United States Patent [19]

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[11] **3,713,134**

[45] **Jan. 23, 1973**

[54] DIGITAL STROKE CHARACTER GENERATOR

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[22] Filed: **Sept. 16, 1970**

[21] Appl. No.: **72,613**

[52] **U.S. Cl.**.....**340/324 A**, 315/18, 315/22

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

[58] **Field of Search**.....340/324 A; 315/18, 22

[56] **References Cited**

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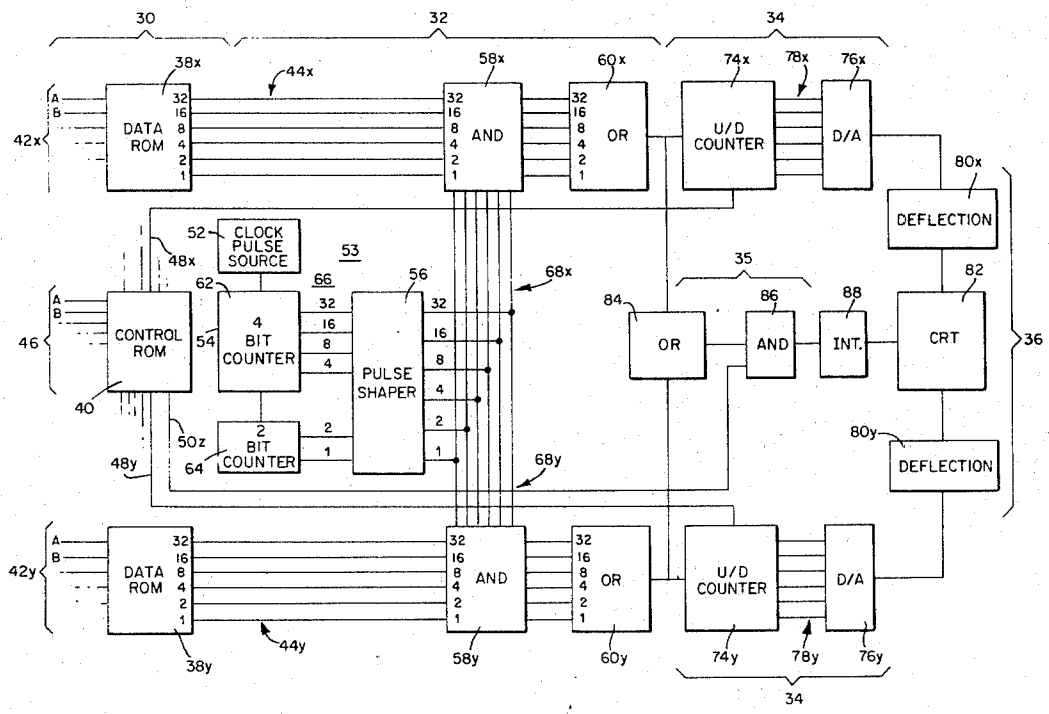
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Primary Examiner—Donald J. Yusko
Assistant Examiner—Marshall M. Curtis
Attorney—Woodcock, Washburn, Kurtz & Mackiewicz, Clarence R. Patty, Jr. and Walter Zebrowski

[57] **ABSTRACT**

A system for generating characters by deflecting an electron beam over a screen having orthogonal X and Y axes. Beam deflection and modulation commands for each segment of each character are stored in read only memories. The deflection commands are read out to a binary rate multiplier after a character has been selected. The binary rate multiplier generates X and Y pulse trains having independently variable binary rates under the control of the deflection commands. The pulse trains are then applied to X and Y UP/DOWN counters and digital-to-analog converters to generate X and Y deflection signals in analog form having independently variable rates of change corresponding to the binary rates of the digital deflection signals. The polarity or direction of the rate of change is determined by deflection commands which control the direction of count in the UP/DOWN counters.

