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D-8000 München 26(DE)(54) **Display apparatus.**

(57) A display apparatus adapted to display characters in superscript and subscript on a screen. A character generator stores a character font corresponding to superscript and subscript and excluding insignificant blank data. The character generator is switchable by a logic circuit between an enable state and a disable state. The logic circuit produces an enable signal, for example, by deriving a logical product conjunction of a most significant digit signal of a register for counting the number of rasters corresponding to one normal size character, a superscript select signal and a subscript enable signal.

EP 0 261 629 A2

DISPLAY APPARATUS

Background of the Invention

(1) Field of the Invention

The present invention relates to a display apparatus mounted on office automation machinery such as the word processor, personal computer, electronic typewriter and the like.

10 (2) Description of the Prior Art

Office automation machinery such as the word processor, personal computer, electronic typewriter and the like have made rapid progress in recent years as the central instrument for streamlining office work. Among the office automation machinery the type having functions to display characters in superscript and subscript, in particular, is spreading to meet the diversified needs of the user.

Having regard to the fact that superscript and subscript have opposite display ranges, the conventional system of displaying superscript and subscript presents both superscript and subscript by means of the same font data by utilizing the polarity of an MSD signal (most significant digit bit data) in a raster address transmitted from the number of character lines register which transmits the raster address is incremented with every raster scan on the display screen and is reset with every count to the number of rasters (for example, 16) corresponding to one normal size character which is approximately twice the size of a superscript or subscript character. Consequently, the most significant digit bit data output from this register is "0" until the upper half of the normal size character is displayed on the display screen, and "1" after the upper half is displayed and until the lower half is displayed. The upper half of the normal size character corresponds precisely to the display region of superscript, and the lower half to the display region of subscript. Thus the polarity of the MSD signal is reversed between the superscript display and the subscript display.

Fig. 1 shows a known control circuit for producing superscript and subscript from one font data by utilizing the MSD signal as noted above. This control circuit comprises a character generator memory b which stores bit data having character "A" for the upper half and a blank pattern for the lower half, for example, as shown in Fig. 2A. A super/sub switching signal is reversible between "0" for displaying superscript and "1" for displaying subscript. Assuming that the super/sub switching signal is set to "0", the MSD signal is input through an EXCLUSIVE OR gate to the character generator memory b with its polarity remaining unreversed. Consequently, the character pattern in the upper half of Fig. 2A is displayed in the superscript region on the display screen when the MSD signal is "0", and the blank pattern in the lower half of Fig. 2A is displayed in the subscript region on the display screen when the MSD signal is "1". When the super-sub switching signal is switched to "1", the MSD signal is input through the EXCLUSIVE OR gate to the character generator memory b with its polarity reversed. Consequently, the blank pattern in the lower half of Fig. 2A is read out of the character generator memory b and displayed in the superscript region on the display screen when the MSD signal is "0" (the output of the EXCLUSIVE OR gate being "1"0, and the character pattern in the upper half of Fig. 2A is read out of the character generator memory b and displayed in the subscript region on the display screen when the MSD signal changes to "1" (the output of the EXCLUSIVE OR gate changing to "0"). Thus, subscript as shown in Fig. 2B is displayed on the screen in this case.

The foregoing conventional system, which is capable of displaying both superscript and subscript by means of one character font, has the advantage of requiring only a half memory capacity compared with the case of storing character font data corresponding to superscript characters and subscript characters. However, this system also has the disadvantage of including the insignificant blank data in either the upper half or the lower half of the character matrix. In particular, taking the different shapes of characters into account, the number of character fonts stored in the character generator memory is overwhelming. Besides, one character font requires a memory capacity of several to several tens of bytes. The character generator memory must, therefore, have a very large capacity, and hence the problem of enlarging and raising the cost of apparatus.

Summary of the Invention

A primary object of the present invention, therefore, is to provide a display apparatus including a character memory having a reduced capacity.

5 Another object of the invention is to provide a display apparatus for displaying superscript and subscript by using a character generator storing a superscript and subscript characters in a font data from that does not include the insignificant blank data.

A further object of the invention is to provide a display apparatus which allows superscript and subscript to be displayed with a desired number of rasters.

