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(54) Printing apparatus and initialization method thereof

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Description

[0001] This invention relates to a so-called serial printer that prints while a print head is moved relative to a recording medium. In particular, the present invention relates to a technique of preventing a loss of print data when the print head does not move correctly. Therefore, the present invention is particularly useful for printers used in systems that handle monetary data, such as POS/ECR.

[0002] Because of its structure, a serial printer needs to know the position of the print head. Without knowing the current print head position, the printer is unable to print accurately at a specified position on the recording medium. In this sense, the printer also needs to know the position at which the recording medium is mounted.

[0003] In order to set the print head at a predetermined reference position, a conventional serial printer moves the print head in a specified direction until the print head is detected by a reference position detector. Because the reference position detector normally is provided at one end of the printable area, i.e., the area in which the print head can print, the direction of motion is uniquely determined as the direction from the current position of the print head toward the reference position detector. If a reference position is not detected even after a drive motor for the print head has been operated to an extent equivalent to the amount of motion of the print head corresponding to the width of the printable area, the printer determines that the print head cannot be set at its reference position, and terminates processing by stopping the drive motor. Incidentally, the process or operation of setting the print head at its reference position is referred to as "initialization of the print head", or, simply, "initialization".

[0004] The document JP-A-2072984 discloses a method of initializing a printer intended to detect a reference position of the print head without using a reference position detector. In this prior art a rotary encoder is connected to the drive motor for the print head. First, the motor is energized to move the print head toward the reference position at one end of the printable area until the rotary encoder stops putting out pulses. Next, the motor is energized to move the print head in the opposite direction. When a predetermined number of pulses from the rotary encoder has been detected, the position from which the print head was moved in the opposite direction is judged to be the reference position and the print head is returned to this reference position.

[0005] The document US-A-4,669,900 discloses a method of detecting an out-of-step condition of a carriage of a daisy-wheel printer, i.e., a condition where the actual position of the carriage differs from the position calculated based on drive signals previously applied to move the carriage. This prior art utilizes a reference position detector. Based on the calculated current position of the carriage it is driven so as to move to the reference position and an offset position spaced apart from the reference position by a predetermined distance. An out-of-step condition is detected when either no signal is generated from the reference position detector while the carriage is assumed to be at the reference position, or a signal is generated from the reference position detector while the carriage is assumed to be at the offset position.

[0006] The document US-A-4,315,268 discloses a serial printer using a linear motor for driving a carriage carrying a print head. To avoid overheating of the linear motor the drive current to the linear motor is stopped if the printer detects that the movement of the carriage is hindered by some reason. For detecting such situation the printer uses a counter for counting clock pulses while the linear motor is being driven. Each time the drive signal to the linear motor is changed to reverse the direction of movement the counter is cleared. If the counter has counted a number of clock pulses larger than corresponding to one stroke of the carriage an error condition is indicated and the drive of the linear motor stopped.

[0007] Serial printers are used as output terminals for various information-processing devices. In particular, they are often used in systems that are involved in handling of money, such as POS/ECR systems. Confirming the details of transactions in writing is deep-rooted in the customary use of these systems, and transaction data is always printed. Therefore, for handling monetary transactions using such a system, the results of printing are critical; in such a system, the accuracy and reliability of print results are of paramount importance.

[0008] The information-processing devices and associated printers discussed above are normally used by operators of varying skill levels. Therefore, it is important that the printer be able to print reliably, regardless of the operator. With a printer, an especially important requirement is the absence of printing malfunction that could lead to a loss of print data.

[0009] In the conventional initialization discussed above, it is possible to determine whether or not the moving operation was performed correctly by moving the print head from the current position to the reference position. In other words, if the reference position is not detected during the initialization, it is possible to infer that moving of the print head to the reference position was not performed correctly due to some error.

[0010] The range in which the print head is moved for initialization, however, does not necessarily encompass the entire printable area. Therefore, the initialization cannot detect error conditions in the entire printable area. In other words, even if the initialization has normally terminated, problems could exist in part of the printable area through which the print head did not pass. These problems include a recording medium protruding into the path of print head motion, the presence of foreign objects, or an error in the print head transport mechanism. Conventional methods cannot detect these problems.

[0011] Therefore, conventionally it is possible that printing is performed (or attempted to be performed) even if such a print hindering condition exists. In such a case, the print data which the printer has received from the information-processing equipment is liable to be erased from the printer before it can be printed in a form amenable to visual inspection. This can be a serious problem especially in POS/ECR systems involved in handling of money.

[0012] EP-A-0 607 871 discloses a serial printing apparatus according to the preamble of claim 1.

[0013] An object of the invention is to solve the above problems by providing an improved printing apparatus which is able to detect potential errors in transferring the print head prior to performing any printing operations. Another object of the invention is to provide a method of initializing such printing apparatus.

[0014] These objects are achieved with an printing apparatus as claimed in claim 1 and a method as claimed in claim 9.

[0015] Preferred embodiments of the invention are subject-matter of the dependent claims.

[0016] According to the present invention the print head is provisionally moved to a reference position and subsequently controlled to move over the entire printable area while it is examined whether or not the motion is performed correctly. In this manner the printer would detect the presence of any obstacles over the entire printable area of the print head. If an obstacle is found, the printer performs an error processing that disables the execution of printing on the recording medium. This prevents the loss of print data during a printing operation that would occur if the motion of the print head failed during the printing operation.

[0017] The invention will be better understood by reference to the following description of preferred embodiments, taken in connection with the accompanying drawing, in which:

Fig. 1 is a schematic plan view of the printer according to an embodiment of the present invention;

Fig. 2 is a block diagram of the control system of the printer shown in Fig. 1;

Fig. 3 is a schematic front view of the printer shown in Fig. 1; and

Fig. 4 is a flowchart showing an example of a print head control procedure of the control system shown in Fig. 2.

[0018] Fig. 1 shows a schematic plan view of a printer, which is an embodiment of the present invention. In particular, the figure only shows components that are involved in printing operations. The printer of the present embodiment houses receipt paper 2 and journal paper 4 in a parallel configuration along the path through which print head 3 moves. The printer is also provided with a print head unit 15 moveable along carriage guide axis 6 in a direction that is across receipt paper 2 and journal paper 4. The print head unit 15 comprises a print head 3 and a carriage 14 on which print head 3 is mounted. Although not shown in the drawings the printer also has paper feed means for advancing the receipt paper 2 and journal paper 4. Since the paper feed means is not related to the present invention and various types of such paper feed means are known to those skilled in the art the paper feed means will not be explained any further here.

[0019] Carriage 14 is supported on carriage guide axis 6. The lower portion of carriage 14 is connected to a part of carriage belt 13. In the figure, carriage belt 13 extends between carriage belt pulley 17 located at the left edge of body 1 and carriage-belt drive gear 8 located at the right edge of body 1. As carriage-belt drive gear 8 rotates, carriage belt 13 moves along an oblong path whose long axis extends from left to right. And, as carriage belt 13 rotates, print head unit 15 is moved parallel to carriage guide axis 6 since part of the print head unit is connected to carriage belt 13.

[0020] Carriage-belt drive gear 8 is engaged with stepping-motor gear 9. As stepping-motor gear 9 rotates, the carriage-belt drive gear rotates in the direction opposite of the rotation of stepping-motor gear 9. Stepping-motor gear 9 is directly linked to stepping-motor rotary axis 7. When the stepping motor control circuit, which is not shown in the figure, rotates stepping-motor rotary axis 7, the stepping-motor gear rotates in the same direction as the rotation of the stepping motor.

