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(54) Printing device having function for correcting shift in printing during a reciprocal printing.

(57) In a printing device capable of executing a reciprocal printing operation, provided are means for drive means for driving a printing head so as to move one reciprocal movement before a printing operation, means for calculating a value relating to a deflection between a forward movement and a reverse movement, and mans for correcting a shift in printing caused by a backlashes of driving force transmission system can be corrected.

FIG. 1A

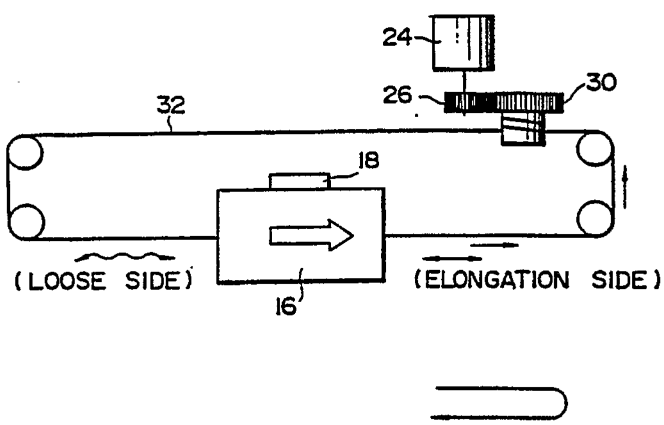
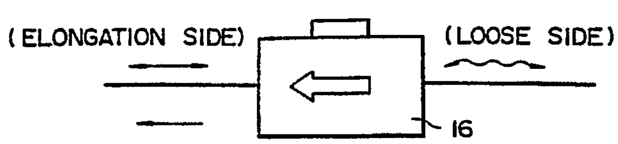


FIG. 1B



EP 0 392 702 A1

Printing Device Having Function for Correcting Shift in Printing During A Reciprocal Printing Operation

The present invention relates to a printing device, for example, a so-called serial printer which performs printing operations on movement of its reciprocal carriage having a printing head, and more particularly to a printer capable of reciprocal printing.

Printing methods in serial printers are classified into two types i.e., unidirectional and bidirectional (reciprocal) printing methods. The unidirectional printing method comprises the steps of printing letters while moving, i.e., scanning, a carriage in a direction along a printing line of a printing sheet on which printing operations are executed, returning the carriage and feeding up the printing sheet by one line and printing the succeeding printing line of the sheet while moving the carriage likewise in the direction of this line so as to print, e.g. a plurality of printing lines. In brief, the printing operations during only a forward movement of the carriage out of its reciprocal movement is repeated and the disadvantage is consequently that the printing speed becomes low. In the case of so-called two-pass printing wherein the printing operations for a printing line are performed twice separated by slight upward feeding of the sheet (i.e. the second printing operation is made with a shift of, e.g. 1/2 dot pitch relative to the first printing to fill up the gap between the dots), the carriage has to be reciprocated twice to execute a printing operation for one printing line. The printing velocity is accordingly slowed down further.

On the other hand, the reciprocal printing method for printing letters during the forward and reverse movements of the carriage is such that letters are printed during the reverse movement of the carriage at the same velocity as during the forward movement thereof. Thus, the printing velocity becomes twice as high as that in the unidirectional printing method.

However, because of backlash of the power transmission system of such a printer for reciprocal printing, the printing positions during the forward movement of the carriage tend to shift from those during the backward movement thereof. As conceptually illustrated in FIGs. 1A and 1B, for instance, the backlash of the driving force transmission system can be understood as a composite of backlash resulting from a loose engagement between the output gears of the carriage driving motor (hereinafter referred to as the carriage motor), an elongation of the drive wire, the lag of the rotor relative to the excitation phase of the carriage motor, for example, stepping motor, etc. in the drive system as a whole. Although the "backlash" originally means play of teeth between two gears meshing with each other, the term "backlash" in this specification is used for what denotes the shifting of printing positions during the forward movement of the carriage from the position during the backward movement thereof in the drive system as a whole in a broader sense.

The lag of the rotor relative to the excitation phase of the carriage motor causes, as conceptually illustrated in FIGs. 2A and 2B, the actual printing position A.P. to lag by ΔL behind an ideal printing position I.P. during the forward movement, as illustrated in FIG. 2A, whereas the lag of the rotor relative to the excitation phase causes the printing position to lag by ΔL to the right-hand side during the backward movement when the carriage motor reverses. For this reason, the shifting of the printing position during the reciprocal printing operation is doubled. As for the elongation of the drive wire, the tensile force applied to the carriage during the forward movement is reversed during the backward movement as illustrated in FIGs. 1A and 1B, so that the carriage tends to lag in the direction in which it proceeds during both the forward and backward movements. This propensity affects the shifting of the printing position. Moreover, the backlash resulting from the loose connection of the gears on the output side of the carriage motor also constitutes a factor in shifting the printing point during the backward movement,which corresponds to the printing point during the forward movement,relatively backwardly in the moving direction of the carriage.

In consideration of the fact that the backlash of the driving force transmission system as a whole causes the shifting of the printing position during the reciprocal printing operation, the following three methods have heretofore been known as techniques of correcting shifts in printing position during the reciprocal printing operation.

A first known method comprises the steps of detecting the actual position of the carriage at all times and supplying a printing command when the carriage arrives at the same position during the forward and backward movements in order to make the printing positions coincide with each other during the reciprocal printing operation. More specifically, this method is realised with a printer equipped with a circuit for detecting the carriage position, the circuit comprising a timing fence having a line of minute slits for detecting the moving position of the carriage at all times, and a photo encoder for detecting the moving amount of the carriage relative to the timing fence, whereby letters are printed synchronously with clock pulses produced therefrom.

A second known method employs programs or the like for use in measuring or computing the backlash of the driving force transmission system of a printer beforehand to make printing timing lagged by the amount of backlash thus uniformly obtained. This method premises that overall backlashes of driving force transmission systems in individual products of printers are substantially the same. A third known method employs a means for manually regulating printing timing during either forward or backward printing operations. The manually regulating means is so controlled on the part of the manufacturer to correct any shift in printing position at a point of time a printer is set up after it has been assembled and before it is shipped. An operator is otherwise expected to control the means for regulating the printing timing at the time of its use to visually ensure that a shift in printing position has been corrected before actually printing letters. The user will have to make such an adjustment frequently to secure utmost precision.

However, the method introduced as the first example is disadvantageous in that the continuous detection of the actual position of the carriage tends to become costly as it requires the provision of the means for detecting the carriage position including the timing fence, the photo encoder, etc.

The problem in the method of shifting printing timing beforehand in compliance with the measurement or computation of a backlash at the stage of designing printers as the second example is that overall backlashes of individual products of printers vary and also change with time and these difficulties are impossible to cope with satisfactorily.

As the third example thus introduced, the method of manually controlling the means for regulating printing timing on the part of user, when necessary, in order to visually correct the shifting of the printing position is troublesome as the operator is compelled to perform the complicated adjusting operation. In addition, it still poses a problem that visual inspection is relied upon to correct a shift in position because precise correction is hardly possible.

It is therefore an aim of the invention to provide an improved printing device capable of correcting shift between the printing positions by the forward movement and the reverse movement.

For this purpose, according to the present invention, there is provided a printing device comprising a printing head member movable along a platen member for supporting a printing sheet on which a printing operation is to be executed, said printing head member being capable of executing printing operations during both forward movement and reverse movement thereof and said platen member being drivable to feed the printing sheet by a predetermined amount, said printing device further comprising:

driving means for driving said printing head member reciprocally;

calculating means for calculating a certain value, during one reciprocal travel of said printing head member, relating to a deflection between two periods respectively required for a forward and a reverse movement of said printing head member; and

controlling means for controlling said printing head member, in accordance with said value calculated by said calculating means, so as to execute a printing operation in such a manner that a pair of printing positions, adjacently located along a vertical direction, at which the printing operations are respectively executed during the forward movement and the reverse movement are made near each other in a horizontal direction.