10 The above objects are fulfilled by a display apparatus according to the present invention, which comprises a display sequencer for generating a character address signal, a raster address signal and a synchronizing signal; video memory means for outputting character code data selected by the character address signal from the display sequencer; a character generator for receiving the character code data and the raster address signal and outputting a bit pattern for a selected character, the character generator
15 storing significant data for superscript and subscript excluding unnecessary blank data; raster scan type display means operable in response to the synchronizing signal received from the display sequencer for displaying a character corresponding to the bit pattern generated by the character generator; and control means for enabling and disabling the character generator, the control means enabling the character generator at a raster address value corresponding to a superscript display region when a superscript select
20 signal is input from outside, and at a raster address value corresponding to a subscript display region when a subscript select signal is input from outside.

Specifically, the control means includes a logic circuit for deriving a logical product conjunction of a most significant digit signal from a register for counting raster addresses corresponding to one character, and the superscript select signal and subscript select signal input from outside.

25 Further, the control means may include a decoder for decoding the raster address, and a logic circuit for deriving a logical product conjunction of a decode signal generated by the decoder and the superscript select signal and subscript select signal. The decoder is operable to set a decode output to a selected raster address value.

The character generator may include means for producing a mock blank pattern when in a disable
30 state.

The raster scan type display means may comprise a flat panel display.

In a preferred embodiment of the invention, the display sequencer and the video memory means are connected through a data bus to a CPU which rewrites the number of character lines and the character code data. The CPU supplies the superscript select signal and the subscript select signal to the control
35 means.

The objects of the present invention may also be fulfilled by a display apparatus comprising a display sequencer for generating a character address signal, a raster address signal and a synchronizing signal; video memory means for outputting character code data selected by the character address signal from the display sequencer; a character generator for receiving the character code data and the raster address signal and outputting a bit pattern for a selected character, the character generator storing significant data for
40 superscript and subscript excluding unnecessary blank data; conversion means for effecting parallel to serial conversion of the bit pattern generated by the character generator; raster scan type display means for receiving the bit pattern after the parallel to serial conversion in accordance with the synchronizing signal provided by the display sequencer, and displaying a character corresponding to the bit pattern; and control
45 means for enabling and disabling the character generator, the control means enabling the character generator at a raster address value corresponding to a superscript display region when a superscript select signal is input from outside, and at a raster address value corresponding to a subscript display region when a subscript select signal is input from outside. The specific constructions of and connections among the control means, display means and other components may be similar to those described hereinabove.

50 According to the present invention, when the enable signal is transmitted from the control means to the character generator, a selected character is displayed in superscript or subscript. The bit data of the character displayed in superscript or subscript on the screen is a minimum data excluding an unnecessary blank pattern. This feature provides the advantage of permitting the character generator to have a small capacity memory and the display apparatus to have a compact construction.

55

Brief Description of the Drawings

These and other objects or features of the present invention will become apparent from the following description of preferred embodiments thereof taken in conjunction with the accompanying drawings, in which:-

- Fig. 1 is a view illustrating a character generator in a conventional display apparatus,
- Figs. 2(A) and (B) are views illustrating a superscript and a subscript displayed when the circuit of Fig. 1 is used,
- Fig. 3 is a block diagram of a display apparatus according to the present invention,
- Fig. 5(A) and (B) are views showing examples of character displayed produced by a control means in Fig. 4,
- Fig. 6 is a diagram illustrating a logic circuit constituting another example of control means,
- Fig. 7 is a view illustrating an example of character produced by the logic circuit of Fig. 6, and
- Figs. 8(A) and (B) and Figs. 9(A) and (B) are views illustrating examples of character displayed when the number of rasters for a decode region is set to odd numbers.

Detailed Description of the Invention

- Fig. 3 is a block diagram illustrating an entire display apparatus. This display apparatus comprises a CPU 1, a display sequencer 2, a video RAM 3, a latch 4, a character generator memory 5, a shift register 6, a display 7, and an external input device 8 such as a keyboard.

The character generator memory 5 stores characters in various scripts constituted by significant data. The significant data here means minimum bit data excluding unnecessary space data and corresponding to selected scripts stored in the memory 5.

The display apparatus further comprises a control device 9 for controlling display of the characters in superscript or subscript on a screen.