[0021] Stepping-motor gear 9 is also engaged with transfer gear 10. As stepping-motor gear 9 rotates, the transfer gear rotates in the direction opposite of the rotation of stepping-motor gear 9. Transfer gear 10 is engaged with star-shaped gear 11. As transfer gear 10 rotates, the star-shaped gear 11 rotates in the direction opposite of the rotation of transfer gear 10. Star-shaped gear 11 comprises six blade-shaped plates, the blades being disposed at equal angular intervals. The blade-shaped plates are arranged to rotate through a position where they can be detected by motion detector 12 which serves to detect the motion of print head 3.

[0022] Motion detector 12 incorporates a photo-interrupter. The photo-interrupter generates a pulse signal each time a blade-shaped plate passes by the detector 12. The pulse signals are used as motion detection signals, the number of pulse signals being indicative of the amount of movement. Control unit 21 of the printer in the present embodiment, shown in Fig. 2, confirms that print head unit 15 has moved correctly based upon the number of pulse signals generated by motion detector 12.

[0023] Thus, each time a drive signal for moving print head 3 is supplied to the stepping motor by head motion

circuit 24 shown in Fig. 2, control unit 21 detects signals from motion detector 12, i.e., the presence or absence of a motion detection signal. In other words, the control unit compares drive signals with motion detection signals, i.e. whether there is one (or more) motion detection signal in response to each drive signal. As a result, if a motion detection signal is not generated, the control unit 21 determines that an error has occurred in moving the print head. In this case, the stepping motor has produced a condition known as an out-of-step condition. Therefore, the detection process that determines whether or not a motion has been performed correctly is sometimes referred to as an out-of-step detection.

[0024] A reference position detector 16 is located on the left edge of body 1. Reference position detector 16 incorporates a built-in photo-interrupter. In the figure, the photo-interrupter generates a reference position signal as print head unit 15 moves to the left of body 1 and a part of carriage 14 passes by the detector 16. When reference position detector 16 has generated a reference position signal, head motion circuit 24, shown in Fig. 2, stops the rotation of the stepping motor thereby halting the motion of print head unit 15.

[0025] At this time, a rotation step count for the stepping motor is set to zero defining the current position of print head unit 15 as the reference position. By counting the number of successive rotation steps by the stepping motor (actually, the drive signals applied to the stepping motor) from the position at which the rotation step count for the stepping motor was set to zero, it is possible to determine the current position of print head unit 15, based upon the rotation step count for the stepping motor that was counted.

[0026] Fig. 2 shows a block diagram of the control system for the printer of the present embodiment. The printer of the present embodiment is provided with a control unit 21 that controls the operation of the entire printer. Connected to I/O (input/output) circuit 31 of control unit 21 is an external personal computer 19, which is information-processing equipment not included in the printer of the present embodiment.

[0027] Print data, control commands, and other types of information related to printing are input from personal computer 19 to I/O circuit 31, which provides an interface with external devices. Control unit 21, which includes CPU 22 as its main control part, executes printing operations through print head control circuit 23 and other circuits, based upon the input information.

[0028] Also input into to control unit 21 via I/O circuit 31 is information that indicates the status of reference position detector 16, motion detector 12, cover-open detector 34, paper-feed detector 33, and end-of-paper detector 32. The detector information thus input is processed by control unit 21. Based upon this information, control unit 21 controls print head motion circuit 24, print circuit 25 for driving print elements provided in the print head 3, error LED drive circuit 26, end-of-paper LED drive circuit 27, and paper feed motor drive circuit 28 through print head control circuit 23, LED control circuit 30, and paper-feed motor control circuit 29, respectively.

[0029] In response to instructions from head control circuit 23, head motion circuit 24 of the present embodiment can generate two types of drive signal resulting in different drive torques of the stepping motor, employed as drive means in this embodiment. The drive signals specify current values to be supplied to magnetization phases of the stepping motor. By having the two types of the drive signal specify different current values, it is possible to select one of two drive torques to be generated by the stepping motor.

[0030] For printing, head control circuit 23 controls head motion circuit 24 to output drive signals that generate a larger drive torque; on the contrary, during print head move verification processing, to be described later, i.e., processing steps ST4, ST6, and ST7 in Fig. 4, the head control circuit provides an instruction to output drive signals that generate a smaller drive torque. If the print head is moved correctly in the print head motion verification processing, this ensures that the print head is moved accurately in the normal printing operation in which the print head is moved using a larger drive torque.

[0031] A head motion circuit adapted to selectively generate two types of drive signal can easily be realized using constant-current drivers in which a current value can be set, digital/analog converters, and voltage/current converters. Therefore, a detailed description of the circuit is omitted.

[0032] Referring now to Fig. 3, initialization according to an embodiment of the present invention at power-on time will be explained. Before initialization, print head unit 15 may be located at any position between its leftmost position 38 and its rightmost position 37. At which position the print head unit will be located before its initialization is indeterminate, i.e., immediately after the power is turned on, control unit 21 does not have any information about the present position of the print head unit.

[0033] When its initialization commences, print head unit 15 begins to move from its pre-initialization position to the left edge of body 1, at which reference position detector 16 is provided. When print head unit 15 has reached the leftmost position 38, indicated by the broken line, print head unit 15 stops in accordance with the reference position signal generated by reference position detector 16.

[0034] In a conventional initialization operation, the initialization operation terminates when print head unit 15 halts at the initial position predetermined relative to the reference position, e.g., the leftmost position 38 in the embodiment. Subsequently, the input of print data from personal computer 19 initiates a printing operation.

[0035] Assume print head unit 15 is located in receipt paper print area 35 before initialization and there are no paper troubles in this area, but a paper jam has

occurred by journal paper 4 protruding beyond paper-holding leaf spring 18 into the moving path of print head 3. In such a case print head unit 15 passes through receipt paper print area 35 without any trouble and assumes a standby position at leftmost position 38. In the next step, the print head unit begins a printing operation because of a printing instruction from personal computer 19 to receipt paper 2 and journal paper 4. After correctly printing on receipt paper 2, print head unit 15 attempts to print on journal paper 4. However, journal paper 4 is in a paper jam, and consequently printing is not executed correctly and the printing operation terminates abnormally.

[0036] When a printing operation commences, any print data received from personal computer 19 is sequentially erased from a print buffer in the printer. Therefore, if the printing operation terminates abnormally, as described above, the data is lost without being printed in a condition that allows visual inspection.

[0037] On the contrary, according to the present embodiment of the invention, reference position detector 16 detects the position of print head unit 15 during the initialization of print head unit 15, and then print head unit 15 is moved through the entire printable area from the leftmost position 38 to the rightmost position 37. In this manner, the present invention would detect anomalies wherever they may occur within the entire printable area. The entire printable area refers to receipt paper print area 35 and journal paper print area 36, which are located between the leftmost position 38 and the rightmost position 37 of print head unit 15 in Fig. 3.

[0038] The following is an explanation of the flow of initialization operations in the present embodiment of the invention, shown in Fig. 4, with reference to Figs. 1 and 3.

[0039] When an initialization operation is commenced in ST1, ST2 examines whether or not reference position detector 16 has generated a reference position signal. If reference position detector 16 did not generate a reference position signal, control proceeds to ST3, which moves print head unit 15 by one step to the left of body 1. Steps ST2 and ST3 are repeated until a reference position signal is generated by reference position detector 16.

[0040] When a reference position signal is generated in ST2, control proceeds to ST4. ST4 applies a drive signal so as to move print head unit 15 by one step towards the right of body 1 and the control proceeds to ST5.

[0041] ST5 examines whether or not motion of the print head has been detected by motion detector 12. If no motion detection signals were generated by motion detector 12, i.e., it was detected that a motion was not performed correctly, control proceeds to ST6, where an error processing is performed.

