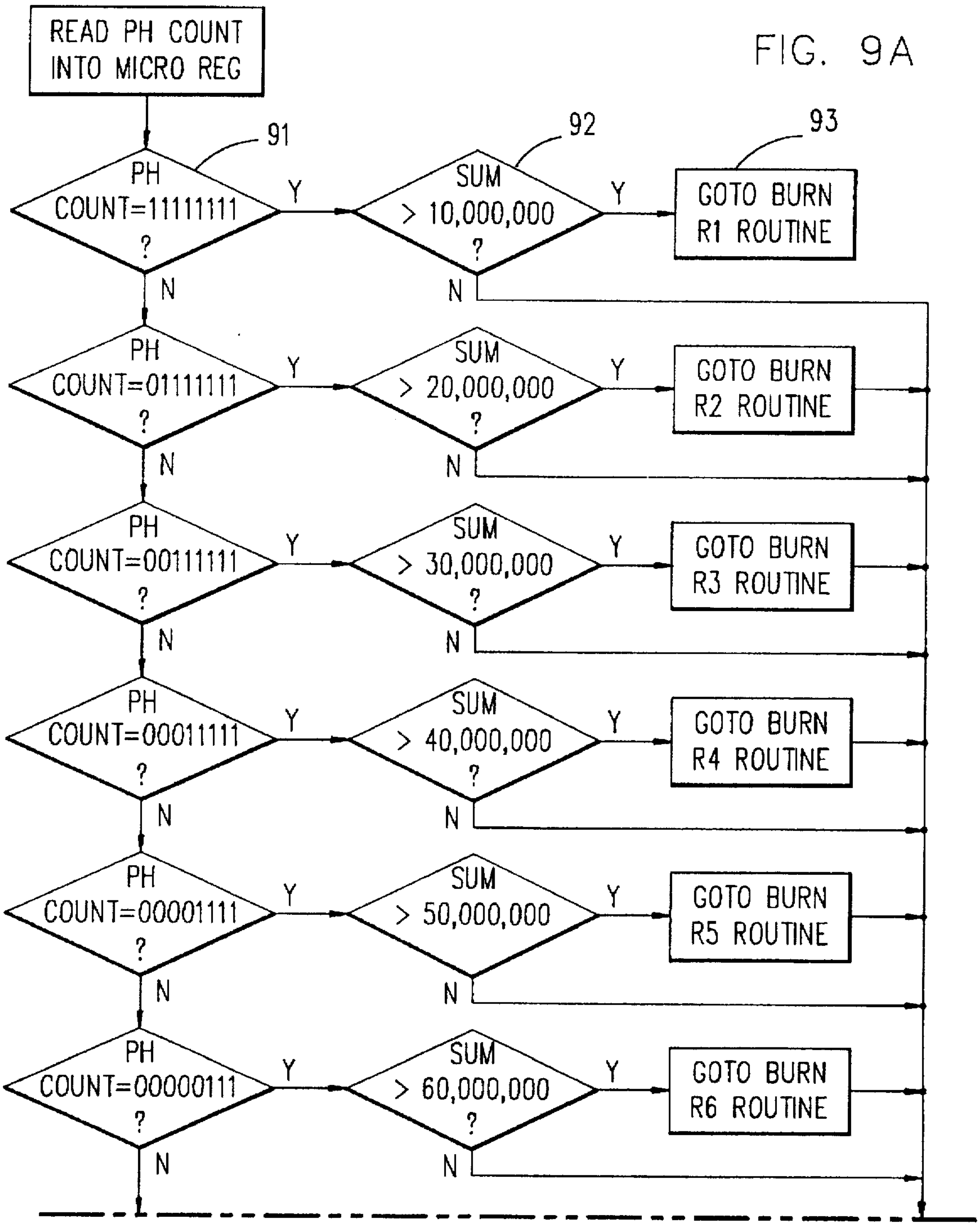

READ PH COUNT INTO MICRO REG
91
92
93
PH COUNT=11111111 ?
SUM > 10,000,000 ?
GOTO BURN R1 ROUTINE
PH COUNT=01111111 ?
SUM > 20,000,000 ?
GOTO BURN R2 ROUTINE
PH COUNT=00111111 ?
SUM > 30,000,000 ?
GOTO BURN R3 ROUTINE
PH COUNT=00011111 ?
SUM > 40,000,000 ?
GOTO BURN R4 ROUTINE
PH COUNT=00001111 ?
SUM > 50,000,000
GOTO BURN R5 ROUTINE
PH COUNT=00000111 ?
SUM > 60,000,000 ?
GOTO BURN R6 ROUTINE
Y
N

