United States Patent

Flanagan

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[54] **VIDEO DATA COLOR DISPLAY SYSTEM**

[72] Inventor: **Michael J. Flanagan,** Bedford, Mass.

[73] Assignee: **Viatron Computer Systems Corporation,** Bedford, Mass.

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

[58] **Field of Search** .....340/324 A, 168 SR; 178/6.8

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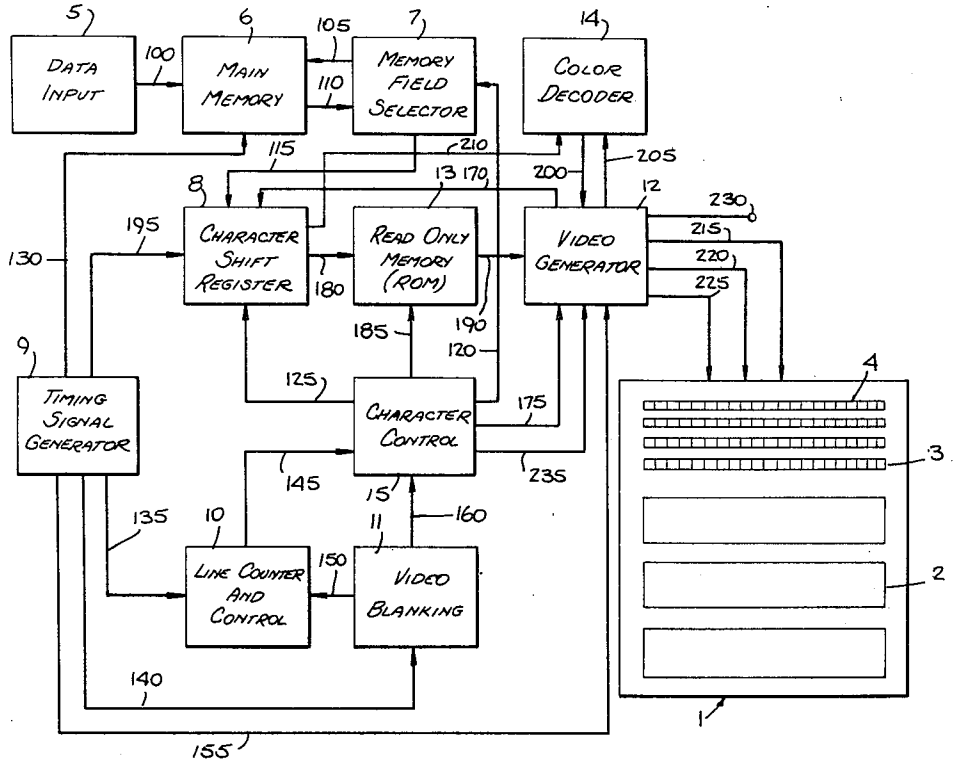
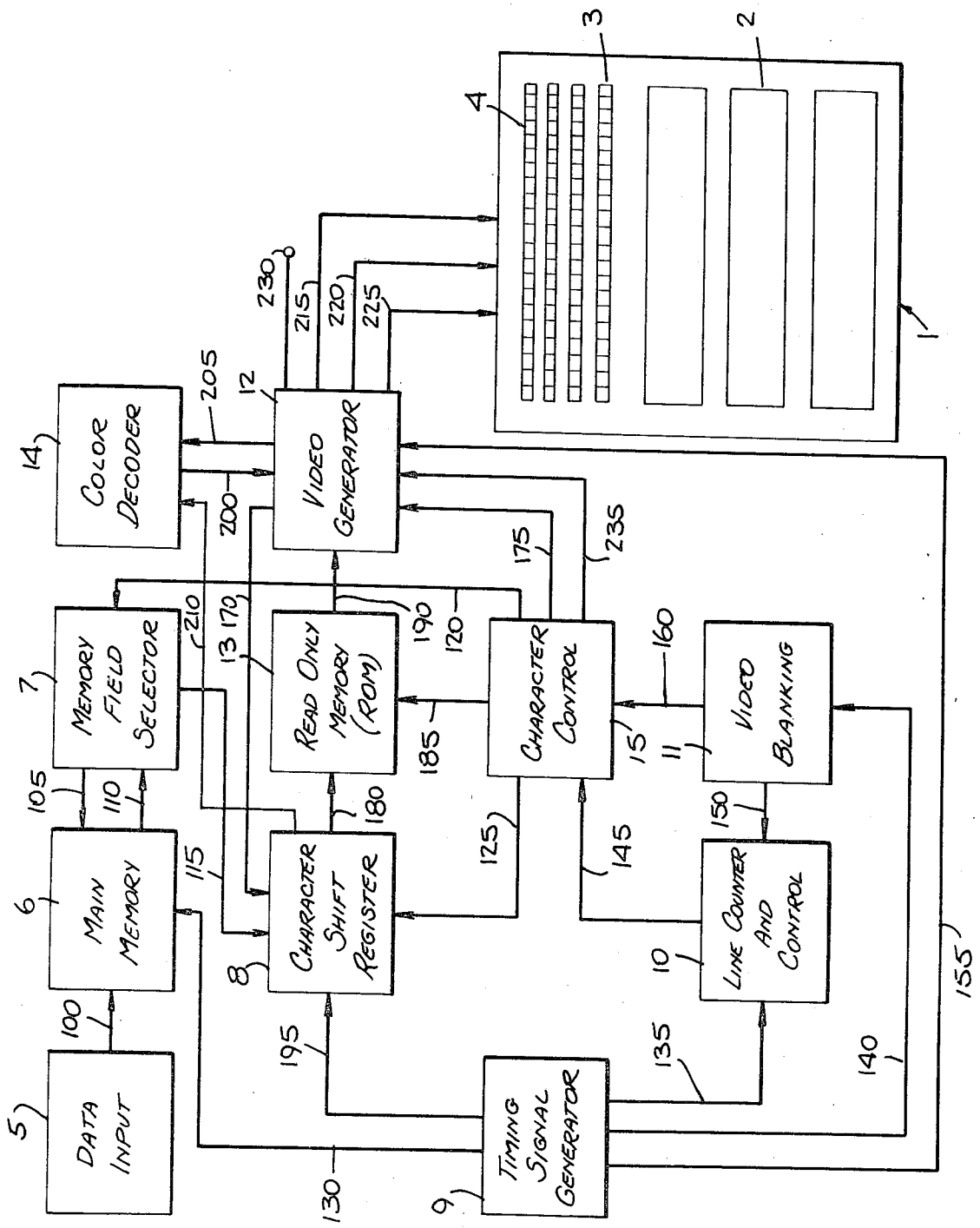
Primary Examiner—John W. Caldwell
Assistant Examiner—Marshall M. Curtis
Attorney—Charles Hicken

