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CHARACTER POSITIONING CONTROL

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FIG. 1

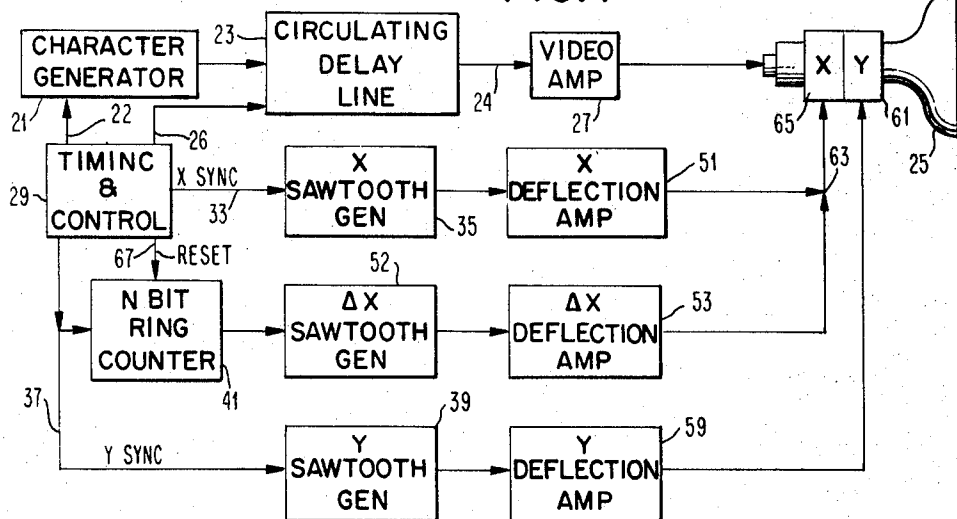


FIG. 2

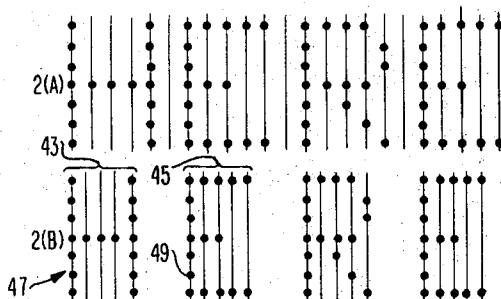
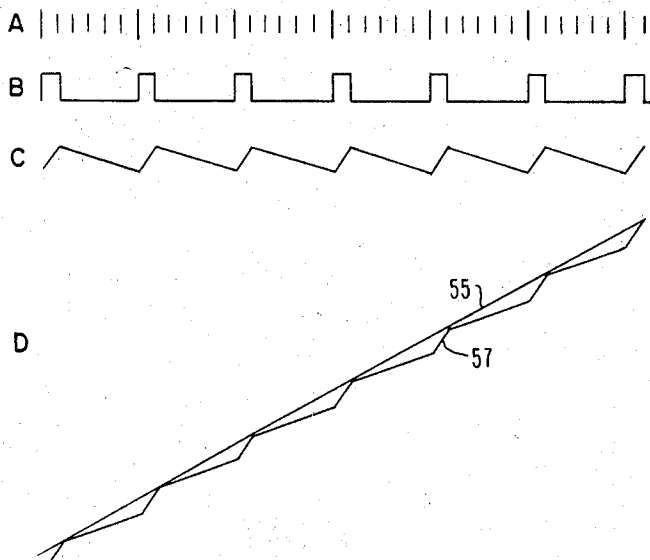


FIG. 3



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1

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CHARACTER POSITIONING CONTROL

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8 Claims

ABSTRACT OF THE DISCLOSURE

In a display system, symbols are generated by unblanking the CRT beam during five vertical sweeps under control of video signals stored in a buffer, while a single vertical sweep is used for the space between characters. To prevent merging of adjacent symbols and improve the aesthetic appearance of the display, the vertical character components are effectively compressed and the space between characters expanded, both in the horizontal dimension. A character counter responsive to the vertical sweep controls a sawtooth generator which generates a sawtooth having high and low slope portions. The low slope portion of the sawtooth signal modifies the horizontal sweep during the character composing period, thus compressing the character in a horizontal direction, while the high slope portion of the staircase slope expands the space between characters.