- The CPU 1 is connected through a data bus A to the display sequencer 2, video RAM 3 and latch 4. The CPU 1 transmits a rewrite command regarding the number of lines to be displayed to the display sequencer 2, and a character code rewrite command to the video RAM 3.

The display sequencer 2 transmits a character address signal to the video RAM 3 through a bus line B, a raster address signal to the character generator memory 5 through a bus line E, and a synchronizing signal to the display 7 through a signal line G. The character address signal corresponds to a character position on the screen of display 7. Upon receipt of this signal, the video RAM 3 outputs a character code data corresponding to a character address in the video RAM 3.

As described above, the CPU 1 and the display sequencer 2 access to the video RAM 3. One display cycle period is divided into two parts, one of which is allocated for the access by the CPU and the other for the access by the display sequencer 2.

- The character code data output from the video RAM 3 are retained at the latch 4 during one display cycle, and are successively input to an address input terminal of the character generator memory 5 through a bus line D. The character generator memory 5 receives, along with the character code data, the raster address signal from the display sequencer 2, and outputs character bit data corresponding to the two signals. As described in connection with the prior art, the raster address is the number (or address) produced by a number of character lines register included in the display sequencer 2 for determining each of rasters (16 rasters, for example) corresponding to one character in the normal size.

The characters are presented in a selected script on the screen of display 7 under control by the control device 9. More particularly, the control device 9 outputs an appropriate enable signal to the character generator memory 5 after receiving a superscript select signal or a subscript select signal input from the external input device 8 through the CPU 1 and checking this signal with the raster address signal received from the display sequencer 2.

- Fig. 4 shows a specific circuit construction of the control device 9. As in the prior art, the control device 9 allows the characters to be displayed in the superscript region or the subscript region through polarity reversal of the MSD signal. According to the illustrated construction, when the character "A" is to be displayed on the screen, for example, the superscript select signal is input in "1" to a first NAND gate 10. Therefore, the first NAND gate 10 outputs a signal in "1" which is input in "0" to an OR gate 13 when the MSD signal is output in "0". On the other hand, a second NAND gate 11 receives the subscript select signal in "0" and the MSD signal in "1" through a NOT gate 12. The second NAND gate 11 outputs a

signal in "1" which is input in "0" to the OR gate 13. The OR gate 13, therefore, outputs a signal in "1" which constitutes the enable signal input to the character generator memory 5. The character generator memory 5 generates the bit data in response to the enable signal, the character code data input from the video RAM 3 and the raster address signal input from the display sequencer 2.

5 The bit data output from the character generator memory 5 is applied to the shift register 6 through a data line E, where the bit data are subjected to parallel to serial conversion for input to the display 7 as a video signal. In response to this video signal and to the synchronizing signal received from the display sequencer 2, the display 7 shows the character "A" in the superscript region 14 of the screen as illustrated in Fig. 5A.

10 When the superscript select signal is output in "1" and the MSD signal is also output in "1", the OR gate 13 outputs the signal in "0". Then the character generator memory 5 is disabled into a standby state outputting no bit data, whereby the screen shows a blank pattern referenced 15 in Fig. 5A. Similarly, when the subscript select signal is provided, the enable signal is input to the character generator memory 5 from the control device 9 which results in the character "A" shown in the subscript region 15 of the screen as
15 illustrated in Fig. 5B. In this case also, the character generator memory 5 is disabled into the standby state by the "0" state of the MSD signal, outputting no bit data, whereby the screen shows a blank pattern referenced 14 in Fig. 5B. Thus, selected characters may be disabled on the screen by enabling superscript or subscript as described above. It is now possible for superscript or subscript characters stored in the character generator memory 5 to be constituted by significant data only, thereby permitting the character
20 generator memory 5 to have a small capacity. Table 1 shows the relationship between the superscript select signal and other input signals and the enable signal.

Table 1

25

MSD	Superscript Select	Subscript Select	Enable
0	1	0	1
	0	1	0
	1	1	1
1	1	0	0
	0	1	1
	1	1	1

30

35

40

As seen from Table 1, the enable signal is input to the character generator memory 5 when the superscript select signal and the subscript select signal are provided simultaneously. This allows characters
45 to be displayed in superscript and subscript almost simultaneously through polarity reversal of the MSD signal, which provides convenience for the operator. In the prior art example shown in Fig. 1, the use of a switching signal results in the inconvenience of the characters being displayed in either superscript or subscript.