[57] **ABSTRACT**

A data color display system is disclosed which will display groups of characters in color on a background in color. The shapes or outlines of the different characters which are available for display are predetermined by the hard wiring of a read only memory, but the selection of the particular characters to be displayed is left to be specified by input data to the system. The color display system is adapted to store input digital data and to process it digitally so as to provide video signals synchronized with the raster of a raster-type color monitor whereby desired colored characters on a colored background are formed. In one mode, the input data determines the colors of the characters and character backgrounds. In another mode, the colors of four types of characters are predetermined by hard wiring.

6 Claims, 1 Drawing Figure





INVENTOR
MICHAEL J. FLANAGAN
BY James J. Cannon

ATTORNEY

VIDEO DATA COLOR DISPLAY SYSTEM

BACKGROUND OF THE INVENTION

The present color display system provides a visual color indication of digital data which has been entered into the main memory circuit. The source of the digital data may be a keyboard or records such as punch tape, punch card, and magnetic tape with compatible transducers.

In my copending application Ser. No. 814,534, titled Video Data Display System dated Apr. 9, 1969, several advantages of having a visual display of digital data are given. One significant advantage of a display system is that furnishing the punch card operator with a visual display reduces data errors through self-correction and because of a greater interest by the operator. Ordinarily, an operator prepares a punch card with no direct means of knowing if the input data is correct or even logical. Another operator must prepare a separate card with the identical data and compare the two cards. Identical cards are interpreted as correctly representing the data.

The use of color in the visual display of the digital data provides additional interest and stimulation to both for the operator entering the data and for the person who will retrieve the data. The value of color in data displays has been long recognized in other display media such as printed volumes, advertisements and accounting ledgers.

SUMMARY OF THE INVENTION

The present invention provides a means for a video color display of digital data and is adapted to interface with a modified conventional color television monitor for providing the color display. This result is obtained by digitally transforming the memory data into a serial video bit output synchronized to the raster signal.

The displayed data ordinarily consists of four fields where each field contains four lines, each line having up to 20 characters. The choice of 80 characters in a field is motivated by the wide use of punch cards using 80 characters based on the Hollerith code.

A main memory is provided for storing data in five fields. Three of these fields are ordinarily displayed while the operator may choose which one of the remaining two will be displayed.

Each character is stored in the ASCII code. In general, the ASCII code for a character word has eight bits and the main memory and the ancillary subsystems can accommodate eight-bit words. However, in the preferred embodiment all the ASCII characters need not be employed so that only seven bit words are needed to adequately identify all the characters and instructions used.

Two different color modes are available to the operator. Mode A allows the operator to select a character and/or a background from a group of eight different colors which include black and white. Each color selected remains in effect for all the characters which follow within the line. The selection of a character and/or a background color corresponds to a character data so that a blank space appears on the video display where each selection was made. Mode B differs from mode A in that only four colors are available and these are fixed as, for example, for four character groups of: lower case letters—green, upper case letters—aqua, numerals and punctuations—yellow, and communication characters—red. These color patterns are "hardwired" and no character spaces are lost in using mode B.

The general operation of the color display systems involves eighty character spaces in a field consisting of four equal groups. The field resides in a circulating shift register in the main memory. The timing of this shift register and other shift registers of the system is controlled by a timing system synchronized with the monitor raster signal.

The digital data from a group of twenty character spaces transfers to the character shift register which addresses a read only memory (ROM) sub-system. For modes A and B, the color information is addressed to the color decoder.

A character memory cell in the ROM comprises a bit array of five wide by seven deep. Each bit in the array corresponds to a dot position on the visual display of a character. The "zero" and "one" arrangement in the ROM memory cell determines the shape of the character corresponding to that cell.

The character shift register stores all twenty characters and the data is recirculated until the ROM has been addressed seven times. Each time the ROM has been addressed, the ROM cells are scanned in the five bit direction. The data from the ROM and the color decoder is transformed into a video serial bit stream comprising red, green, blue and black and white information suitable for the color television monitor.

A line of 20 character spaces on a visual display is then generated by seven sweeps of the raster scan where each sweep produces dots in accordance with the ROM and the color decoder.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawing, forming a part of the specification, wherein:

The figure is a block diagram of a preferred embodiment of the video display system in accordance with the present invention.

The data color display system is designed for displaying recorded digital data. FIG. **1** shows the preferred video display **1** with four fields **2** where each field has four character lines **3** each having 20 character spaces **4**. The data input **5** can be any digital data source in the appropriate format. Typical sources are a keyboard, punch cards, punch tape, or magnetic tape with compatible transducers.

The digital data stream for the preferred embodiment are seven bit ASCII code words. While all the sub-systems can be modified to process the eight-bit ASCII code, the number of different codes used here only requires a seven-bit code.