5 Claims, 4 Drawing Figures



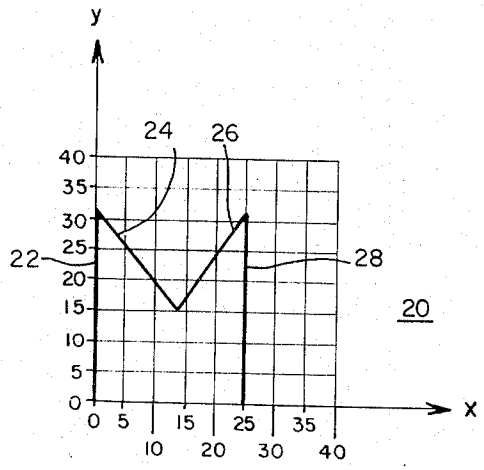


Fig. 1

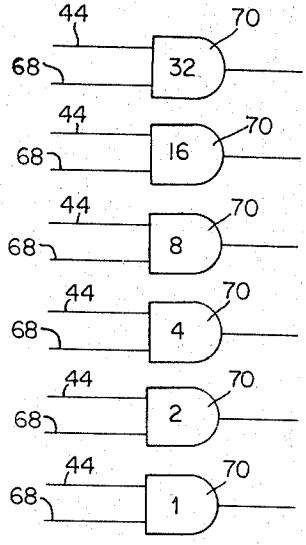


Fig. 3

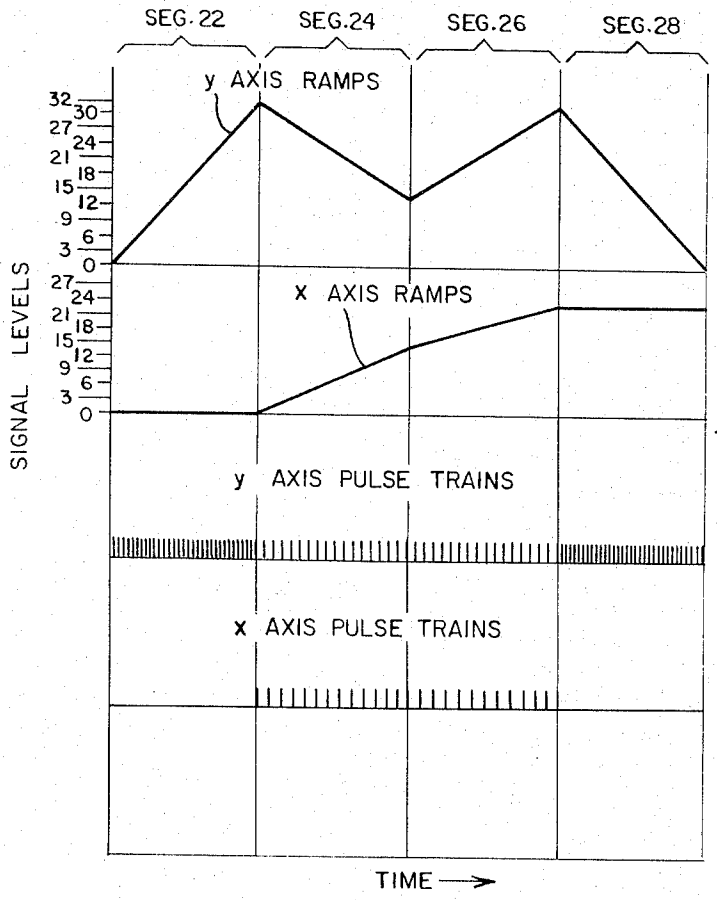


Fig. 4

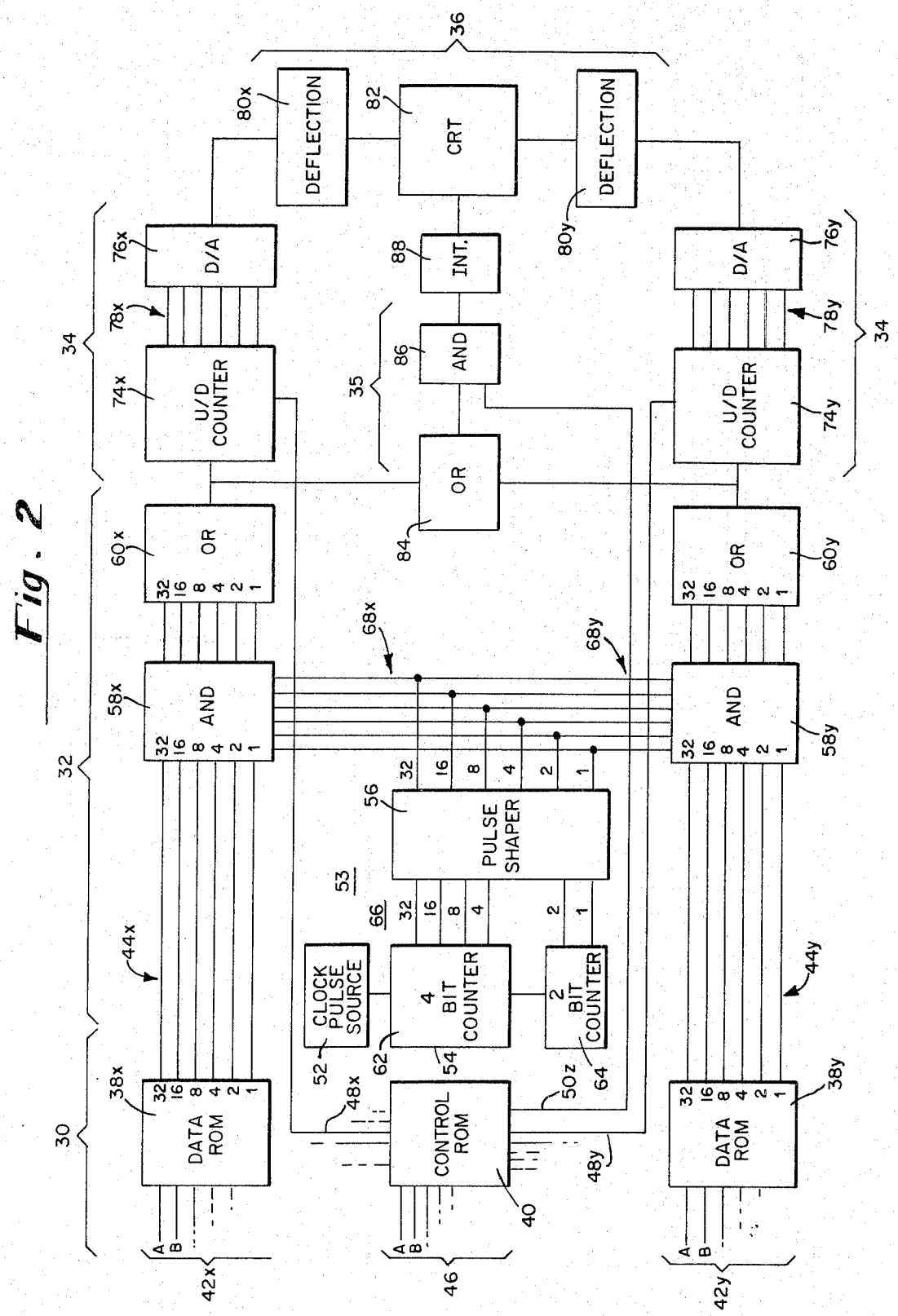

36
80x
DEFLECTION
82
CRT
DEFLECTION
80y
76x
D/A
88
INT.
D/A
76y
78x
78y
34
74x
U/D COUNTER
86
AND
35
U/D COUNTER
74y
OR
84
60x
OR
60y
68x
68y
58x
AND
AND
58y
32
56
PULSE SHAPER
53
66
44x
44y
CLOCK PULSE SOURCE
52
4 BIT COUNTER
62
54
2 BIT COUNTER
64
50z
38x
48x
CONTROL ROM
40
48y
38y
30
DATA ROM
DATA ROM
A
B
42x
46
42y

Fig. 2

DIGITAL STROKE CHARACTER GENERATOR

BACKGROUND OF THE INVENTION

This invention relates to character generators of the stroke type.