FIG. 9

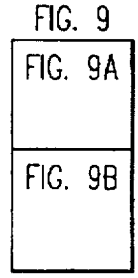
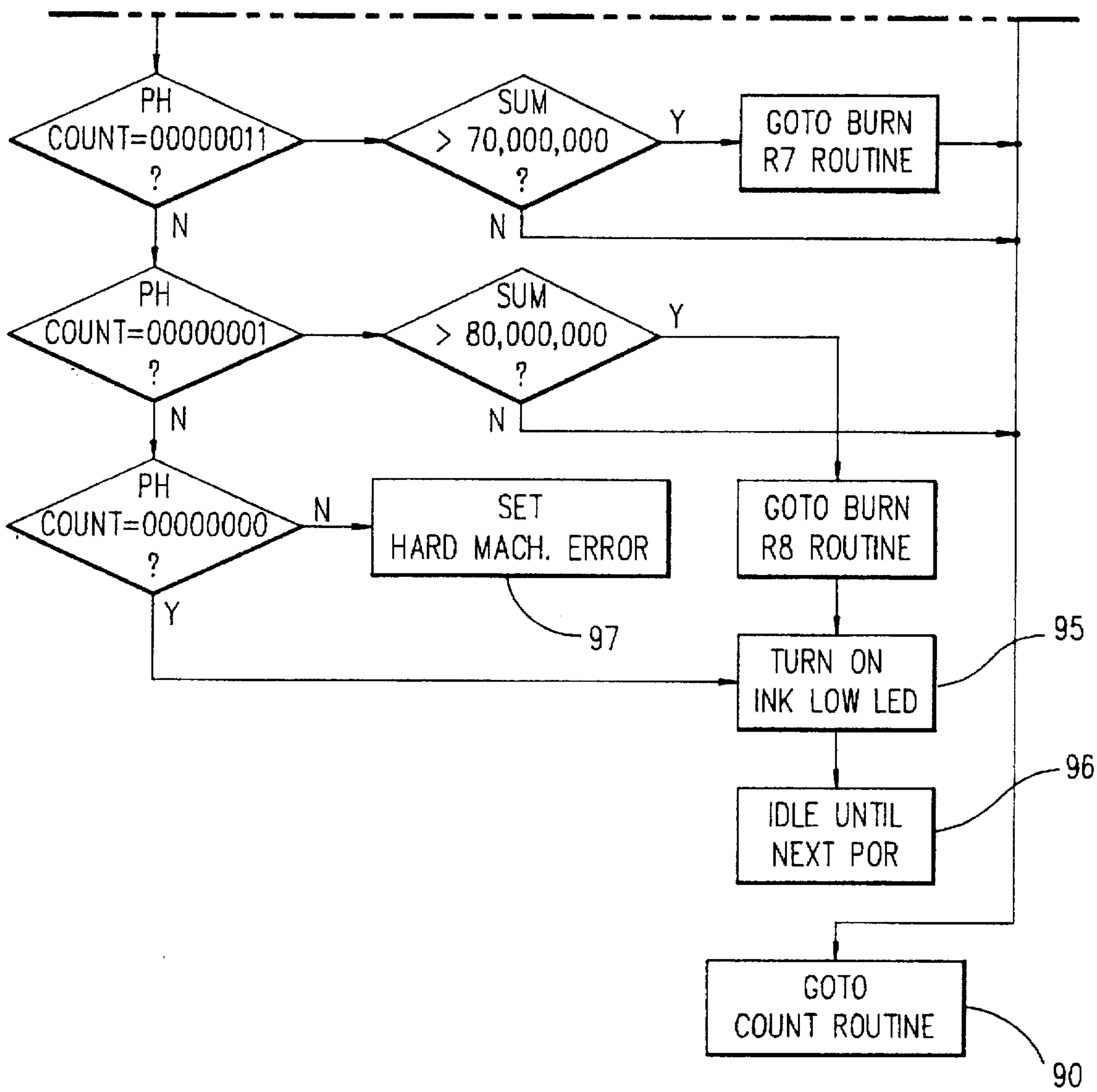