[0042] The error processing, at a minimum, disables printing. This prevents any loss of print data that might otherwise be caused by a motion error during printing. In order to alert personal computer 19 not to transmit any (further) print data, the error processing also transmits an error status that indicates a printer error to personal computer 19 through the I/O circuit 31. If no print data have been sent from the personal computer to the printer, the printer may go to an error condition in which all functions of the printer are halted until the printer is reset by, for example, reapplication of the power. In this case, the operator has to turn off the power and turn it on again after removing the cause of the error state, e.g., a paper jam. On the other hand, if the personal computer had already sent print data, the printer will enter a stand-by condition in which the printer transmits an error signal to the personal computer 19, makes LED control circuit 30 and error LED drive circuit 26 to flash error LED on an operation panel not shown in the drawings, and is waiting for an error recovery instruction from the personal computer or the operator through a switch provided on the operation panel. While the printer is in such stand-by condition an operator might inadvertently switch off power which would cause loss of print data having been sent already. To avoid this happening, it is preferable to have the printer send an error signal to the personal computer during the initialization procedure to prevent print data from being sent to the printer prior to a successful termination of the initialization.

[0043] On the other hand, if a signal was generated by motion detector 12 in ST5, i.e., if the motion of the print head is detected, control proceeds to ST7. ST7 counts the number of drive signals applied to the stepping motor and compares the count value with a predetermined number of drive signals required to move print head unit 15 to its rightmost position 37.

[0044] In ST7, if print head unit 15 has not reached its rightmost position 37, control loops to ST4, i.e., detects whether or not there is a motion detection signal (may be one or more) in response to the drive signal applied in step ST4. Steps ST4, ST5, and ST7 are performed repeatedly until print head unit 15 reaches its rightmost position 37 which is assumed to be the case if the predetermined number of drive signals has been generated. In ST7, if print head unit 15 has reached its rightmost position 37, control proceeds to ST8. This indicates a normal termination of the initialization of print head unit 15. During this process, when step ST5 indicates there is no motion detection signal, control proceeds to step ST6 as mentioned before.

[0045] The text above described the initialization of print head unit 15 in conjunction with the operation of turning the power on. Print head motion verification over the entire printable area, as described above, is preferably also performed as part of initialization after a printer cover is opened and then closed or when receipt paper is cut in order to take out a receipt. Errors relating to the motion of print head unit 15 are likely to occur when the power for the printer is turned on, the printer cover is opened and then closed, or when a receipt is issued. Therefore, it is effective to perform the initializa-

tion operation in each of these cases.

[0046] Although in the present embodiment the printer is constructed using a motion detector and repeatedly performing a one-step feed and subsequent check for a corresponding motion detection signal to detect whether there is an error in the motion of the print head anywhere within the entire printable area, an out-of-step condition, for example, can also be detected by generating a prescribed number of drive signals, counting the number of motion detection signals that are generated when the print head is moved a prescribed distance corresponding to the prescribed number of drive signals, and by comparing the counted number of motion detection signals with an expected number. This method is effective in cases in which a motion method is employed in which the relationship varies between the phases of drive signals and the phases of motion detection signals so that there is no clear correspondence between motion detection signals and drive signals, e.g., when a stepping motor acceleration/deceleration drive method is employed.

[0047] As explained in detail above, initialization according to the present invention comprises moving the print head unit over the entire printable area or the full stroke of the print head unit so as to detect any problems in the print head unit's motion prior to starting printing operations. In the embodiment described so far a reference position detector is employed for detecting the print head unit's reference position, while an additional motion detector is used to verify that the print head unit is actually being moved.

[0048] In an alternative embodiment the reference position detector can also be used for verifying the motion of the print head. In such case an extra motion detector is not required. In this alternative embodiment the print head unit 15 is made to travel from the reference position to the opposite end of the printable area and back to the reference position. Counting the number of drive signals required for this loop of the print head unit until the reference position signal is generated again and comparing the count value with a prescribed number also allows to verify the print head unit's correct motion. The number of drive signals required to perform the loop can be prescribed because the distance that the print head has to travel is known. Alternatively, this prescribed number of drive signals can be generated to determine whether or not the reference position is redetected by the time all the drive signals have been applied to the stepping motor. If the print head unit returns to the reference position as indicated by the reference position signal after the said prescribed number of drive signals has been applied, it can be concluded that the print head has moved correctly over the entire print area; otherwise, an error processing may be performed on the assumption that some error has occurred in the motion of the print head at some location within the print area.

Claims

1. A serial printing apparatus comprising:

   means for holding a recording medium (2, 4);
   a print head (3, 15) supported to be moveable across said recording medium (2, 4);
   drive means responsive to drive signals for moving said print head (3, 15) to any desired position within a printable area;
   print control means (22-25) for applying drive signals to said drive means and control signals to said print head (3, 15) so as to perform printing on said recording medium (2, 4) while moving the print head (3, 15) relative to said recording medium (2, 4);
   reference position detection means (16) for putting out a reference position signal when said print head (3, 15) is at a reference position;
   reference position return means (21-24) for applying drive signals to said drive means so as to move said print head (3, 15) to said reference position;
   error processing means (22) for preventing said print head (3, 15) from printing in response to the detection of an error condition; and
   scanning means (21-24) for applying drive signals to said drive means so as to move said print head (3, 15) through the entire printable area after it has been moved to said reference position by said reference position return means (21-24),
   characterized by
   verification means (22, 16, 12) responsive to said scanning means (21-24) for detecting whether or not the print head (3, 15) has actually moved through the entire printable area, said verification means (22, 16, 12) being adapted to indicate an error condition upon detecting that the print head (3, 15) has not moved through the entire printable area.

2. The apparatus according to claim 1, **characterized in that** said verification means comprises:

   motion detection means (12) responsive to a movement of said print head (3, 15) for generating motion detection signals; and
   comparison means (22) for detecting whether or not a corresponding motion detection signal is generated in response to each drive signal applied by said scanning means (21-24) and indicating said error condition if no motion detection signal is generated in response to a drive signal.

3. The apparatus according to claim 1, **characterized**

in that said verification means comprises:

motion detection means (12) responsive to a movement of said print head (3, 15) for generating motion detection signals;
counter means (22) for counting the motion detection signals generated while said scanning means (21-24) applies said drive signals; and
comparison means (22) for comparing the count value of said counter means (22) with a predetermined value and for indicating said error condition if there is a mismatch between said count value and said predetermined value.

4. The apparatus according to claim 1, **characterized in that**

said scanning means (21-24) being adapted to apply said drive signals so as to move said print head (3, 15) through the entire printable area and back to said reference position; and
said verification means comprises:
drive signal counter means (22) for counting said drive signals applied by said scanning means (21-24);
comparison means (22) responsive to said reference position signal for comparing the count value of said counter means (22) when the print head (3, 15) returns to the reference position with a predetermined value and for indicating said error condition if there is a difference between said count value and said predetermined value.

5. The apparatus according to claim 1, **characterized in that**

said scanning means (21-24) is adapted to apply a predetermined number of drive signals so as to move said print head (3, 15) through the entire printable area and back to said reference position; and
said verification means comprises:
means for detecting whether, in response to the last drive signal applied by said scanning means (21-24), said reference position signal is generated and for indicating said error condition if the reference position signal is not generated.

6. The apparatus according to any one of the preceding claims, **characterized in that** said verification means (22, 16, 12) is adapted to put out an error signal while said scanning means (21-24) applies said drive signals and stops putting out the error signal upon detecting that the print head (3, 15) has moved through the entire printable area.

7. The apparatus according to any one of the preceding claims, **characterized in that** said drive means is adapted to generate a first and a second drive force in response to a first and a second kind of drive signal, respectively, said first drive force being higher than said second drive force, and said print control means (22-25) is adapted to apply drive signals of said first kind while said scanning means (21-24) is adapted to apply drive signals of said second kind.

8. The apparatus according to claim 7, **characterized in that** said drive means comprises a stepping motor, and said first and second kind of drive signal correspond to different values of energizing current for the stepping motor.

