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(54) Printing method for bidirectional serial printer.

(57)

(Purpose)

The useless stop of the printing head during the printing operation is eliminated, and the printing time can be shortened.

(Arrangement)

A printing method for a bidirectional serial printer comprising a printing data buffer 1 and 2 for at least two lines, and characterized in that:

comparing a printing end position of a predetermined line, a left end position of a printing range for a next line, and a right end position thereof, and a judgement is made which end position, the printing operation of the next line is commenced from; and in case that a printing head moving direction from said printing end position for said predetermined line to said printing start position of the next line is the same as the printing direction at said predetermined line, said printing head is continuously scanned without any interruption also after the printing operation for the predetermined line has been completed, and is moved to the printing start position of the next line.

In particular, a scanning speed of said printing head from the printing end position of the predetermined line to the printing start position of the next line during the continuous scanning operation, may be preferably higher than a scanning speed thereof during the printing operation.

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(Detailed Description of the Invention)

(Industrial Field of Utilization)

The present invention is related to a printing method for a bidirectional serial printer.

(Prior Art)

In the conventional bidirectional serial printer, to shorten printing time, such a printing method has been employed that when the printing operation for 1 line is completed, the printing head is stopped; a judgement is done either a left end position within a printing range for the next line, or a right end position within the printing range is close to this stop position; and after the printing head is moved to the closer position and once stepped, a paper feeding operation is carried out to print the subsequent line.

(Means for Solving the Problems)

In the above-described conventional printing method, after the printing head is stopped at the printing end position of one line and the line feed operation is performed, the printing head is moved to the printing start position of the next line and stopped there. That is to say, the printing head is stopped twice from the commencement of the printing operation for 1 line to the end of the printing operation for the next line, whereby the printing time is prolonged.

The present invention has an object to provide a printing method for a bidirectional serial printer capable of shortening printing time.

(Means to Solve the Problems)

The above-described problem may be solved by the present invention in such a manner that a printing data buffer for at least two lines is provided; based on a printing end position of a predetermined line within the printing data buffer, a left end position of a printing range for a next line, and a right end position thereof, a judgement is made which end position, the printing operation of the next line is commenced from; and in case that a printing head moving direction from said printing end position for said predetermined line to said printing start position of the next line is the same as the printing direction at said predetermined line, said printing head is continuously scanned without any interruption also after the printing operation for the predetermined line has been completed, and is moved to the printing start position of the next line.

In particular, a scanning speed of said printing head from the printing end position of the predetermined line to the printing start position of the next line during the continuous scanning operation, may be preferably higher than a scanning speed thereof during the printing operation.

(Embodiments)

An embodiment of the present invention will now be explained with reference to drawings.

In Fig. 1, reference numerals 1 and 2 indicate buffers for storing printing data of 1 line, respectively; reference numeral 3 represents a printing unit constructed of a printing head and a carriage or the like; and reference numeral 4 denotes a control circuit for controlling a printing operation, constructed of a CPU, a ROM and the like.

Referring now to a flow chart shown in Fig. 2, a printing operation will be explained. It is now assumed that a pattern as shown in Fig. 3 is printed out. First, printing data of a first line is stored into the buffer 1 and then the printing operation is carried out at the printing unit 3 in accordance with this printing data (step A).

It is also assumed that the first line is printed out by the right-head scanning operation of the printing unit 3.

Printing data of a second line is stored into the buffer 2 while the first line is printed out. When this data storing is completed, a decision is made that which distance is closer among the left end position "b1" of the printing range for the second line and the right end position "b2" thereof from the printing end position "a2" of the printing range for the first line (step B). As to the pattern shown in Fig. 3, since the distance from the position "a2" to the position "b2" is shorter than that from the position "a2" to the position "b1", this position "b2" becomes a printing start position for the second line.

Next, a judgement is made whether or not the scanning direction when the printing unit 3 is moved from the printing end position "a2" of the first line to the printing start position "b2" of the second line, is coincident with the printing direction of the first line. If the scanning direction is coincident with the printing direction, a direction coincident flag is set to "1". Conversely, if the scanning direction is not coincident with the printing direction, this direction coincident flag is set to "0" (step C). In this embodiment, since both of these scanning/printing directions are right directions and are coincident with each other, the above-described direction coincident flag is set to "1".