FIG. 9A
FIG. 9B

FIG. 9B


PH
COUNT=00000011
?
N
SUM
> 70,000,000
?
Y
N
GOTO BURN
R7 ROUTINE
PH
COUNT=00000001
?
N
SUM
> 80,000,000
?
Y
N
PH
COUNT=00000000
?
N
Y
SET
HARD MACH. ERROR
97
GOTO BURN
R8 ROUTINE
TURN ON
INK LOW LED
95
IDLE UNTIL
NEXT POR
96
GOTO
COUNT ROUTINE
90

INK LEVEL SENSING FOR DISPOSABLE INK JET PRINT HEAD CARTRIDGES

BACKGROUND OF THE INVENTION

This invention relates generally to printers and more particularly concerns printers with an ink supply, and monitoring of the level of ink in the ink supply. The invention is disclosed particularly in relation to an ink jet printer having a disposable ink jet print head containing an ink supply.

Exemplary of printers having a consumable ink supply are ink jet printers which apply droplets of ink onto a medium to effect printing. It would be useful to know the level of ink available for printing in such a printer in order to prevent, for example, exhaustion of the ink supply in the course of printing a page.

There have been ink jet printers which have provided "ink low" indications. Early ink jet printers had ink reservoirs; and they used floating contacts, limit switches or thermistors in a number of ink level sensing schemes. In today's "drop-on-demand" ink jet printers, at least one such printer uses a reservoir float for an "ink low" sensor, together with a lifetime print head and replaceable ink cartridges connected to that print head.

However, the majority of lower cost ink jet printers use disposable cartridges including both print head and ink. The cartridges are very inexpensive but do not lend themselves readily to previously used ink level sensing approaches, for reasons such as the small size and low price point of these cartridges.

Ink jet printers utilizing such disposable print head cartridges generally do not provide ink level sensing. If there is no ink level indication provided to the user of a printer, there will be inaccurate or complete lack of warning before a cartridge runs out of ink. In such a case the ink may run out in the course of printing a page, and then the print job must be redone.

It is the general aim of the invention to provide ink level monitoring in an ink jet printer which utilizes replaceable ink cartridges. The invention is particularly suited for use in ink jet printers which employ removable and disposable print head and ink cartridges.

In carrying out the invention, a printer is provided which includes a disposable print head with an ink supply; the print head being actuatable to dispense ink from the ink supply onto a record medium. The printer further includes means for maintaining a cumulative record of actuations of the print head and means which are responsive to this cumulative record for causing a physical change in the print head.

In one embodiment of the invention, to be described hereinafter, the record of actuation of the print head is maintained in a memory which periodically receives a count of ink drops to be fired by the print head. In this exemplary printer, the print head includes a number of resistors which are periodically driven to an open circuit condition as the droplet count in the memory increases. The printer is capable of detecting the condition of the resistors in the print head in order to provide an indication of the ink level in the print head.

Further advantages and uses of the invention will become apparent in the following detailed description, with regard to which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a generalized block diagram of a printer employing the present invention;

FIG. **2** is a more detailed block diagram of a portion of a controller for the printer of FIG. **1**;

FIG. **3**, made up of FIG. **3A** and FIG. **3B**, is a more detailed block diagram of portions of the printer controller and of the print head of FIG. **1**;

FIG. **4** is a diagrammatic illustration of a print module head driver of FIG. **3**;

FIG. **5** is a flowchart of the ink level sensing and checking process carried out by the microprocessor of FIG. **2**;

FIG. **6** is a flowchart of the power on reset routine of the flowchart of FIG. **5**;

FIG. **7**, made up of FIG. **7A** and FIG. **7B**, is a flowchart of the "new head" routine of FIG. **6**;

FIG. **8** is a flowchart of the count routine shown in FIG. **5**;

FIG. **9**, made up of FIG. **9A** and FIG. **9B**, is a flowchart of the new level routine of FIG. **5**; and

FIG. **10** is a flowchart of a typical burn resistor routine of FIG. **9**.

