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Naka

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[54] **PATTERN DISPLAY APPARATUS**

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[73] Assignee: **Ise Electronics Corporation,** Ise Japan

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July 16, 1970 Japan 45/61976

[52] **U.S. Cl.**.....**340/324 AD,** 315/30, 315/31 R

[51] **Int. Cl.**.....**G06f 3/14**

[58] **Field of Search** .....340/324 A, 324 AD; 315/30, 31 R

[56] **References Cited**

UNITED STATES PATENTS

3,331,985	7/1967	Hamann	315/31 R X
3,503,063	3/1970	Starr	340/324 A
3,421,044	1/1969	Murdock et al.	340/324 A X
3,168,679	2/1965	Kobbe	315/30
3,140,473	7/1964	Gaffney	340/324 A X

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[57] **ABSTRACT**

Apparatus for displaying patterns on an enlarged or reduced scale comprising a cathode ray tube including a cathode electrode, a plurality of matrix electrodes arranged in a matrix, a fluorescent screen, focusing means and deflection means which are disposed between the matrix electrode and the fluorescent screen; a pattern memory connected to the matrix electrodes for storing the patterns of letters, digits, symbols, etc. to be displayed; a memory for supplying an enlargement or reduction signal and a position designation signal of the information of the pattern to be displayed; an enlargement-reduction control connected to the supply memory for controlling the potential applied to the focusing means in accordance with the enlargement or reduction signal supplied from the memory; and a position designator connected to the memory for converting the position designation signal into an analogue signal and for applying the analogue signal to the deflecting means, whereby said focusing means operates to enlarge or reduce the pattern displayed on the fluorescent screen in accordance with the enlargement or reduction signal supplied from the memory and said position designator operates to position said pattern on said screen.