The invention also provides a correcting device for use in such a printing device and a printing process.

The invention will be more clearly understood from the following description which is given by way of example only with reference to the accompanying drawings in which:

FIGs. 1A and 1B are diagrams illustrating factors in a backlash of a driving force transmission system of a carriage;

FIGs. 2A and 2B are diagrams illustrating a lag of a rotor relative to the excitation phase of a carriage motor as one of the factors in the backlash simultaneously with a shift in printing position;

FIG. 3 is a schematic top view of a printer embodying the present invention;

FIG. 4 is a block diagram illustrating a control system of the printer of FIG. 3;

FIGs. 5A and 5B are diagrams illustrating a two-pass printing theory.

FIG. 5C is a diagram illustrating a specific example of a shift in printing position in two-pass printing;

FIG. 6 is a diagram illustrating an occurrence of a shift in printing position between forward and backward movements and the theory of correcting the shift in printing position according to the present invention;

FIG. 7 is a graph illustrating a relationship between carriage loci during the forward and backward movements relative to the excitation phase of the carriage motor;

FIG. 8 is a flowchart illustrating a program for use in computing time difference Δt in FIG. 7;

FIG. 9 is a flowchart illustrating a routine for use in measuring t_R of FIG. 8; and

FIG. 10 is a flowchart illustrating a routine for use in measuring t_L of the same.

An embodiment of the present invention will subsequently be described with reference to the accompanying drawings.

FIG. 3 is a schematic top view of a printer embodying the present invention. A platen 12 is fitted to a frame 10 and driven to rotate by a platen motor 14 shown in FIG. 4. A carriage 16 is provided opposite to the platen 12 and loaded with a dot matrix printing head 15. The carriage 16 is supported so that it is movable in parallel to the platen 12 while guided by a pair of guide bars 20, 22. A stepping motor as a carriage motor 24 is used for driving the carriage 16 and a gear 26 fixed to the output shaft of the motor 24 is engaged with a gear 30 incorporating a drive pulley 28. A drive wire 32 for use in driving the carriage 16 is wound on the drive pulley 28. One end of the drive wire 32 is directly fixed to the carriage 16, whereas the other is turned around an auxiliary pulley 34 and fixed to the carriage 16. When the carriage motor 24 rotates clockwise or counterclockwise, the driving force thereof is transmitted via the gears 26, 30 to the drive pulley 28 and further transmitted from the drive pulley 28 via the wire 32 to the carriage 16. The carriage 16 is accordingly reciprocated in the directions of "L" and "R", of FIG. 3. While the carriage 16 is moved by the carriage motor 24 in the direction of "L" or "R" at uniform velocity, the printing head 18 is driven to print a line of letters. The platen 12 then feeds up a printing sheet, not shown, so as to make the next line of letters ready for printing.

A photo-interrupter 36 which functions as a means for detecting the carriage position is fixed to the frame 10 and placed within the shuttle movement of the carriage 16. Although a detailed description of the photo-interrupter 36 is omitted since it is well known, it is an element for detecting the presence or absence of an object between a pair of light-emitting and light-receiving parts set opposite to each other therein.

On the other hand, a shield 38 is fixed to the carriage 16 and disposed so that it passes between the light-emitting and light-receiving parts of the photo-interrupter 36. When the shield 38 intercepts the light from the light-emitting part to the light-receiving part, the carriage 16 is detected as being located at the photo-interrupter 36.

FIG. 4 is a block diagram illustrating a control system of the printer. What forms the nucleus of this control system is a microcomputer 40, which comprises a MPU (microprocessor unit) 44 having a built-in timer 42, a ROM (Read Only Memory) 46 prestored with programs for use in operating the printer as a whole and correcting a shift in printing position, a RAM (Random Access Memory) 48 for working and data-recording, and an I/O (Input/Output) port 50 for inputting and outputting corresponding control signals. A head drive 54, a carriage motor driver 56 and a platen motor driver 58 in addition to the photo-interrupter 36 are connected to the I/O port 50, whereas the printing head 18, the carriage motor 24 and the platen motor 24 are respectively connected thereto. Moreover, a printer interface 60 is connected to the MPU 44, the printer interface being used for receiving printing data from external equipment such as a P.C. (Personal Computer) 62, a wordprocessor or the like. Even in the case of a wordprocessor or a personal computer in which a printer and a keyboard have been combined together, its control system configuration is substantially the same as what has been referred to above.

A printing mechanism with the printing head 18 as a principal component in the embodiment shown is arranged so that, as shown in FIG. 5A, a vertical dot train having a pitch of "L" may be printed at a time. As the carriage 16 moves, the printing mechanism is continuously driven while it selects dots and prints characters, figures, etc. composed of dot matrices. In order to make high-quality printing by increasing the vertical dot density, the printing mechanism is capable of so-called two-pass printing. As shown in FIG. 5B, the two-pass printing denotes a printing technique comprising the steps of feeding up paper by an L/2 pitch after printing a dot string once and further printing a dot string to fill up the gap between the dots in order to double the dot density. In this case, the double printing operation intended to print a line of letters is achieved by giving the first pass during the forward movement and the second pass during the backward one. If the shifting of the printing position attributed to the backlash of the driving force transmission system (e.g. the lag of the rotor relative to the excitation phase of the carriage motor 24, the elongation of the drive wire 32, loose connection between the gears 26, 30, etc.) during the reciprocate printing operation is left uncorrected, the printing position in forward letter-printing at the first pass may not be superposed on that in backward letter-printing at the second pass as shown in FIG. 5C. A detailed description will subsequently be given of the fact mentioned above with reference to FIG. 6. FIG. 6 illustrates the excitation phase of the carriage motor 24 (a stepping motor of four phases ranging from "A" to "D" in this example) and the actual printing position corresponding to the position of the carriage 16. In order to avoid complications, however, printing of only two lines of dots in tiers is considered and, to simplify the description further, printing of one dot per corresponding step is also considered, though a plurality of dots are normally vertically printed at one step of the carriage motor 24.

When the driving of the "n"th dot during the forward movement is carried out at the head of the excitation phase "C" of FIG. 6, a printing point in an ideal state falls on a position "P" therein. However, the actual printing is made at a position closer to "B" between "B" and "C" because of backlash such as the lag of the rotor relative to the excitation phase. Even though a printing command is issued at the head of the phase "D" excitation in FIG. 6 at the same timing as the timing during the forward printing operation so as to print the dot "n" on the second dot line during the backward movement at the same position as that of the "n"th dot during the forward printing operation, the actual printing is made at a position closer to "A" between "A" and "D" because of the aforementioned backlash. As a result, the printing position results in shifting by ΔL between the forward and backward printing operations. In the embodiment shown, the shifting ΔL of the printing position is taken out as time Δt and the printing timing is delayed by that Δ?t during the backward printing operation, whereby it is intended to cancel the shifting of the printing position by printing the dot n on the first dot line and the dot "n" on the second dot line at the vertically corresponding position, i.e. at the same linear position.

This theory will be described in detail further with reference to FIG. 7. In FIG. 7, the abscissa axis represents the excitation phase (four phases of "A" -"D") of the carriage motor 24, whereas the ordinate axis represents a position at which the carriage 16 should stop when a given excitation phase is excited. In other words, assuming no backlash of the driving force transmission system and the like exist, an ideal stop position (absolute position) of the carriage 16 is indicated by means of a symbol corresponding to the excitation phase of the carriage motor 24.