Fig. 6 illustrates another embodiment which includes a decoder 16 for detecting and decoding the
50 numerical value of the raster address signal input from the display sequencer, thereby allowing the number of rasters to be freely selected for a decode region. While the embodiment of Fig. 4 allows the number of rasters to be set only to the powers of 2, the embodiment of Fig. 6 allows the number of rasters to be set to any even number. In other words, the input signal from the raster address corresponding to the powers of 2 such as 2^0 , 2^1 , 2^2 , 2^3 , etc. may be combined into any selected value through a decoder 16, thereby to
55 increase the freedom of selecting the number of rasters for the characters in superscript or subscript. According to the construction illustrated in Fig. 6, a first NAND gate 10 receives a superscript select signal and a raster address signal (U signal) for the superscript region, and a second NAND gate 11 receives a subscript select signal and a raster address signal (L signal) for the subscript region. When, for example,

the number of rasters for the normal size character is set to "16" and the first NAND gate 10 receives the superscript select signal and the U signal indicating the number of rasters set to "10" by the decoder 16, the character generator memory receives an enable signal and outputs corresponding bit data whereby, as illustrated in Fig. 7, the character "A" is displayed in the superscript region 14 including ten rasters. Thus,

characters may be displayed in various sizes by varying the number of rasters for the superscript region 14. Furthermore, as illustrated in Fig. 8(A) and 8(B), the character font stored in the character generator memory 5 may include an uppermost range X and a lowermost range Y void of significant data, with decode regions partly overlapping each other. This allows the number of rasters to be set to odd numbers. If significant data were stored in the ranges X and Y, an inconvenience could be encountered in which the decode regions overlap each other when characters are displayed in superscript and subscript. The above arrangement, however, allows the number of rasters to be set to odd numbers thereby further increasing the freedom of character display in superscript and subscript. This embodiment is particularly effective for a display device such as a panel type display which has a limited number of display dots.

Figs. 9(A) and 9(B) illustrate another method of allowing the number of rasters to be set to odd numbers. In this example, an interleave is provided between the uppermost range X and the lowermost range Y of the decode region, whereby intermediate scan lines always represent a blank on the screen.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.

Claims

1. A display apparatus adapted to display characters in superscript and subscript, comprising:
a display sequencer for generating a character address signal, a raster address signal and a synchronizing signal;

video memory means for outputting character code data selected by the character address signal from said display sequencer;

a character generator for receiving the character code data and the raster address signal and outputting a bit pattern for a selected character, said character generator storing significant data for superscript and subscript excluding unnecessary blank data;

raster scan type display means operable in response to the synchronizing signal received from said display sequencer for displaying a character corresponding to the bit pattern generated by said character generator;

and

control means for enabling and disabling said character generator, said control means enabling said character generator at a raster address value corresponding to a superscript display region when a superscript select signal is input from outside, and at a raster address value corresponding to a subscript display region when a subscript select signal is input from outside.

2. A display apparatus as claimed in Claim 1, wherein said control means includes a logic circuit for deriving a logical product conjunction of a most significant digit signal from a register for counting raster addresses corresponding to one character, and the superscript select signal and subscript select signal input from outside.

3. A display apparatus as claimed in Claim 1, wherein said control means includes a decoder for decoding the raster address, and a logic circuit for deriving a logical product conjunction of a decode signal generated by said decoder and the superscript select signal and subscript select signal.

4. A display apparatus as claimed in Claim 3, wherein said decoder is operable to set a decode output to a selected raster address value.

5. A display apparatus as claimed in Claim 1, wherein said character generator includes means for producing a mock blank pattern when in a disable state.

6. A display apparatus as claimed in Claim 1, wherein said raster scan type display means comprises a flat panel display.

7. A display apparatus as claimed in Claim 1, wherein said display sequencer and said video memory means are connected through a data bus to a CPU which rewrites the number of character lines and the character code data.

8. A display apparatus as claimed in Claim 7, wherein said CPU supplies the superscript select signal and the subscript select signal to said control means.

