

[54] **DISPLAY SYSTEM**[75] Inventor: **Lorenz A. Hittel**, Scottsdale, Ariz.[73] Assignee: **Courier Terminal Systems, Inc.**,
Phoenix, Ariz.[22] Filed: **Feb. 12, 1973**[21] Appl. No.: **331,768****Related U.S. Application Data**[63] Continuation of Ser. No. 115,641, Feb. 16, 1971,
abandoned.[52] U.S. Cl. **340/324 AD**, 178/7.5 D, 315/22,
340/172.5[51] Int. Cl. **G06f 3/14**

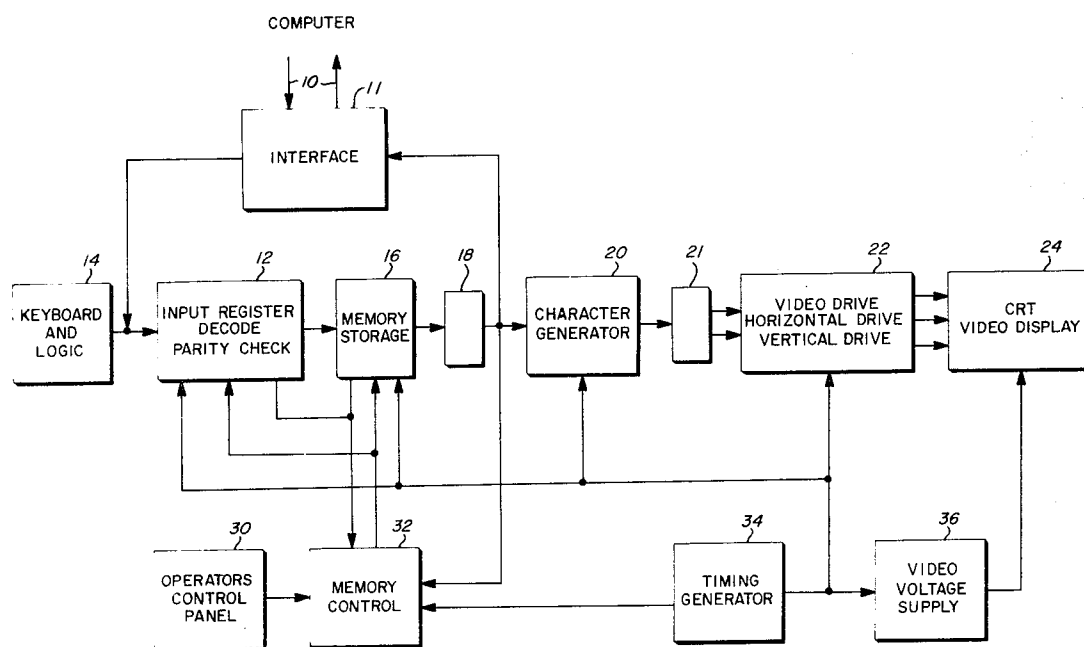
[58] Field of Search..... 340/324 AD, 172.5; 315/22

