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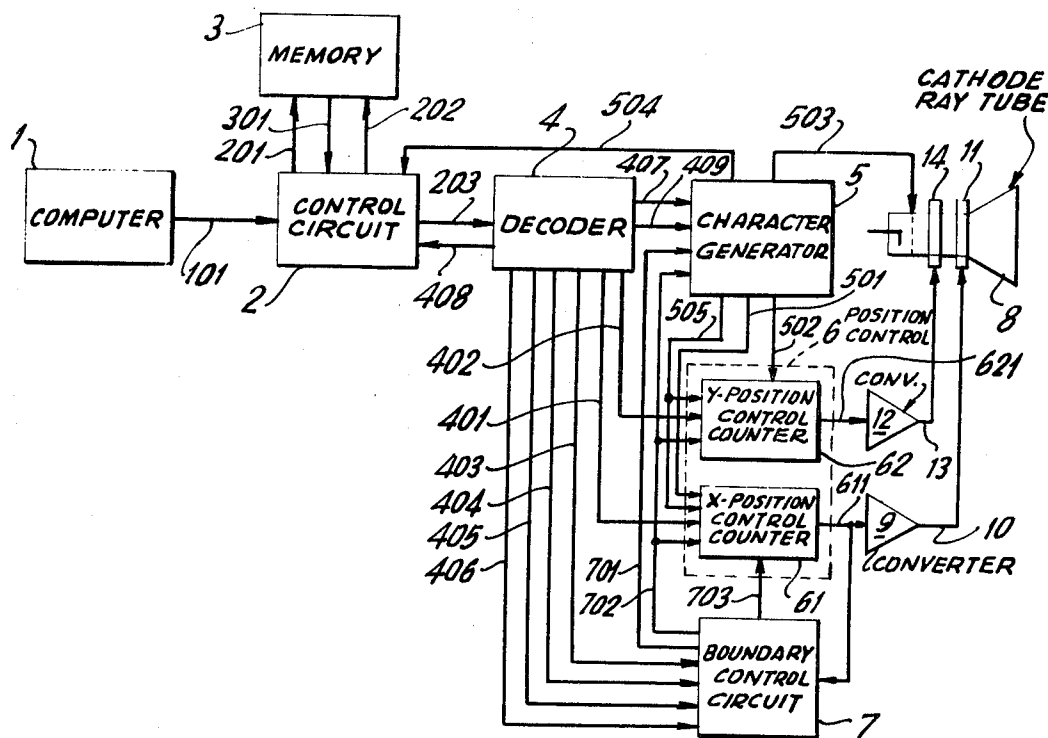
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## [54] CATHODE/RAY TUBE DISPLAY DEVICE 1 Claim, 5 Drawing Figs.

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95/4.5  
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95/4.5; 178/6.6, 6.7, 15, 89, 90

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**ABSTRACT:** A cathode ray tube (CRT) display device for alphanumeric characters includes a first boundary register for storing the numerical value of a boundary defining the beginning of a row line of characters to be displayed on the CRT. A second boundary register stores a numerical value representing the end of the row line. A first position control counter designates the position of a character in the row line direction. A boundary detector compares the numerical value of the second boundary register with the numerical value of the first position control counter. When the result of the comparison shows that the first position control counter value is larger than the second boundary register, a check pulse is initiated which is employed to reset the counters and initiate a new line of characters on the CRT.