A curve 11 in FIG. 7 shows the relation between the position of the carriage 16 and the motor excitation phase when the carriage motor 24 is driven from the leftmost excitation phase "A" up to the excitation phase "A" (rightmost therein) 8 steps ahead in order to forwardly move the carriage 16 that has been stopped at the leftmost excitation phase "A" therein. The reason for the non-correspondence of the carriage position to the excitation phase on that curve is mainly ascribed to the backlash of the driving force transmission system and this is a view of the aforementioned follow-up lag of the carriage 16 from a different angle. On the other hand, a curve 12 shows the relation between the motor excitation phase and the actual carriage position when the carriage that has been stopped at the rightmost excitation phase "A" is backwardly moved through a section equivalent to what is to be moved forward. The hysteresis of the locus 11 of the carriage during the forward movement and the locus 12 during the backward movement are said to constitute the backlash of the drive system as a whole and the hysteretic range may be considered constant within the range of uniform motion of the carriage 16. The aforementioned hysteretic range can be taken out as time data by measuring the hysteretic range in distance as time Δt. Although the hysteretic range may be given as a distance if it is taken in the ordinate direction, it is given as time Δt if it is taken in the abscissa direction.

In order to measure Δt, a reference drive control point of the carriage motor 24 is set at a point "S", for instance, as shown in FIG. 7. The reference drive control point "S" is a point of time at which the phase "D" three steps ahead starts being excited with the leftmost phase "A" as a reference during the forward movement, whereas it is a point of time at which the phase "C" six steps ahead starts being excited with the rightmost phase "A" as a reference during the backward movement. The time t_R required until the carriage 16 reaches the photo-interrupter 36 after the motor excitation phase reaches the reference drive control point "S" is measured during the forward movement of the carriage 16 and the time t_L required until the motor excitation phase reaches the reference drive control point "S" after the carriage 16 passes the photo-interrupter 36 is measured during the backward movement, so that the difference in the time required therebetween is obtained from $\Delta t = t_R - t_L$. The time required t_L during the backward movement is smaller than t_R during the forward movement and this is because the excitation phase moves to the preceding step while the backlash of the drive system is absorbed.

FIGs. 8 through 10 are flowcharts showing the specific procedures of measuring the t_R, t_L and computing Δt in the embodiment shown.

In FIG. 8, the MPU 44 supplies the carriage driver 56 with a control signal in Step 1 (hereinafter referred to as simply S1 and similar abbreviations shall apply to other steps) when power is turned on and causes the carriage 16 to move up to a home position to the left of the photo-interrupter 36 in FIG. 3 and to stop thereat. In S2 and S3, t_R, t_L are subsequently measured respectively and the difference in transit time therebetween is computed in S4.

FIG. 9 illustrates a routine in S2 further. More specifically, the timer 42 is reset in S10 after the carriage 16 is moved to the home position on the "L" side in FIG. 3 and the carriage motor 24 is driven at the same constant pulse rate as the printing velocity to move the carriage 16 up to the fixed position on the "R" side in FIG. 3 beyond the photo-interrupter 36. In S1, the MPU 44 checks up to see if each step position falls on the reference drive control point "S" on a step basis, i.e. on the basis of initial excitation in each excitation phase and, if the step falls on the reference drive control point "S", starts the timer 42 for measuring time in S13 and continues the process of driving the carriage 16 in S14. While the carriage motor 24 is being driven, the output of the photo-interrupter 36 is simultaneously checked in S15 and, when the output varies, i.e. when either edge of the shield 38 of the carriage 16 is detected as the output of the photo-interrupter 36 has a pulse-like waveform with a given width, a decision made in S15 becomes "YES". The timer 42 is then stopped and the value t_R of the timer is stored in the RAM 48. When the carriage 16 subsequently comes to the fixed position to the "R" of the photo-interrupter 36 of FIG. 3 in S17, the driving of the carriage is stopped and it remains stationary thereat.

FIG. 10 illustrates a routine for use in measuring the time t_L during the forward movement and the processing flow is substantially similar to that of measuring t_R. The MPU 44 resets the timer 42 in S30 and starts driving the carriage motor 24 at a pulse rate in constantly proportional to the printing velocity in order to move the carriage 16 from the stationary position on the "R" side in FIG. 3 up to what is to the "L" beyond the photo-interrupter 36. The output of the photo-interrupter 36 is checked in parallel to the driving of the carriage motor 42 at this time in S32. The timer 42 is started in S33 when the edge of the shield 38 on the same side as that during the forward movement at the output pulse is detected and the driving process is continued in S34. While the carriage motor 24 is being driven, a decision is made in S35 and the initial excitation in each step is checked to see if the step falls on the reference drive control point "S". When the step is determined to fall on the reference drive control point "S", the timer 42 is stopped in S36 and the then value t_L is stored in the RAM 48. When the carriage 16 returns to the original position on the "L" side of FIG. 3, the driving process is stopped and the carriage 16 becomes stationary.

The flow then proceeds to S4 of FIG. 8, wherein the MPU 44 computes the difference in the time required from $\Delta t = t_R - t_L$ using the time values t_R, t_L stored in the RAM 48 and causes the RAM 48 to store Δt thus computed.

The shift in printing position is corrected according to the data Δt as a difference in time and, in the embodiment shown in FIG. 6, there is arranged a program for use in delaying the timing of driving the printing head during the backward printing operation by Δt from the head point of time of the phase "C" excitation as the reference drive control point "S". In other words, the time lag Δt is set to the timer 42 in order that the issuance of a printing command is delayed by the time set to the timer 42 during the backward printing operation. As a result, the n printing point on the first dot line coincides with that on the second dot line, whereby high-density precision printing can be achieved as shown in FIG. 5B.

In setting actual delay time, a certain length of processing time, though it is extremely short, is required until a drive signal is actually delivered after a given point of time is decided to be the timing of driving the printing head 18 and the processing time in forward and backward letter-printing is reversely added and accumulated. A constant correction value "ta" including the processing time is added together with a symbol so as to set actual delay time $\Delta T = \Delta t +$ "ta".

As is obvious from the description above, the carriage motor 24 is mainly used as the means for reciprocating the carriage 16 and the timer 42 is mainly used as the means for measuring the transit time; whereas the programs stored in the ROM 46 and used for correcting shifts in printing position and the MPU 44 for executing the programs are mainly used as means for computing the difference in transit time and correcting the printing timing in the embodiment shown.

Although a description has been given of an embodiment of the present invention, it is intended to exemplify nothing but the present invention, which is needless to say applicable, with various modifications based on knowledge deriving from those skilled in the art, to e.g. two-pass printing, for not solely high-density printing but printing enlarged characters twice, ordinary shuttle printing for printing one line of letters with one pass or the like.

Claims

1. A printing device comprising a printing head member movable along a platen member for supporting a printing sheet on which a printing operation is to be executed, said printing head member being capable of executing printing operations during both forward movement and reverse movement thereof and said platen member being drivable to feed the printing sheet by a predetermined amount, said printing device further comprising:
driving means for driving said printing head member reciprocally;
calculating means for calculating a certain value, during one reciprocal travel of said printing head member, relating to a deflection between two periods respectively reguired for a forward and a reverse movement of said printing head member; and
controlling means for controlling said printing head member, in accordance with said value calculated by said calculating means, so as to execute a printing operation in such a manner that a pair of printing positions, adjacently located along a verti-

cal direction, at which the printing operations are respectively executed during the forward movement and the reverse movement are made near each other in a horizontal direction.