More and more emphasis is being placed on a basic technique which may be utilized for generating characters and symbols for display regardless of the desired shape of these characters and symbols. The dot matrix character generator wherein the electron beam intensity or Z modulation is cut on or off depending on required intensification at particular dots is the simplest way to present characters. However, this method limits the display to a certain type of characters. In particular, it does not permit the display of anything but the simplest block type characters and does not permit the display of script type characters.

Because of the limitation on the types of characters which may be displayed with a dot matrix character generator, stroke generators are in general preferred. In a stroke generator, Z modulation is substantially continuous as the electron beam moves through a continuous stroking display in response to horizontal X axis or vertical Y axis deflection. Although the stroke character generator is preferred in those instances where characters other than the block type are to be displayed, there are difficulties associated with a stroke character generator. One very significant difficulty involves the necessary coordination between X axis and Y axis deflection where the electron beam is being deflected in both the X axis and Y axis directions simultaneously. If coordination between the X axis and Y axis deflection is not maintained, it is not possible to accurately trace any character or symbol having any segment which is non-parallel to either the X axis or the Y axis. Obviously, many characters and symbols include such segments.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved stroke generator for accurately displaying all character segments for a wide variety of characters.

In accordance with one important aspect of the invention, the character generator comprises a control means having stored deflection commands. A binary rate multiplier means generates X and Y axis pulse trains having independently variable binary rates under the control of the stored deflection commands. The X and Y axis pulse trains are then converted to analog signals having rates of change corresponding to the variable rates for deflecting an electron beam through each segment of each character during uniform segment time intervals.

In accordance with another aspect of the invention, the control means generates modulation commands for Z axis modulation or electron beam intensity control.

In accordance with still another aspect of the invention, the X and Y axis pulse trains are applied to UP/DOWN counters having a direction of count under the control of deflection polarity commands generated by said control means and then converted to analog X and Y deflection signals.

The foregoing and other objects, aspects, features, and advantages of the invention may be better understood from the following more detailed description, the appended claims and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically represents the display of a character on the screen of a stroke character generator embodying the invention;

FIG. **2** is a block diagram of a stroke character generator embodying the invention;

FIG. **3** is a schematic diagram of particular gate means used in the stroke character generator of FIG. **2**; and

FIG. **4** depicts various signals generated by the stroke character generator of FIG. **2**.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **1** schematically illustrates a screen **20** of a display device such as a cathode ray tube. The screen **20**, which has been subdivided into an imaginary grid for purposes of explaining the invention, comprises a continuum of material capable of emitting light energy under electron bombardment from the cathode ray tube electron beam source. The imaginary grid comprises a series of equally spaced lines parallel to the horizontal X axis and a series of equally spaced lines parallel to the vertical Y axis. For purposes of illustrating the invention, the letter M is shown as displayed on the screen **20**.

In order to generate the character M, the following strokes can be made. In generating a first segment **22**, the electron beam is deflected along the Y axis from a grid position of **0, 0** to a grid position **0, 32**. The stroke of the first segment **22** is achieved by providing increasing Y axis deflection in the form of a ramp function beginning with a magnitude of zero units and increasing to 32 units. No X deflection is applied during this stroke.

In generating a second segment **24**, the electron beam is deflected from the grid position **0, 32** to the grid position **13, 15** by simultaneously applying changing X and Y deflection forces to the electron beam. In order to achieve the straight line **24** connecting these positions, the X deflection force must increase by a magnitude of 13 units while the Y deflection force must simultaneously decrease by a magnitude of 17 units.

Third, the electron beam is stroked through a segment **26** from the position **13, 15** to the position **25, 32** by again simultaneously applying changing X and Y deflection forces to the electron beam. For this third stroke, the X deflection force must increase by a magnitude of 12 units while the Y deflection force simultaneously increases by a magnitude of 17 units.