9. A display apparatus adapted to display characters in superscript and subscript, comprising:
 a display sequencer for generating a character address signal, a raster address signal and a synchronizing signal;
 video memory means for outputting character code data selected by the character address signal from said display sequencer;
 a character generator for receiving the character code data and the raster address signal and outputting a bit pattern for a selected character, said character generator storing significant data for superscript and subscript excluding unnecessary blank data;
 conversion means for effecting parallel to serial conversion of the bit pattern generated by said character generator;
 raster scan type display means for receiving the bit pattern after the parallel to serial conversion in accordance with the synchronizing signal provided by said display sequencer, and displaying a character corresponding to the bit pattern; and
 control means for enabling and disabling said character generator, said control means enabling said character generator at a raster address value corresponding to a superscript display region when a superscript select signal is input from outside, and at a raster address value corresponding to a subscript display region when a subscript select signal is input from outside.
10. A display apparatus as claimed in Claim 9, wherein said control means includes a logic circuit for deriving a logical product conjunction of a most significant digit signal from a register for counting raster addresses corresponding to one character, and the superscript select signal and subscript select signal input from outside.
11. A display apparatus as claimed in Claim 9, wherein said control means includes a decoder for decoding the raster address, and a logic circuit for deriving a logical product conjunction of a decode signal generated by said decoder and the superscript select signal and subscript select signal.
12. A display apparatus as claimed in Claim 11, wherein said decoder is operable to set a decode output to a selected raster address value.
13. A display apparatus as claimed in Claim 9, wherein said character generator includes means for producing a mock blank pattern when in a disable state.
14. A display apparatus as claimed in Claim 9, wherein said raster scan type display means comprises a flat panel display.
15. A display apparatus as claimed in Claim 9, wherein said display sequencer and said video memory means are connected through a data bus to a CPU which rewrites the number of character lines and the character code data.
16. A display apparatus as claimed in Claim 15, wherein said CPU supplies the superscript select signal and the subscript select signal to said control means.