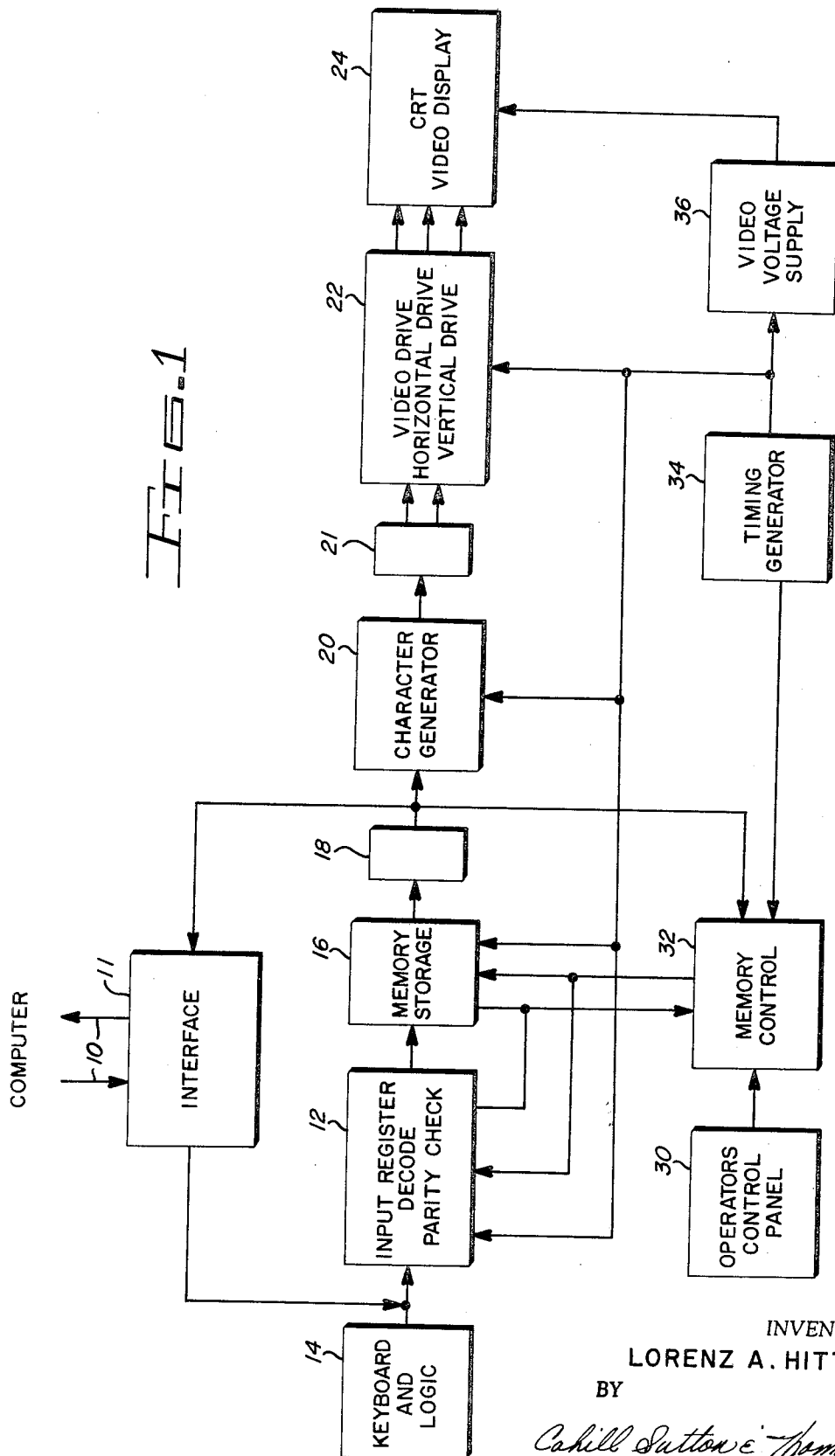
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Primary Examiner—David L. Trafton*Attorney, Agent, or Firm*—Cahill, Sutton & Thomas[57] **ABSTRACT**

A display system primarily for utilization as a remote terminal device in a computer system, incorporating a single recirculating store. The store incorporates a recirculating register that stores the entire message to be displayed on a cathode ray tube; the register operates at a predetermined first frequency and a character generator is utilized to continuously read the encoded characters recirculating in the store and develop video signals therefrom. The beam of the cathode ray tube, under the control of a timing generator, sweeps the first scan line of each row of characters to be displayed, then sweeps the second scan line of each row and so on until all of the scan lines of each row of characters has been scanned and the message has been displayed. No scanning takes place between the character rows. During the sweep of the beam along a scan line, the recirculating register operates at the predetermined first frequency; however, upon the completion of each scan line and until the sweep of the next scan line, the recirculating register operates at a second predetermined but lower frequency.