This invention relates to character display and more particularly to an improved deflection system for use in a cathode ray tube display.

In certain data processing systems, a cathode ray tube display is used to provide real time access to computer information in visual form in applications that require rapid man-machine communications. The ability of such display devices to reproduce computer data on a screen much faster than that produced by ordinary terminal printout makes it an exceptional graphic solution for a wide range of industrial, scientific and commercial applications. Such data processing installations may utilize a number of CRT display units which may be selectively serviced by a common control. One of the essential elements of a display system common control is the character generator, which may be operated in real time to directly control the deflection of the associated cathode ray tubes, or may be operated with a buffer storage where the video output from the character generator is stored for subsequent display and reintensification. The present invention will be described with reference to the latter system using a recirculating delay line buffer, although it will be appreciated that the invention is applicable to the former CRT character generator system operated in real time.

In display systems of the above described type, the display may be designed to provide a television type raster upon which alphanumeric characters are displayed by selective unblanking of the CRT beam during appropriate sequences in the beam sweep pattern. Such characters may be generated by stroke or dot rasters, the latter being used to illustrate the present invention. These systems may employ horizontal raster scanning, a system of this type being shown in copending application Ser. No. 512,106, "Improved Display System," filed by John L. Botjer et al. on Dec. 7, 1965, or alternatively, the system may generate characters by selectively unblanking the beam during the vertical sweep. The present invention will be described in the latter environment, using a 5 x 7 dot raster consisting of five vertical columns of seven dot capacity.

In a display system operated with a delay line buffer, one of the significant factors affecting the operation of

2

the system is the storage capacity and format of the delay line buffer. In addition to storing the video signals, it may be desirable to store the coded equivalent of the character adjacent to the video portion for computer recognition. In the environmental system contemplated by the present invention, the display format included rows of 80 characters, each character utilizing five slots of delay line information interspersed with one slot of character identification code. For purposes of the instant invention, a delay line slot may be defined as the storage capacity utilized to store the seven dots of video information representing one row of a character. When displayed on the screen, the resulting space between characters appeared insufficient, tending to provide ambiguities or merging of symbols in the display. The two obvious solutions were to reduce the character capacity of the row, decreasing the display capacity, or to increase the buffer storage space, which would require additional buffer storage capacity and would also decrease the available character capacity. In addition, such a modification using a longer delay line would decrease the repetition rate of the display thus introducing flicker into the display. It was therefore highly desirable to improve the aesthetic appearance of the display format utilizing the existing storage capacity and character density.

In accordance with the present invention, there is provided an improved display system in which the space between characters is effectively increased, without sacrificing character capacity or increasing buffer storage. Recurrent signals from the high speed (vertical) sweep are used to generate signals indicative of the beginning position of each character. These signals in turn are used to control a sawtooth generator which generates sawtooth signals having a period corresponding to that of the character generator. This sawtooth generator signal in turn is used to modify the horizontal sweep of the CRT in a sloping staircase pattern having low and high slope components by slowing down the sweep during the character composing period and speeding up the sweep during the period between the characters. The characters selected for display are thereby effectively compressed in a horizontal direction by operation of low slope components of the staircase and the space between the characters increased by operation of the high slope portion of the staircase. This results in an aesthetically pleasing display without sacrifice of buffer storage capacity or character display capability.

Accordingly, a primary object of the present invention is to provide an improved display system.

Another object of the present invention is to provide an improved display system wherein the normal space between characters is increased.

Another object of the present invention is to provide an improved display system wherein the characters are effectively compressed in one direction and the resultant space between characters increased in the same direction.