2. A correcting device for use in providing a shift in printing, adapted to be positioned in a printing device comprising a printing head member movable along a platen member for supporting a printing sheet on which a printing operation is executed, said printing head member capable of executing printing operations during both forward movement and reverse movement therof and said platen member being driven to feed the printing sheet in a predetermined amount of value at each termination of said forward movement of said printing head member, said correcting mechanism comprising:
calculating means for calculating a certain value, during one reciprocal movement of said printing head member, relating to a deflection between two periods respectively required for a forward and a reverse movement of said printing head; and
controlling means for controlling said printing head member, in accordance with said value calculated by said calculating means, so as to execute a printing operation in such a manner that a pair of printing positions, adjacently located along a vertical direction, at which the printing operations are respectively executed during the forward movement and the reverse movement are to be neared with each other in a horizontal direction.

3. A device according to claim 1 or 2 wherein said certain value calculated by said calculating means comprises a value defined by the equation below, and wherein said controlling means controls said printing head member so as to execute printing operations in such a manner that the printing operations of said pair of printing operations are backwardly executed in said certain value during one reciprocal movement,
$\Delta t = t_R - t_L$
where, Δt: said certain value;
t_R: a period required for, in said forward movement, said printing head member to move from a first predetermined timing to second predetermined timing after said first predetermined timing;
t_L: another period required for, in said reverse movement, said printing head member to move from a timing corresponding to said second predetermined timing to another timing corresponding to said first predetermined timing.

4. A device according to claim 3, wherein said backward printing operations are executed during either of said forward movement and said reverse movement.

5. A device according to claim 3, wherein said backward printing operations are executed during said reverse movement.

6. A device according to claim 3, 4 or 5 wherein said printing head member is arranged to be driven by a motor having a plurality of excitation phases and said first predetermined timing comprises a timing at which said motor is first excited by a predetermined phase of said excitation phases, and wherein said second predetermined timing comprises a timing at which said printing head member passes a predetermined position provided in a moving pass thereof.

7. A device according to claim 6, wherein said predetermined position is provided with a sensor for detecting a passing of a predetermined part of said printing head member.

8. A device according to claim 7, wherein said sensor comprises a light transmitting element and a light receiving element between which said predetermined part of said printing head member is passed.

9. A device according to claim 6, 7 or 8 wherein number of said excitation phases of said motor is four.

10. A device according to any preceding claim, wherein said predetermined amount of feed of the printing sheet corresponds to a half line of a printing line on the printing sheet and the feed occurs at the termination of forward movement of the printing head member.

11. A printing process using a printing device comprising a printing head member movable along a platen member for supporting a printing sheet on which a printing operation is executed, said printing head member being capable of executing printing operations during both forward movement and reverse movement thereof and said platen member being driven to feed the printing sheet in a predetermined amount
said printing process comprising:
calculating a certain value, during one reciprocal travel of said printing head member, relating to a deflection between a period required for the forward movement and another period required for the reverse movement; and
executing printing operation during the reciprocal movement in such a manner that, in accordance with said calculated value, a pair of printing positions, adjacently located along a vertical direction, at which the printing operations are respectively executed during the forward movement and the reverse movement are made near to each other in a horizontal direction.

12. The printing process according to claim 11, wherein said certain calculated value comprises a value defined by the following equation, and the printing operations are executed in such a manner that the printing operations on said pair of printing operations are backwardly executed in said certain calculated value during one reciprocal movement,

$\Delta t = t_R - t_L$
where, Δt: said certain value;
t_R: a period required for, if said forward movement, said printing head moves from a first predetermined timing to a second predetermined timing after said first predetermined timing;
t_L: another period required for, in said reverse movement, said printing head moves from a timing corresponding to said second predetermined timing to another timing corresponding to said first predetermined timing.

