



Europäisches Patentamt
European Patent Office
Office européen des brevets



Publication number: **0 473 191 A1**

EUROPEAN PATENT APPLICATION

Application number: **91114657.9**

Int. Cl.⁵: **B41J 2/355**

Date of filing: **30.08.91**

Priority: **30.08.90 JP 228668/90**

Inventor: **Kashiwagi, Shinichi**

Date of publication of application:
04.03.92 Bulletin 92/10

**486-9, Hiramatsu
Susono-shi, Shizuoka-ken(JP)**

Designated Contracting States:
DE FR GB

Representative: **Weber, Joachim, Dr. et al**

Applicant: **TOKYO ELECTRIC CO., LTD.**
**6-13, 2-chome, Nakameguro
Meguro-ku Tokyo(JP)**

**Hoefler, Schmitz, Weber, Patentanwälte
Ludwig-Ganghofer-Strasse 20
W-8022 Grünwald/München(DE)**

Driving apparatus for a thermal print head, and driving method for the same.

A driving apparatus for a thermal print head comprises a data supplying circuit (11, 12) for supplying a line of dot data to the thermal print head (13) in each drive cycle, which data specifies which one of heating elements (14) of the thermal print head is (13) used to print a dot, and enabling the thermal print head (13) to energize the heating elements (14) specified by the dot data line for a first energizing time from the time when the dot data line is supplied. In the driving apparatus, a replacing circuit (21, 22) is provided to replace the dot data line supplied to the thermal print head (13) by in-

verted data of the dot data line supplied in the drive cycle preceded by one cycle when a second energizing time has elapsed from the time at which the line of dot data is supplied from the data supplying circuit (11, 12) to the thermal print head (13), wherein the second energizing time is set to a length suitable for printing a dot by the heating element (14) in a preheated state, and the first energizing time is set longer than the second energizing time by a length suitable for preheating the heating element (14).

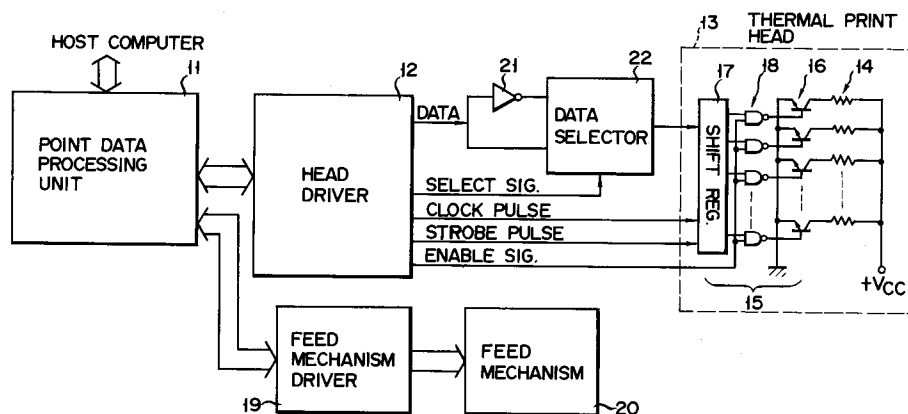


FIG. 3

EP 0 473 191 A1

The present invention relates to a driving apparatus and driving method for a thermal print head, and more particularly to a driving apparatus and driving method for controlling the energization time of each heating element of a thermal print head in accordance with the energization history thereof.

Fig. 1 shows part of a circuit of a conventional label printer which prints characters and bar codes on a label. The label printer comprises a print data processing unit 1, a head driver 2 and a thermal print head 3. The print head 3 has a line of heating elements 4 arranged perpendicularly to the feeding direction of the label, and an energization controller 5 which controls energization of the heating elements. The print data processing unit 1 receives print data for one label from an external computer and produces dot image data for characters and bar codes on the basis of this print data. The head driver 2 repeatedly drives the thermal print head 3 to print a label corresponding to the dot image data produced by the processing unit 1.

Specifically, the print data processing unit 1 sequentially extracts one line of dot data from the produced dot image data at an interval corresponding to a drive cycle at which the print head 3 is driven, and supplies the dot data line to the head driver 2 so as to specify which of the heating elements 4 is to be energized at one time. The head driver 2 supplies the line of dot data in synchronization with clock pulses, then a strobe pulse and an enable signal to the energization controller 5 of the thermal print head 3. The enable signal continues for a predetermined time from the time the strobe pulse is supplied. The energization controller 5 includes a plurality of switches 6 for selectively supplying power to the corresponding heating elements 4, a shift register circuit 7 for sequentially receiving the line of dot data in response to the respective clock pulses, and latching the line of dot data in response to the strobe pulse, and a gate circuit 8 for selectively turning the power switches 6 on, based on the line of dot data latched in the shift register circuit 7 during a period while the enable signal is being supplied. In other words, the power switches 6 energize the corresponding heating elements 4 when the dot data is "1", and deenergizes the corresponding heating elements 4 when the dot data is "0". The print head 3 prints a dot on the portion of the label facing the energized heating element 4, and blanks the portion of the label facing the deenergized heating element 4.