Fig. 1

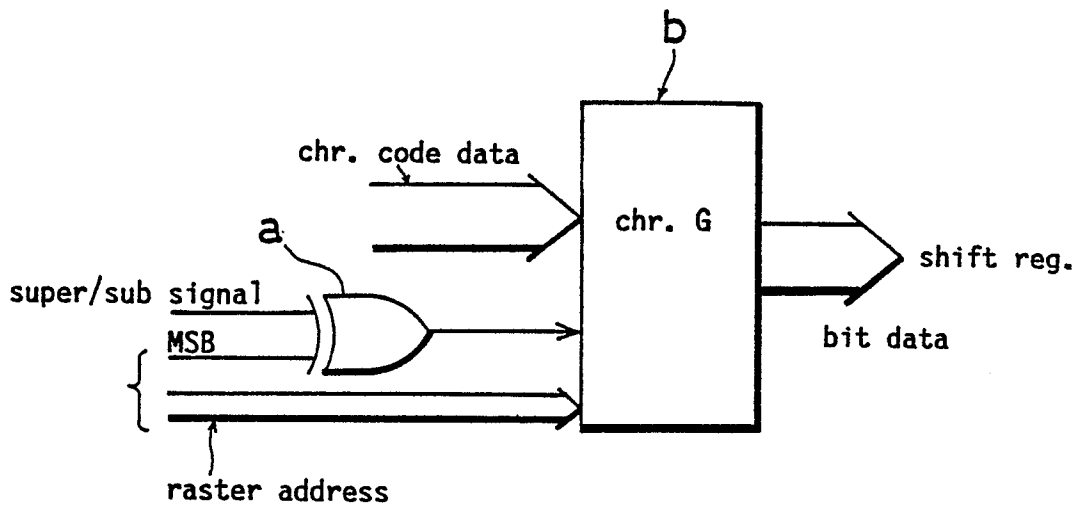


Fig. 2A

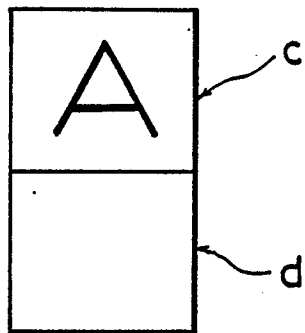


Fig. 2B

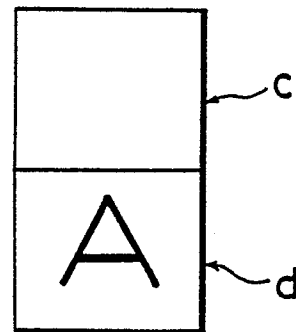


Fig. 3

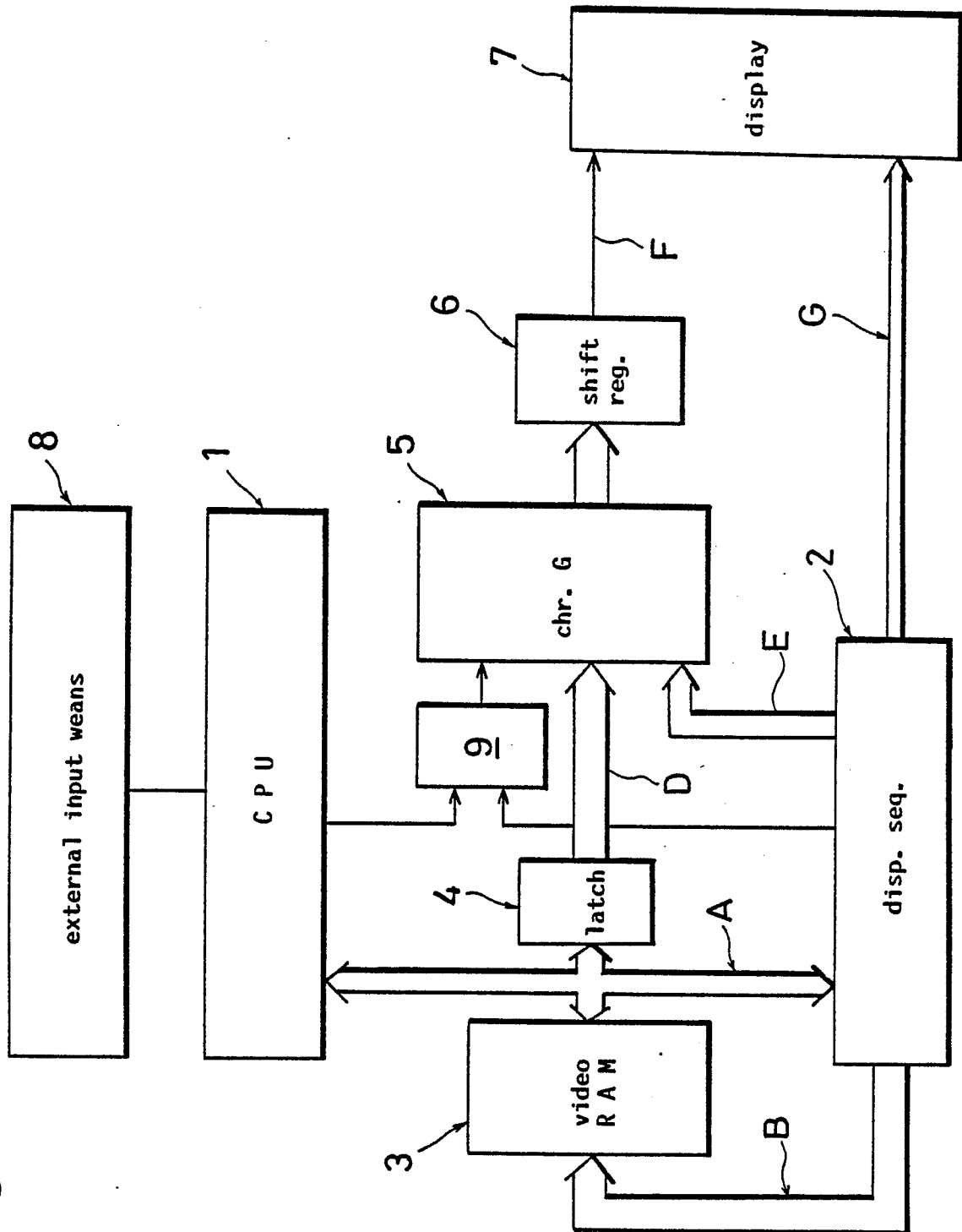