FIG. 1A

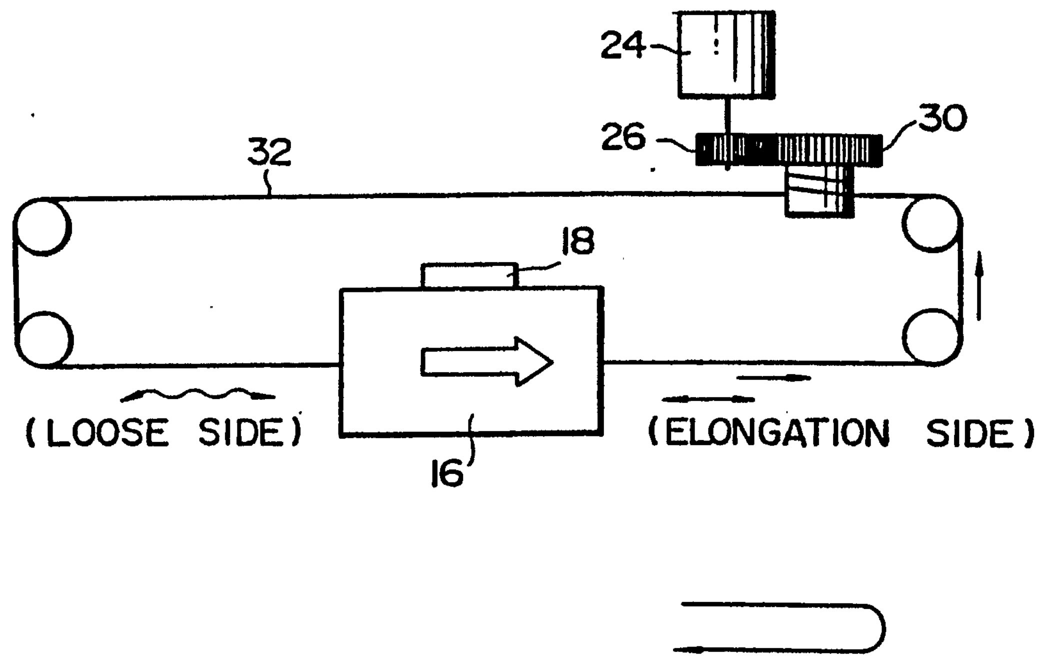

24
26
30
32
18
(LOOSE SIDE)
(ELONGATION SIDE)
16

FIG. 1B

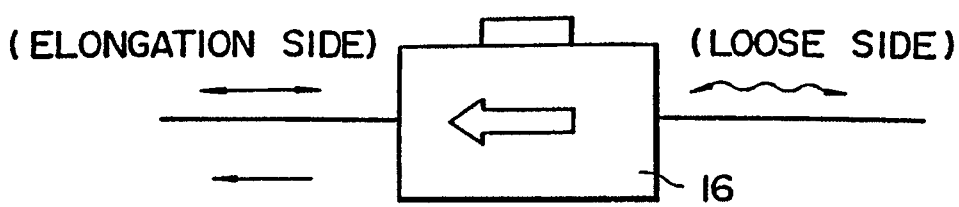

(ELONGATION SIDE)
(LOOSE SIDE)
16

FIG. 2A

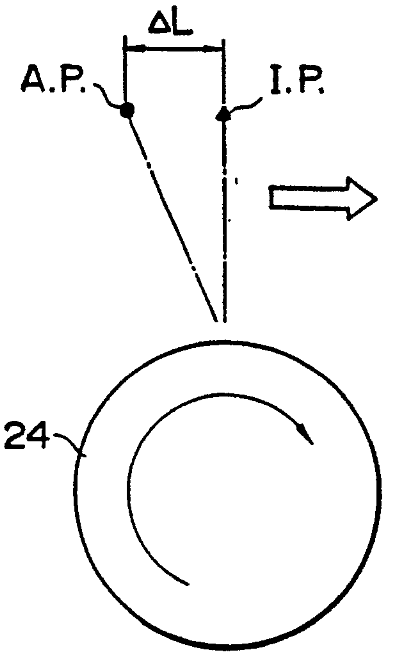


FIG. 2B

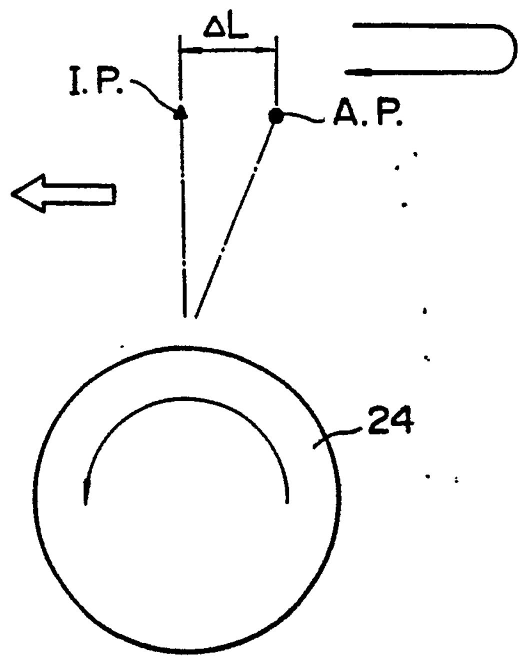


FIG. 3

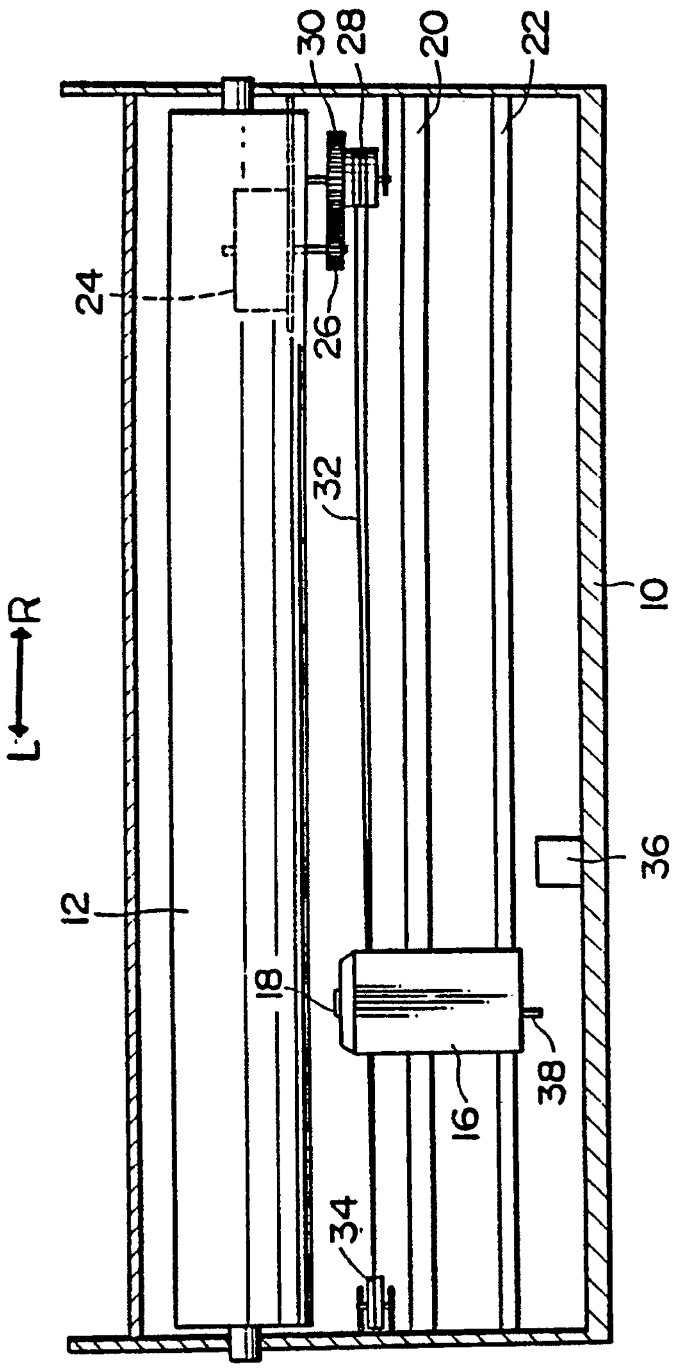


FIG. 4

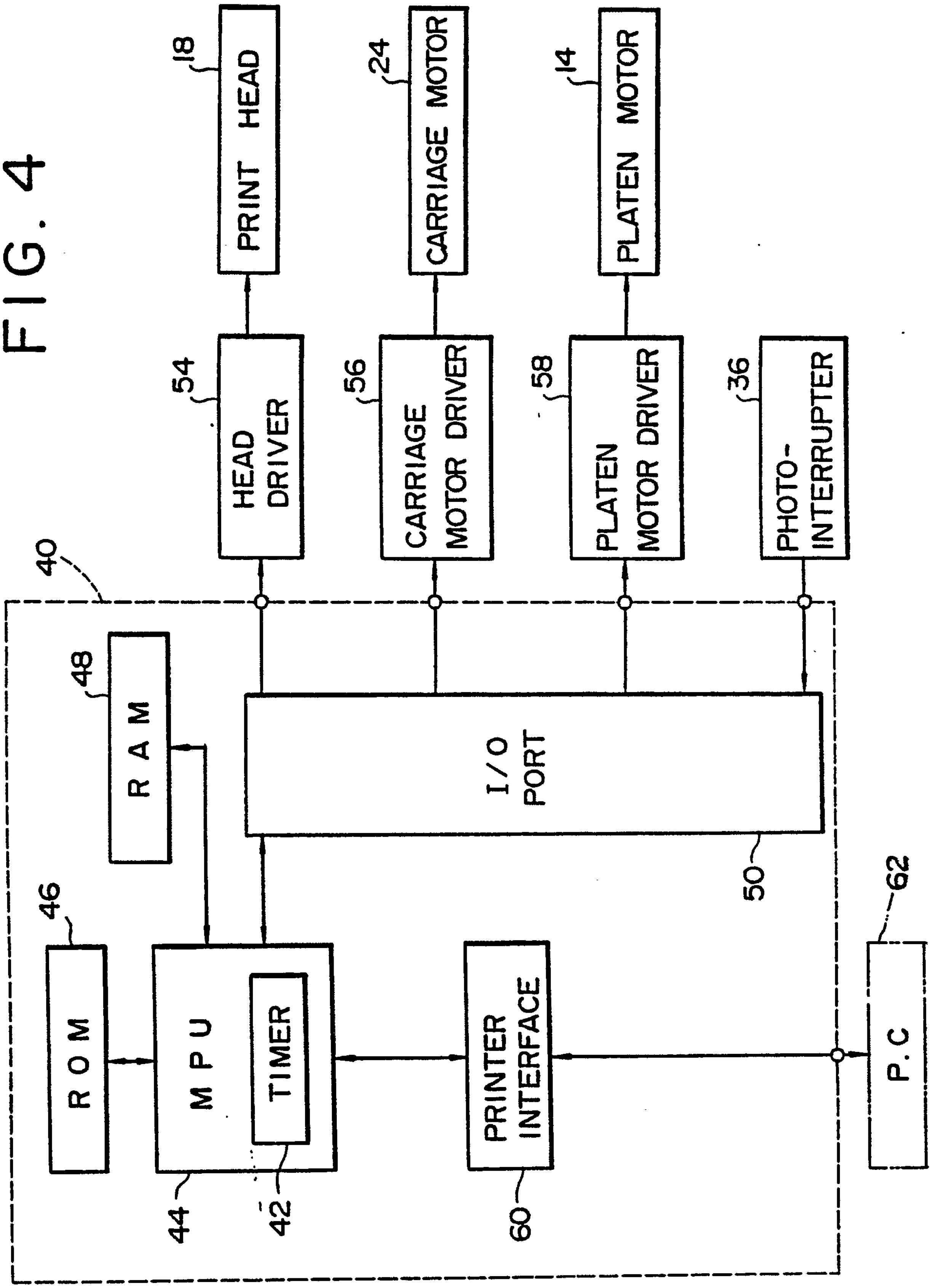

18
PRINT HEAD
24
CARRIAGE MOTOR
14
PLATEN MOTOR
54
HEAD DRIVER
56
CARRIAGE MOTOR DRIVER
58
PLATEN MOTOR DRIVER
36
PHOTO-INTERRUPTER
40
48
RAM
I/O PORT
50
46
ROM
MPU
TIMER
44
42
PRINTER INTERFACE
60
62
P.C