In general, the image density becomes irregular due to the difference in energization histories of the heating elements 4. For simplicity of description, it is considered that two heating elements, for example, are energized for a predetermined time to

print dots in a certain drive cycle. If both the heating elements are initially used in this drive cycle, the dots can be printed uniformly since the temperatures of these heating elements are in the same temperature immediately before energization. However, if one of the heating elements is already used in a preceding drive cycle, the dots cannot be printed uniformly since there is a difference in temperature between these heating elements immediately before energization. The above-described head driver 2 normally performs a complicated process so as to reduce the irregularity in image density.

More specifically, the head driver 2 controls the energizing time of each heating element 4 in accordance with the energization history thereof 4 for one preceding drive cycle. In this control, a first energizing time is prepared for those heating elements 4 used to print dots during the preceding drive cycle, and second energizing time is prepared for those heating elements 4 not used to print dots during the preceding cycle. When the first energizing time has a length T_1 , the second energizing time is set to a length of the sum of T_1 and T_2 . The head driver 2 processes the line of dot data supplied from the print data processing unit 1 so as to selectively assign one of the first and second energizing times to the heating element 4. As shown in Fig. 2, when one line of dot data D_n is supplied for energization in the n -th drive cycle, the head driver 2 stores the line of dot data D_n as the energization history data H_n of the n -th drive cycle, and further sequentially supplies the line of dot data D_n and clock pulses synchronized there with to the energization controller 5. The head driver 2 supplies a first strobe pulse to the energization controller 5 after supplying all of the dot data, and supplies an enable signal to the energization controller 5. The enable signal is continued from the time when the first strobe pulse is supplied for the length of the second energizing time ($T_1 + T_2$). Thus, the dot data line D_n is set in the shift register circuit 7 and output therefrom. At this time, the heating elements specified by the dot data line D_n are energized to print dots. The head driver 2 checks energization history data $H(n-1)$ stored in the $(n-1)$ -th drive cycle while the specified heating elements are being energized, produces one line of dot data D_n' for specifying the heating elements 4 not energized in the $(n-1)$ -th drive cycle and energized in the n -th drive cycle, and sequentially supplies the line of dot data D_n' and clock pulses synchronized therewith to the energization controller 5. The supply of the entire dot data is completed before the time of T_1 has elapsed from the generation of the first strobe pulse. The head driver 2 supplies a second strobe pulse to the energization controller 5 when the lapse of time T_1 is

detected. Thus, the dot data line Dn' is set in the shift register circuit 7 and further output therefrom instead of the dot data line Dn. At this time, energization of those heating elements 4 specified by the dot data line Dn' is continued, and energization of those heating elements 4 not specified by the dot data line Dn' is stopped. In other words, the heating element 4 used to print a dot in the (n-1)-th drive cycle and the n-th drive cycle is energized for the time of T1, and the heating element 4 not used in the (n-1)-th drive cycle and used to print a dot in the n-th drive cycle is energized for the time of (T1 + T2). Thus, uniform dots can be obtained by suitably setting the time length T2.

However, since the above-described head driver 2 produces the line of dot data Dn' by calculation, a relatively long time is required to produce the dot data line Dn'. The first energizing time must be set in consideration the time needed to produce the dot data line Dn'. This makes it difficult to shorten the energizing time by increasing the energizing power so as to improve the printing speed.

Further, the head driver does not check the energization history of each heating element for two preceding drive cycles or more. Therefore, when heating elements unused for two or more drive cycles are energized to print dots, their energizing time is set to (T1 + T2), likewise the heating elements unused for only one drive cycle. This control does not satisfactorily prevent non-uniform dots from being printed. The non-uniformity of such dots can be reduced if more lines of dot data are produced and supplied to the energization controller 5 during one drive cycle. However, this makes it necessary to lengthen the drive cycle in accordance with an increase of the total time needed to produce the lines of dot data. Accordingly, sufficient print quality cannot easily be obtained without decreasing the printing speed.