12 Claims, 8 Drawing Figures

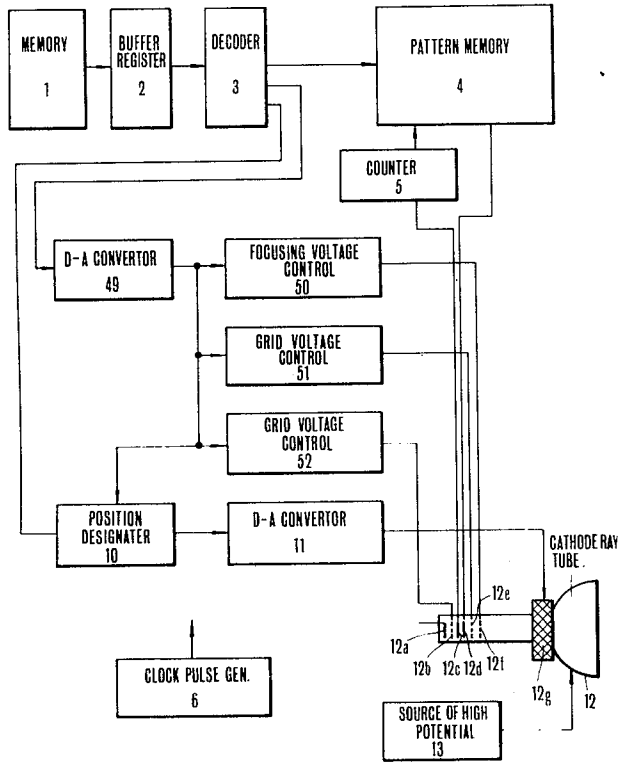

FIG. 1

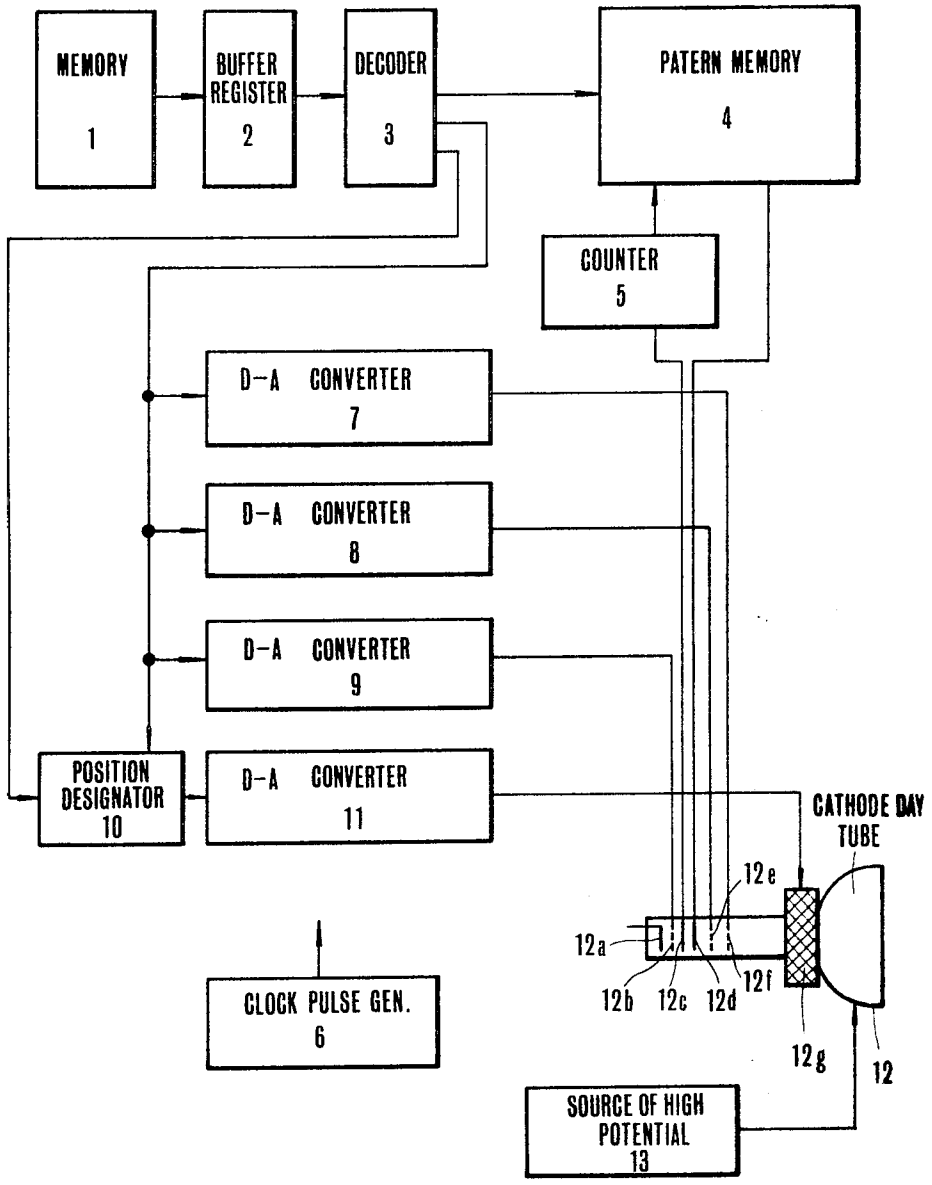

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FIG. 2

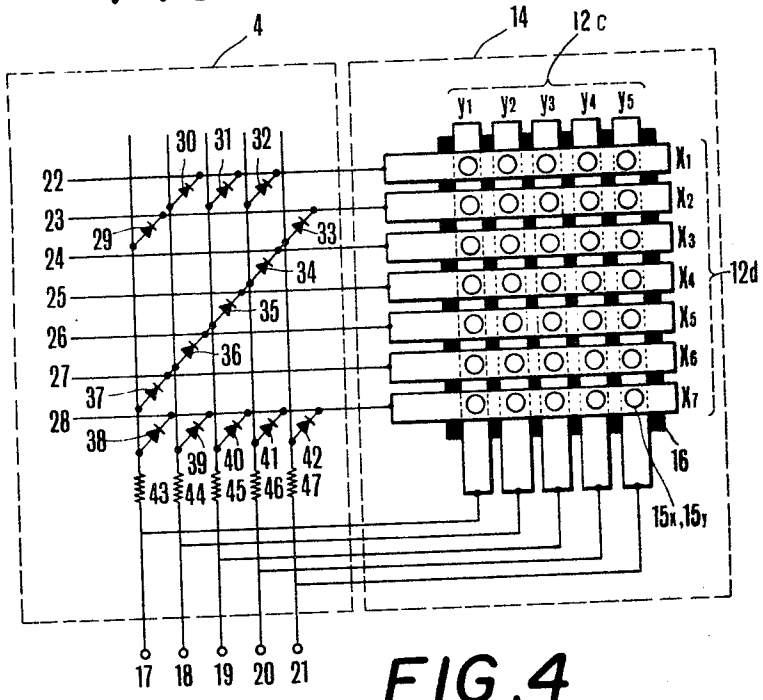

FIG. 3

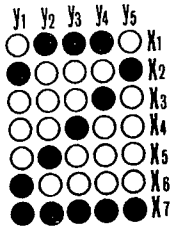

FIG. 4

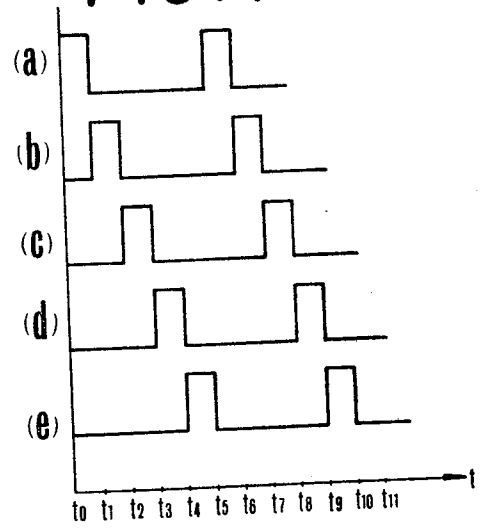

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FIG. 5

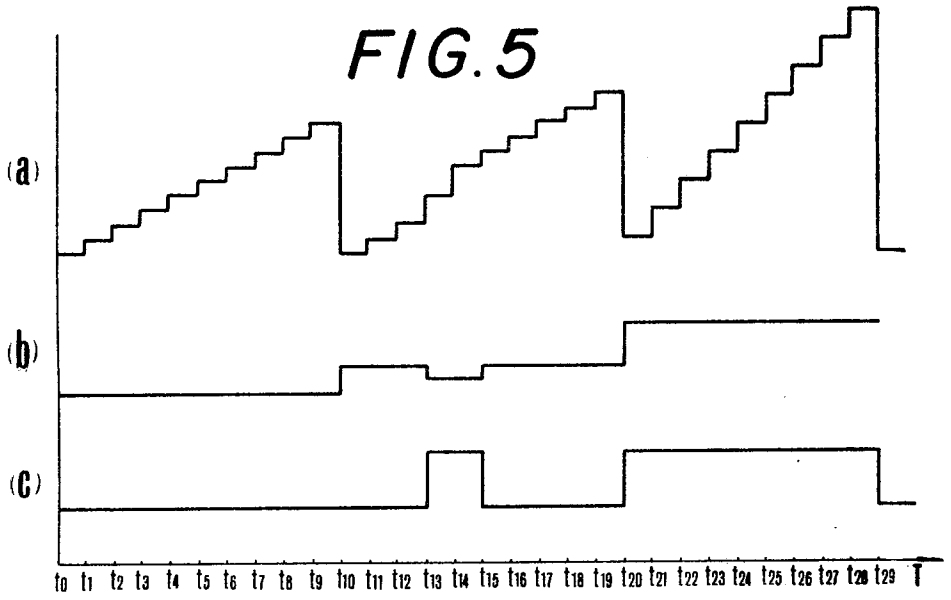

FIG. 6

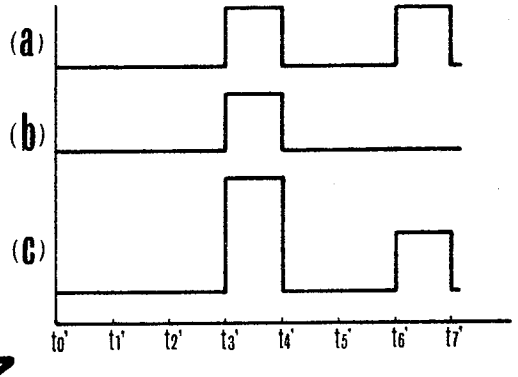

FIG. 7

1234567890
ABC DE FGHIJ
1234567890

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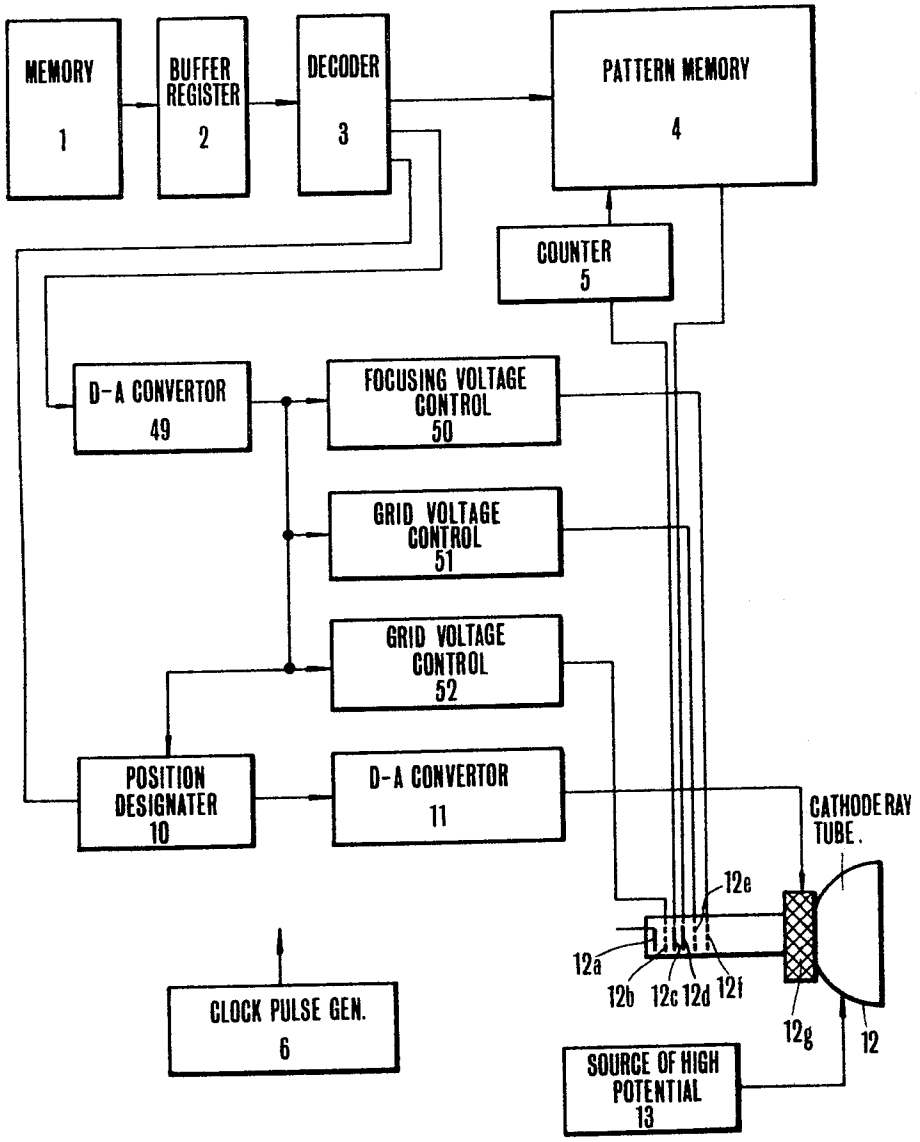
FIG.8



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PATTERN DISPLAY APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to display apparatus utilizing a cathode ray tube, more particularly a cathode ray tube utilizing a matrix electrode capable of displaying on an enlarged or reduced scale, under the control of a predetermined signal, such information as letters, numerals and symbols (for the sake of simplicity, merely expressed as a letter or letters in the following description) which have been or now are being stored in an electronic computor or another memory.

In conventional pattern display apparatus of the enlarging or reducing type which is generally termed as the raster type, a single electron beam is scanned in the vertical or horizontal direction and the intensity of the electron beam is increased when it reaches a predetermined position to cause the fluorescent screen to luminesce whereby the luminesced portion forms a portion of the pattern. For this reason, in order to display a single pattern it is necessary to scan the electron beam many times, thus requiring an increase in the frequency of the deflection signal. With this system, although the enlargement and reduction of the pattern can be realized by varying the deflection signal of high frequency, this approach is not advantageous because variation in the level of the high frequency deflection signal causes instability of the deflection signal which results in a unclear pattern and it is difficult to vary the level of the high frequency deflection signal. This also complicates the circuit construction and increases the cost of manufacturing.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved apparatus for displaying patterns of letters, digits, symbols and the like on the fluorescent screen of a cathode ray tube utilizing a matrix electrode without the necessity of scanning the electron beam.