FIG. 5A

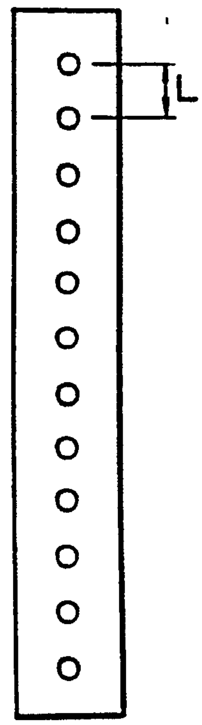


FIG. 5B

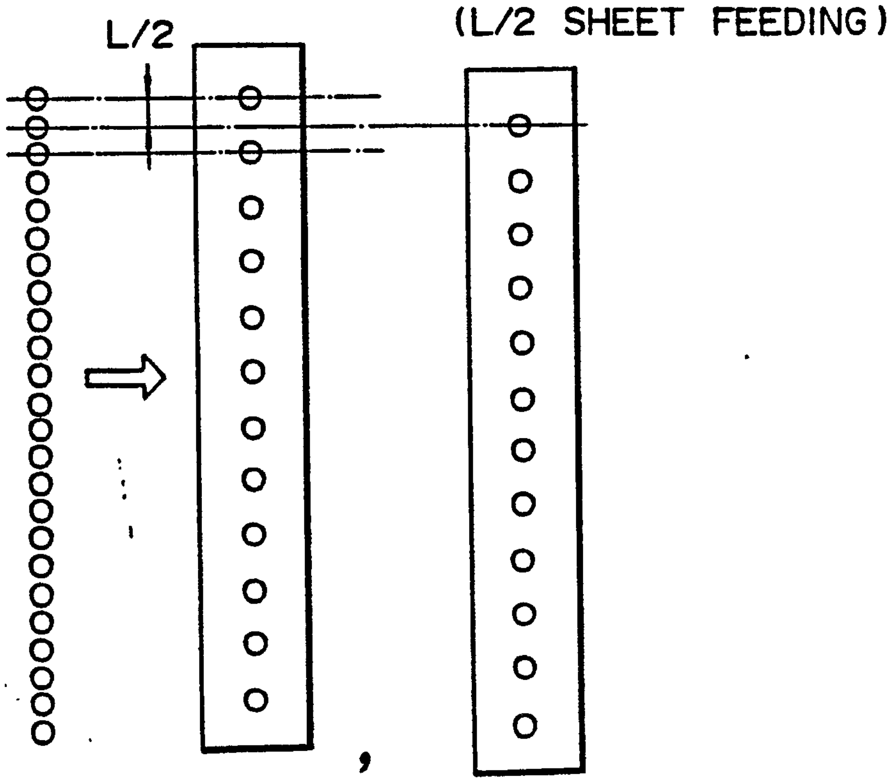


FIG. 5C

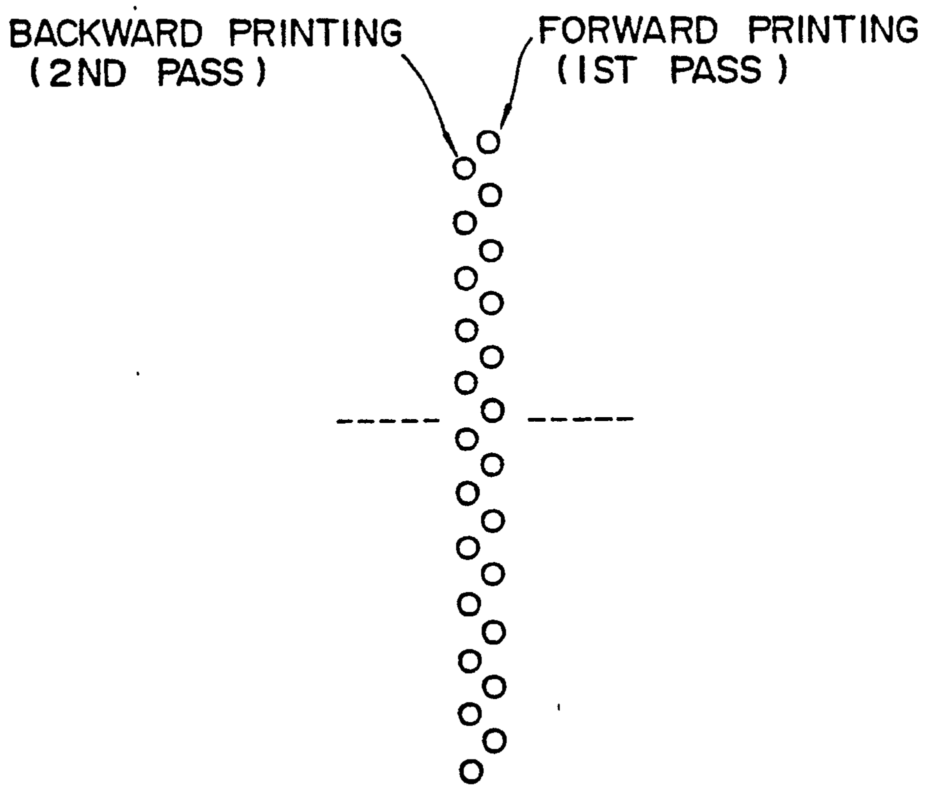


FIG. 6

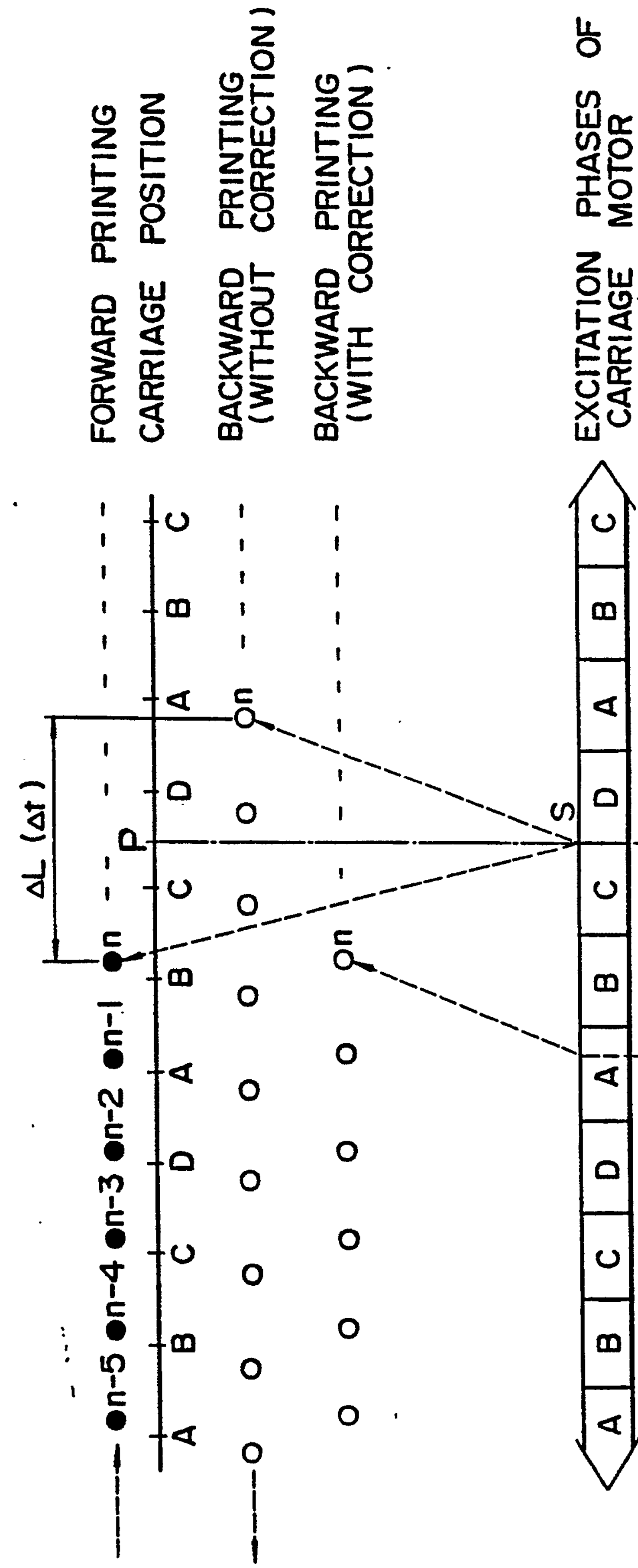
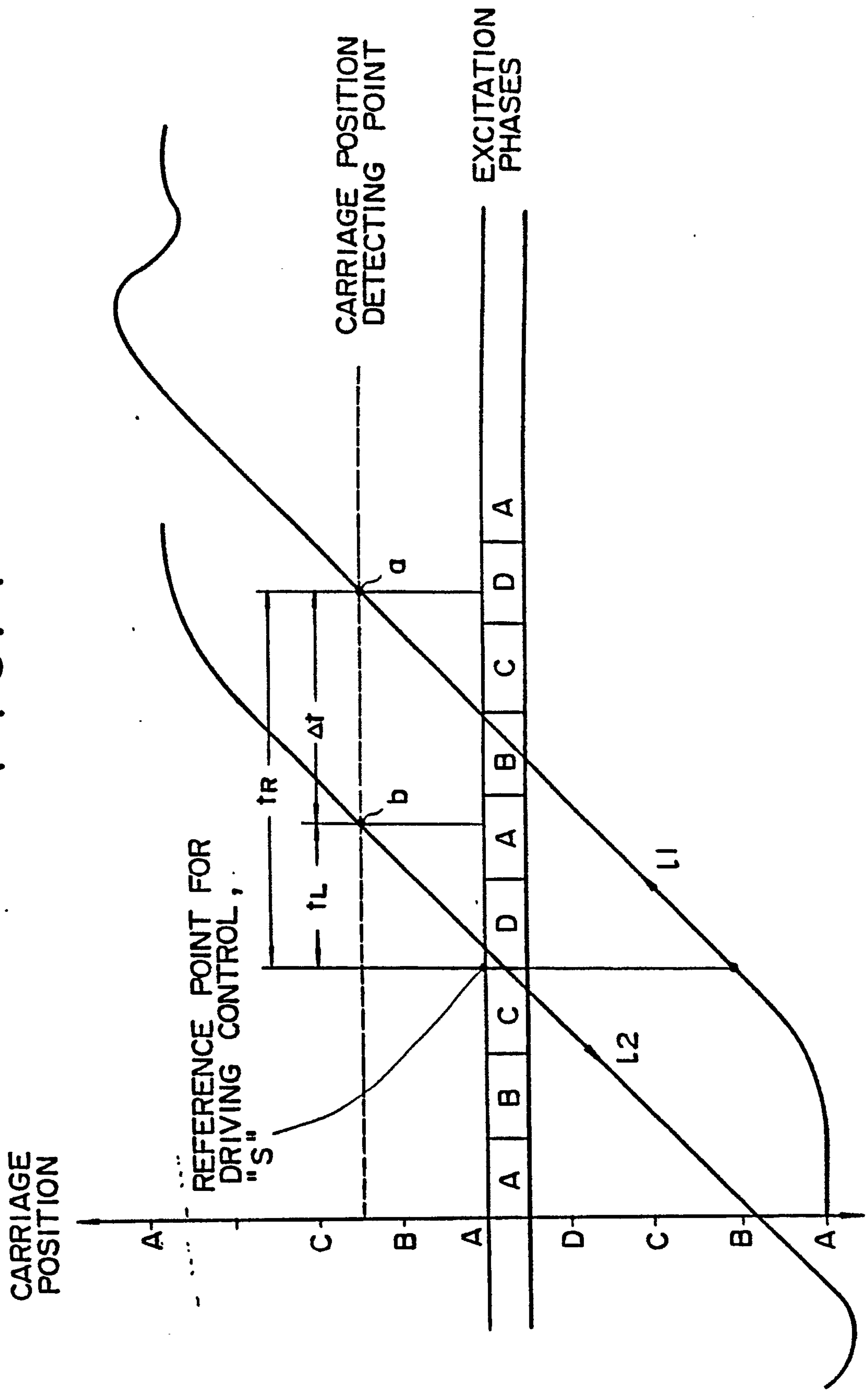

FORWARD PRINTING
CARRIAGE POSITION
BACKWARD PRINTING (WITHOUT CORRECTION)
BACKWARD PRINTING (WITH CORRECTION)
EXCITATION PHASES OF CARRIAGE MOTOR
n-5
n-4
n-3
n-2
n-1
n
ΔL (Δt)
P
S
Δt
A B C D A B C D A B C

FIG. 7



CARRIAGE POSITION
REFERENCE POINT FOR DRIVING CONTROL, "S"
CARRIAGE POSITION DETECTING POINT
EXCITATION PHASES
tR
tL
Δt
a
b
L1
L2
A
B
C
D