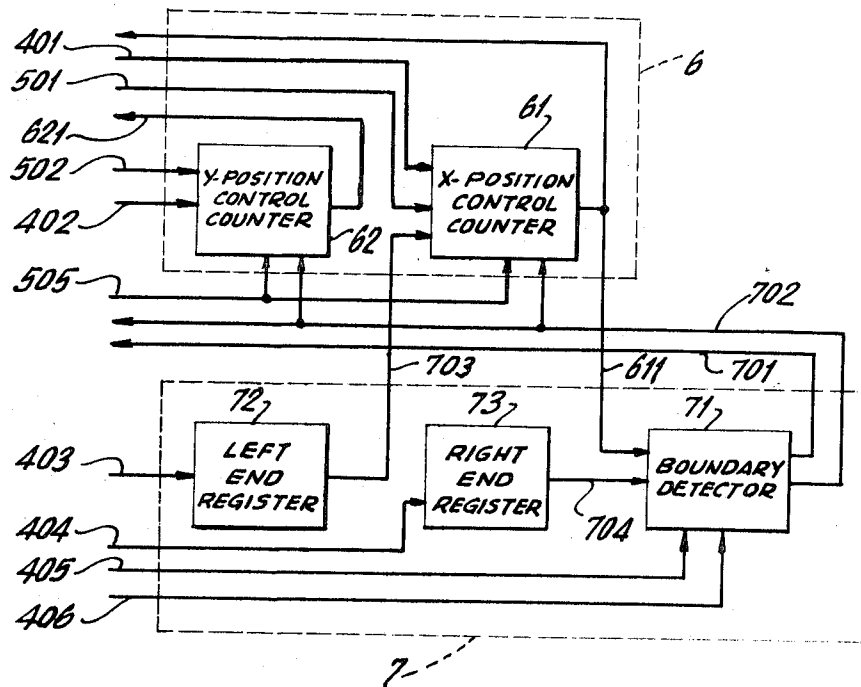
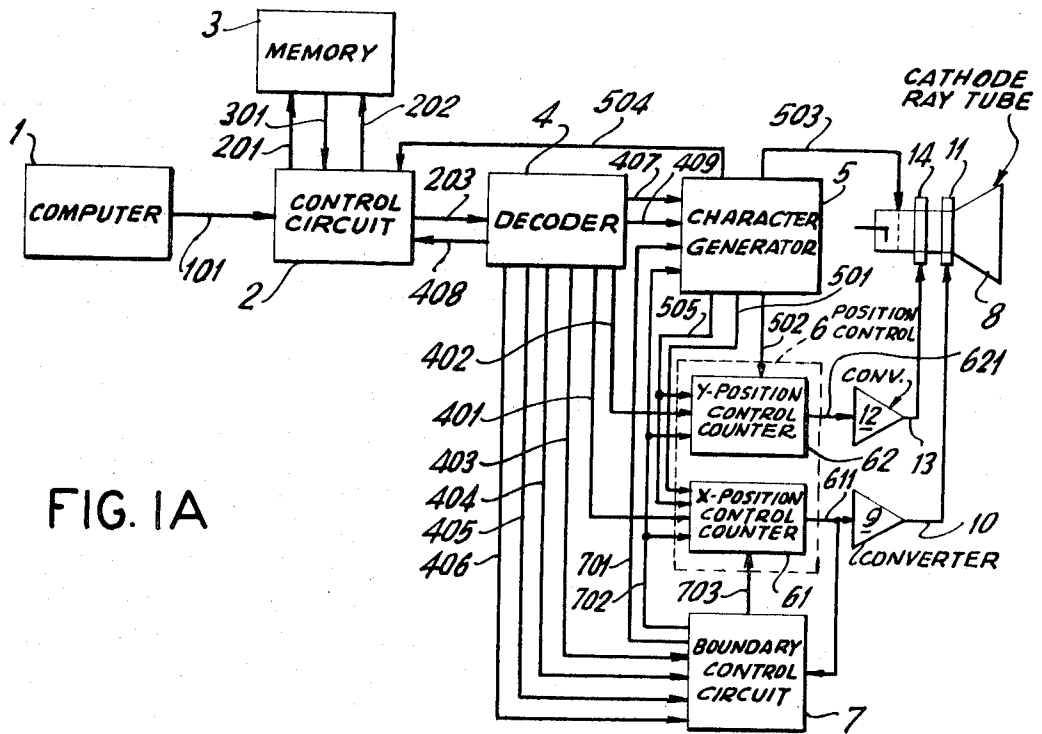