2 Claims, 5 Drawing Figures



INVENTOR.

LORENZ A. HITTEL

BY

Cahill Sutton & Thomas

ATTORNEYS

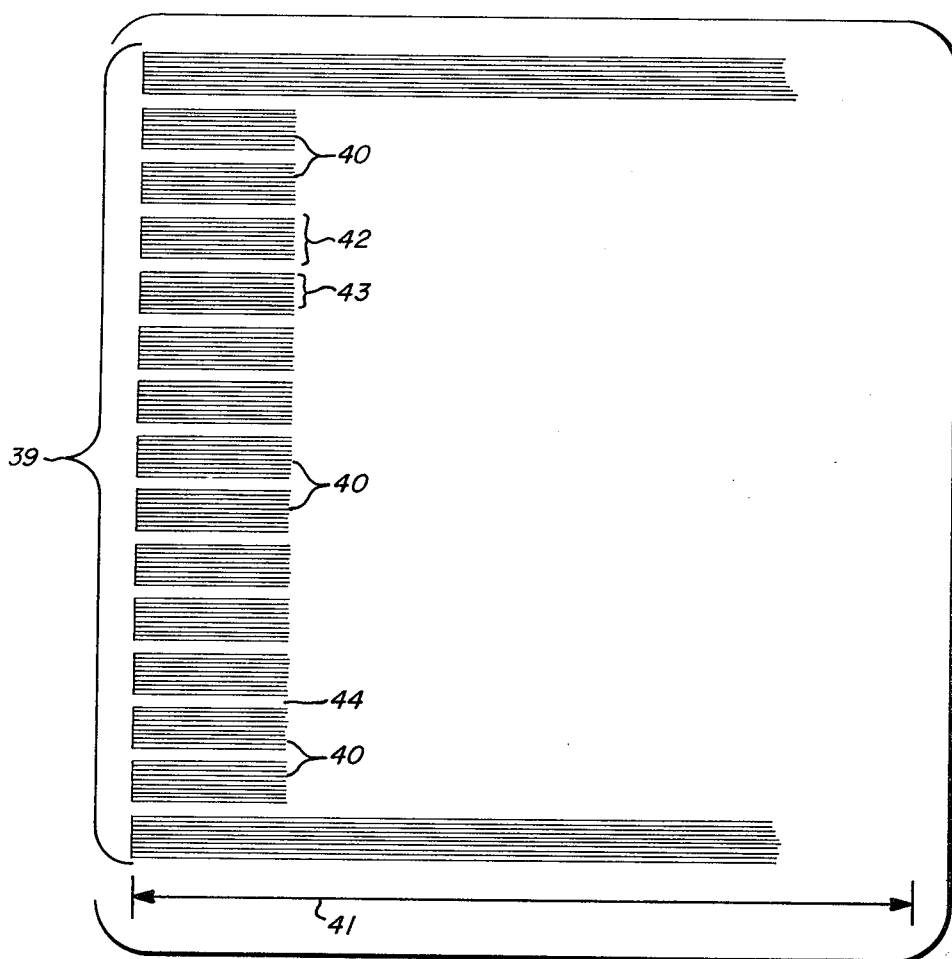


FIG. 2

INVENTOR

LORENZ A. HITTEL

BY

Cahill Sutton & Thomas
ATTORNEYS

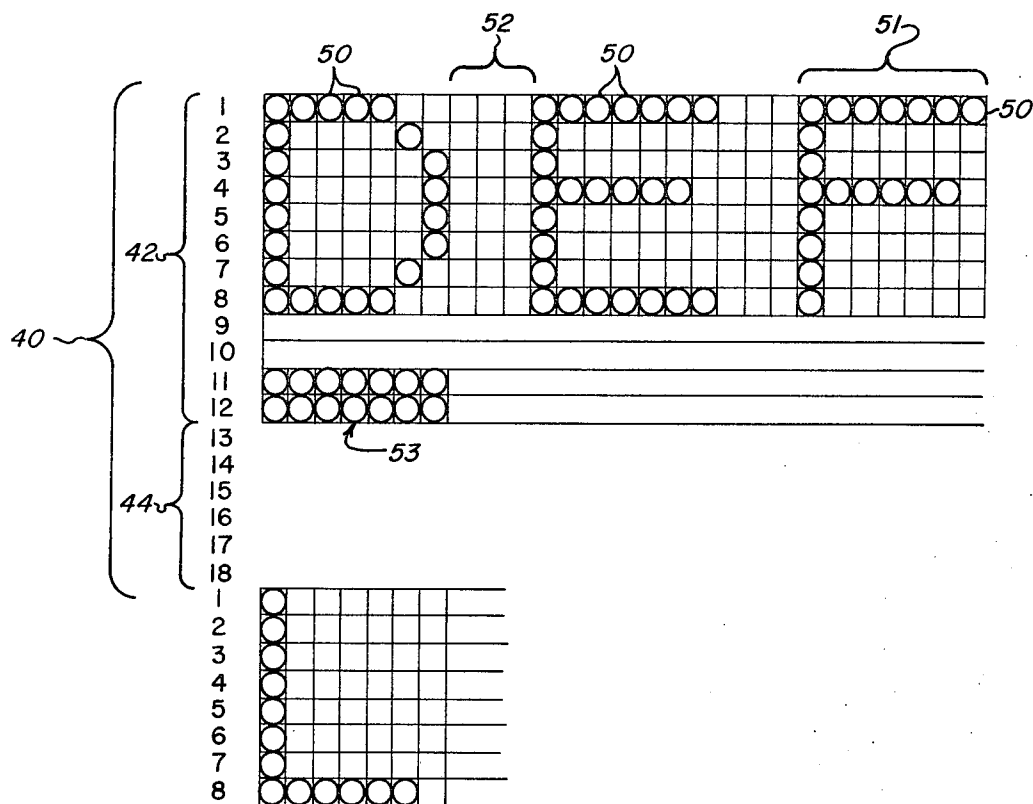


FIG. 3

INVENTOR.