9. A method of initializing the printing apparatus as defined in any one of the preceding claims, comprising the steps of:

(a) supplying drive signals to said drive means to move said print head (3, 15) to said reference position until said reference position signal is generated;
(b) subsequently supplying drive signals to said drive means to move said print head (3, 15) over the entire printable area;
(c) verifying whether or not the print head (3, 15) has actually moved over the entire printable area in step (b); and
(d) performing error processing including preventing said apparatus from printing when step (c) reveals that the print head (3, 15) has not moved over the entire printable area.

10. The method according to claim 9, **characterized in that** step (c) comprises:

generating motion detection signals in response to a movement of said print head (3, 15);
detecting whether or not a motion detection signal is generated in response to each drive signal applied in step (b); and
deciding that said print head (3, 15) has not moved over the entire printable area when in response to any one of said drive signals no motion detection signal is generated.

11. The method according to claim 9, **characterized in that** step (c) comprises:

generating motion detection signals in response to a movement of said print head (3, 15);
counting the number of motion detection signals generated while said drive signals are

applied in step (b);
comparing said counted number with a predetermined value; and
deciding that said print head (3, 15) has not moved over the entire printable area when said counted number differs from said predetermined value.

12. The method according to claim 9, **characterized in that** step (c) comprises:

counting the number of drive signals applied in step (b);
repeating step (a) while continuing counting of the drive signals;
comparing said counted number of drive signals with a predetermined value; and
deciding that said print head (3, 15) has not moved over the entire printable area when said counted number differs from said predetermined value.

13. The method according to claim 9, **characterized in that** step (b) comprises:

supplying a predetermined number of drive signals to said drive means to move said print head (3, 15) over the entire printable area and back to said reference position; and
step (c) comprises
detecting whether or not said reference position signal is generated in response to the last drive signal applied in step (b); and
deciding that said print head (3, 15) has not moved over the entire printable area when said reference position signal is not generated.

14. The method according to any one of claims 9 to 13, **characterized in that** step (a), (b) or (c) further includes generating an error signal the error signal being generated until step (c) reveals that the print head (3, 15) has moved over the entire printable area.

15. The method according to any one of claims 9 to 14, **characterized in that** the drive signals applied in step (b) differ from drive signals applied for normal printing in that the former drive signals result in a smaller drive force of said drive means than the latter ones.

16. The method according to any one of claims 9 to 15, **characterized in that** steps (a) to (d) are performed in response to at least one of the following events:

turning the power on for the printer;
one of opening and closing the cover for covering the print head move area; and
cutting the recording paper.

Patentansprüche

1. Serielldruckgerät, umfassend:

eine Anordnung zum Halten eines Aufzeichnungsmediums (2, 4);
einen Druckkopf (3, 15), der so gelagert ist, daß er quer über das Aufzeichnungsmedium (2, 4) bewegbar ist;
eine auf Treibersignale ansprechende Antriebsanordnung zum Bewegen des Druckkopfs (3, 15) an eine beliebige gewünschte Position innerhalb eines Druckbereichs;
eine Drucksteueranordnung (22-25) zum Anlegen von Treibersignalen an die Antriebsanordnung und von Steuersignalen an den Druckkopf (3, 15), um einen Druck auf das Aufzeichnungsmedium (2, 4) auszuführen, während der Druckkopf (3, 15) bezüglich des Aufzeichnungsmediums (2, 4) bewegt wird;
eine Referenzpositionserfassungsanordnung (16) zum Ausgeben eines Referenzpositionssignals, wenn sich der Druckkopf (3, 15) an einer Referenzposition befindet;
eine Anordnung (21-24) für die Rückkehr zu der Referenzposition zum Anlegen von Treibersignalen an die Antriebsanordnung, um den Druckkopf (3, 15) zu der Referenzposition zu bewegen;
eine Fehlerverarbeitungsanordnung (22), um den Druckkopf (3, 15) als Antwort auf die Erfassung eines Fehlerzustands am Drucken zu hindern; und
eine Abtastanordnung (21-24) zum Anlegen von Treibersignalen an die Antriebsanordnung, um den Druckkopf (3, 15) durch den gesamten Druckbereich zu bewegen, nachdem er von der Anordnung (21-24) für die Rückkehr zu der Referenzposition in die Referenzposition bewegt wurde,
gekennzeichnet durch
eine auf die Abtastanordnung (21-24) ansprechende Verifikationsanordnung (22, 16, 12) zum Erfassen, ob sich der Druckkopf (3, 15) tatsächlich durch den gesamten Druckbereich bewegt hat oder nicht, wobei die Verifikationsanordnung (22, 16, 12) so ausgebildet ist, daß sie bei der Erfassung, daß sich der Druckkopf (3, 15) nicht durch den gesamten Druckbereich bewegt hat, einen Fehlerzustand anzeigt.

2. Gerät nach Anspruch 1, **dadurch gekennzeichnet**, daß die Verifikationsanordnung aufweist:

eine auf eine Bewegung des Druckkopfs (3, 15)

ansprechende Bewegungserfassungsanordnung (12) zum Erzeugen von Bewegungserfassungssignalen; und

eine Vergleichsanordnung (22) zum Erfassen, ob ein entsprechendes Bewegungserfassungssignal als Antwort auf die einzelnen von der Abtastanordnung (21-24) angelegten Treibersignale erzeugt wird, und die den Fehlerzustand anzeigt, wenn kein Bewegungserfassungssignal als Antwort auf ein Treibersignal erzeugt wird.

3. Gerät nach Anspruch 1, **dadurch gekennzeichnet**, daß die Verifikationsanordnung aufweist:

eine auf eine Bewegung des Druckkopfs (3, 15) ansprechende Bewegungserfassungsanordnung (12) zum Erzeugen von Bewegungserfassungssignalen;
eine Zähleranordnung (22) zum Zählen der Bewegungserfassungssignale, die erzeugt werden, während die Abtastanordnung (21-24) die Treibersignale anlegt; und
eine Vergleichsanordnung (22) zum Vergleichen des Zählwerts der Zähleranordnung (22) mit einem vorbestimmten Wert und zum Anzeigen des Fehlerzustands, wenn eine Nichtübereinstimmung zwischen dem Zählwert und dem vorbestimmten Wert vorhanden ist.

4. Gerät nach Anspruch 1, **dadurch gekennzeichnet**, daß

die Abtastanordnung (21-24) ausgebildet ist, um die Treibersignale so anzulegen, daß der Druckkopf (3, 15) durch den gesamten Druckbereich und zurück zur Referenzposition bewegt wird; und
die Verifikationsanordnung aufweist:
eine Treibersignalzähleranordnung (22) zum Zählen der durch die Abtastanordnung (21-24) angelegten Treibersignale;
eine auf das Referenzpositionssignal ansprechende Vergleichsanordnung (22) zum Vergleichen des Zählwerts der Zähleranordnung (22), wenn der Druckkopf (3, 15) zur Referenzposition zurückkehrt, mit einem vorbestimmten Wert und zum Anzeigen des Fehlerzustands, wenn eine Differenz zwischen dem Zählwert und dem vorbestimmten Wert vorhanden ist.

5. Gerät nach Anspruch 1, **dadurch gekennzeichnet**, daß

die Abtastanordnung (21-24) so ausgebildet ist, daß sie eine vorbestimmte Anzahl an Treibersignalen anlegt, um den Druckkopf (3, 15) durch den gesamten Druckbereich und zurück zur Referenzposition zu bewegen; und
die Verifikationsanordnung aufweist:
eine Anordnung zur Erfassung, ob als Antwort auf das letzte von der Abtastanordnung (21-24) angelegte Treibersignal das Referenzpositionssignal erzeugt wird, und zum Anzeigen des Fehlerzustands, wenn das Referenzpositionssignal nicht erzeugt wird.

6. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß die Verifikationsanordnung (22, 16, 12) ausgebildet ist, um ein Fehlersignal auszugeben, während die Abtastanordnung (21-24) die Treibersignale anlegt, und das Ausgeben des Fehlersignals bei der Erfassung stoppt, daß sich der Druckkopf (3, 15) durch den gesamten Druckbereich bewegt hat.

7. Gerät nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß die Antriebsanordnung ausgebildet ist, um eine erste und eine zweite Antriebskraft als Antwort auf eine erste bzw. eine zweite Art von Treibersignal zu erzeugen, wobei die erste Antriebskraft größer als die zweite Antriebskraft ist, und die Drucksteueranordnung (22-25) ausgebildet ist, um Treibersignale der ersten Art anzulegen, während die Abtastanordnung (21-24) ausgebildet ist, um Treibersignale der zweiten Art anzulegen.

8. Gerät nach Anspruch 7, **dadurch gekennzeichnet**, daß die Antriebsanordnung einen Schrittmotor umfaßt und die erste sowie die zweite Art von Treibersignal unterschiedlichen Werten des Speisestroms für den Schrittmotor entsprechen.

9. Verfahren zur Initialisierung des Druckgeräts gemäß einem der vorhergehenden Ansprüche, umfassend folgende Schritte:

(a) Liefern von Treibersignalen an die Antriebsanordnung, um den Druckkopf (3, 15) zu der Referenzposition zu bewegen, bis das Referenzpositionssignal erzeugt wird;
(b) anschließendes Liefern von Treibersignalen an die Antriebsanordnung, um den Druckkopf (3, 15) über den gesamten Druckbereich zu bewegen;
(c) Verifizieren, ob sich der Druckkopf (3, 15) in Schritt (b) tatsächlich über den gesamten Druckbereich bewegt hat oder nicht; und
(d) Ausführen einer Fehlerverarbeitung, die umfaßt, daß das Gerät am Drucken gehindert wird, wenn Schritt (c) ergibt, daß sich der Druckkopf (3, 15) nicht über den gesamten Druckbereich bewegt hat.

10. Verfahren nach Anspruch 9, **dadurch gekenn-**

zeichnet, daß Schritt (c) umfaßt:

Erzeugen von Bewegungserfassungssignalen als Antwort auf eine Bewegung des Druckkopfs (3, 15);
Erfassen, ob ein Bewegungserfassungssignal als Antwort auf die einzelnen in Schritt (b) angelegten Treibersignale erzeugt wird oder nicht; und
Feststellen, daß sich der Druckkopf (3, 15) nicht über den gesamten Druckbereich bewegt hat, wenn als Antwort auf irgendeines der Treibersignale kein Bewegungserfassungssignal erzeugt wird.

11. Verfahren nach Anspruch 9, **dadurch gekennzeichnet**, daß Schritt (c) umfaßt:

Erzeugen von Bewegungserfassungssignalen als Antwort auf eine Bewegung des Druckkopfs (3, 15);
Zählen der Anzahl an Bewegungserfassungssignalen, die erzeugt werden, während die Treibersignale in Schritt (b) angelegt werden;
Vergleichen der gezählten Anzahl mit einem vorbestimmten Wert; und
Feststellen, daß sich der Druckkopf (3, 15) nicht über den gesamten Druckbereich bewegt hat, wenn die gezählte Anzahl sich von dem vorbestimmten Wert unterscheidet.

12. Verfahren nach Anspruch 9, dadurch gekennzeichnet, daß Schritt (c) umfaßt:

Zählen der in Schritt (b) angelegten Treibersignale;
Wiederholen von Schritt (a], während das Zählen der Treibersignale fortgesetzt wird;
Vergleichen der gezählten Anzahl an Treibersignalen mit einem vorbestimmten Wert; und
Feststellen, daR sich der Druckkopf (3, 15) nicht über den gesamten Druckbereich bewegt hat, wenn sich die gezählte Anzahl von dem vorbestimmten Wert unterscheidet.

13. Verfahren nach Anspruch 9, **dadurch gekennzeichnet**, daß Schritt (b) umfaßt:

Liefern einer vorbestimmten Anzahl an Treibersignalen an die Antriebsanordnung, um den Druckkopf (3, 15) über den gesamten Druckbereich und zurück zur Referenzposition zu bewegen; und
Schritt (c) umfaßt
Erfassen, ob das Referenzpositionssignal als Antwort auf das letzte in Schritt (b) angelegte Treibersignal erzeugt wird oder nicht; und
Feststellen, daß sich der Druckkopf (3, 15) nicht über den gesamten Druckbereich bewegt hat, wenn das Referenzpositionssignal nicht erzeugt wird.

14. Verfahren nach einem der Ansprüche 9 bis 13, **dadurch gekennzeichnet**, daß Schritt (a), (b) oder (c) des weiteren das Erzeugen eines Fehlersignals umfaßt, wobei das Fehlersignal erzeugt wird, bis Schritt (c) ergibt, daß sich der Druckkopf (3, 15) über den gesamten Druckbereich bewegt hat.

15. Verfahren nach einem der Ansprüche 9 bis 14, **dadurch gekennzeichnet**, daß sich die in Schritt (b) angelegten Treibersignale von zum normalen Drucken angelegten Treibersignalen insofern unterscheiden, als die erstgenannten Treibersignale zu einer kleineren Antriebskraft der Antriebsanordnung führen als die letztgenannten.

16. Verfahren nach einem der Ansprüche 9 bis 15, **dadurch gekennzeichnet**, daß die Schritte (a) bis (d) in Antwort auf zumindest eines der folgenden Ereignisse ausgeführt werden:

Einschalten der Stromversorgung für den Drucker;
Öffnen oder Schließen des Deckels für die Abdeckung des Druckkopfbewegungsbereichs; und
Abschneiden des Aufzeichnungspapiers.

Revendications

1. Dispositif d'impression sériel comprenant :

un moyen pour maintenir un support d'enregistrement (2, 4);
une tête d'impression (3, 15) supportée de façon à pouvoir se déplacer à travers ledit support d'enregistrement (2, 4);
un moyen d'entraînement réagissant à des signaux d'entraînement pour déplacer ladite tête d'impression (3, 15) dans toute position souhaitée à l'intérieur d'une zone pouvant être imprimée;
un moyen de commande d'impression (22-25) pour appliquer des signaux d'entraînement audit moyen d'entraînement et des signaux de commande à ladite tête d'impression (3, 15) de façon à exécuter l'impression sur ledit support d'enregistrement (2, 4) tout en déplacant la tête d'impression (3, 15) par rapport audit support d'enregistrement (2, 4);
un moyen de détection de position de référence (16) pour émettre un signal de position de référence quand ladite tête d'impression (3, 15) est dans une position de référence;
un moyen de retour à la position de référence

(21-24) pour appliquer des signaux d'entraînement audit moyen d'entraînement de façon à déplacer ladite tête d'impression (3, 15) à ladite position de référence;

un moyen de traitement d'erreur (22) pour empêcher ladite tête d'impression (3, 15) d'imprimer en réponse à la détection d'une condition d'erreur; et

un moyen de balayage (21-24) pour appliquer des signaux d'entraînement audit moyen d'entraînement de façon à déplacer ladite tête d'impression (3, 15) à travers toute la zone pouvant être imprimée après qu'elle a été déplacée à ladite position de référence par ledit moyen de retour à la position de référence (21-24),

caractérisé par

un moyen de vérification (22, 16, 12) réagissant audit moyen de balayage (21-24) pour détecter si la tête d'impression (3, 15) s'est réellement déplacée à travers toute la zone pouvant être imprimée, ledit moyen de vérification (22, 16, 12) étant adapté pour indiquer une condition d'erreur lorsqu'il détecte que la tête d'impression (3, 15) ne s'est pas déplacée à travers toute la zone pouvant être imprimée.