DETAILED DESCRIPTION

The invention will be described with reference to a "drop-on-demand" ink jet printer made up of a printer mechanism **11**, a printer controller **12** and a replaceable print head **13**, as shown diagrammatically in FIG. **1**. As will be described in more detail subsequently, the printer controller **12** is a microprocessor-based controller, and the print head **13** is a cartridge which includes an ink supply and a number of heater resistors. The heater resistors are in nozzle chambers which communicate with the ink supply. Driving a heater resistor causes the formation of a bubble on the heater in the nozzle chamber, resulting in the jetting of an ink droplet through a nozzle in the nozzle chamber. In accordance with this embodiment of the invention, the print head **13** also includes ink level indicating resistors which are selectively driven to an open circuit condition as ink is used from the ink supply in the cartridge.

With regard to FIG. **2**, the printer controller **12** includes a microprocessor **14** for controlling the paper feed and print head movement in the ink jet printer, firing of the heaters in the print head **13** (FIG. **1**), and controlling the other functions of the printer. In one form of the invention, the microprocessor **14** (FIG. **2**) was a Motorola 68008 microprocessor. The operation of the microprocessor **14** will be described herein only to the extent necessary to disclose the present invention. The microprocessor **14** is coupled by a bus **16**, which in the present case is an eight bit bus, to suitable random access and read-only-memory **17** to permit the microprocessor to control the print mechanism and print head. The print head DATA, CLOCK, STROBE and various ENABLE lines, collectively designated **18**, connect the microprocessor **14** with print head drivers, which serve to energize the bubble jet print head resistors and also eight ink level indicating resistors. The eight print head ink level indicating resistors are also connected by print head COUNT lines, collectively designated **19**, to the microprocessor **14** by way of the bus **16** and a tri-state buffer **21**.

With reference now to FIG. **3**, a print head driver circuit **22** in the printer mechanism is made up of a number of print head driver modules such as **23** which receive data serially and output bubble jet nozzle fire pulses on a group of parallel lines **25**. A 1 in the serial data stream associated with one of the lines **25** causes a nozzle to fire on the head when firing is enabled. The illustrated driver modules are UCN 5821 driver modules.

Heater resistors in ink jet nozzle chambers in the print head are driven by several driver modules such as **23**, while an extra driver module **24** identical to module **23** is provided for burn-out resistors which indicate print head cartridge ink level. The burn-out resistors used to indicate print head ink level are segregated from the heater resistors, which are in nozzle chambers in the print head. As shown in FIG. **4**, each of the driver modules such as module **24** includes an eight bit serial-in, parallel-out shift register **26**, an eight bit latch **27**, and eight Darlington driver transistors such as **28**. Serial data on the DATA line is shifted into the shift register **26** with each activation of the CLOCK line by the microprocessor **14** (FIG. **2**). The several driver modules such as **23** used to drive the ink jet heater resistors, and the driver module **24**, used to burn out the ink level resistors, are daisy chained (DATA OUT of one module connected to DATA IN of the next) so that all the ink drop firing data for all of the print head nozzles, or all of the resistor burn out data, can be serially shifted into the shift registers of the driver modules. When all of the modules' shift registers have been loaded with data, the data in the modules is transferred from the shift registers **26** to the latches **27** when the STROBE line is activated by the microprocessor. Each driver module's output driver transistors, such as the driver transistor **28**, are enabled to fire when the module's ENABLE line goes active if the associated latch data bit is a 1, or at a logic "high". In normal printing operation, the drivers such as **23** are sent print data while the ink level resistor driver **24** is sent zeroes, all in the same serial data transfer. For ink level resistor operation, the heater drivers such as **23** are sent zeroes, and the driver **24** is sent data all in one serial transfer.

Both the ink jet heater resistors such as **29** (FIG. **3**) and the ink level-indicating burn-out resistors such as **31** are on the print head and are connected on one side to the DC supply voltage VS. The other side of each resistor is connected to the collector of a drive transistor in a driver module such as **23** or **24**. The burn out resistors such as **31** are also connected to resistor dividers, such as the resistors **34** and **36**.

When not enabled by a pulse on the ENABLE line and a logic "high," or "1" in the associated latch position, the drive transistor appears as a high impedance; and no current flows through a resistor such as **29**, or just a small amount of current flows through a resistor such as **31** due to the resistor divider. When a drive transistor is enabled, it appears as a very low impedance and a large drive current flows through the associated resistor into the transistor. In the case of heater resistors such as **29**, a bubble is formed on the heater and ink is expelled from a nozzle when the heater resistor is energized. Thus, the heat resistors such as **29** function as actuators for causing dispensing of ink from an ink supply when energized through energization of the drive transistor such as **28** by a pulse.