FIG. 1B

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TIMING RELATION FOR LETTER A INDICATED BY II IN FIG. 2

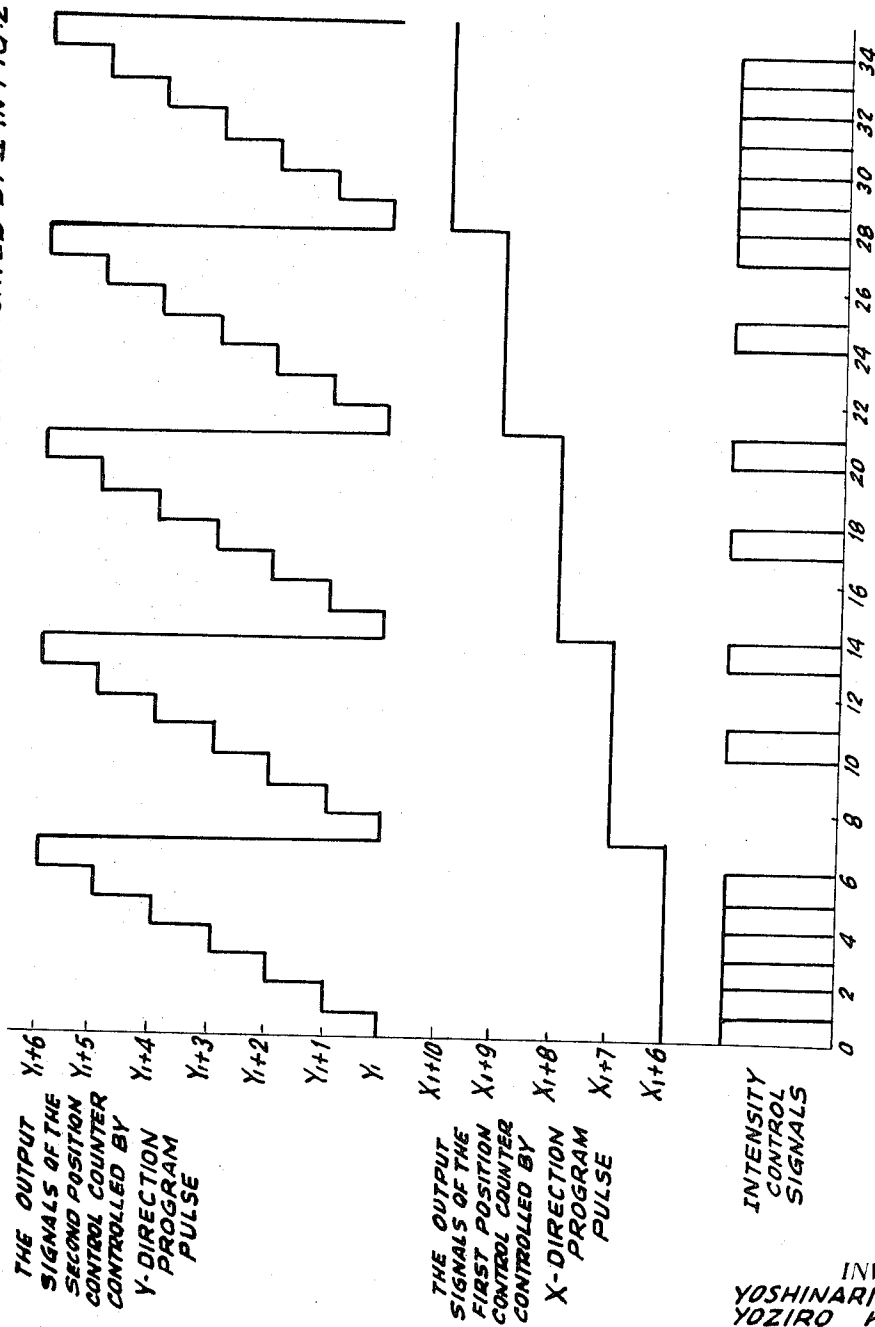


FIG. 3B

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## CATHODE/RAY TUBE DISPLAY DEVICE

## BACKGROUND OF THE INVENTION

The present invention relates to a cathode ray tube (CRT) display device which automatically renders a uniform format to a group of characters appearing on the display face of a cathode ray tube.