2. Dispositif selon la revendication 1, caractérisé en ce que ledit moyen de vérification comprend :

un moyen de détection de mouvement (12) sensible à un mouvement de ladite tête d'impression (3, 15) pour générer des signaux de détection de mouvement; et

un moyen de comparaison (22) pour détecter si oui ou non un signal de détection de mouvement correspondant est généré en réponse à chaque signal d'entraînement appliqué par ledit moyen de balayage (21-24) et indiquer ladite condition d'erreur si aucun signal de détection de mouvement n'est généré en réponse à un signal d'entraînement.

3. Dispositif selon la revendication 1, caractérisé en ce que ledit moyen de vérification comprend :

un moyen de détection de mouvement (12) réagissant à un mouvement de ladite tête d'impression (3, 15) pour générer des signaux de détection de mouvement;

un moyen de comptage (22) pour compter les signaux de détection de mouvement générés pendant que ledit moyen de balayage (21-24) applique lesdits signaux d'entraînement; et

un moyen de comparaison (22) pour comparer la valeur comptée dudit moyen de comptage (22) à une valeur prédéterminée et pour indiquer ladite condition d'erreur s'il y a un défaut de correspondance entre ladite valeur comptée et ladite valeur prédéterminée.

4. Dispositif selon la revendication 1, caractérisé en ce que

ledit moyen de balayage (21-24) est adapté pour appliquer lesdits signaux d'entraînement de façon à déplacer ladite tête d'impression (3, 15) à travers toute la zone pouvant être imprimée et la ramener à ladite position de référence; et

ledit moyen de vérification comprend :

un moyen de comptage de signal d'entraînement (22) pour compter lesdits signaux d'entraînement appliqués par ledit moyen de balayage (21-24);

un moyen de comparaison (22) réagissant audit signal de position de référence pour comparer la valeur comptée dudit moyen de comptage (22) lorsque la tête d'impression (3, 15) revient à la position de référence à une valeur prédéterminée et pour indiquer ladite condition d'erreur s'il y a une différence entre ladite valeur comptée et ladite valeur prédéterminée.

5. Dispositif selon la revendication 1, caractérisé en ce que

ledit moyen de balayage (21-24) est adapté pour appliquer un nombre prédéterminé de signaux d'entraînement de façon à déplacer ladite tête d'impression (3, 15) à travers toute la zone pouvant être imprimée et la ramener à ladite position de référence; et

ledit moyen de vérification comprend :

un moyen pour détecter si, en réponse au dernier signal d'entraînement appliqué par ledit moyen de balayage (21-24), le signal de position de référence est généré et pour indiquer ladite condition d'erreur si le signal de position de référence n'est pas généré.

6. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit moyen de vérification (22, 16, 12) est adapté pour émettre un signal d'erreur pendant que ledit moyen de balayage (21-24) applique lesdits signaux d'entraînement et cesse d'émettre le signal d'erreur lorsqu'il détecte que la tête d'impression (3, 15) s'est déplacée à travers toute la zone pouvant être imprimée.

7. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit moyen d'entraînement est adapté pour générer une première et une deuxième forces d'entraînement en réponse à une première et une deuxième sortes

de signaux d'entraînement, respectivement, ladite première force d'entraînement étant plus élevée que ladite deuxième force d'entraînement, et ledit moyen de commande d'impression (22-25) est adapté pour appliquer des signaux d'entraînement de ladite première sorte tandis que ledit moyen de balayage (21-24) est adapté pour appliquer des signaux d'entraînement de ladite deuxième sorte.

8. Dispositif selon la revendication 7, caractérisé en ce que ledit moyen d'entraînement comprend un moteur pas à pas, et lesdites première et deuxième sortes de signaux d'entraînement correspondent à différentes valeurs du courant d'activation destiné au moteur pas à pas.

9. Procédé pour initialiser l'appareil d'impression tel que défini dans l'une quelconque des revendications précédentes, comprenant les opérations consistant à :

(a) fournir des signaux d'entraînement audit moyen d'entraînement pour déplacer ladite tête d'impression (3, 15) à ladite position de référence jusqu'à ce que ledit signal de position de référence soit généré;
(b) fournir ensuite des signaux d'entraînement audit moyen d'entraînement pour déplacer ladite tête d'impression (3, 15) sur toute la zone pouvant être imprimée;
(c) vérifier si oui ou non la tête d'impression (3, 15) s'est réellement déplacée sur toute la zone pouvant être imprimée dans l'opération (b); et
(d) exécuter un traitement d'erreur en empêchant ledit appareil d'imprimer lorsque l'opération (c) indique que la tête d'impression (3, 15) ne s'est pas déplacée sur toute la zone pouvant être imprimée.

10. Procédé selon la revendication 9, caractérisé en ce que l'opération (c) comprend les opérations consistant à :

générer des signaux de détection de mouvement en réponse à un mouvement de ladite tête d'impression (3, 15);
détecter si oui ou non un signal de détection de mouvement est généré en réponse à chaque signal d'entraînement appliqué dans l'opération (b); et
décider que ladite tête d'impression (3, 15) ne s'est pas déplacée sur toute la zone pouvant être imprimée lorsqu'en réponse à l'un quelconque desdits signaux d'entraînement aucun signal de détection de mouvement n'est généré.

11. Procédé selon la revendication 9, caractérisé en ce que l'opération (c) comprend les opérations consistant à :

générer des signaux de détection de mouvement en réponse à un mouvement de ladite tête d'impression (3, 15);
compter le nombre de signaux de détection de mouvement générés pendant que lesdits signaux d'entraînement sont appliqué dans l'opération (b);
comparer ledit nombre compté à une valeur prédéterminée; et
décider que ladite tête d'impression (3, 15) ne s'est pas déplacée sur toute la zone pouvant être imprimée lorsque ledit nombre compté diffère de ladite valeur prédéterminée.

12. Procédé selon la revendication 9, caractérisé en ce que l'opération (c) comprend les opérations consistant à :

compter le nombre de signaux d'entraînement appliqués dans l'opération (b);
répéter l'opération (a) tout en continuant de compter les signaux d'entraînement;
comparer ledit nombre compté de signaux d'entraînement à une valeur prédéterminée; et
décider que ladite tête d'impression (3, 15) ne s'est pas déplacée sur toute la zone pouvant être imprimée lorsque ledit nombre compté diffère de ladite valeur prédéterminée.

13. Procédé selon la revendication 9, caractérisé en ce que l'opération (b) comprend les opérations consistant à :

fournir un nombre prédéterminé de signaux d'entraînement audit moyen d'entraînement pour déplacer ladite tête d'impression (3, 15) sur toute la zone pouvant être imprimée et la ramener à ladite position de référence; et
l'opération (c) comprend les opérations consistant à
détecter si oui ou non ledit signal de position de référence est généré en réponse au dernier signal d'entraînement appliqué dans l'opération (b); et
décider que ladite tête d'impression (3, 15) ne s'est pas déplacée sur toute la zone pouvant être imprimée lorsque ledit signal de position de référence n'est pas généré.

14. Procédé selon l'une quelconque des revendications 9 à 13, caractérisé en ce que l'opération (a), (b) ou (c) comprend aussi la génération d'un signal d'erreur, le signal d'erreur étant généré jusqu'à ce que l'opération (c) indique que la tête d'impression (3, 15) s'est déplacée sur toute la zone pouvant être

imprimée.

15. Procédé selon l'une quelconque des revendications 9 à 14, caractérisé en ce que les signaux d'entraînement appliqués dans l'opération (b) diffèrent des signaux d'entraînement appliqués pour une impression normale en ce que les premiers signaux d'entraînement ont pour conséquence une force d'entraînement plus faible dudit moyen d'entraînement que les derniers.

16. Procédé selon l'une quelconque des revendications 9 à 15, caractérisé en ce que les opérations (a) à (d) sont exécutées en réponse à au moins un des événements suivants :

mettre l'imprimante en service;
ouvrir et fermer le capot servant à recouvrir la zone de déplacement de la tête d'impression; et
couper le papier d'enregistrement.