In the case of a burn-out resistor such as **31**, the resistor heats until it burns to an open circuit condition. This open circuit condition creates a substantially irreversible significant change in resistance since an open circuit has an infinite impedance or resistance. The flow of current through the burn-out resistors such as **31** is through a resistance path.

In order to track ink usage, the microprocessor **14** (FIG. **2**) counts print head dots to be fired by monitoring the 1's on the DATA line as the 1's and 0's are clocked to the print head driver circuit **22** (FIG **3**). The microprocessor **14** (FIG. **2**) updates the cumulative count from a counter **32** into non-volatile RAM (NVRAM) **33** at the end of every form boundary, typically at the end of each page printed by the printer.

There are eight extra resistors such as **31** (FIG. **3**) on the print head which act like fuses and, as indicated earlier, they are burned to an open circuit condition when driven. The eight driver transistors in the driver module **24** drive the resistors such as **31** to an open circuit condition, one at a time, after certain amounts of print head usage.

In order to provide an indication of print head ink level, the number of open resistors is sensed, and the count of open circuited resistors is coupled back to the microprocessor **14** (FIG. **2**). A resistor divider for each burn-out resistor permits sensing an open-circuit condition. For example, the burn-out resistor **31** (FIG. **3**) is in a resistor divider made up of the sensor resistors **34** and **36**. If the drive transistor on the drive line **30** of the driver module **24** is not enabled, the voltage at the divider output **37** between the resistors **34** and **36** is about 3.6 volts, or a logic "high"to indicate a state of conductivity. In this example, VS is about 19 volts, the resistor **31** is relatively small, such as 30 ohms, while the resistor **34** is about 4.22K ohms and the resistor **36** is about 1.00K ohms. After activation of the drive transistor on the line **30**, there is a large current flow from VS through the resistor **31** into the transistor **38** (FIG. **4**), which burns the resistor open. Thereafter, the voltage at the divider output **37** (FIG. **3**) becomes extremely small, such as a few tenths of a volt, appearing as a logic "low" to indicate a state of non-conductivity. When the driver transistor turns off, after the resistor **31** is open circuited, the divider output **37** is effectively held to ground or at a logic low to remain in the state of non-conductivity. The state of each of the burn-out resistors such as **31**, as to whether it is conductive or non-conductive, is returned to the microprocessor **14** (FIG. **2**) through tri-state buffer **21** and the data bus **16**.

The counter **32**, which accumulates a count of the dots to be printed, is selected to be large enough to hold the count of activated nozzle heaters for the maximum amount of printing which can occur before the count in the counter is added to the count in the NVRAM **33** and the counter **32** is reset. In the present instance, a worst case form-boundary to form-boundary count, or the maximum dot count which the counter must be able to store before off-loading the count to the NVRAM, is a little over sixteen million dots, equivalent to an all-black graphics page. This size count requires a 24 bit counter.

The counter data is moved onto the bus **16** through tri-state buffers **41–43** and written to NVRAM **33** (FIG. **2**). Light emitting diodes such as **44** and **46** are provided on the printer operator panel for ink level indications, which are selected by the microprocessor **14** based upon the information from the sense lines **19**. An "ink low" LED **45** is also provided, and this LED is energized when all of the ink level indicating resistors such as **31** (FIG. **3**) have been open-circuited.

Turning now to FIGS. **5–10**, the microprocessor **14** executes a number of routines to effect the foregoing ink level sensing and indicating functions. These routines are illustrated in flow chart form. In the process overview shown in FIG. **5**, the microprocessor first executes a Power-On Reset routine **51**. In this routine (FIG. **6**) the processor determines if the print head has been changed since the last time the printer was powered on. The processor reads the NVRAM resistor count (**61**) and reads the print head resistor count (**62**). The processor then compares the resistor count on the print head with the resistor count saved in NVRAM from the last power down to determine if there is a match (**63**). The resistor count on the print head is determined by reading the "high" and "low" conditions of the sense points on the lines **19** (FIG. **3**) through the tri-state buffer **21** (FIG. **2**).