The data from the data input **5** enters the main memory **6** on line 100 and the data is stored in five fields, A, B, C, D, and E, each consisting of 80 character spaces. Memory field selector **7** permits the operator to select the fields for visual display. The operator can choose any or all of fields A, B, and C and one of fields D and E. In practice, field A would be the most recent data input from a keyboard, field B would be data from the keyboard that has been reviewed and

sent to a magnetic tape recording, field C would be the description of the data the operator is to input such as employee name, hourly rate, etc., and field D would be the machine instructions such as capitals, space, etc., so that the operator is relieved from these functions. This invention is particularly directed to color display of the data.

In order to facilitate the technical description, the flow of data for the display of only one field **2** will be given since the description is applicable to each field.

The digital data in the main memory **6** is stored in circulating shift registers. There is an 80 word (eight bits per word) circulating shift register for each of the four fields. The recirculating frequency of the main memory **6** is a multiple of the raster line frequency of the video display **1** and is supplied by the timing signal generator **9** on line 130.

The eight character words of a field are treated as four equal groups of 20 words. Each group corresponds to a character display line **3**.

Selection of the field **2** to be displayed is made by the operator and results in the memory field selector **7** sending command signals on line 105 to the main memory **6**. The main memory **6** responds by sending the selected field **2** data on line 110 to the memory field selector **7** where the data flow leaves on line 115 and enters the character shift register **8**.

The flow of data from the main memory **6** through the memory field selector **7** to the character shift register **8** as with the flow of data through the remainder of the system must be synchronized to the various subsystems and, of course, the raster of the video display **1**.

A raster line signal from the timing signal generator **9** goes to the character shift register **8** on line 195, the line counter and control **10** on line 135 and to the video blanking **11** on line 140. The function of the line counter and control **10** is to supply raster line information to the character control **15** on line 145 so that the character control **15** can supply various signals, which will be described to synchronize the flow of data. The line counter and control **10** counts the seven raster lines needed to generate one character display line **3**. The video blanking **11** input on line 150 to the line counter and control **10** and on line 160 to the character control **15** controls the formation of vertical margins on the video display **1** through the proper timing and delay of synchronizing signals from the timing generator **9** on line 155.

The character control **15** sends a control signal on line 120 to the memory field selector **7** and sends a load signal on line 125 to the character shift register **8** in order to facilitate the transfer of the field **2** data into the character shift register **8**. The data transfer is for one character line **3** at a time. That is, a group of twenty characters at a time. This transfer must be coordinated with the display of the last character line **3**. The clock signal for the transfer of the group of 20 characters comes from the video generator **12** on line 170 since the video generator **12** has the best information on the flow of data to the video display **1** due to the fact that they are directly coupled. The slow load command on line 175 from the character control **15** to the video generator **12** initiates the clock signal for the transfer of the group of 20 characters into the character shift register **8**.

After the 20 character group is transferred to the character shift register **8**, the video generator **12** supplies a fast clock signal on line 170 to the character shift register **8** for the circulation of the data. A command signal on line 175 from the character control **15** to the video generator **12** initiates the fast clock signal for the circulation of the data group in the character shift register **8**. The video generator **12** supplies the fast clock signal in order to coordinate the circulation of the digital data in the character shift register **8** to the flow of data to the video display **1**. The character control **15** supplies a 5 MHz gate signal on line 235 to the video generator so as to form margins on the video display **1**.

The group of data in the circulating shift register **8** is stored and used to address the read only memory (ROM) **13** and the color decoder **14**.

The ROM **13** comprises a five bit by seven bit memory matrix for each of the possible characters which can be displayed. The "hard" wiring of the "one's" and "zero's" of each of the matrices correlates to the dot array in a character space **4** and determines the shape of the character corresponding to each of the respective matrices. The "one's" correspond to the dots which form the character whereas the "zero's" correspond to the background of the character.