In case that the above-described direction coincident flag is set to "1", even when the printing operation of the first line is accomplished, the printing unit 3 is not stopped at the printing end position "a2", but is moved to the printing start position

"b2" of the second line . At this time, the printing unit 3 is moved at its maximum speed from the position "a2" to the position "b2" (step D).

A relationship between the positions of the printing unit 3 and the moving speeds thereof at this case is represented in Fig. 4(a). Fig. 4(b) indicates such a relationship according to the conventional printing method. Comparing both of the moving speeds, the printing time according to the printing method of the present invention is shorter than that of the conventional printing method only by a time period for which the printing unit 3 is not stopped when the printing operation for the first line is carried out, and also only by increasing the moving speed of the printing unit 3 up to the printing start position for the second line.

Subsequently, the printing operation for the second line is carried out from the printing start position "b2" by the left-hand scanning operation. Since the right end position "C2" of the printing range for the third line is closer than the left end position "C1" thereof, as measured from the printing end position "b1" for the second line, the printing direction for the second line is not coincident with the moving direction from the position "b1" to the position "C2" and thus the above-described direction coincident flag is set to "0".

When the above-described direction coincident flag is "0", the printing unit 3 is stopped at the printing end position "b1" similar to that of the conventional printing method (step E), and thereafter the printing unit 3 is moved to the printing start position C2 for the third line at maximum moving speed thereof (step D).

The above-described operations are repeated every line, whereby the bidirectional printing operation is performed.

In accordance with the above-mentioned preferred embodiment, since with respect to the printing end position b1 for the second line, the right end position C2 for the third line is closer than the left end position C1 thereof, the printing operation for the third line is performed from the right end position C2. However, since there is a slight difference between the distance b1-c1, and the distance b1-c2, a short time printing operation can be achieved in view of temporal matter when the printing unit 3 is not stopped at the position b1, but moved to the position c1 at the maximum moving speed thereof, and then the printing operation is commenced from this position c1.

First, a description will now be made of a judging method for printing time. As shown in Fig. 5, considering, for instance, the right-hand printing operation is carried out for a first line and then a printing start position for a second line is selected, if a right end position "y1" is selected, then as shown in Fig. 6(a), a total time T1 consisting of move time t1, deceleration time t2, stop time t3, acceleration time t4 and printing time t5 is required, whereas when a position "y2" is selected to the printing start position and a right-hand printing operation is performed, as shown in Fig. 6(b), a total time "T2" consisting of deceleration time t6, stop time t7, acceleration time t8, move time t9, deceleration time t10, stop time t11, acceleration time t12, and printing time t13, is needed. It should be noted that the deceleration time t2, t6, t10, stop time t3, t7, t11, acceleration time t4, t8, t12 are constant values which are determined by various factors of the printer. With regard to the move time t1, t9 and the printing time t5, t13, since the moving speeds of the printing head are constants respectively, a predetermined time period is calculated from its move distance. That is to say, assuming now that the move speed (maximum speed) of the printing unit 3 from a printing end position for one line to another printing start position for a next line is "S max" and the moving speed of the printing unit 3 during the printing operation is "S pri", these time periods are given as follows:

$$t1 = (y1 - X1)/Smax$$
$$t5, t13 = (y1 - y2)/Spri$$
$$t9 = (x1 - y2)/Smax$$

Comparing the total time T1 with the total time T2, if T1 is equal to, or smaller than T2, the right end position "y1" is selected. To the contrary, if T1 is greater than T2, the left end position "y2" is selected.

It should be noted that in case when, as shown in a third line of Fig. 5, the printing end position (y1 or y2) of the preceding line is not located between a left end position z2 of the third line and a right end position z1, a printing start position can be selected without performing the above-described calculation. For instance, if "y1" corresponds to the printing end position for the second line, it is clearly defined that the right end position "z1" should be selected to the printing start position for the third line. In this case, no calculation as explained before is performed.