Accordingly, an object of the present invention is to provide a driving apparatus for a thermal print head capable of improving a printing speed and obtaining a sufficient print quality.

The above-described object can be achieved by a driving apparatus for a thermal head which comprises a data supplying circuit for supplying a line of dot data to the thermal print head in each drive cycle, which data specifies which one of heating elements of the thermal print head is used to print a dot, and enabling the thermal print head to energize the heating elements specified by the dot data line for a first energizing time from the time when the dot data line is supplied, and a replacing circuit for replacing the dot data line supplied to the thermal print head by inverted data of the dot data line supplied in the drive cycle preceded by one cycle when a second energizing time has elapsed from the time at which the line of

dot data is supplied from the data supplying circuit to the thermal print head,

wherein the second energizing time is set to a length TA suitable for printing a dot by the heating element in a preheated state, and the first energizing time is set longer than the second energizing time by a length TB suitable for preheating the heating element.

In the driving apparatus, the energizing time of each heating element is controlled as below in accordance with the energization history thereof for one preceding drive cycle.

If dot data of a first level is supplied from the data supplying circuit to the print head in a certain drive cycle, a corresponding heating element of the print head is energized for the time TA from the time when the dot data is supplied, irrespective of its energization history. When the time TA has elapsed, the dot data being supplied to the print head is replaced by inverted data of the dot data supplied thereto in the drive cycle preceded by one cycle. If the heating element is not used to print a dot in the preceding drive cycle, energization of the heating element is further continued for the time TB. On the other hand, if the heating element is used to print a dot in the preceding drive cycle, energization of the heating element is stopped here.

If dot data of a second level is supplied from the data supplying circuit to the print head, a corresponding heating element of the print head is not energized for the time TA from the time when the dot data is supplied. When the time TA has elapsed, the dot data being supplied to the print head is replaced by inverted data of the dot data supplied thereto in the drive cycle preceded by one cycle. If the heating element is not used to print a dot in the preceding drive cycle, the heating element is energized for the time TB. On the other hand, if the heating element is used to print a dot in the preceding drive cycle, the heating element is not energized further for the time TB.

More specifically, each heating element of the thermal print head is prevented from being left in a non-preheated state more than two drive cycles. Thus, the energization histories of the heating elements are averaged to improve the print quality as compared with that of the prior art. Further, the driving apparatus has advantages to realize the operation for inverting the line of dot data supplied in the preceding drive cycle and supplying the inverted data to the print head by a relatively simple hardware, and not to disturb the acceleration of the print operation by the above operation.

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

Fig. 1 is a partial circuit diagram of a conventional label printer;

Fig. 2 is a view showing a signal to be supplied to a thermal print head shown in Fig. 1;

Fig. 3 is a circuit diagram of a label printer according to an embodiment of the present invention; and

Fig. 4 is a view showing signals to be supplied to a thermal print head shown in Fig. 3.

A label printer according to an embodiment of the present invention will be described with reference to Figs. 3 and 4. The label printer is used to print, for example, characters and bar codes on a label.

Fig. 3 shows a circuit of this label printer. The label printer comprises, similarly to the prior art, a print data processing unit 11, a head driver 12 and a thermal print head 13. The print head 13 has a line of heating elements 14 arranged perpendicularly to the feeding direction of the label, and an energization controller 15 for selectively supplying power to the heating elements 14. The print data processing unit 11 receives print data for one label from an external computer and produces dot image data for characters and bar codes on the basis of this print data. The head driver 12 repeatedly drives the thermal print head 13 to print a label corresponding to the dot image data produced by the print data processing unit 11. More specifically, the print data processing unit 11 sequentially extracts one line of dot data from the produced dot image data at an interval corresponding to a drive cycle at which the print head 13 is driven, and supplies the line of dot data to the head driver 12 so as to specify which of the heating elements 14 is to be energized at one time. The head driver 12 sequentially supplies the line of dot data to the energization controller 15 in synchronization with clock pulses, then supplies a strobe pulse and an enable signal to the energization controller 15. The enable signal continues for a predetermined time (TA + TB) from the time when the strobe pulse is supplied to the energization controller 15. The energization controller 15 has a plurality of switches 16 for selectively supplying power to the corresponding heating elements 14, a shift register circuit 17 for sequentially receiving the line of dot data in response to the clock pulses and latching the line of dot data in response to the strobe data, and a gate circuit 18 for selectively turning the power switches 16 on, based on the line of dot data latched in the shift register circuit 17 during a period while the enable signal is being supplied. In other words, the power switches 16 energize the corresponding heating elements 14 when the dot data is "1", and deenergizes the corresponding heating elements 14 when the dot data is "0". The print head 13 prints the dot on the portion of the

label facing the energized heating element 14, and blanks the portion of the label facing the deenergized heating element 14. Further, the label printer comprises a feed mechanism driver 19 and a feed mechanism 20 to feed a label upon operation of the thermal print head 13. The feed mechanism driver 19 drives the feed mechanism 20 under the control of the print data processing unit 11.