In the conventional CRT display device for converting information signals derived from an information processor, such as an electronic computer, into a visible pattern, both the size of the characters to be displayed and the position of the characters on the display face are predetermined. Consequently, in order to make the format uniform, it has been sufficient to designate, via an instruction information of the computer, the number of characters to be displayed in one row line. Where, however, the characters to be displayed comprise several sizes, it has heretofore been impossible for such a CRT display device to display the characters.

A recently developed CRT display device is capable of designating a coordinate point ( $X_0, Y_0$ ), in response to the instruction information of the computer, for the first character of a character group. The CRT display face is assumed to be a coordinate plane. For this CRT display device to automatically sequence horizontally or vertically from the initial position and display various sizes of characters, it is necessary for the computer instruction code to designate in advance the number of characters to be displayed along with the size and the format. However, it will be appreciated that the designation of such information of the computer is extremely complicated.

For example, where several widths of characters with uniform height are employed, taking into consideration the quality of characters to be displayed, a matrix of  $5 \times 7$  (a character is displayed by a combination of bright or dark spots at  $5 \times 7$  dot points) is generally used when roman letters and numerals are displayed with dot patterns. However, the specific roman letter I may be displayed with a matrix of  $3 \times 7$ , while the letter W would require a matrix of  $7 \times 7$ . With uniform height characters of varying widths, it has thus been difficult for such CRT display devices to display the character even when they are displayed at a uniform spacing between adjacent characters.

## OBJECT OF THE INVENTION

It is the object of the present invention to provide a CRT display device capable of automatically restoring the initial display state and making a new row line upon the display reaching the end of the predetermined display region, regardless of the number of characters to be displayed in a row line or the size and kind of characters to be used.

## SUMMARY OF THE INVENTION

The present invention provides a CRT display device comprising a first boundary register for storing a numerical value of a boundary defining the beginning of a row line of characters on the CRT display face; a second boundary register for storing a numerical value representative of the end of the row line; a first position control counter for designating a position of character in the row line direction; a second position control counter for designating the character position in the column line direction; and a boundary detector.

The boundary detector compares the output numerical value of the second boundary register with the output numerical value of the first position control counter. When the result of the comparison shows that the output numerical value of the first position control counter is larger than that of the second boundary register, a boundary check or detection pulse from a command decoder is caused to pass through the boundary detector, and changes the contents of the position control counter to that of the boundary register indicating the boundary of the beginning of the row line of characters. Also, the boundary check pulse causes the contents of the second position control counter, defining the position of each

character in the column direction, to be changed to a constant value designated according to the height of the character. Thus, the resetting and initiation of a new line are carried out by changing the contents of the first and second control counters.

According to the present invention, therefore, if the positions of the first and last characters among a character group are once designated, each character is displayed one by one on the display face, and when the display has reached the predetermined position near the end of a row line, the resetting is automatically carried out, thus enabling a document to be displayed in good format.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will best be understood by references to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, the description of which follows:

FIG. 1A shows a block diagram of a cathode ray tube display device of the present invention;

FIG. 1B shows a block diagram of the control section of the present invention;

FIG. 2 shows various sizes of characters which may be indicated on the display face of the cathode ray tube display device; and

FIGS. 3A and 3B show the timing relationship between X-direction counter output, Y-direction counter output, and intensity control signals for the letter A indicated by I and II in FIG. 2.