A further object of this invention is to provide improved display apparatus which can enlarge or reduce the pattern by any factor merely by adjusting the voltage impressed upon an electrode disposed between the matrix electrode and the fluorescent screen of the cathode ray tube.

Another object of this invention is to provide an improved pattern display apparatus which can display the pattern always at a constant brightness irrespective of the factor of enlargement or reduction.

Yet another object of this invention is to provide a new and improved pattern display apparatus which can align the displayed patterns by varying a low frequency deflection signal.

According to this invention there is provided a pattern display apparatus comprising a cathode ray tube including a cathode electrode, a plurality of matrix electrodes arranged in a matrix, a fluorescent screen, focusing means and deflection means which are disposed between the matrix electrodes and the fluorescent screen ; a pattern memory connected to the matrix electrodes for storing the patterns of letters, digits, symbols, etc. to be displayed ; a memory for supplying an enlargement or a reduction signal and a position designation signal of the information of the pattern to be displayed ; an enlargement-reduction control connected to the supply memory for controlling the potential applied to the focusing means of the cathode ray tube in accordance with the enlargement or reduction signal supplied from the memory ; and a position designator connected to the supply memory for converting the position designation signal into an analogue signal and for applying the analogue signal to the deflecting means.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawing :

FIG. **1** shows a block connection diagram of a display apparatus utilizing the novel cathode ray tube ;

FIG. **2** is a connection diagram showing the relationship between the X-axis matrix electrodes and the Y-axis matrix electrodes of the cathode ray tube shown in FIG. **2**, and a pattern memory ;

FIG. **3** is a diagram to explain the operation of the matrix electrodes shown in FIG. **2** ;

FIGS. **4** to **6** show graphs of waveforms of various elements shown in FIG. **1** ;

FIG. **7** shows some examples of the patterns displayed on the cathode ray tube and

FIG. **8** is a block connection diagram of a modified embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the invention shown in FIG. **1** comprises a memory **1**, a buffer register **2** connected to the memory, a decoder **3** connected to the buffer register and a pattern memory **4** comprising a diode matrix corresponding to the matrix electrodes in the cathode ray tube for storing the patterns of the letters, as will be described later in more detail. A counter **5** is connected to the pattern memory **5** for producing a predetermined number of pulses in synchronism with the output of a clock pulse generator **6.** First, second and third D-A (digital -analogue) converters **7, 8** and **9** and a position designator **10** are connected to the outputs of decoder **3** and the output of position designator **10** is connected to a cathode ray tube **12** via a fourth D-A converter **11.** Cathode ray tube **12** comprises a cathode electrode **12*a***, a first grid electrode **12*b*** connected to the third D-A converter **8,** a Y-axis matrix electrode **12*c*** connected to counter **5,** a X-axis matrix electrode **12*d*** connected to pattern memory **4,** a second grid electrode **12*e*** connected to the second D-A converter **8,** a focusing electrode **12*f*** connected to the first D-A converter **7,** a deflection coil **12*g*** mounted on the tube neck and connected to the fourth D-A converter **11** and an anode electrode or fluorescent screen (not shown) connected to a source of high potential **13.** It is to be understood that clock pulse generator **6** is connected to supply a synchronizing signal to memory **1,** buffer register **2,** decoder **3,** counter **5** and position designator **10.**

A dotted line block **14** in FIG. **2** shows the detail of the X and Y-axis matrix electrodes **12*d*** and **12*c***. In this figure, y_1 to y_5 show five Y-axis electrode elements in the form of parallel strips which are spaced apart an equal distance and arranged in a common plane. Each of the elements is provided with seven equally spaced apart perforations **15*y***. The X-axis matrix electrode comprises seven equally spaced apart parallel strip shaped electrode elements x_1 to x_7 which are also arranged in a common plane. Each of the elements x_1 to x_7 is provided with five perforations **15*x***. X-axis matrix electrode elements and Y-axis matrix electrode ele-

ments cross each other at right angles, so that perforations 15*x* and 15*y* of respective elements x_1 to x_7 and y_1 to y_5 align with each other. The assembly is contained in the neck of the cathode ray tube. Between X and Y axis matrix electrodes 12 *d* and 12*c* is interposed a shield 16 having perforations (not shown) of the same diameter and positions as perforations 15*x* and 15*y* so that the electron beam emanated from the cathode electrode 12*a* can pass through only these aligned perforations.