Still another object of the present invention is to provide an improved character display system wherein the display is modified to provide a greater space between the characters without sacrificing the character capacity or increasing the storage facility required for the present invention.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing.

In the drawings:

FIGURE 1 illustrates in block schematic form a display system incorporating a preferred embodiment of the present invention;

3

FIGURES 2A and 2B are fragmentary illustrations of portions of the display generated prior to the instant invention and by operation of the present invention;

FIGURE 3 illustrates a family of waveforms including the vertical sync generator, a six bit counter responsive to the vertical sync generator, a sawtooth generator responsive to the counter and the modified signal applied to the horizontal amplifier.

Referring to the drawings and more particularly to FIGURE 1 thereof, there is illustrated in block schematic form an improved display system of the type contemplated by the present invention. A character generator 21 is adapted to convert coded digital signals representative of selected characters into serialized video signals used for deflection and intensity control. While character generators adapted to provide this function are known in the art, one preferred character generator is that disclosed in copending application Ser. No. 496,016, "Character Code Translator," filed by Robert W. Love on Oct. 14, 1965. The aforementioned copending application translates binary coded digital signals into video signals which are serialized and applied directly to control the cathode ray tube, or may be applied to a buffer such as circulating delay line 23 where they are stored for subsequent display on associated cathode ray tube 25. The character generator is synchronized with the delay line by line 22 from timing and control circuit 29, while the delay line is constantly being retimed by a clocking pulse on line 26 from the timing and control circuit 29.

Referring briefly to FIGURE 2A, there is illustrated four characters generated by a raster of five vertical sweeps or columns in a manner more fully described hereinafter using single column spacing between adjacent characters. While not readily apparent from the exaggerated showing of FIGURE 2A, the single column spacing between adjacent characters was deemed inadequate to avoid ambiguities resulting from contacting or merging of adjacent symbols. To recognize the true significance of the problem, it must be appreciated that the CRT display of the present invention contemplates a display of twelve rows of 80 characters per row on a 12" diagonal screen using a total of 512 vertical raster sweeps. The video output from recirculating delay line 23 on line 24 is amplified by video amplifier 27 and applied directly to the cathode or control grid of the CRT to control the unblanking of the CRT beam. While the X and Y sync signals are shown emanating from the timing and control circuit 29 on lines 33 and 37 respectively, the invention is equally applicable to incoming quantized video signals where the sync signals would be detected by conventional sync apparatus. The horizontal sync signal on line 33 is used to control the frequency of the horizontal oscillator shown as sawtooth generator 35, while the vertical sync signal on line 37 is used to control the frequency of the vertical oscillator shown as Y sawtooth generator 39, and is also applied to the input to the N bit ring counter 41. Ring counter 41 in the preferred embodiment operates as a six bit counter to provide an output on each sixth vertical sweep, and is used as the control signal to initiate character generation and, as more fully described hereinafter, to modify the corresponding portion of the sweep produced by sawtooth generator 52.

As previously described, a display format which can be executed advantageously by the present invention is shown in FIGURE 2B. It will be appreciated that the electron beam is sequentially swept vertically, from top to bottom, for each of the five vertical columns, while simultaneously being swept at a slower speed in the horizontal direction, from left to right as viewed from the face of the tube. While in practice the vertical columns would tend to be slightly skewed because the horizontal displacement occurs during the application of the individual traces, they are shown in FIGURE 2 as a substantially rectangular pattern. In this mode of operation,

4

the cathode ray path, i.e., the trace path which the ray would make if unblanked, is arranged to form a group of five vertical raster lines 43, which would be followed by a blanked oblique line which extends the spacer before the next group of vertical lines 45, and so forth. The character generator 21 is designed to store for subsequent display luminous dots in the raster pattern forming the character "H" 47, followed by the character "E" 49 and so on for the remainder of the message to be displayed. The present invention is adapted to modify the character format as shown in FIGURE 2A to the one shown in FIGURE 2B.