Fig. 4

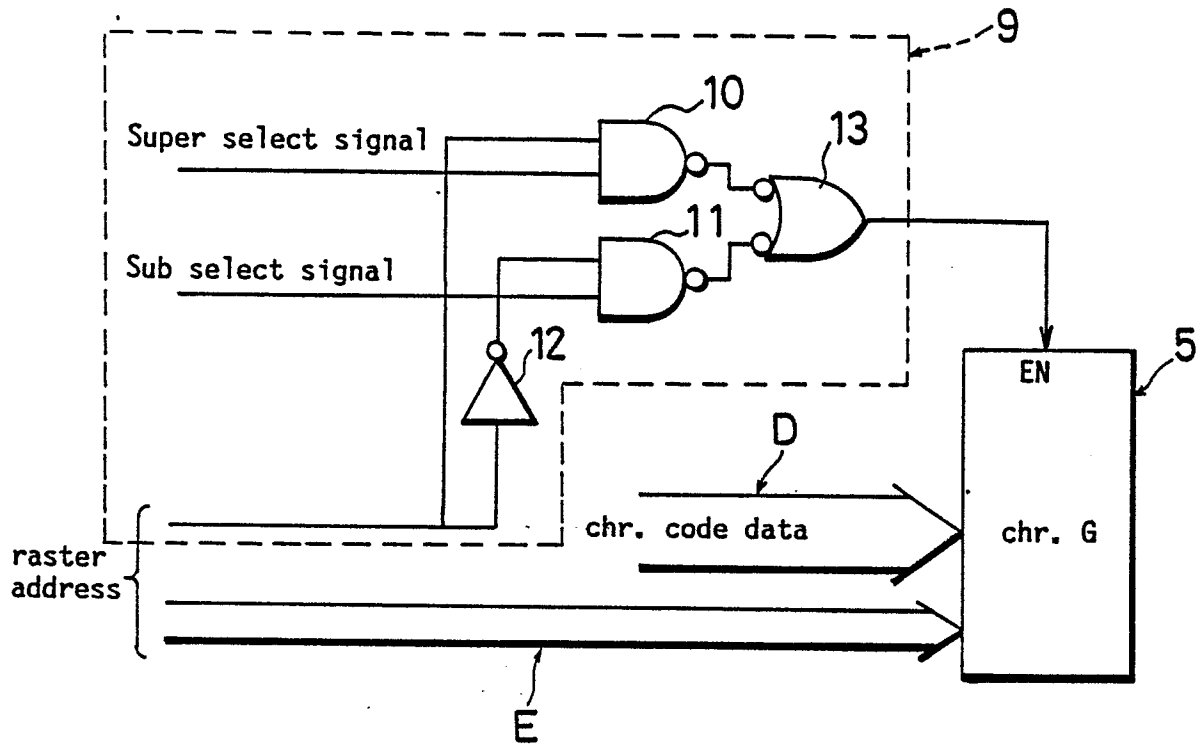


Fig. 5A

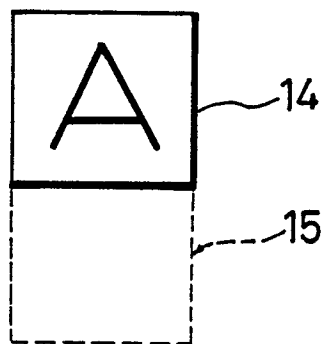


Fig. 5B

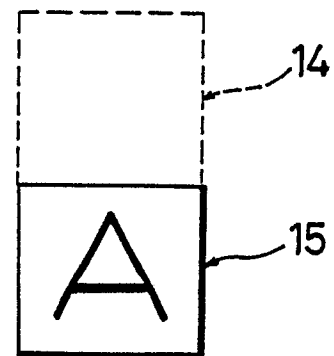


Fig. 6

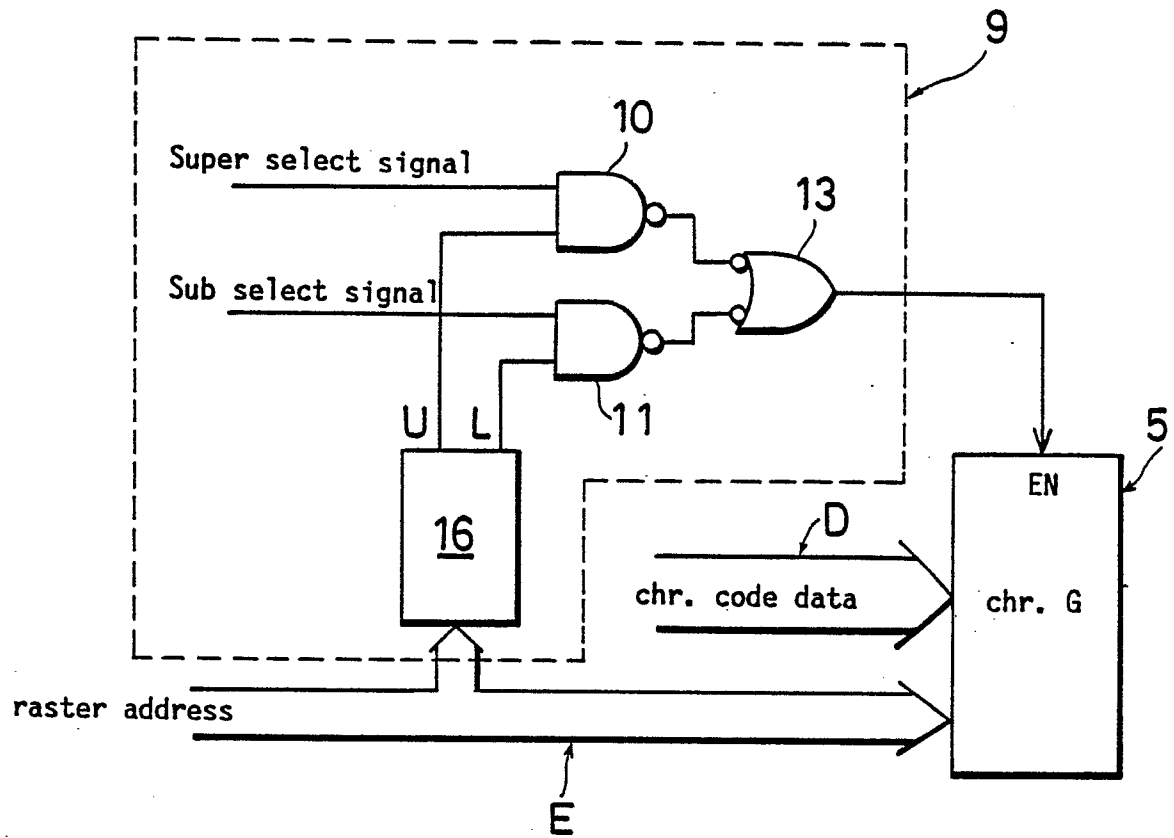


Fig. 7