If the stored count and the sensed count match, it is assumed that the print head has not been replaced, and the processor proceeds (**64**) (FIG. **6**) to the Count routine. If the resistor counts do not match, it is assumed that the print head has been replaced with a new print head, and the processor proceeds (**66**) to the "new head" routine (FIG. **7**).

The "new head" routine (FIG. **7**) resets the cumulative count in the NVRAM based on the print head resistor count. This print head resistor count is 0–7 depending upon how many of the eight sense resistors have been open-circuited on the print head. In the exemplary form of print head, cartridge life is about 90 million ink drops, or dots. If a new print head has, for example, two count resistors intact (**71**), the NVRAM cumulative count will be set (**72**) to 65 million. This is based upon 6 open count resistors representing usage from 60 million to 70 million dots. Similarly, one open count resistor represents usage from 10 million to 20 million dots, etc. The processor also sets the resistor count in the NVRAM to the print head resistor count. In the earlier example, the NVRAM resistor count is set to "2" (**73**).

Since the point of actual usage in the possible range is not known, the midpoint for the range of usage for a particular resistor count is chosen. An exception is made in the case of a spent (eight open resistor) head being replaced by a new head. In this case, it is assumed that the new head with eight intact ink-low resistors is indeed unused and the NVRAM cumulative count is reset to zero (**74**).

With the NVRAM information properly updated by the "new head" routine (FIG. **7**), or directly after the power on reset routine **51** if it does not appear that the print head has been changed, the microprocessor executes the Count routine **52**, shown in more detail in FIG. **8**. The Count routine is continuously executed during operation of the printer to track the ink usage of the print head.

In the Count routine, the counter **32** (FIG. **2**) is reset to zero (**81**) by the microprocessor **14** via the RESET line **35**. Subsequently, logic 1's in the print data stream, which will result in the firing of ink drops, are added in a cumulative count in the counter. The counter is allowed to cumulate (**82**) (FIG. **8**) the drop counts until a form boundary is encountered (**83**), typically a form feed at the end of a page. At the form boundary, the microprocessor reads (**84**) the NVRAM cumulative count and adds (**86**) the count from the counter **32** (FIG. **2**) to the NVRAM cumulative count to .get a new sum, which is stored (**87**) (FIG. **8**) in the NVRAM **33** (FIG. **2**).

Returning to FIG. **5**, to determine if the new sum exceeds a level boundary (meaning another ⅑th of the cartridge's ink has been used up), the "New Level" routine (FIG. **9**) is entered (**53**). If the cumulative count in the NVRAM is not beyond a level boundary, the count routine is reentered (**90**), resetting the counter to zero and permitting an accumulation of dot count for the next page.

The new level routine of FIG. **9** shows how the microprocessor determines if the count is beyond a level boundary. In the new level routine the print head resistor count is loaded by the processor into a register where it is compared to the new cumulative count in the NVRAM **33** (FIG. **2**). The microprocessor then determines if a resistor should be burned open on the print head, to indicate a reduced ink level, and which resistor that should be. For example, if the print head count is all 1's (**91**) (FIG. **9**), meaning that none of the print head resistors have yet been open circuited, but the new cumulative count in NVRAM is greater than 10 million dots (**92**), it is time to burn open (**93**) the first resistor (the resistor **20** in FIG. **3**), to record that ⅑th of the cartridge's ink has been expended. If the resistor count is all 1's, but the cumulative dot count from NVRAM is not yet greater than 10 million (**92**) (FIG. **9**), the level boundary has not been reached and the microprocessor returns (**90**) to the Count routine **52**.

For a given resistor count on the print head, if a dot count from the NVRAM **33** (FIG. **2**) indicates that a new level (of a multiple of 10 million dots) has been reached, then the appropriate next resistor on the print head is open circuited, by execution of a Burn Resistor routine to open the appropriate resistor. An exemplary Burn Resistor routine is shown in FIG. **10**, to be described subsequently.

In essence, the Burn Resistor routine (FIG. **10**) results in the loading of the appropriate serial datastream to the print head to fire a burn-out pulse to the desired ink level resistor. For example, to burn open the resistor **20** (FIG. **3**) a byte of data 10000000 is clocked into the shift register of the driver module **24** (FIG. **4**); strobed to the latch **27** in the driver module **24**; and, when the ENABLE IL line is driven, the Darlington transistor **28** is driven coupling the DC supply voltage VS through the resistor **20**, open circuiting the resistor **20** (**101**) (FIG. **10**). When the data is clocked into the driver module **24** (FIG. **3**), zeroes are clocked into all the other driver modules such as **23**.