The label printer further comprises an inverter 21 for inverting the line of dot data supplied from the head driver 12, and a data selector 22 for selecting one of the inverted dot data line supplied from the inverter 12 and the dot data line supplied from the head driver 12. The selecting operation of the data selector 22 is controlled by the select signal supplied from the head driver 12. The data selector 22 selects the dot data line supplied from the head driver 12 when the select signal is set to an "H" level and selects the inverted dot data line supplied from the inverter 21 when the select signal is set to an "L" level.

The head driver controls the energizing time of each heating element 14 corresponding to the energization history thereof in a preceding drive cycle. First to fourth energizing times are prepared in this control. The first energizing time is prepared for those heating elements 14 used to print a dot during a present drive cycle and also used to print a dot during the drive cycle preceded by one cycle, and is set to a length equal to the time TA suitable for printing a dot by each heating element in a preheated state. The second energizing time is prepared for those heating elements 14 used to print a dot during the present drive cycle and not used to print a dot during the drive cycle preceded by one cycle, and is set to a length equal to the sum of the time TA and the time TB suitable for preheating each heating element. The third energizing time is prepared for those heating elements 14 not used to print a dot during the present drive cycle and not used to print a dot during the drive cycle preceded by one cycle, and is set to a length equal to the time TB. The fourth energizing time is prepared for those heating elements 14 not used to print a dot during the present drive cycle and used to print a dot during the drive cycle preceded by one cycle, and is set to zero. The head driver 12 includes first and second buffer registers for storing the line of dot data supplied from the print data processing unit 11 as energization history data by turns. The head driver 12 initially outputs the line of dot data from the processing unit 11 together with the select signal of "H" level, and then outputs the energization history data together with the select signal of "L" level, so as to selectively assign the first to fourth energizing times to the heating elements 14.

The operation of the driving apparatus will be

described with reference to Fig. 4. As shown in Fig. 4, when the line of dot data D_n is supplied from the print data processing unit 11 to the head driver 12 so as to print dots in the n -th drive cycle, the head driver 12 stores the dot data line D_n , then set the select signal to the "H" level, and thereafter sequentially outputs dot data contained in the dot data line D_n in synchronization with the clock pulses. The data selector 22 selects the dot data supplied directly from the head driver 12. As a result, the dot data line D_n is set in the shift register circuit 7. The head driver 12 supplies a first strobe pulse to the energization controller 15 after all of the dot data are sent, and supplies the enable signal to the energization controller 15. The enable signal continues for the second energizing time ($TA + TB$) from the time when the first strobe pulse is supplied. When the line of dot data D_n is output from the shift register circuit 17, the heating elements specified by the dot data line D_n are energized to print the dot. The head driver 12 sets the select signal to the "L" level immediately after the head driver 12 supplies the first strobe pulse, and sequentially all of the dot data contained in the energization history data $D(n-1)$ stored in the drive cycle preceded by one cycle in synchronization with the clock pulses. The data selector 22 selects the dot data inverted by the inverter 21. As a result, the inverted energization history data $\overline{D(n-1)}$ is set in the shift register circuit 17. The head driver 12 supplies a second strobe pulse to the energization controller 15 when all of the dot data contained in energization history data $D(n-1)$ and the time TA has elapsed from the generation of the first strobe pulse. Thus, when the inverted energization history data $\overline{D(n-1)}$ is set in the shift register circuit 17 and output instead of the dot data line D_n from the shift register circuit 17, only the heating elements 14 specified by the dot data line $\overline{D(n-1)}$ are energized. This energization is continued until the time TB has further elapsed and the supply of the enable signal is stopped. Energization of the heating elements 14 specified by the line of dot data D_n and not specified by the line of dot data $\overline{D(n-1)}$ is stopped upon outputting of the line of dot data $\overline{D(n-1)}$. More specifically, the heating elements 14 used to print dots in the n -th drive cycle subsequently to the $(n-1)$ -th drive cycle are energized for the length of time equal to the time TA , the heating elements 14 not used in the $(n-1)$ -th drive cycle and used to print dots in the n -th drive cycle are energized for the length of time equal to the time $(TA + TB)$, the heating elements 14 not used in the $(n-1)$ -th drive cycle and not used to print dots in the n -th drive cycle are energized for the length of time equal to the time TB , and the heating elements 14 used in the $(n-1)$ -th drive cycle and not used to print dots

in the n -th drive cycle are not energized at all. The head driver 12 again sets the select signal to the "H" level immediately after the second strobe pulse is supplied, in preparation for sending the line of dot data in the next drive cycle.