LORENZ A. HITTEL

BY

Cahill Sutton & Thomas

ATTORNEYS

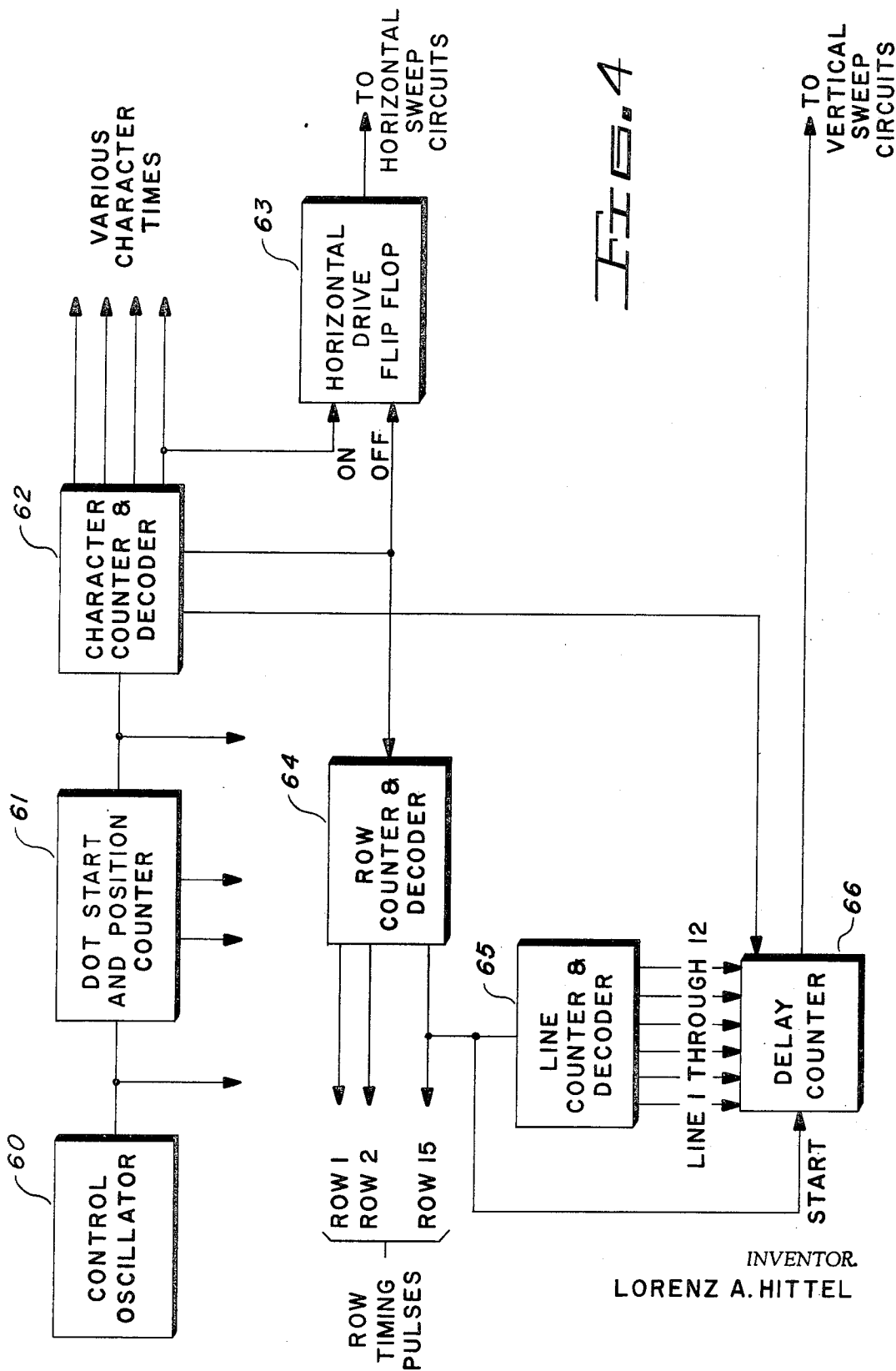
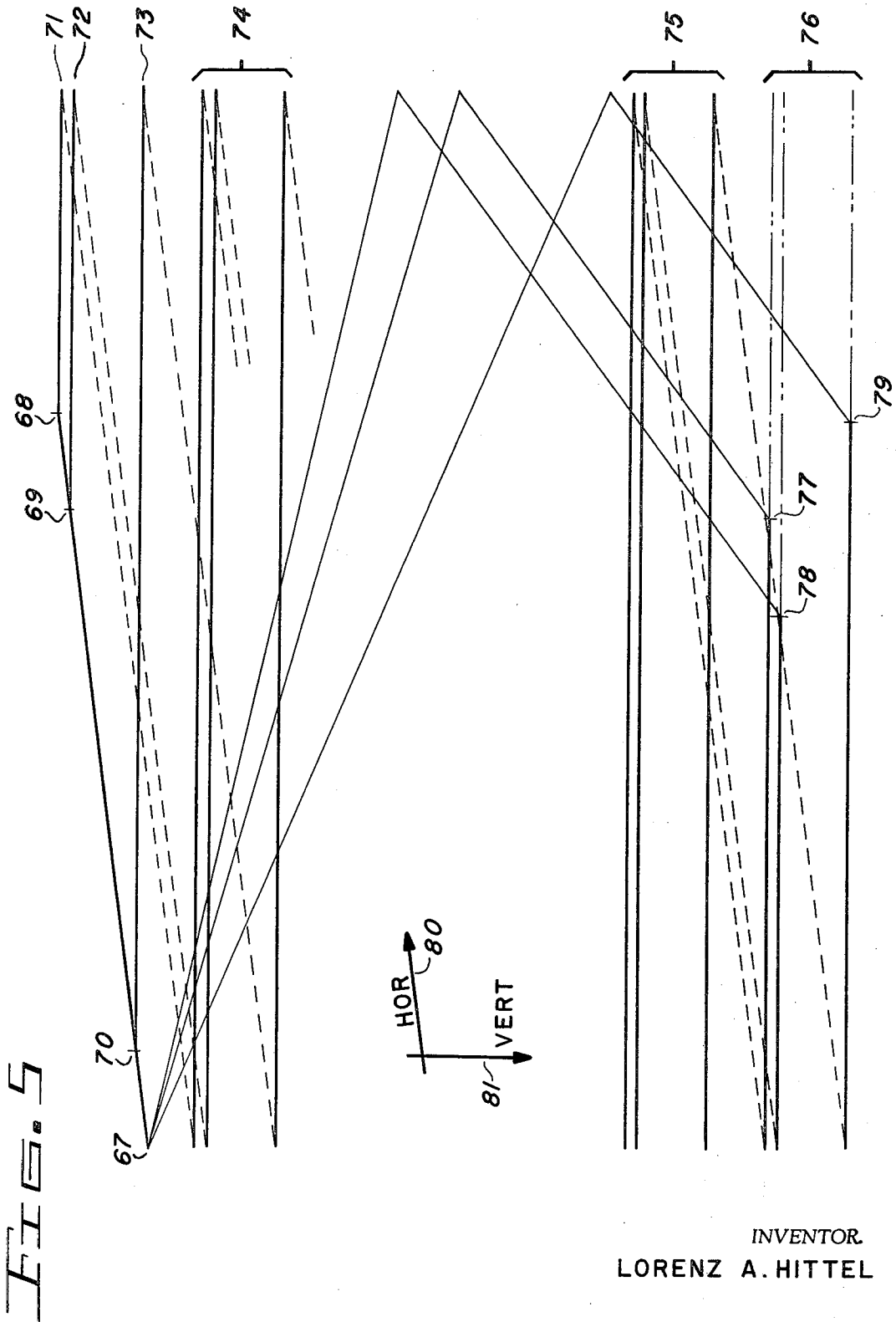