## DETAILED DESCRIPTION OF THE DRAWINGS

In FIG. 1A, a computer is employed as an information processor 1, and the display information from the information processor 1 is stored in the form of a command signal in a memory 3 via a control circuit 2. The information signals to be stored in the memory 3 include, for example: a positioning command information designating the position of the first dot of a character to be displayed on the display face of the cathode ray tube 8; the numerical information defining coordinates (X, Y) of said position on the display face; a character designation command information indicating that the character to be displayed is a letter; and coded information of a character to be displayed, all arranged in the order mentioned above.

The control circuit 2, for controlling the above-described information signals, comprises a circuit for interconnecting the information processor 1 and the memory 3, and includes conventional means for reading out information from the memory 3 and sending the readout information to a command decoder 4, a sequence control counter for designating an address in the memory 3 at the time of readout and write-in, and a timing pulse generator for controlling the above-described operations. The command decoder 4 decodes the command information signals read out from the memory 3 and distributes the last-mentioned numerical information signals and coded information signals of characters following each command information signal, to position control circuit 6 and a character generator 5, respectively. The character generator 5 receives coded information signals of characters from the command decoder 4, and produces intensity-modulating and program pulses for scanning X and Y directions to be supplied to signals corresponding to a visible pattern, the cathode ray tube 8, and the position control circuit 6, respectively. The position control circuit 6 comprises a X position control counter 61 and a Y position control counter 62, each of which respectively stores the positioning information supplied from the command decoder 4 in the form of X and Y coordinates of the position of the first dot forming a character to be displayed at first on the CRT display face. A boundary control circuit 7 comprises (as shown in FIG. 1B), in the case of characters being arranged in a horizontal scan display, a left-end boundary register 72 for defining the beginning of the display region

of characters row, a right-end boundary register 73 for defining the end of the character row, and a boundary detector 71 for comparing the contents of the above-described X position control counter 61 with the contents of the above-described right-end boundary register 73.

The cathode ray tube unit comprises the cathode ray tube 8, a X-axis deflecting coil 11 for deflecting the electron beam in the X (horizontal) direction, and a Y-axis deflecting coil 14 for deflecting the electron beam in the Y (vertical) direction. Digital-Analogue (D/A) converters 9 and 12 are for converting signals from the position control circuit 6 into analogue signals to be supplied to the X-axis and Y-axis deflecting coils of the CRT unit.

In operation, an information in the form of the command form the information processor 1 is stored in the memory 3 via leads 101 and 201. This operation is carried out according to a location address designated by the sequence control counter in the control circuit 2. The information stored in the memory 3 is transmitted under the command of the location address sent from the control circuit 2 through a lead 202 to the command decoder 4 via leads 301 and 203. In the command decoder 4, the information signals are decoded into the character information signals to be supplied to the character generator 5 and the numerical information signals to be supplied to the position control circuit 6, respectively. The position control circuit 6 designates, in response to the numerical information, a position of the first dot forming a character to be displayed at first on the display face of the CRT 8. On the other hand, the character information applied to the character generator 5 causes the generator 5 to produce the intensity-modulating signals representative of the pattern to be displayed, and program pulses representative of the scanned X and Y coordinates. These intensity-modulating signals and program pulses are applied to the CRT 8 and the position control circuit 6, respectively.

Referring to FIG. 1B, which shows an essential part of the embodiment, the X position control counter 61 receives the X coordinate program pulse, a character size designating information, a X-positioning information, a boundary detection pulse and a left-end output numerical value, through an input lead 501, an input lead 505, an input lead 401, an input lead 702 and an input lead 703, respectively. An output lead 611 of the counter 61 is connected to the boundary detector 71 and the D/A converter 9. The Y position control counter 62 is connected by an input lead 502 to the character generator 5 for receiving the Y coordinate program pulse. Through another input lead 402, the counter 62 receives a Y-positioning information. Similarly, through the input lead 505 and the input lead 702, the counter 62 receives the character size information and the boundary detection pulse, respectively. The output lead 621 of the counter 62 is connected to the D/A converter 12.