The above-described operation is executed in accordance with a flow chart shown in Fig. 7.

Operations up to the judgement whether or not the printing data on the next line has been stored are similar to those of the above-described preferred embodiment. Subsequently, assuming now that a printing end position for a certain line under printing operation is "P"; a right end position in a printing range for a next line is "R", and a left end position thereof is "L", a judgement is first done whether or not R is positioned at a right side, as compared with "P" (step F). If the judgement

result is NO, namely if the overall printing range of the next line is positioned at the left side, as compared with the printing end position "P" for the present printing line, since the printing operation should be commenced from the right end position R without any conditions, it is decided that the printing start position for the next line is "R" (step G).

When R is located at the right side, as compared with P, another judgement is made whether or not L is positioned at the right side, as compared with P (step H). If the judgement result becomes YES, namely the overall printing range for the next line is located at the right side, as compared with the printing end position P for the present printing line, it is determined that the printing start position for the next line is the left end position L (step I).

If L is not located at the right side, as compared with P, namely if the printing end position for the present printing line is positioned between the left end L for the next line and the right end R, each of the printing time periods is calculated in accordance with the previous explanation under conditions that R is the printing start position, and also L is the printing start position. Then, the shorter printing time period is selected (step J).

The subsequent operations are similar to those of the above-described preferred embodiment.

(Effects of the Invention)

In accordance with the present invention, since the useless stop of the printing unit during the printing operation can be eliminated, the printing time can be shortened. In particular, if the printing unit is moved from the print end position of one line to the print start position of the next line at its maximum speed, more particular advantages may be obtained.

[Brief Description of Drawings]

(Fig. 1)
A block diagram for showing a major unit of a printer according to the present invention.
(Fig. 2)
A flow chart for explaining a printing operation.
(Fig. 3)
An explanatory diagram for showing one example of a printing pattern.
(Fig. 4)
An explanatory diagram for explaining a printing operation.
(Fig. 5)
An explanatory diagram for showing one example of a printing pattern.
(Fig. 6)
An explanatory diagram for explaining a printing operation according to another preferred embodiment.
(Fig. 7)
A flow chart for explaining a printing operation according to another preferred embodiment.
1 --- buffer,
2 --- buffer,
3 --- printing unit.

Claims

1. A printing method for a bidirectional serial printer comprising a printing data buffer for at least two lines, characterized in that:

based on a printing end position of a predetermined line, a left end position of a printing range for a next line, and a right end position thereof, a judgement is made which end position, the printing operation of the next line is commenced from; and

in case that a printing head moving direction from said printing end position for said predetermined line to said printing start position of the next line is the same as the printing direction at said predetermined line, said printing head is continuously scanned without any interruption also after the printing operation for the predetermined line has been completed, and is moved to the printing start position of the next line.

2. A printing method for a bidirectional serial printer characterized in that a scanning speed of said printing head from the printing end position of the predetermined line to the printing start position of the next line during the continuous scanning operation, is higher than a scanning speed thereof during the printing operation.