Returning to FIGURE 1, to provide character spacing control as indicated in accordance with the present invention, an additional sawtooth generator 52, identified as the delta X sawtooth generator, is actuated under control of the vertical sync controlled ring counter 41 to generate a negative waveform which is combined in a manner more fully described hereinafter with the horizontal sweep signals generated by the horizontal sawtooth generator 35 such that the horizontal sweep is slowed during the character generation period and speeded up during the interval between characters to effectively compress the vertical character components in a horizontal direction and expand the space between characters. It should be noted that both effects are accomplished by the instant invention.

Referring briefly to FIGURE 3, the waveforms of FIGURES 3A, 3B, 3C and 3D are plotted along the same time axis to indicate the relation of the vertical sweep pulses to the ring counter 51, the delta X sawtooth generator 52 and the resultant horizontal deflection signal comprising the output from the horizontal deflection amplifier 51 as modified by the output of sawtooth generator 52 and amplifier 53. Referring first to FIGURE 3A, each sixth vertical sync signal shown slightly larger than the five signals therebetween represents the signal which identifies the row between characters, while the five video signals representing the five vertical sweep lines or columns comprising the character are shown therebetween. As illustrative of one system operated in accordance with the present invention, the pulse repetition rate of the vertical oscillator as shown in FIGURE 3A was 15,360 c.p.s. As previously described, the vertical sync signals are also applied to the six bit ring counter 41. Ring counter 41 is a conventional counter which generates an output having a duration equal to one vertical sync period for each six input pulses applied thereto. As evident from FIGURE 3B, this output occurs during the interval between the sixth vertical sweep and the first vertical sweep on the next character. This counter output is used to control the sawtooth generator 52 to generate the negative sawtooth illustrated in FIGURE 3C. The waveform indicated in FIGURE 3C is generated by a conventional RC ramp generator having a time constant which charges toward a negative voltage generating a negative sawtooth waveform. As shown in FIGURE 3C, the waveform between the first and second vertical raster sweeps of each six unit period rises toward its maximum value and slowly decays during the next five vertical sync signals. In the display device constructed in accordance with the principles of the present invention, the amplitude of the negative ramp varied between a zero and a negative level, for example, -15 volts, which can be adjusted by means of a potentiometer. Referring to FIGURE 3D, the slope of the output from the horizontal oscillator 35 is shown in exaggerated form to clarify the operation of the present invention and the manner in which the horizontal deflection waveform is modified. It will be appreciated, however, that in practice, the waveform from the horizontal sawtooth generator 35 would have a much more gradual slope.

Referring back to FIGURE 1, the preferred embodiment of the invention includes a Y deflection system which comprises the Y sawtooth generator 39 and associ-

ated deflection amplifier 59 operated in a properly inter-timed relationship by a Y sync signal provided by timing and control circuit 29 via line 37 so as to provide a series of ramp signals to the Y deflection yoke 61. This Y deflection arrangement may be similar to the horizontal deflection system in conventional television receivers where the raster is a horizontal rather than a vertical line as in the present illustration.

As is usual in raster generating systems, the raster line separation is provided by a second ramp signal generator arranged to provide deflection transversely of the direction of the raster lines. Such a ramp is provided in the preferred embodiment of the instant invention, by a sawtooth generator 35 in properly timed relation to an X sync signal provided from timing and control circuit 29 via line 33, the ramp signal being amplified by associated deflection amplifier 51. This output is logically combined with the negative sawtooth waveform generated by sawtooth generator 52 which, when amplified by amplifier 53, is connected at junction 63 such that the resultant waveform, as shown in FIGURE 3D, line 57, is applied to the horizontal deflection yoke 65.