The left-end boundary register 72 receives, through an input lead 403, the numerical value indicating the left-hand end position of a row line. The output lead 703 of the register 72 is connected to the X position control counter 61. Through an input lead 404, the right-end boundary register 73 receives the numerical value indicating the right-hand end position of a row line of characters. An output lead 704 of the register 73 is connected to the boundary detector 71. The detector 71 receives the output of the counter 61 and the numerical value indicating the right-hand end position of a row line of characters through the input leads 611 and 704, respectively. The detector 71 receives, via lead 405, a comparison command signal which causes the detector 71 to compare the output of the counter 61 with right-hand end defining output of the right-end boundary register 73. Also, the detector 71 receives a boundary check pulse through an input lead 406. The character generator 5 is connected by a lead 701 and the lead 702 to the boundary detector 71 for receiving a boundary nondetection pulse and the boundary detection pulse, respectively.

Boundary designation signals designating the region of characters to be displayed on the display face of the CRT display device are stored in advance in the left-end boundary register 72 and the right-end boundary register 73 through the leads 403 and 404. In addition, the boundary detector 71 receives the boundary check pulse through the lead 406. The comparison command signal which brings the detector 71 into the state of comparing the output of the position control counter 61 with the output of the boundary register 73 is received through the lead 405.

The information received from the information processor 1 and stored in the memory 3 is read out through a lead 301 in response to the location address sent from the control circuit 2 through the lead 202, and is transmitted to the command decoder 4 through a lead 203.

Upon receipt of the positioning command information first, the command decoder 4 supplies, through the leads 401 and 402, positioning information signals to the X position control counter 61 and Y position control counter 62. The command decoder 4 then sends the end pulse to the control circuit 2 through a lead 408. The control circuit 2 controls the memory 3 so as to read out the command information of the following location. On the other hand, the numerical value set in the counter 61 is compared with the numerical value set in the right-hand boundary register 73 by the boundary detector 71 when the signal supplied through the lead 405 and the boundary check pulse supplied through the lead 406 are applied to the boundary detector 71. The boundary detector 71 is ready to send out the boundary check pulse to the lead 701 as a boundary nondetection pulse indicating that the signal value of the X position control counter 61 is smaller than that of the signal  $X_2$  of the right-end boundary register 73.

The command decoder 4 decodes the character designating command information and the coded information of character and transmits them to the character generator 5 through a lead 407 and transmits the boundary check pulse to the boundary detector 71 through the lead 406. When the character generator 5 receives the boundary nondetection pulse from the boundary detector 71, it generates the program pulses of X and Y coordinates to change the contents of the control counters 61 and 62 through leads 501 and 502. Also, the contents of the counters 61 and 62 are sent out respectively as output signals to the D/A converters 9 and 12 through the leads 611 and 621 in synchronism with the scanning of the intensity control matrix. D/A-converted signals drive the X-axis and Y-axis deflection coils 11 and 14 through leads 10 and 13 to deflect the electron beam in X and Y directions.

The intensity-modulating signals representative of display pattern sent out from the character generator 5 are supplied to the CRT 8 through a lead 503. Thus, the patterns of characters are displayed at positions of the CRT display face defined by the X-axis and Y-axis deflections.

Upon completion of the display of one total character, the X-directional program pulse changes the contents of the counter 61 by the width of one character plus the interval between horizontally adjacent characters, while the Y-directional program pulse maintains the contents of the Y position control counter 62 at the Y coordinate value unchanged. As soon as the display of one whole character is completed, the character generator 5 transmits a one-character-display-end pulse to the control circuit 2 through a lead 504. The control circuit 2 then causes a readout from the memory 3 of the succeeding coded character information with reference to the location address. The read out information is transmitted to the command decoder 4. In such a manner, the characters are displayed one by one in the horizontal direction on the CRT display surface.