The fourth and last stroke generating a segment **28** deflects the electron beam from the position **25, 32** to the position **25, 0** by the application of a decreasing Y deflection force and a constant X deflection force.

In accordance with this invention, the deflection for generating each of the segments **22, 24, 26,** and **28** in forming the letter M, are generated by X axis deflection signals in the form of ramp functions having various rates of change as well as Y axis deflection signals in the form of ramp functions having various rates of change as shown in FIG. **4**. The segments **24** and **26** of the character M are generated by X axis and Y axis deflection signals in the form of ramp functions having different rates of change as shown in FIG. **4**. In order to generate segments **22** and **28** of the character M, ramp function Y axis deflection signals are generated as also

shown in FIG. 4 while simultaneously generating zero or constant X axis deflection signals. In order to generate the horizontal segments of the letter Z, it is similarly necessary to generate X axis deflection signals which are ramp functions while generating zero or constant Y axis deflection signals. Finally, in order to generate the letter H, it is necessary to generate intensity control signals for modulating the electron beam. A system embodying the invention and capable of generating the foregoing deflection signals for characters such as M, Z, and H will now be described with reference to FIG. 2.

As shown in FIG. 2, the stroke character generator system comprises a control section **30**, a pulse train generating section **32**, an analog deflection signal section **34**, a modulation section **35** and a display device **36**. The control section **30** comprises a pair of data ROM's (read only memories) **38X** and **38Y** for storing X and Y axis deflection commands for each segment of each character to be displayed. The memory section **30** also comprises a control ROM **40** for storing additional commands including Z axis modulation or beam intensity control commands for each segment of each character to be displayed. In order to provide random access for the particular characters selected at one of the character selection inputs **42X** and **42Y**, the ROM's **38X** and **38Y** may comprise diode matrices where the character selection inputs **42X** and **42Y** are the input lines for the diode matrices and binary deflection command outputs **44X** and **44Y**, (**1, 2, 4, 8, 16, 32**) are the output lines of the diode matrices. Depending upon the particular characters selected at one of the input lines **42X**, certain of the binary outputs **44X** will be energized and the resulting binary outputs will be applied to the digital deflection signal section **32**.

The control ROM **40** having character selection inputs **46**, one for each character to be selected, may also comprise diode matrices where the character selection inputs **46** are the input lines and deflection polarity command outputs **48X** and **48Y** are the output lines which are connected to the analog deflection generation section **34**. A binary Z axis modulation command output **50Z** is connected to the intensity control section **35**. The control ROM **40** also includes means for changing the deflection and intensity control commands after each character segment is generated. This may be accomplished by applying suitable control signals from the control ROM **40** to the ROM's **38X** and **38Y** as shown. The control function may be provided by appropriate logic circuitry well known in the art.

The pulse train generating section **32** comprises a source of clock pulses which may be gated by the control ROM **40** through a connection not shown and a BRM (binary rate multiplier) **53** comprising a ripple counter **54**, a pulse shaper **56**, AND gate means **58X** and **58Y** and OR gate means **60X** and **60Y**. As the clock pulses from the source **52** enter the ripple counter **54** having a four bit section **62** and a two bit section **64**, a plurality of pulse trains are generated at each of the pulse train outputs **66**. The pulse rates of each of the pulse trains correspond to the binary outputs **44X** and **44Y** (**1, 2, 4, 8, 16, 32**), i.e., of one pulse per unit of time, two pulses per unit of time etc. Each of the pulses of the pulse train is then applied to the pulse shaper **56** before application to the AND means **58X** and **58Y** at inputs **68X** and **68Y**.

As shown in FIG. 3, each of the AND gate means **58X** and **58Y** comprises a group of six AND gates **70**, one for each of the pulse trains from the ripple counter **54**. By selectively enabling particular AND gates in response to deflection commands from the ROM's **38X** and **38Y**, particular pulse trains will be passed by the AND gate means **58X** and **58Y** and the OR gate means **60X** and **60Y**. Where more than one AND gate **70** is enabled, more than one pulse train will be passed and the pulse trains leaving the OR gate means **60X** and **60Y** will be composite pulse trains having pulse rates equal to the sum of the rates of the component pulse trains.