In the above-described embodiment, it is possible to prevent the heating elements 14 of the thermal print head 13 from being maintained in no preheated state more than two drive cycles. Thus, the energization histories of the heating elements 14 are averaged to improve the printing quality as compared with that of the prior art. The operation for inverting the energization history data stored in the preceding drive cycle and supplying the inverted data to the print head is realized by a relatively simple hardware. Further, this operation does not disturb the acceleration of the printing operation.

In the above embodiment, the head driver 12 has two buffer registers. However, these registers are not required if one line of dot data supplied in the drive cycle preceded by one cycle is supplied from the data processing unit 11, as energization history data.

Claims

1. A driving apparatus for a thermal print head, comprising:
 - data supplying means (11, 12) for supplying a line of dot data to said thermal print head (13) in each drive cycle, which data specifies which one of heating elements (14) of said thermal print head (13) is used to print a dot, and enabling said thermal print head (13) to energize the heating elements (14) specified by the dot data line for a first energizing time from the time when the dot data line is supplied; and
 - characterized in that said driving apparatus further comprises replacing means (21, 22) for replacing the dot data line supplied to said thermal print head (13) by inverted data of the dot data line supplied in the drive cycle preceded by one cycle when a second energizing time has elapsed from the time at which the line of dot data is supplied from said data supplying means (11, 12) to said thermal print head (13); and
 - in that said second energizing time is set to a length suitable for printing a dot by the heating element (14) in a preheated state, and said first energizing time is set longer than the second energizing time by a length suitable for preheating the heating element (14).
2. A driving method for a thermal print head, comprising steps of:

supplying a line of dot data to said thermal print head (13) in each drive cycle, which data specifies which one of heating elements (14) of said thermal print head (13) is used to print a dot,

5

enabling said thermal print head (13) to energize the heating elements (14) specified by the dot data line for a first energizing time from the time when the dot data line is supplied; and

10

characterized in that

said driving method further comprises a step of replacing the dot data line supplied to said thermal print head (13) by inverted data of the dot data line supplied in the drive cycle preceded by one cycle when a second energizing time has elapsed from the time at which the line of dot data is supplied to said thermal print head (13); and

15

in that said second energizing time is set to a length suitable for printing a dot by the heating element (14) in a preheated state, and said first energizing time is set longer than the second energizing time by a length suitable for preheating the heating element (7).