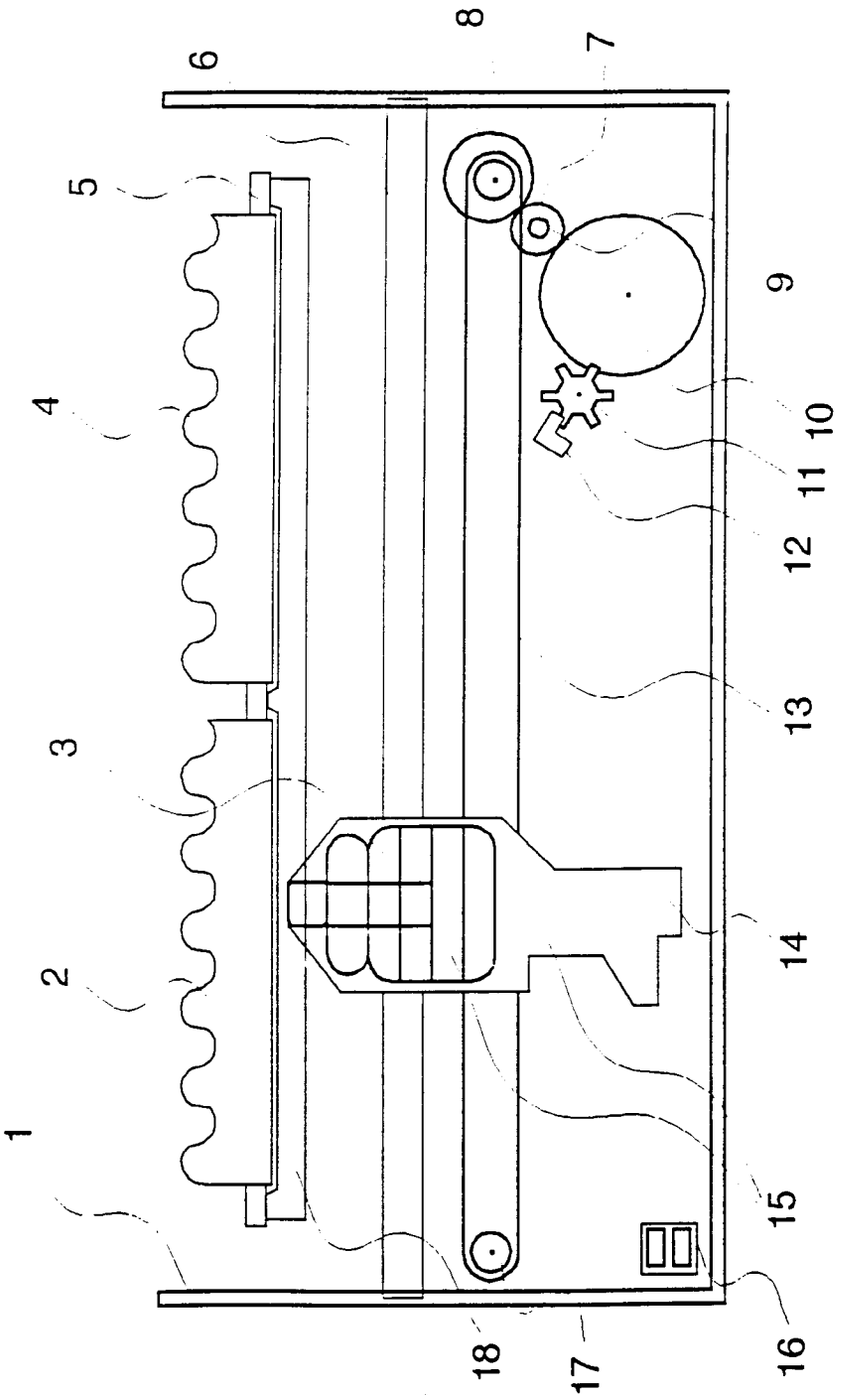


FIG. 1

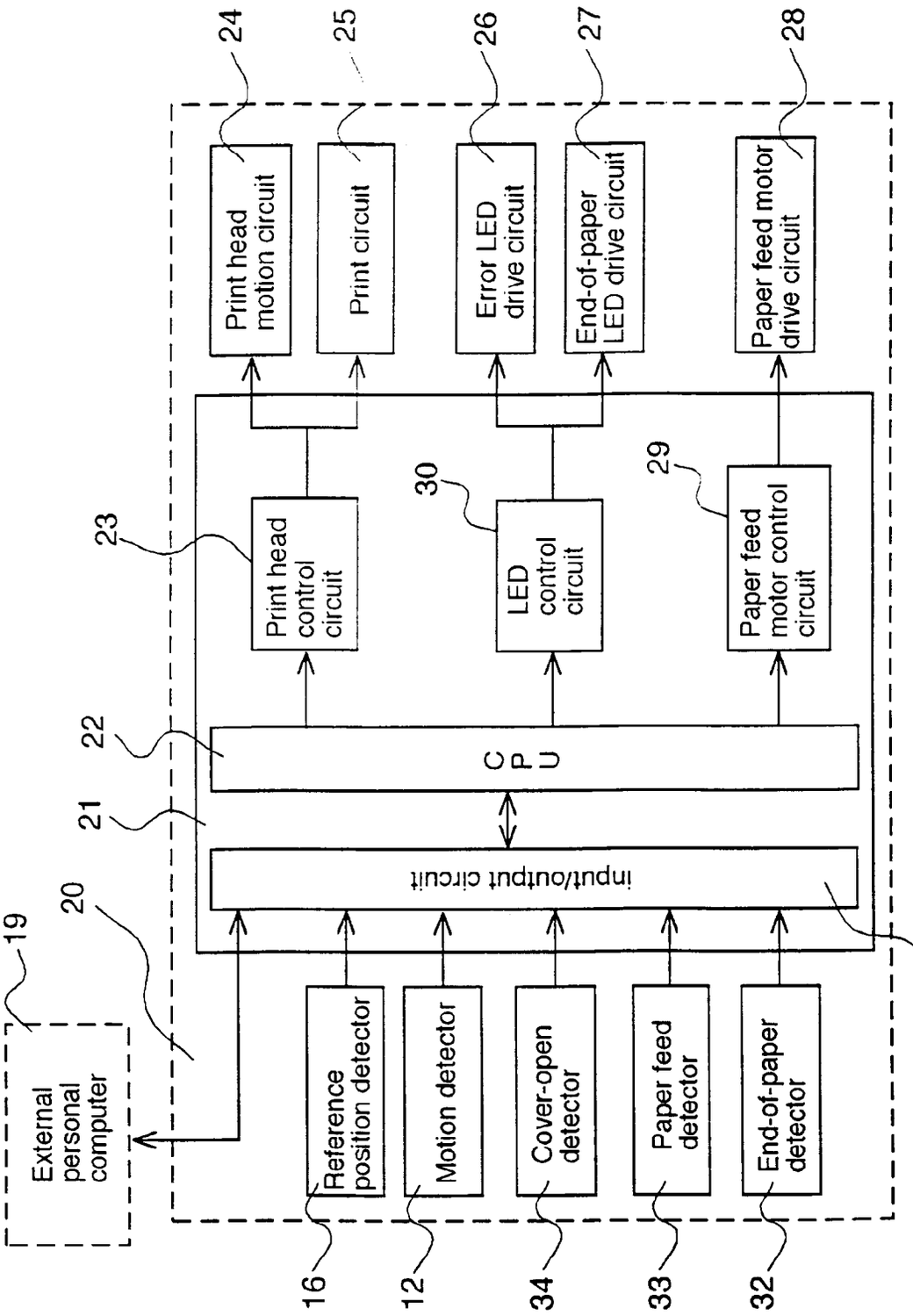

External personal computer
19
20
21
22
23
24
25
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27
28
29
30
31
16
12
34
33
32
Reference position detector
Motion detector
Cover-open detector
Paper feed detector
End-of-paper detector
input/output circuit
C P U
Print head control circuit
LED control circuit
Paper feed motor control circuit
Print head motion circuit
Print circuit
Error LED drive circuit
End-of-paper LED drive circuit
Paper feed motor drive circuit