It is now assumed that a digit 2 is to be displayed. In FIG. 3, black circles show selected cross points of the matrix electrodes, whereas white circles not selected cross points. In this case, the diode matrix elements of pattern memory 4 shown in FIG. 2 which display digit 2 are used. More particularly, Y-axis conductors 17 to 21 are connected to Y-axis matrix electrode elements y_1 to y_5, respectively, and X-axis conductors 22 to 28 are connected to X-axis matrix electrode elements x_1 to x_7, respectively. Further, there are provided a plurality of diodes 29 to 42 which are connected across appropriate pairs of Y-axis conductors 17 to 21 and X-axis conductors 22 to 28 to supply a signal displaying digit 2 to the matrix electrode 12 in the manner well known in the art. Resistors 43 to 47 are connected in series with Y-axis conductors 17 to 21, respectively.

When positive pulses shown in FIG. 4*a* to 4*e* are supplied sequentially to respective conductors 17 to 21, positive potentials are supplied to Y-axis matrix electrode conductors y_1 to y_5 and X-axis matrix electrode conductors x_1 to x_7 at their cross-points through appropriate diodes of the diode matrix corresponding to the pattern to be displayed. Consequently, the electrons projected on the entire surface of the matrix electrode from the cathode electrode 12*a* pass perforations 15*x* and 15*y* alone at cross points where both elements of the X-axis matrix electrode 12*d* and Y-axis matrix electrode 12*c* are biased positively through the diodes to display a pattern of digit 2 on the fluorescent screen of the cathode ray tube. In the arrangement shown in FIG. 2, by selecting a suitable combination of $5 \times 7 = 35$ dots at the crosses between the X and Y-axis matrix electrode elements any desired pattern can be displayed.

The operations of the various elements shown in FIG. 1 utilizing the cathode ray tube described above are as follows :

Memory 1 represents a memory of an information processing apparatus such as an electronic computor and operates to send a particular information stored therein to buffer register 2, which is intended to be displayed. It is to be understood that such an information also contains a signal designating the selected pattern, its size and position. The buffer register 2 operates to temporally store an information from memory 1 and send it to decoder 3 which converts the information into a pattern selection signal, an enlargement-reduction signal and a position designation signal, the pattern selection signal being sent to pattern memory 4. The counter 5 operates to generate a series of pulse signals which are dephased by a predetermined interval as shown in FIGS. 4*a* to 4*e* and in synchronism with a pulse signal of a definite period generated by the clock pulse generator 6. These pattern signals are supplied to selected addresses of pattern memory 4, for example conductors 17 to 21, respectively, shown in FIG. 2 and hence to respective elements of Y-axis matrix electrode 12*c* of the cathode ray tube 12. Conductors 22 to 28 of the pattern memory 4 corresponding to the selected pattern are connected to respective elements of X-axis matrix electrode of the cathode ray tube. As a consequence, only the perforations corresponding to the selected pattern of the pattern memory, that is those corresponding to diodes 29 to 42 of the memory, 4 shown in FIG. 2, can transmit the electrons thereby displaying the selected pattern (the digit 2) of the fluorescent screen of cathode ray tube 12 as a combination of dots, as shown in FIG. 3. The position designation signal from decoder 3 is supplied to position designator 10 and is then converted into a X-axis deflection signal (FIG. 5*a*) and a Y-axis deflection signal (FIG. 5*b*) by the action of the fourth D-A converter 11. The X and Y-axis deflection signals thus formed are then supplied to deflection coil 12*g* surrounding the neck of the cathode ray tube. Each of the small steps of the X-axis deflection signal shown in FIG. 5*a* corresponds to the horizontal position of the displayed pattern and the saw tooth wave comprised by a number of small steps represents a line of the displayed pattern. The vertical height of the Y-axis deflection signal shown in FIG. 5*b* represents the vertical position of the displayed pattern. In this manner, position designator 10 and the fourth D-A converter 11 cooperate to act as a position control for controlling the position of the displayed pattern.

Enlargement and reduction of the displayed pattern are made in the following manner.

The enlargement and reduction signals generated by decoder 3 and shown in FIGS. 6*a* and 6*b* are supplied to the first and second D-A converters 7 and 8 and are converted into analogue signals of a predetermined magnitude as shown in FIG. 6*c*. For the sake of description these signals are dipicted to have the same level. The analogue signals are then supplied respectively to the focusing electrode 12*f* and to the second grid electrode 12*e* of the cathode ray tube. Consequently, the focal distance of the lens system comprised by the focusing electrode 12*f* and the second grid electrode 12*e* is varied to enlarge or reduce the size of the pattern displayed by the electron beam :

Thus, it will be clearly noted that the factor of amplication or reduction can be varied at will by varying the level of the signals impressed upon focusing electrode 12*f* and the second grid electrode 12*e*.