The ROM **13** is addressed by nine bits: six bits from the character shift register **8** on line 180 and three bits from the character control **15** on line 185 . Even though the character words contain seven bits, the ROM **13** is only responsive to the six bits in the character word which define the character. The seventh bit comprises information which specifies a color for either a character or a character background. The three bits from the character control **15** selects which of the seven lines of the character matrices will be read out.

The first time the group of 20 characters in the character shift register **8** addresses the ROM **13** the input from the character control **15** on line **185** results in the top five bits on the respective matrices being read out in parallel. The parallel five bits to on line 190 into the video generator **12** which also has an input on line 200 from the color decoder **14**. The top line of each of the twenty characters is read out and transformed into a serial bit stream to form the first of the seven raster lines which defines a character line **3**.

The 20 characters in the character shift register **8** recirculates and addresses the ROM **13** again but this time the line counter and control **10** has sent a signal to the character control **15** indicating that the next line of the character matrices in the ROM **13** should be read this time. The character control **15** then sends a three-bit code to the ROM **13** on line 185 addressing the second line of all the matrices. Again, parallel five bits are read from each addressed matrix and are transformed into a serial video bit stream by the video generator **12** in conformance with an input on line 200 from the color decoder **14** so as to form the second raster line of the character line **3**.

This process of recirculating the 20 characters in the character shift register **8**, addressing the ROM **13** and generating a serial bit stream in the video generator **12** is repeated until the seven raster lines which form a character display line **3** has been generated.

In color mode A, eight character colors and eight character background colors are selected by the use of ASCII codes corresponding to lower case alphabet letters not otherwise used. The color codes each have seven bits and occupy a word space just as a character code would. The video display **1** will have a blank character space **4** which corresponds to the location of the color code.

The character shift register **8** addresses the color codes to the color decoder **14** through line **210**. The color decoder **14** processes the color codes and sends data on line 200 to the video generator **12**. If color words for both the character and character background have been entered, then the data on line 200 into the video generator **12** will result in color outputs on lines 215, 220, and 225 specifying colors corresponding to the color codes. A color code for the color of characters corresponds to the selected color being associated with the "one's" read out of the ROM **13**. Similarly, the color code for character background corresponds to "zero's" out of ROM **13**. The color decoder **14** logic for the color data is set by the color codes and is maintained until the end of a twenty word group. Feedback from the video Generator **12** on line 205 to the color decoder **14** synchronizes the flow of the data on line 200 to the data on line 190.

The output of the video generator **12** appears as black and white at terminal **230**, red on line 215, green on line 220, and blue on line 225. Lines 215, 200, and 225 go to the video display **1** while the signal at terminal **230** is available for a simultaneous display on a black and white monitor.

In color mode B, the colors for characters are predetermined so that a special color code is not required. The character background for this mode is black. All twenty character spaces **4** are available for characters in this mode.

In mode B, the character shift register **8** addresses all the characters to both the ROM **13** and the color decoder **14** on lines 180 and 210, respectively. The color decoder **14** processes the six and seventh bits of a character word and generates color data on line 200. The four colors used in this mode corresponding to the ASCII codes for the following categories: lower case letters, upper case letters, communications characters, and numerals and punctuation. The lower case letters and communications characters are not displayed as such but are the ordinary capital letters with the color used to indicate the category. Then, only six bits of the character word are needed to identify the character. The video generator **12** is synchronized to the color decoder **14** through feedback on line 205. The signals from the color decoder **14** on line 200 to the video generator **12** result in color signals being generated for the "one's" from the ROM **13** the same as for mode A. The "zero's" from the ROM **13** result in a black character background.

As with mode A, the mode B video generator **12** outputs to the video display **1** on lines 215, 220, and 225 are red, green, and blue, respectively, while the signal at terminal **230** is available for a simultaneous display on a black and white monitor.

For both modes A and B, the completion of the processing of a 20-word group must initiate the transfer of the next group until all 80 characters of the field **2** has been displayed. The line counter and control **12** counts the number of raster lines needed for the first character line **3** and a predetermined number of raster lines to be left blank and this information goes to the character control **15** on line 145. The character control **15** sends out a load command signal on line 175 to the video generator **12** which sends a slow clock signal on line 210 to the character shift register **8** which then receives the next 20 characters from the main memory **6**. The data is then processed as described above.