In the present printer, ink level LED's are provided, corresponding to the resistors which can be open circuited. Therefore, in the Burn Resistor routine of FIG. **10**, after a burn-out pulse is fired to open a particular resistor, a corresponding ink level LED is turned off (**102**). The print head count is then reread (**103**) to determine if the ink low resistor has been burnt open (**104**). If not, the Burn Resistor routine is re-executed. If so, the NVRAM resistor count is updated (**106**) and the microprocessor returns to the New Level routine (FIG. **9**).

When returning from executing the Burn R8 Routine, which opens the resistor **31** (FIG. **3**), indicating that all of the count resistors on the print head are open and the ink supply is about to be exhausted, the processor turns on (**95**) (FIG. **9**) the ink low LED **45** (FIG. **2**) and idles (**96**) (FIG. **9**) until the next power-on reset. If one of the other resistors has been open circuited in a Burn Resistor routine of FIG. **10**, the processor returns to the Count routine of FIG. **9**. If an illegal resistor count is read, such as 10001111, processing stops; and a hard machine error is set (**97**).

Variations of the present ink level monitoring approach are, of course, possible. For example, more or fewer burn-out resistors could be used to provide more or less "resolution" in tracking ink usage. The drivers, sensors, counter and other circuitry can also be implemented in different ways. The frequency of updating the NVRAM count can be increased to be more often than at form boundaries. This would increase the resolution of the system in tracking the cartridge ink level. Also, rather than idling after an "ink low" indication, printing may be allowed to continue.

It should also be apparent that ink level information can be used not only for indicating ink level to the user to facilitate changing ink cartridges in a timely manner, but also for inhibiting the use of refilled ink cartridges in which all the resistors have been burned open.

What is claimed is:

1. A printer, including a disposable print head having a plurality of resistance paths, several discrete actuators, and an ink supply, comprising:

means for providing energization of each of the several discrete actuators of the print head to dispense ink from the ink supply onto a record medium;

means for maintaining a cumulative record of energizations of the print head, including a counter which stores a count of said energizations of the print head, and further including a non-volatile memory;

means for periodically adding the count from the counter into a cumulative count in the non-volatile memory; and

means, responsive to the cumulative record, for changing the resistance in the resistance paths on the print head.

2. The printer of claim 1 which further comprises means for detecting the changes in resistance in the resistance paths on the print head.

3. The printer of claim 2 in which the changes in resistance are the creations of open circuits in the resistance paths and in which the means for detecting the changes in resistance in the print head comprises means for detecting a number of open circuits in the resistance paths on the print head and further comprising means for storing the number of open circuits.

4. The printer of claim 3 which further comprises means for indicating that the ink supply in a print head is substantially depleted when the number of open circuits equals a predetermined status.

5. A method of recording an ink level on a disposable print head having a plurality of resistance paths, several discrete actuators, and an ink supply, comprising the steps of:

providing energization of each of the several discrete actuators of the print head to dispense ink from the ink supply onto a record medium;

maintaining a count of actuations of the print head in a counter;

periodically adding the count from the counter into a cumulative count in a non-volatile memory; and,

changing the resistance in the resistance paths on the print head in response to the cumulative count.

6. The method of claim 5, further comprising the step of detecting the change in resistance in the resistance paths on the print head.

7. The method of claim 6, in which the change in resistance is effected by a creation of one or more open circuits in the resistance paths and in which the step of detecting comprises detecting a number of open circuits in the resistance paths on the print head, and further comprising the step of storing the number of open circuits.

8. A printer, comprising:

a disposable print head having an ink supply, and a plurality of resistance paths segregated from a plurality of actuator circuits, wherein each of said plurality of actuator circuits includes an actuator;

means for providing actuation of each actuator of the print head to dispense ink from the ink supply onto a record medium;

means for maintaining a cumulative record of actuations of the print head, including a counter which stores a count of said actuations of the print head, and further including a non-volatile memory;

means for periodically adding the count from the counter into the cumulative record in the non-volatile memory; and

means, responsive to the cumulative record, for changing the resistance in the resistance paths on the print head.

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