FIG. 2

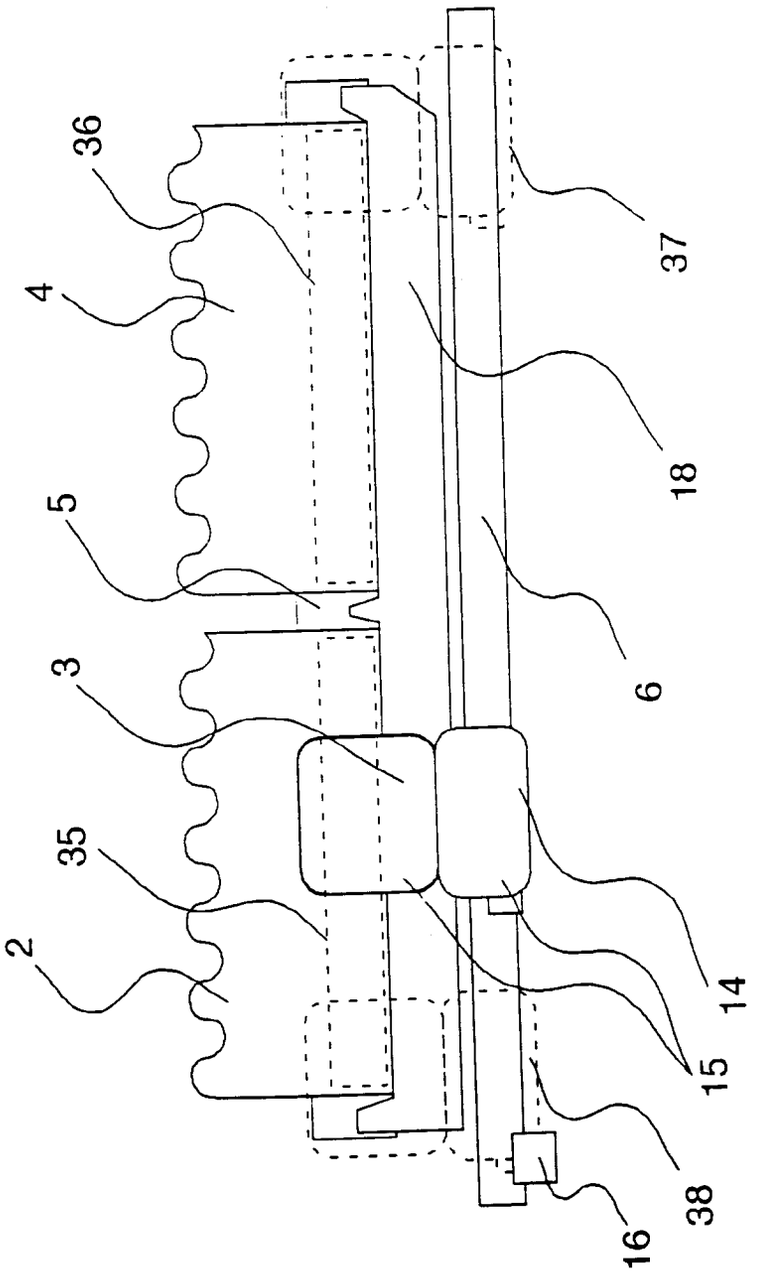


FIG. 3

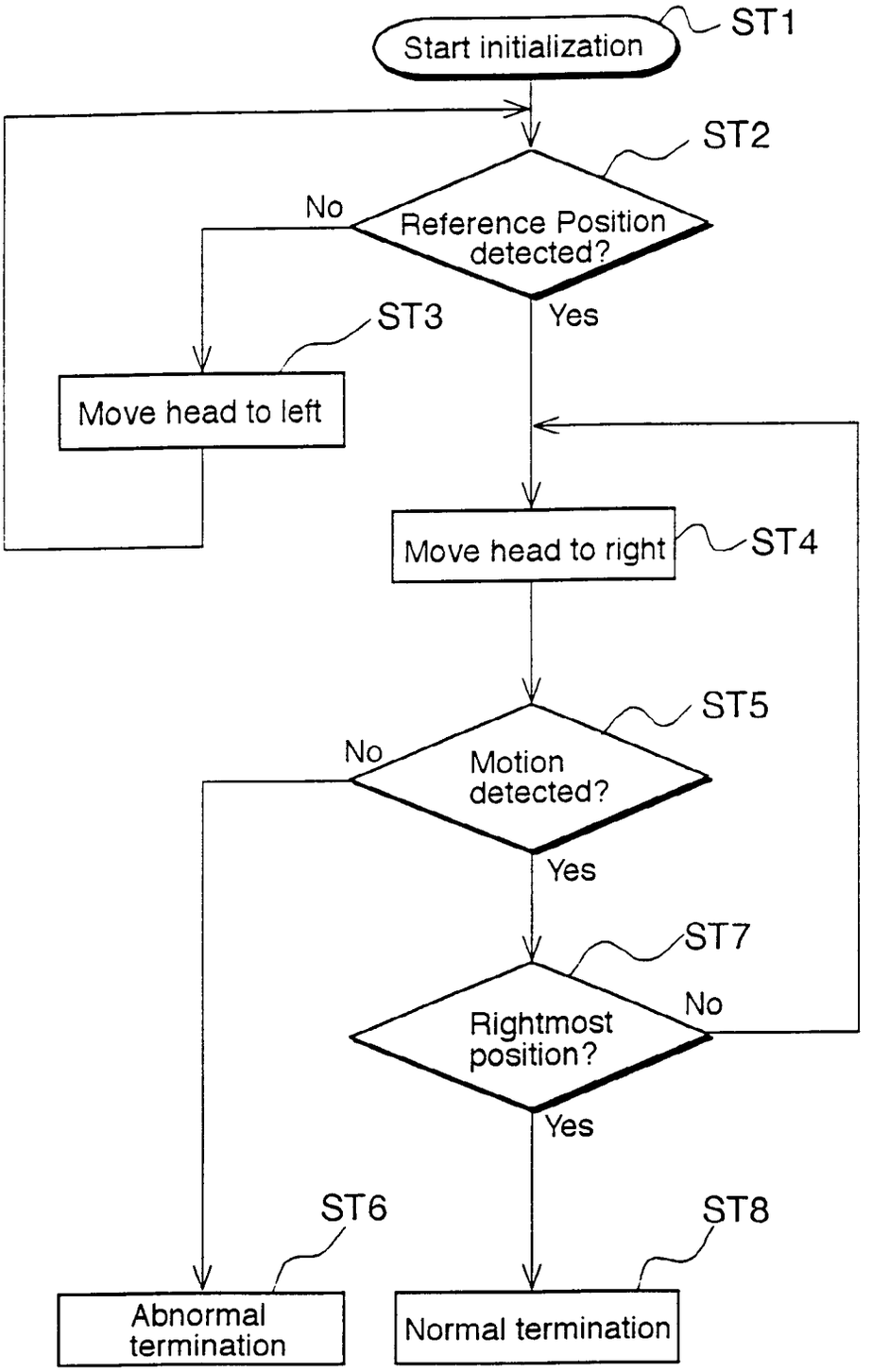

Start initialization
ST1
ST2
Reference Position detected?
No
Yes
ST3
Move head to left
Move head to right
ST4
ST5
Motion detected?
No
Yes
ST7
Rightmost position?
No
Yes
ST6
Abnormal termination
ST8
Normal termination

FIG. 4