FIG.1

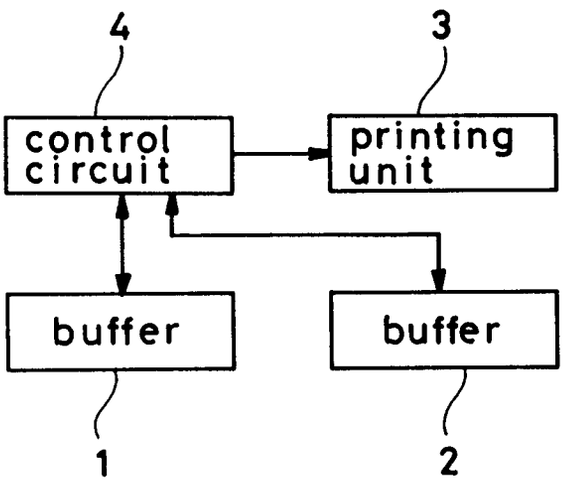


FIG. 2

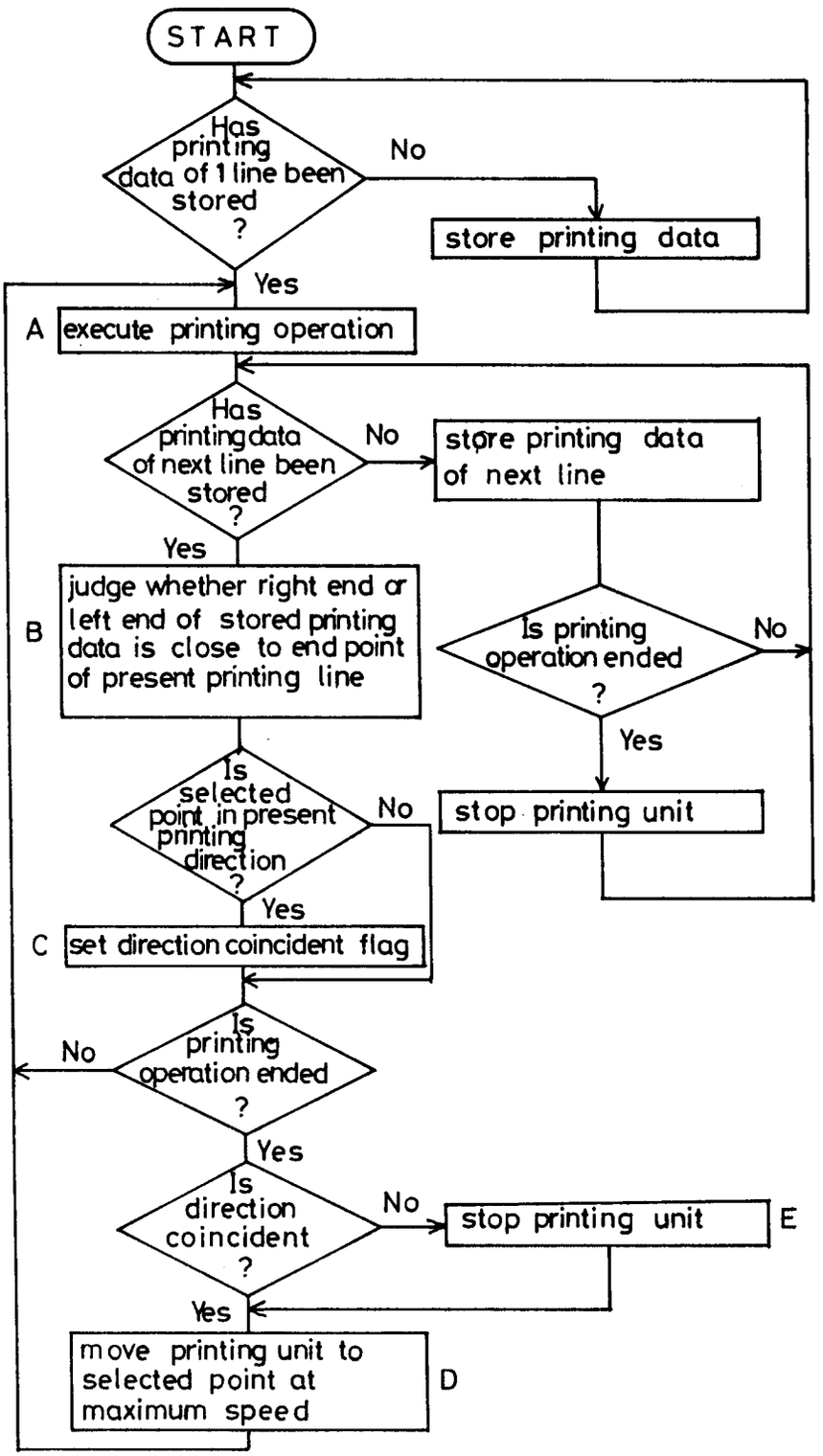

START
Has printing data of 1 line been stored ?
No
store printing data
Yes
A
execute printing operation
Has printing data of next line been stored ?
No
store printing data of next line
Yes
B
judge whether right end or left end of stored printing data is close to end point of present printing line
Is printing operation ended ?
No
Yes
Is selected point in present printing direction ?
No
stop printing unit
Yes
C
set direction coincident flag
Is printing operation ended ?
No
Yes
Is direction coincident ?
No
stop printing unit
E
Yes
move printing unit to selected point at maximum speed
D