20

25

30

35

40

45

50

55

6

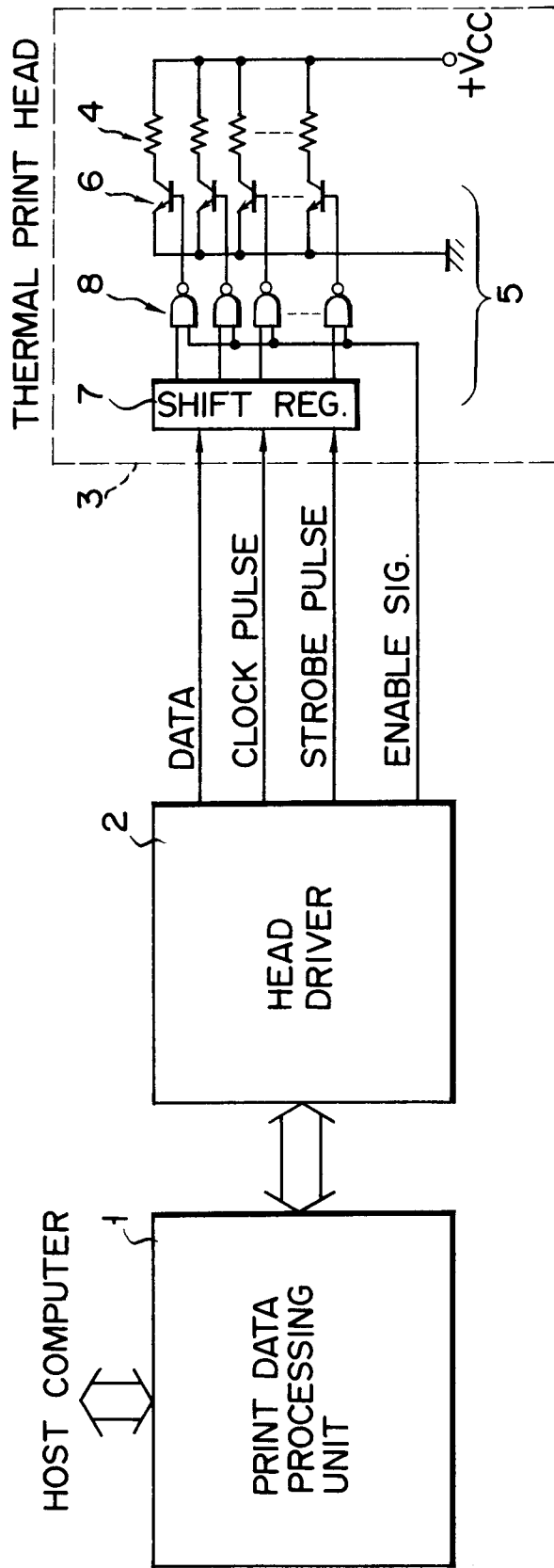


FIG. 1

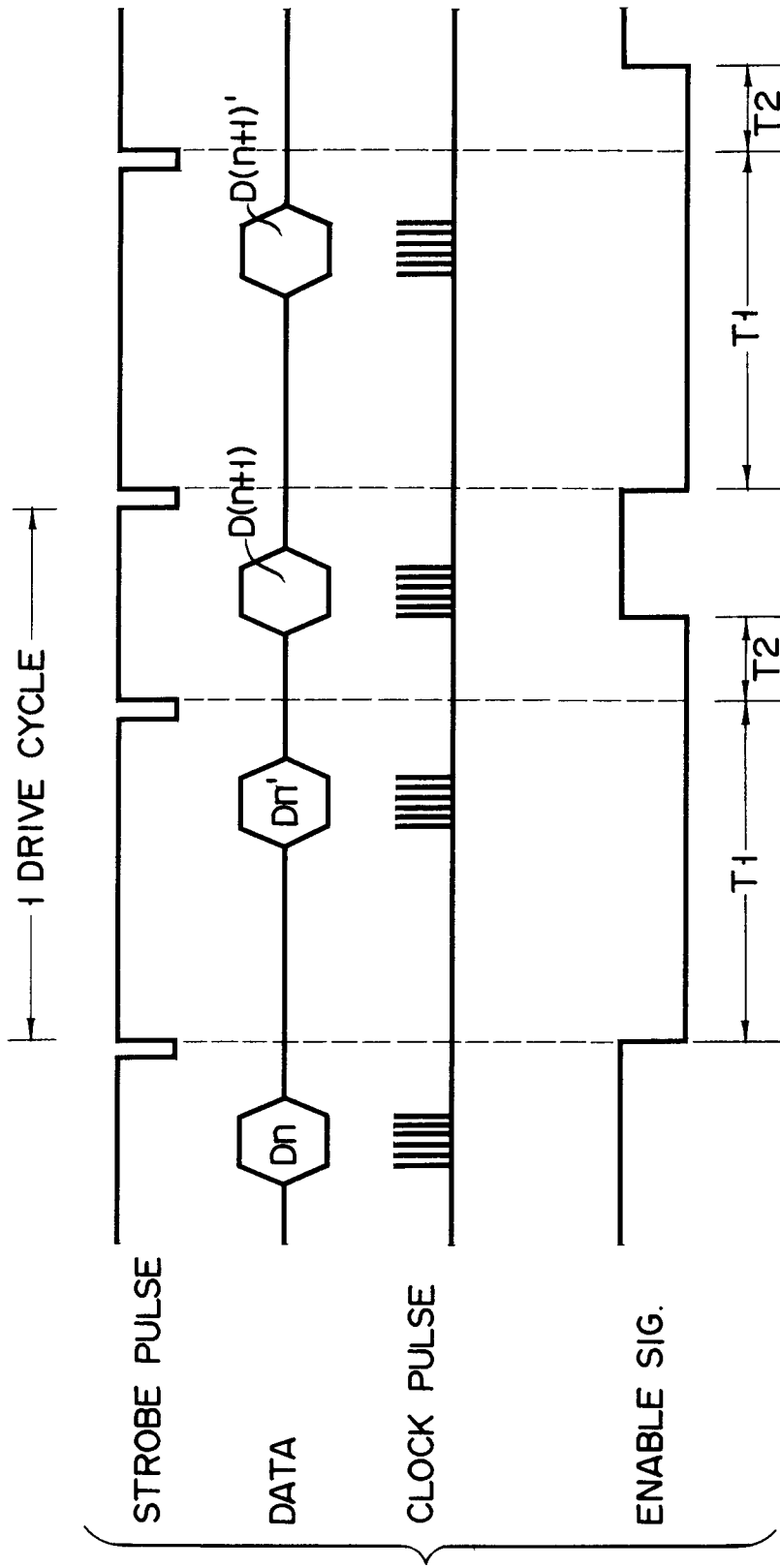


FIG. 2

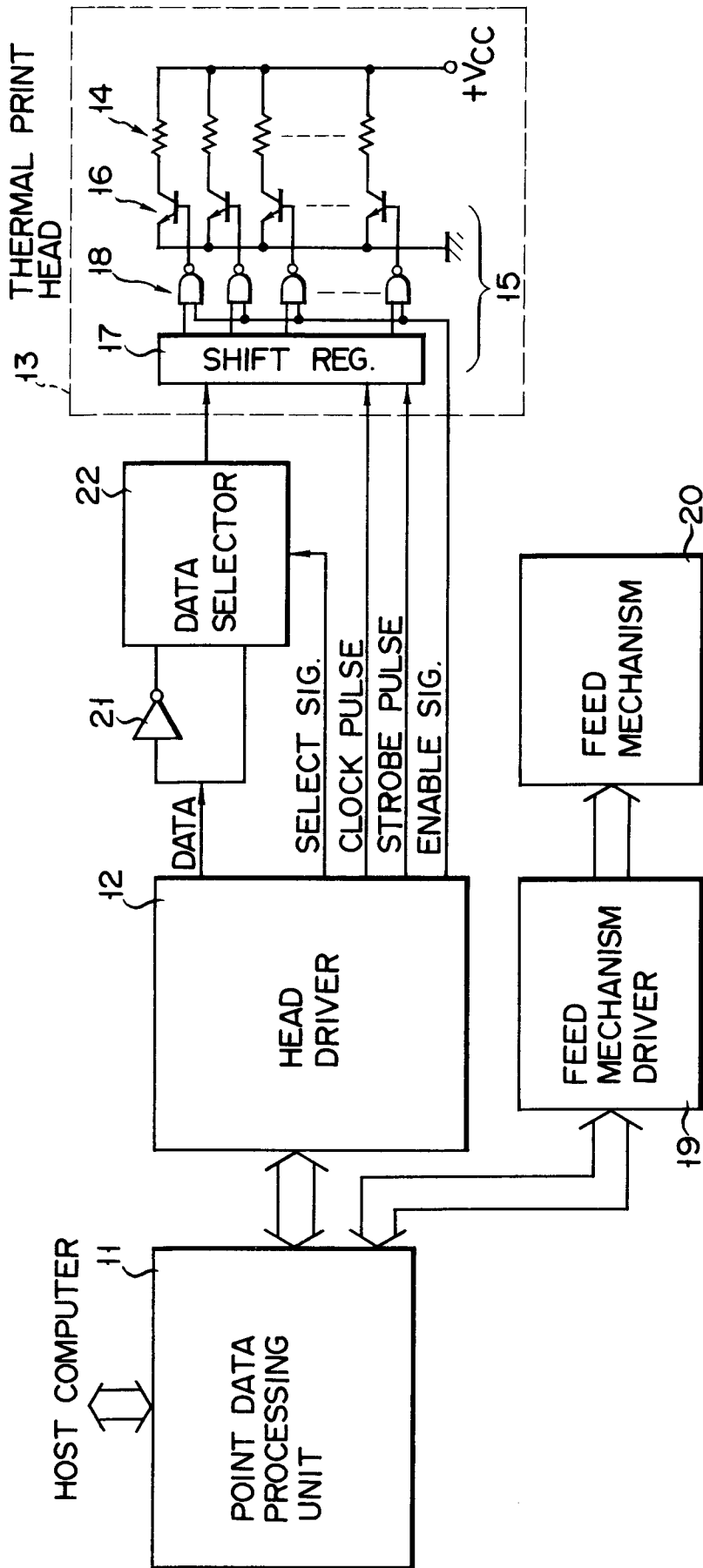


FIG. 3

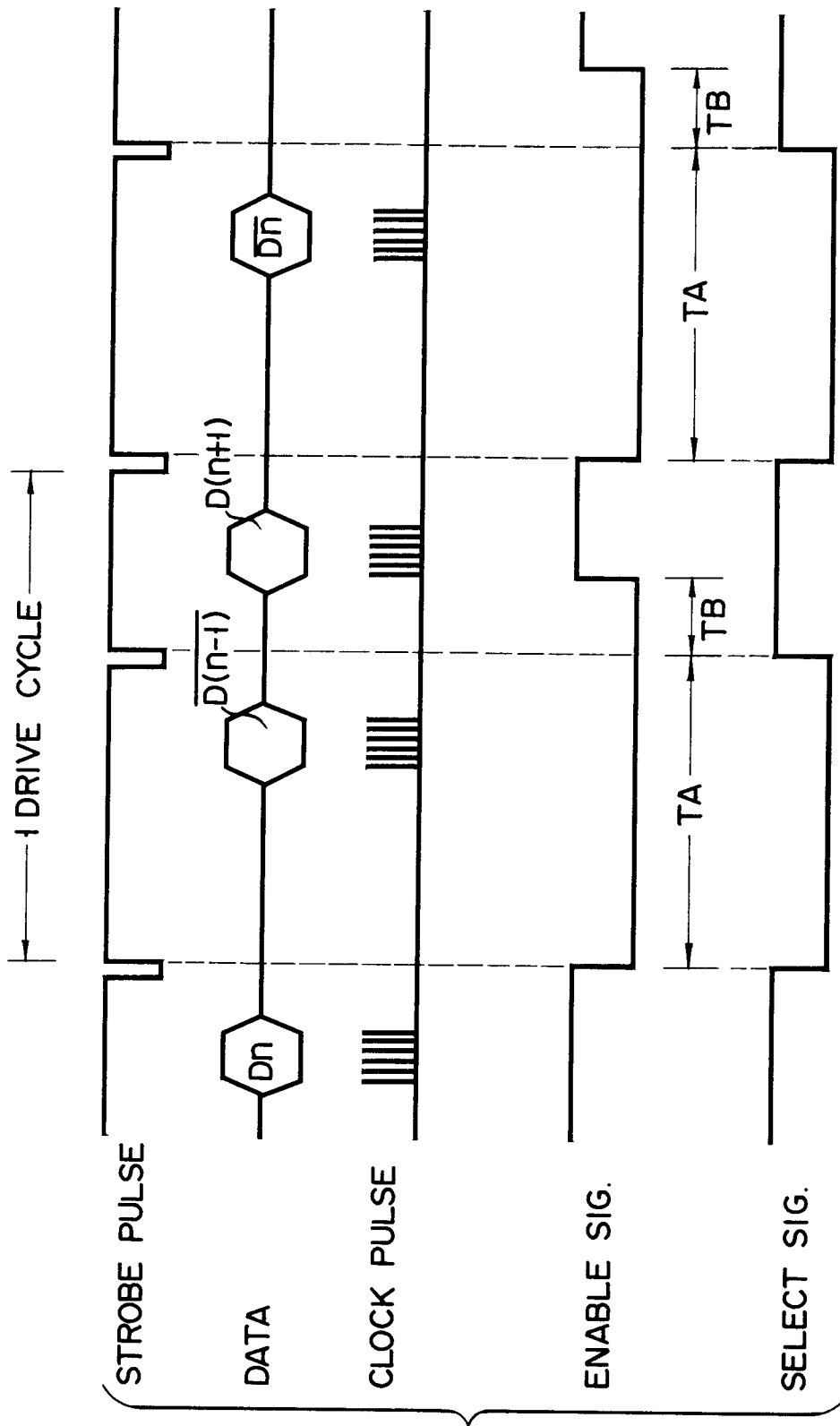


FIG. 4



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	JP-A-01 160 657 (TOSHIBA KABUSHIKI KAISHA) * figures *	1,2	B41J2/355
P,X	& US-A-4 983 054 (MASAAKI NISHIURA) * abstract; figures * * column 3, line 23 - column 4, line 15 * * column 5, line 26 - line 38 *	1,2	
X	US-A-4 560 993 (AKIYOSHI HAKOYAMA) * abstract; figures 5,7,8 * * column 6, line 12 - column 8, line 29; table 1 *	1,2	
X	EP-A-0 367 833 (SONY CORPORATION) * page 7, line 7 - page 10, line 2; figures 1,2 *	1,2	
X	US-A-4 634 063 (GOUSUKE ANNO ET AL) * the whole document *	1,2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B41J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 28 NOVEMBER 1991	Examiner ROBERTS N.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			