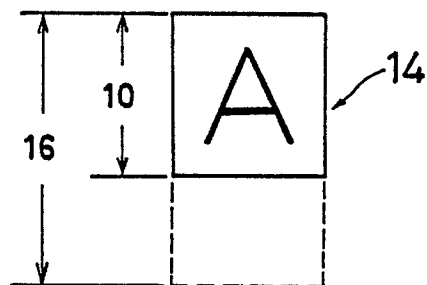


Fig. 8A

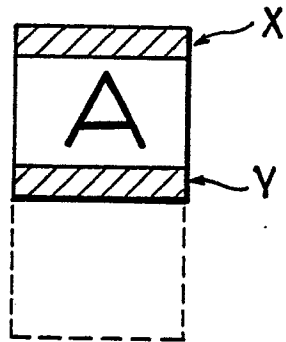


Fig. 8B

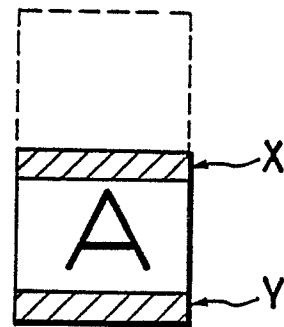


Fig. 9A

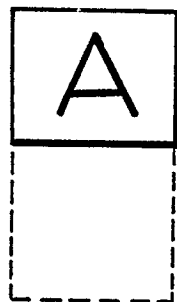


Fig. 9B