FIG. 3

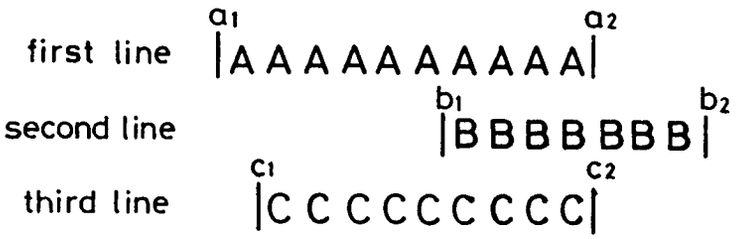

a1
a2
first line
A A A A A A A A A A
b1
b2
second line
B B B B B B B
c1
c2
third line
C C C C C C C C C

FIG. 4

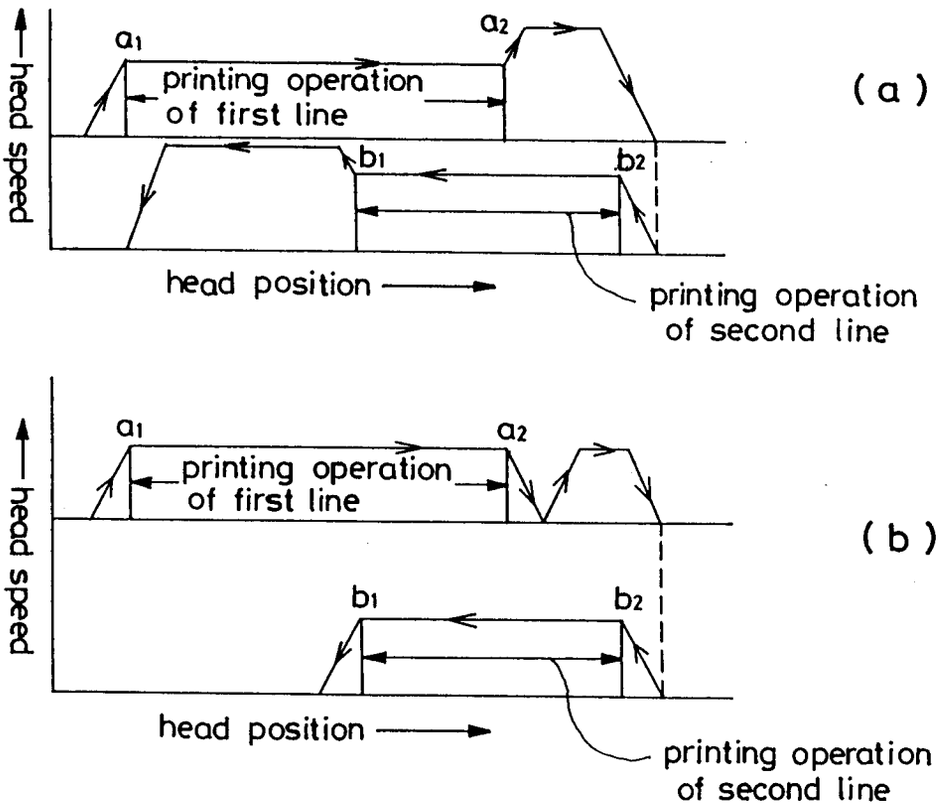

head speed
a1
a2
printing operation of first line
b1
b2
head position
printing operation of second line
(a)
head speed
a1
a2
printing operation of first line
b1
b2
head position
printing operation of second line
(b)