Of course, the brightness of the fluorescent screen varies with the enlargement and reduction of the electron beam, the enlargement decreasing the brightness and the reduction increasing it. To solve this problem the third D-A converter 9 is provided. The purpose of this converter is to convert the enlargement-reduction signal from decoder 3 into an analogue signal and supply it to the first grid electrode 12*b* of cathode ray tube 12. In this manner, the third D-A converter 9 operates to increase the quantity of the electrons projected upon the Y-axis matrix electrode 12*c* and the X-axis matrix electrode 12*d* from cathode electrode 12*a* when the converter 9 receives an enlargement signal whereas to decrease the quantity of the electrons to decrease the brightness of the pattern displayed on the fluorescent screen when it receives a reduction signal.

Enlargement and reduction results in the overlapping of adjacent patterns displayed on the screen or in the variation in the gaps between displayed patterns. Thus, it is necessary to neatly arrange the displayed patterns

irrespective of their enlargement and reduction. Arrangements of the enlarged or reduced diplayed patterns are as follows.

More particularly, the enlargement-reduction signals are applied to position designator **10** from decoder **3.** For example, an enlargement signal, which when converted into an analogue signal is represented by FIG. *5c*, controls the position designation signal produced by position designator **10.** As a result, the level of the output from the fourth D-A converter **11,** that is the X-axis deflection signal shown in FIG. *5a* is elevated at portions between time instants T_{13} to T_{15} and T_{20} to T_{29} of the enlargement signal shown in FIG. *5c*. As above described, since the difference in the levels of adjacent steps of the X-axis deflection signal represents the spacing between adjacent patterns, this above described elevation of the levels results in the broadening of the spacing between adjacent patterns. On the contrary, the level of the Y-axis deflection signal shown in FIG. *5b* is lowered at portions between time instants T_{13} to T_{15} and T_{20} to T_{29} of the enlargement signal shown in FIG. *5c* with the result that at the center of the enlarged pattern, the degree of deflection is decreased in accordance with the magnifying power.

FIG. **7** shows an example of enlarged and reduced patterns displayed in which upper digits correspond to time instants T_0 to T_{10}, middle alphabets to time intervals T_{10} to T_{20} and lower digits to time instants T_{20} to T_{29}. In this manner, it is possible to maintain the pattern spacing at a definite value by establishing a predetermined relationship between the enlargement signal and the X-axis deflection signal. Further, it is possible to align partially enlarged patterns, that is the alphabets shown in the second line in FIG. **7,** in a straight line by establishing a predetermined relationship between the Y-axis deflection signal and the enlargement signal, in the same manner as above described.

Although, the above description refers to the adjustment of the spacing and the alignment of the lower edges of the enlarged patterns, it will be clearly noted that the alignment of the upper edges of the displayed patterns can be accomplished by varying the relationship between the enlargement-reduction signal and the X or Y-axis deflection signal and that the spacing between adjacent patterns can be varied by varying the magnifying power of the lens system.

FIG. **8** shows a modified embodiment of this invention employing the novel cathode ray tube, which differs from that shown in FIG. **1** in that a D-A converter **49** is used to convert the enlargement-reduction signal into an analogue signal which is supplied to focusing electrode **12***f* through a focusing voltage control **50,** to the second grid electrode **12***e* through a second grid voltage control **51** and to the first grid electrode **12***b* through a first grid voltage control **52.** With this arrangement it is possible to eliminate three D-A convecters **7, 8** and **9** shown in FIG. **1.**

In this manner, since in the display apparatus utilizing the novel cathode ray tube a pattern is displayed by a plurality of electrons, the pattern can be readily enlarged or reduced as desired merely by converting the enlargement-reduction signal into an analogue signal and then applying the analogue signal to the electrodes comprising the lens system of the cathode ray tube. Further, according to this invention as the frequency of the enlargement-reduction signal is much lower than that of the prior art raster system it is possible to stabilize the operation of the display apparatus and simplify the circuit construction thereof. Moreover, in this invention, as each pattern is deflected as a unit the deflection frequency may be low and it is possible to adjust the spacing between displayed patterns by varying the level of such low frequency deflection signal in accordance with the enlargement-reduction signal.