The analog deflection signal section comprises the UP/DOWN counters **74X** and **74Y** in series with digital-to-analog convertors **76X** and **76Y** respectively. As the pulse trains from the OR gate means **60X** and **60Y** enter the UP/DOWN counters **74X** and **74Y** respectively, binary outputs of the UP/DOWN counters produce a count representing the pulse rate of the composite pulse trains. Note that pulse rate is a direct function of particular deflection commands at the output **44X** and **44Y** which are then applied to the AND gate means **58X** and **58Y**. Since the deflection commands at the outputs **44X** and **44Y** are mutually and independently variable depending upon the particular segment of a particular character, the binary rate of the composite pulse trains applied to the UP/DOWN counters **74X** and **74Y** are mutually and independently variable. Of course, the resulting analog deflection signal generated by the digital-to-analog convertor **76X** and **76Y** are ramp functions having mutually independent rates of change corresponding to the binary rates. Accordingly, the analog deflection signals which are applied to deflection circuitry **80X** and **80Y** associated with a cathode ray tube **82** of the display section **36** are mutually independent.

The composite pulse trains from the OR gate means **60X** and **60Y** are also applied to the intensity control section **35** comprising an OR gate **84** in series with an AND gate **86** selectively enabled by the intensity control commands at the modulation command output **50Z** of the control ROM **40**. The resulting digital intensity control signal is then applied to intensity control circuitry **88** of the display section **36**.

The operation of the stroke character generator of FIG. 2 will now be described by describing the generation of the character M as shown in FIG. 1. With the character M selected at the character selection inputs **42X, 42Y,** and **46**, the ROM outputs **44X, 44Y, 48X, 48Y,** and **50Z** are as follows:

44X							48X	50Z	48Y	44Y						
32	16	8	4	2	1					32	16	8	4	2	1	
0	0	0	0	0	0	0		1	1	1	0	0	0	0	0	
0	0	1	1	0	1	1		1	0	0	1	0	0	0	1	
0	0	1	1	0	0	1		1	1	0	1	0	**0**	**0**	**1**	
0	0	0	0	0	0	0		1	0	1	0	0	0	0	0	

During the stroking of the segment **22**, the outputs **44X** are all in the low state "**0**" while the output **44Y** (**32**) is in the high state "**1**" so as to enable the AND gate **70** of the AND gate means **58Y** having a pulse train input of 32 pulses per unit of time as shown in FIG. **4**. By placing the UP/DOWN counter **74Y** in the up counting

state by a "1" at the output **48Y** and modulating the beam with an output of "1" at the output **50Z**, the ramp function for stroking the segment **22** is generated as shown in FIG. **4**.

At the end of this stroke, the control ROM **40** changes the commands from the control section **30**. In particular, the outputs **44X** (**8**, **4**, and **1**) are now "1" with the outputs **44Y** (**16** and **1**) "1" to stroke the segment **24**. As a result, the AND gates **70** of the AND gate means **58X** which are coupled to pulse trains having 8, 4, and 1 pulses per unit of time and the AND gates **70** of the AND gate means **58Y** which are coupled to pulse trains having a pulse rate of **16** and **1** pulses per unit of time are applied to the UP/DOWN counters **74X** and **74Y**. Because of the OR gate **60X** and **60Y**, composite pulse trains comprising **13** pulses per unit of time and **17** pulses per unit of time as shown in FIG. **4** are applied respectively to UP/DOWN counters **74X** and **74Y**. The UP/DOWN counter **74X** is maintained in the up counting state since the output **48X** is "1" while the UP/DOWN counter **74Y** is in the down counting state since the output **48Y** is "0" to generate the ramp functions shown in FIG. **4**. The electron beam is modulated throughout the stroking of the segment **24** since the output **50Z** is "1."