FIG. 5

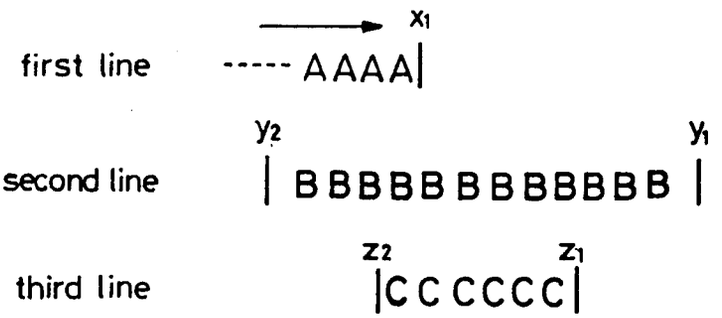

x1
first line
AAAA
y2
y1
second line
BBBBBBBBBBBB
z2
z1
third line
CCCCCC

FIG. 6

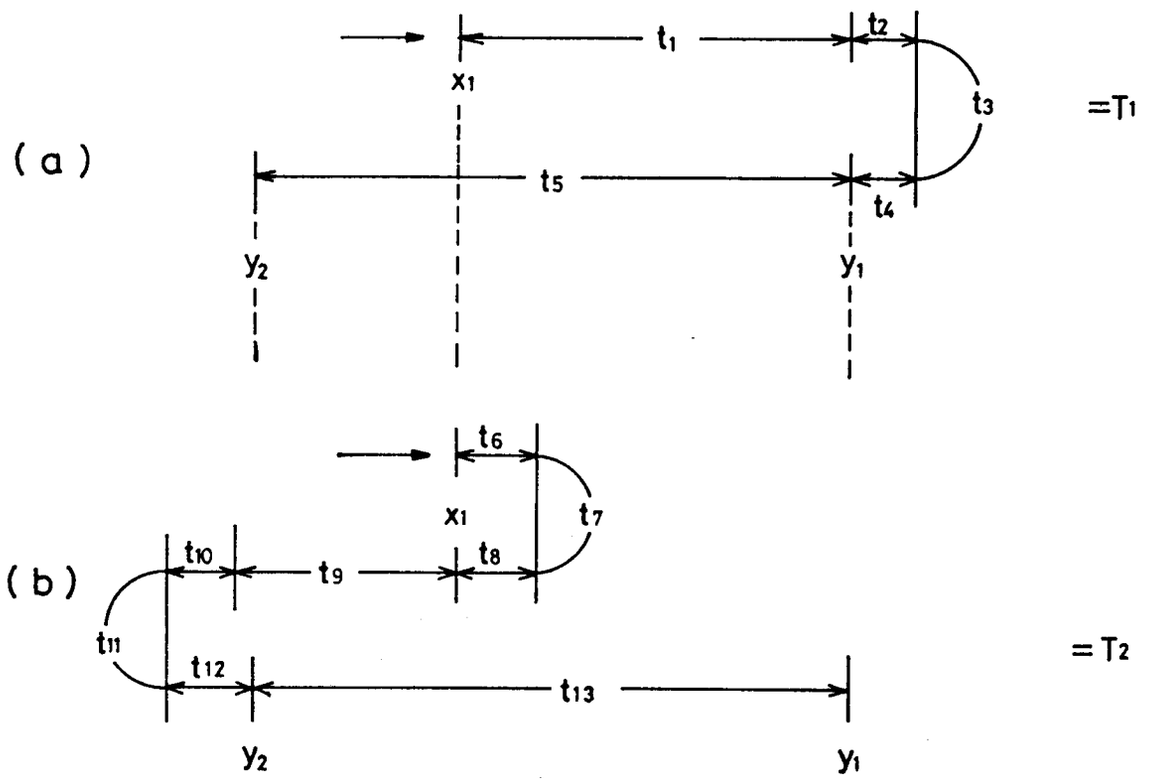
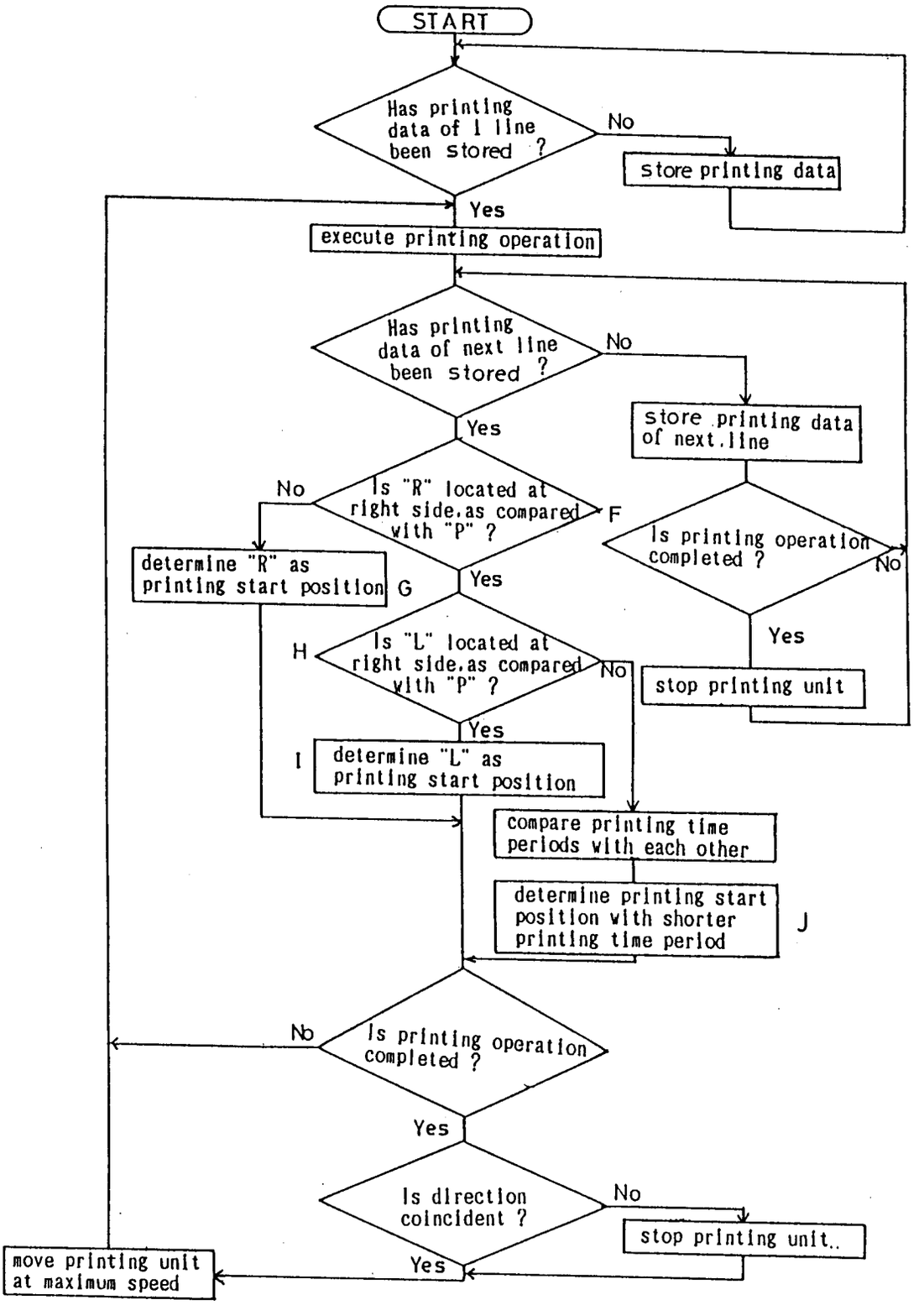

(a)
t1
t2
t3
=T1
x1
t5
t4
y2
y1
(b)
t6
t7
x1
t10
t9
t8
t11
t12
t13
=T2
y2
y1

FIG. 7


START
Has printing data of 1 line been stored ?
No
store printing data
Yes
execute printing operation
Has printing data of next line been stored ?
No
store printing data of next line
Yes
Is "R" located at right side as compared with "P" ?
No
F
determine "R" as printing start position
G
Yes
Is printing operation completed ?
No
Yes
stop printing unit
H
Is "L" located at right side as compared with "P" ?
No
Yes
I
determine "L" as printing start position
compare printing time periods with each other
determine printing start position with shorter printing time period
J
No
Is printing operation completed ?
Yes
Is direction coincident ?
No
stop printing unit
Yes
move printing unit at maximum speed