Since the frequency of the deflection signal is low it is possible to readily control the level of the deflection signal and to stabilize the operation of the apparatus. In addition, the brightness of the enlarged or reduced pattern can be maintained at a constant value and the number of the adjustable elements can be reduced.

While the invention has been shown and described in terms of its preferred embodiments it will be clear that many changes and modifications may be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is :

1. Pattern display apparatus comprising a cathode ray tube including a cathode electrode, a plurality matrix electrodes arranged in a matrix, a fluorescent screen, focusing means and deflection means which are disposed between said matrix electrodes and said fluorescent screen; a pattern memory connected to said matrix electrodes for storing the patterns of letters, digits, symbols etc. to be displayed; a memory for supplying an enlargement or a reduction signal and a position designation signal of the information of the pattern to be displayed; an enlargement-reduction control connected to said supply memory for controlling the potential applied to said focusing means of said cathode ray tube in accordance with said enlargement or reduction signal supplied from said memory; and a position designator connected to said supply memory for converting the position designation signal into an analogue signal and for supplying said analogue signal to said deflecting means, whereby said focusing means operates to enlarge or reduce the pattern displayed on said fluorescent screen in accordance with said enlargement or reduction signal supplied from said memory and said position designator operates to position said pattern on said fluorescent screen.

2. The display apparatus according to claim **1** wherein the output from said position designator is controlled according to said enlargement or reduction signal supplied from said memory to adjust the spacing between adjacent patterns displayed.

3. The display apparatus according to claim **1** which further comprises a grid electrode disposed between said matrix electrodes and said cathode electrode of said cathode ray tube and a digital-analogue converter connected between said supply memory and said grid electrode for converting said enlargement or reduction signal into an analogue signal to maintain at a definite value the brightness of said enlarged or reduced pattern.

4. Display apparatus comprising a cathode ray tube including a cathode electrode for emitting electrons, a first grid electrode, a Y-axis matrix electrode, a X-axis matrix electrode, a second grid electrode, a focusing electrode, deflection means and a fluorescent screen; said component elements of said cathode ray tube being disposed in the order mentioned along the path of said electrons, said X and Y axis matrix electrodes comprising a plurality of electrode elements which are arranged in a matrix and provided with aligned perfora-

tions at their cross points, and said focusing electrode and said second grid electrode cooperating to constitute a lens system; a memory for storing the information of the patterns to be displayed; a decoder connected to said memory for converting the information of a given pattern into a pattern selection signal, an enlargement-reduction signal and a position designation signal; a position designator connected to said decoder to receive therefrom said position designation signal; a first digital-analogue converter connected to said position designator for applying an analogue deflection signal to said deflection means; first means responsive to said enlargement-reduction signal from said decoder for energizing said focuusing electrode and said second grid electrode to enlarge or reduce said displayed pattern, and a pattern memory connected to said decoder to receive therefrom said pattern selection signal and apply it to said matrix electrodes.

5. The display apparatus according to claim **4** which further comprises second means responsive to said enlargement-reduction signal from said decoder for energizing said first grid electrode of said cathode ray tube for controlling the quantity of electrons impinging upon said matrix electrodes to regulate the brightness of the pattern displayed on said fluorescent screen.

6. The display apparatus according to claim **4** wherein said first means comprises digital-analogue converters for converting said enlargement-reduction signals into analogue signals.

7. The display apparatus according to claim **4** wherein said first means comprises controls responsive to said enlargement-reduction signal for producing control voltages for energizing said focusing electrode and said second grid electrode.

8. The display apparatus according to claim **4** which further includes a buffer register connected between said memory and said decoder.

9. The display apparatus according to claim **4** wherein said pattern memory comprises a diode matrix connected between said decoder and said matrix electrodes.

10. The display apparatus according to claim **5** wherein said second means comprises a digital-analogue converter for converting said enlargement-reduction signal into an analogue signal.

11. The display apparatus according to claim **5** wherein said second means comprises a control responsive to said enlargement-reduction signal for producing a control voltage for energizing said first grid electrode.

12. The display apparatus according to claim **4** wherein the output of said position designator is controlled according to said enlargement or reduction signal supplied from said memory to adjust the spacing between adjacent patterns displayed.

* * * * *