FIG. 8

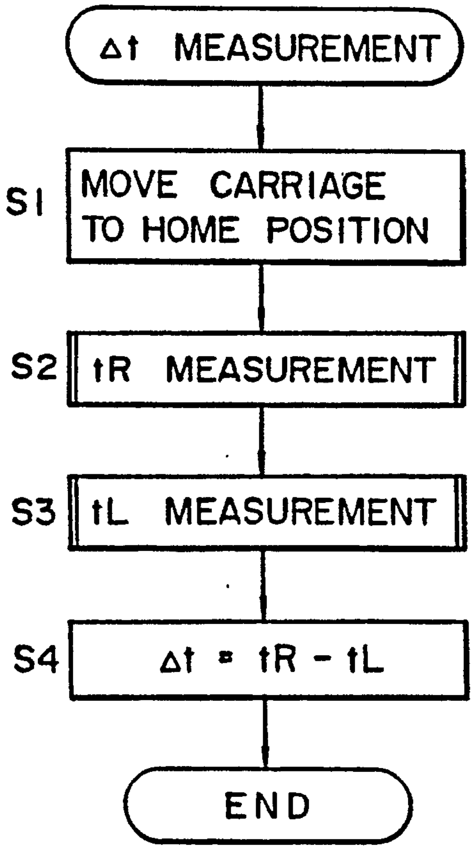

Δt MEASUREMENT
S1
MOVE CARRIAGE TO HOME POSITION
S2
tR MEASUREMENT
S3
tL MEASUREMENT
S4
Δt = tR - tL
END

FIG. 9

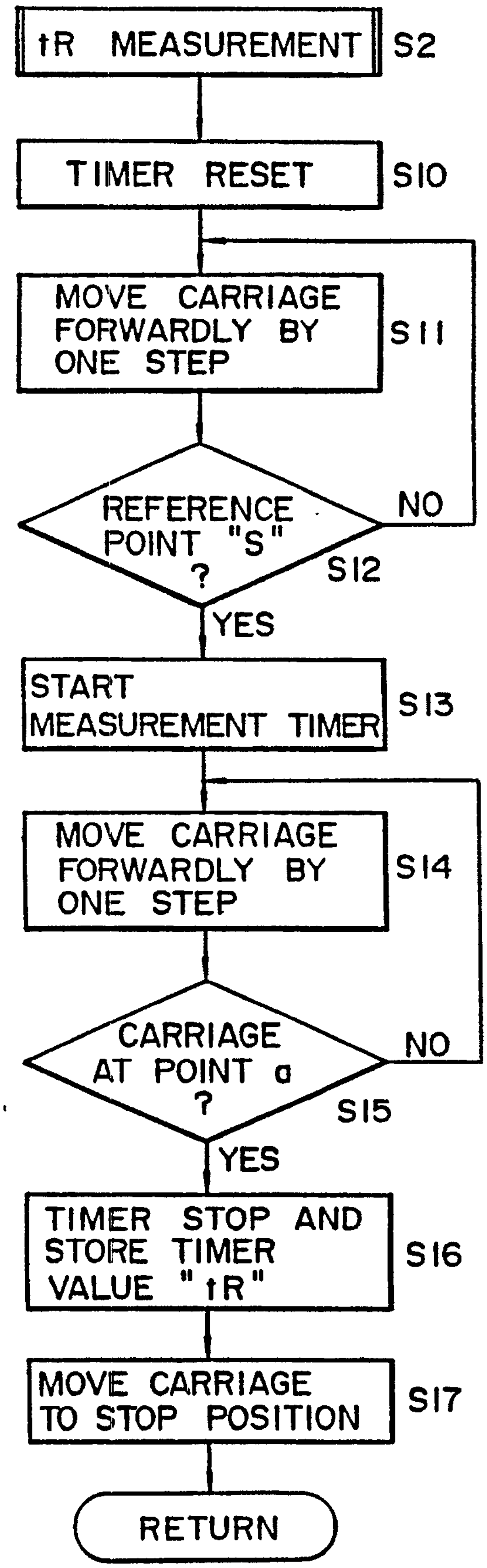
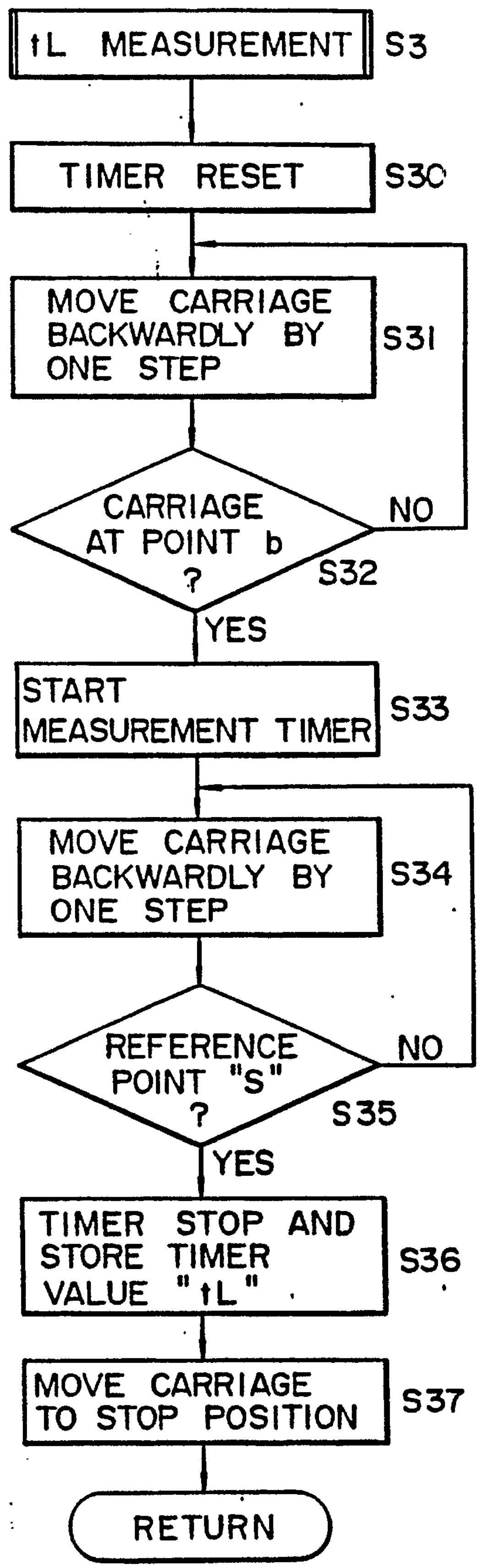

tR MEASUREMENT
S2
TIMER RESET
S10
MOVE CARRIAGE FORWARDLY BY ONE STEP
S11
REFERENCE POINT "S" ?
NO
S12
YES
START MEASUREMENT TIMER
S13
MOVE CARRIAGE FORWARDLY BY ONE STEP
S14
CARRIAGE AT POINT a ?
NO
S15
YES
TIMER STOP AND STORE TIMER VALUE "tR"
S16
MOVE CARRIAGE TO STOP POSITION
S17
RETURN

FIG. 10


tL MEASUREMENT
S3
TIMER RESET
S30
MOVE CARRIAGE BACKWARDLY BY ONE STEP
S31
CARRIAGE AT POINT b ?
NO
S32
YES
START MEASUREMENT TIMER
S33
MOVE CARRIAGE BACKWARDLY BY ONE STEP
S34
REFERENCE POINT "S" ?
NO
S35
YES
TIMER STOP AND STORE TIMER VALUE "tL"
S36
MOVE CARRIAGE TO STOP POSITION
S37
RETURN

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 3369

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 10, no. 311 (M-528)(2367), 23 October 1986; & JP-A-61123559 (SANYO) 11.06.1986	1,2,11	B 41 J 19/64 B 41 J 19/14
X	PATENT ABSTRACTS OF JAPAN vol. 12, no. 247 (M-717)(3094), 13 July 1988; & JP-A-6335374 (TOSHIBA) 16.02.1988	1,2,11	
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 153 (M-226)(1298), 5 July 1983; & JP-A-5862084 (SONY) 13.04.1983	1,2,11	
X	PATENT ABSTRACTS OF JAPAN vol. 8, no. 69 (M-286)(1506), 31 March 1984; & JP-A-58217382 (FUJITSU) 17.12.1983	1,2,11	
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 81 (M-205)(1226), 5 April 1983; & JPA-588681 (RICOH) 18.01.1983	1,2,11	**TECHNICAL FIELDS SEARCHED (Int. Cl.5)**
Y	EP-A-0 291 099 (BROTHER) * figures 3,5; abstract *	1-9,11, 12	B 41 J
Y	EP-A-0 263 688 (OKI) * figure 10; abstract; column 4, line 64 - column 5, line 8 *	1-9,11, 12	
A	US-A-4 752 144 (NEC) * abstract *	1,2,11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	09-07-1990	FRITZ S C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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