The stroking of the segment **26** is similar to the stroking of the segment **24** except that the outputs **44X** (**8** and **4**) are "1" to produce only 12 pulses per unit of time as shown in FIG. **4** for application to the UP/DOWN counters **74X**. In addition, the UP/DOWN counter **74Y** is now in an up counting state due to the "1" at the output **48Y**.

The stroking of the segment **28** is substantially identical to the segment **22** except that the UP/DOWN counter **74Y** is in the down counting state due to the "0" at the output **48Y** and the count of the UP/DOWN counter **74X** remains at 25 since all outputs **44X** are "0."

Although the letters M, Z, and H are specifically mentioned in the foregoing, it should be appreciated that character generator of FIG. **2** may be utilized to generate a wide variety of characters including the ASCII business characters. It should also be understood that the various components shown in block form comprise commercially available and otherwise substantially conventional elements well known to those of ordinary skill in the art.

Although the invention has been described in terms of a particular embodiment, various changes and modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

What is claimed:

1. A character generator system of the type having a display device including a screen, an electron beam source, an X deflection means for deflecting the beam across the screen in a direction parallel to the X axis, and a Y deflection means for deflecting the beam across the screen in a direction parallel to the Y axis, said system comprising:

a control means for generating digital X axis deflection commands representing appropriate X axis deflection and digital Y axis deflection commands representing appropriate Y axis deflection during time intervals of substantially uniform length for each segment of each character to be displayed;

a pulse train generating means comprising a source of pulses and a binary rate multiplier coupled to the output of said control means for generating digital X axis and Y axis pulse trains for each segment having independently variable binary rates determined by said X axis and Y axis deflection commands, said X axis and Y axis pulse trains for each segment being generated in one of said time intervals of substantially uniform length regardless of segment length;

an analog deflection signal generating means coupled to the output of said pulse train generating means for generating analog X axis and Y axis deflection signals from said X axis and Y axis pulse trains respectively for application to the X deflection means and the Y deflection means respectively, said analog X axis and Y axis deflection signals generating each segment of each character during one of said time intervals of substantially uniform length, said analog signals having rates of change corresponding to said independently variable binary rates; and

an intensity control gating means having an input coupled to the output of said binary rate multiplier and an output coupled to said display device for controlling the intensity of said electron beam in response to said X axis and Y axis pulse trains.

2. The character generator system of claim **1** wherein said control means includes means for generating Z axis modulation commands for each segment of each character to be displayed for selectively enabling the intensity control gating means in response to said Z axis modulating commands.

3. The character generator system of claim **2** wherein said control means generates polarity commands for each segment of each character to be displayed, and said analog deflection signal generating means includes means for controlling the polarity of said rate of change of said analog X axis and Y axis deflection signals in response to said polarity commands.

4. The character generator system of claim **1** wherein said binary rate multiplier comprises:

a counter generating a plurality of outputs having different binary rates;

AND gate means comprising an X group of gates and a Y group of gates, the plurality of said outputs from said counter being applied to corresponding inputs of said X group of gates and said Y group of gates, said X group of gates and said Y group of gates being selectively enabled by said deflection commands so as to generate a combined output at said X group of gates and a combined output at said Y group of gates having binary rates equal to the sum of the binary rates for the particular gates enabled in said X group of gates and said Y group of gates respectively; and

an X OR gate means and a Y OR gate means having inputs coupled to the outputs of said X group of gates and said Y group of gates respectively, the outputs of said X OR gate means and said Y OR gate means providing the inputs to said X analog deflection signal means and said Y analog deflection signal means respectively.

5. The character generator system of claim **4** wherein said control means generates deflection polarity commands for each segment of each character to be dis-

played, said analog deflection signal generating means comprising X and Y axis UP/DOWN counters coupled to the output of said X OR gate means and said Y OR gate means respectively and further comprising X and Y axis digital-to-analog convertors coupled to the outputs of said X and Y axis UP/DOWN counters, the counting direction of each said UP/DOWN counter being controlled by said deflection polarity commands.

* * * * *