The timing relationship between the output signals of the first position control counter controlled by the X-direction program pulse, the output signals of the second position control counter controlled by the Y-direction program pulse, and the intensity control signals for the letter A in a 5x7 dot matrix (indicated by arrow I in FIG. 2) and the letter A (indicated by

arrow II in the same drawing) of the first row line is shown in FIG. 3A and FIG. 3B. When the right-hand end portion is reached after a series of characters or, in other words, when the signal of the counter 61 becomes equal to or larger than the signal  $X_2$  of the right-end boundary register 73, the boundary check pulse is applied as the boundary detection pulse to the counters 61 and 62 through the lead 702. At this time, the input signal applied from the boundary register 72 through the lead 703 is applied to the position control counter 61. This boundary detection pulse and the signal from the boundary register 72 change the contents of the counter 61 to the signal  $X_1$  which is the contents of the left-end boundary register 72. The boundary detection pulse also changes the contents of the counter 62 by the appropriate value, depending on character height, making a new line. The value required for making a new line is a value corresponding to the sum of the height of a character itself and the vertical spacing between each adjacent character determined by a signal which specifies the size of characters to be displayed.

Subsequent to the foregoing, the character generator 5 is triggered by the boundary detection pulse supplied through the lead 702 and converts the coded information of character stored within itself into an intensity-modulating signal, and applies the X- and Y-directional program pulses to the position control circuit 6.

Further operation is similar to the first line scanning mentioned above. When the size of characters to be displayed is changed, the character generator 5 generates a signal representing the character size to the counters 61 and 62 through the lead 505 to change the input digit positions of the program pulses to be applied to the counters 61 and 62. Then, the contents of these counters are changed by the program pulses having a scanning unit corresponding to the size of characters.

In FIG. 2, X indicates the horizontal direction and Y indicates the vertical direction of the CRT display surface.  $X_1$  indicates the display-initiation position (Left-end boundary) and  $X_2$  the display-completion position (right-end boundary). In addition,  $Y_1$  indicates the initial position of the roman letters A in the first row line. When roman letters are displayed horizontally in the display region between  $X_1$  and  $X_2$ , the number of letters to be displayed depends on the size and kind of characters. For example, the first row line shows that capital letter A is repeatedly displayed in large size and with

horizontal spacing of four lattice points. The second line shows that the smaller sized capital letter A is also repeatedly displayed with the spacing of two lattice points. As is seen from the drawing, even in the case of display of the uniform-sized letters, it is evident that the number of letters displayed in one row line is different. To demonstrate this, letter I of 3×7 matrix and letter W of 7×7 matrix are shown in the third and fourth lines in FIG. 2.

Points Z displayed at the right-hand end of the last letter in each line have the same respective uniform spacing from the last letter and indicate the point at which a new line should be started. In each of these cases, however, the position control circuit 6 is controlled so that the succeeding letter is displayed on the first position of the next new row line.

It will be obvious to those skilled in the art that the above embodiment is applicable to the vertical scanning display with slight modification.

While the principles of the invention have been described in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention as set forth in the object thereof and in the accompanying claims.

What we claim is:

1. In a cathode ray tube display device of the type for serially displaying the output of a data processor on a cathode ray tube and including means for converting said output into a sequence of language characters, the improvement coupled to said converting means comprising:
  - a first boundary register for storing a numerical value of a coordinate position on the cathode ray tube defining the beginning of a row line of characters;
  - a second boundary register for storing a numerical coordinate position representative of the end of the row line;
  - a position control counter for designating the coordinate position of the character being displayed on the cathode ray tube in the row line direction;
  - a boundary detector coupled to said position control counter and said second boundary register for comparing the coordinate values therebetween and initiating a signal upon an indication that the value in the position control counter is larger than the second boundary register; and
  - means responsive to said signal to initiate the beginning of a new line of characters on the cathode ray tube face at said first boundary and at a new vertical coordinate position.

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