Where the video display **1** is remotely located, it is possible to translate the output video signals from the video generator **12**, transmit the higher frequency, receive the transmitted signal, translate the frequency back to video and then input the video signal to a video display. The process here is similar to the ordinary transmission of color television signals except of a modified commercial color television receiver is used. The modification is made in the video portion of the receiver. The process for transmitting the color information is the same for both modes A and B.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. Apparatus for displaying characters in color comprising,

buffer main memory means for receiving digital data signals representative of characters and at least the color in which said characters are to be displayed,

a data input source of groups of digital data signals with the first digital signal in each group being representative of at least the character color in which the characters represented by the remaining digital signals in the group are to be displayed,

a character shift register means for receiving said groups of digital signals,

means for coupling said data input source to said main memory means,

means for coupling said main memory means to said character shift register,

a color display means having a raster scan for displaying said characters on a sequence of lines sequentially scanned,

raster line counter means for providing a count signal representative of the line then being scanned on said color display means,

read only memory means responsive to the portion of digital input signals provided by said character shift register means representative of said characters for providing decoded output signals identifying the form of the characters decoded thereby on the raster line then being scanned,

timing generator means for providing low and high frequency timing signals to synchronize the flow of digital data from said main memory means to said character shift register means and from the latter to said read only memory means with the display of said characters on said color display means,

means for coupling said timing signals to said main memory means, said character shift register means, said raster line counter means and said color display means for synchronizing said flow,

color decoding means coupled to said character shift register means and responsive to each first digital signal for selecting the color to be displayed and providing at least a character color signal representative of said character color,

and means responsive to said character color signal and said decoded output signals for coupling the latter signals to said color display means to display the characters in each group in the associated character color.

2. Apparatus for displaying characters in color in accordance with claim **1** wherein said first digital signal is also representative of the background color upon which said characters represented by the remaining digital signals in the group are to be displayed,

said color decoding means also includes means for selecting said background color for providing a background color signal representative thereof and further comprising,

means responsive to said background color signal for coupling the latter signal to said color display means to display the characters in each group against the associated background color.

3. Apparatus for displaying characters in color in accordance with claim **2** and further comprising,

mode selecting means for operating said apparatus in a first mode wherein means responsive to said first digital signal selects said character and background colors and in a second mode means responsive to the type of character to be displayed selects the character color which is related only to the type of character being displayed.

4. Apparatus for displaying characters in color comprising,

a data input source of groups of digital data signals with the first digital signal in each group being representative of at least the character color in which the characters represented by the remaining digital signals in the group are to be displayed,

a color display means having a raster scan for displaying said characters on a sequence of lines sequentially scanned,

means responsive to said remaining digital signals for providing decoded output signals identifying the form of the characters decoded thereby on the raster line then being scanned on said color display means,

color decoding means responsive to each first digital signal for selecting the color to be displayed and providing at least a character color signal representative of said character color,

and means responsive to said character color signal and said decoded output signals for coupling the latter signals to said color display means to display the characters in each group in the associated character color.

5. Apparatus for displaying characters in color in accordance with claim **4** wherein said first digital signal is also representative of the background color upon which said characters represented by the remaining digital signals in the group are to be displayed,

said color decoding means also includes means for selecting said background color for providing a background color signal representative thereof and further comprising,

means responsive to said background color signal for coupling the latter signal to said color display means to display the characters in each group against the associated background color.

6. Apparatus for displaying characters in color in accordance with claim **5** and further comprising,

mode selecting means for operating said apparatus in a first mode wherein means responsive to said first digital signal selects said character and background colors and in a second mode means responsive to the type of character to be displayed selects the character color which is related only to the type of character being displayed.

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