In the illustrated system herein described, the modification effected by the sawtooth generator 52 and deflection amplifier 53 effectively modulates the ramp signal 55 from the deflection amplifier 51 to provide the above described staircase configuration shown as line 57 in FIGURE 3D. The sawtooth generator 52 is operated by means of a sync input 42 from the N bit ring counter 41. While this synchronizing signal can of course be derived directly from the master timing and control circuit 29, it is shown as being derived from the N stage ring counter 41 which itself is stepped by the Y deflection sync signal on line 37. Thus the raster arrangement shown in FIGURE 2B comprises five vertical sweeps during a period of relatively slow horizontal displacement to provide relative compression of the raster lines forming the pattern of the character, followed by a sixth vertical sweep which is to be executed during a relatively high rate of horizontal deflection to provide a relatively large space between characters and so on as aforescribed. Accordingly, in the preferred embodiment of the invention herein described, N would be six because it is upon every sixth vertical sweep that re-setting of the modulating sawtooth generator 52 would be desired with attendant relative high rate of horizontal deflection. However, it is obvious that the value of N will vary in accordance with the number of rows utilized in the character configuration employed.

In the above described arrangement, it is assumed that the sawtooth waveforms provided by the deflection systems are substantially linear, and that the operation of the circulating delay line is synchronized with the horizontal and vertical deflection systems in the manner heretofore described. It will be further recognized that the invention is not limited to display systems of the type shown in FIGURE 1, but that the principle of the invention could be utilized, for example in display systems having electrostatic deflection systems by substituting voltage waveforms for the current signals utilized in magnetic deflection. Likewise, the invention is not restricted to a particular buffer format but the same concept of character compression and space expansion could be utilized in a buffer having no available storage space between characters during every Nth vertical retrace, where N is the number of vertical columns comprising the character.

What is claimed is:

1. In a system for generating visual displays, the combination comprising
 - a cathode ray tube,
 - a beam intensity control signal source for said cathode ray tube,
 - means for generating sweep signals for coordinate deflection of the beam of said cathode ray tube in a raster format,

means operative to synchronize said sweep signal generating means with said intensity control signals for creating visual images on said cathode ray tube, and means operable in accordance with a function of one of said coordinate sweep signals for modifying the other of said coordinate sweep signals whereby symbols identified by said visual images are selectively compressed and the space between symbols is selectively expanded.

2. A device of the character defined in claim 1 wherein said other sweep signal is a composite signal, and said system comprises a single electromagnetic deflection coil responsive thereto.

3. A device of the character claimed in claim 1 wherein said beam intensity control signal source comprises a character generator for generating video signals.

4. A device of the character claimed 3 wherein said beam intensity control signal source further comprises a buffer storage device wherein said video signals are selectively stored in appropriate sequence for subsequent display on said cathode ray tube.

5. In a system for controlling the space between symbols generated by raster sweep techniques on a cathode ray tube, the combination comprising

- a character generator for generating beam intensity signals representative of symbols to be displayed,
- a buffer storage device connected to said character generator,

- a cathode ray tube having intensity control means,

- a deflection system comprising first and second coordinate deflection means associated with said cathode ray tube,

- said first coordinate deflection means having primary and secondary deflection control means,

- control means for synchronizing the readout of the video signals from said buffer with the intensity and deflection systems of said cathode ray tube to reproduce and selectively position symbols representative of said video signals on said cathode ray tube, and

- means for modifying the sweep pattern of said primary deflection means in coordination with that of said secondary deflection means whereby the displayed symbols are compressed and the space between symbols expanded in the direction controlled by said primary deflection means.

6. A device of the character defined in claim 5 wherein said buffer storage device comprises a circulating delay line.

7. A device of the character claimed in claim 6 wherein said circulating delay line includes certain data bits comprising video intensity information and other bits containing intersymbol spacing information.

8. A device of the character claimed in claim 7 wherein the readout from said circulating delay line is synchronized with the vertical sweep pattern and said intensity control means whereby said characters are reproduced and spatially oriented on the screen of said cathode ray tube.

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