FIG. 4

INVENTOR
LORENZ A. HITTEL



INVENTOR
LORENZ A. HITTEL

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DISPLAY SYSTEM

This application is a continuation of my co-pending application Ser. No. 115,641, filed Feb. 16, 1971, entitled "Display System," now abandoned.

The present invention pertains to display systems, and more particularly, to cathode ray tube display systems useful for operation as remote terminals of computer systems.

The utilization of a cathode ray tube in combination with a keyboard and communication lines to a computer system to form a remote terminal and read out is well known. Typically, information encoded by manipulation of a keyboard and transmitted via communication or other transmission lines is utilized to gain access to the memory banks of a data processing system for ascertaining the status of a particular address in the computer memory and/or up-dating the stored information. By utilizing the proper control words generated at a remote keyboard, access may be gained, for example, to the status of a commercial account which, in turn, is stored at a remote location in the memory banks of a data processing system. The information thus addressed is retransmitted with appropriate control characters, in bit-serial fashion, through their communication or transmission lines back to the remote terminal. This information is then displayed on a cathode ray tube. The information may be altered by the operator at the keyboard and the up-dated information retransmitted to the remote computer memory banks.

The implementation of cathode ray tube (CRT) techniques in combination with encoded bit-serial binary transmitted information gives rise to several problems. The information received must obviously be stored in some fashion to permit the form of the information to be altered so that it will be compatible with the CRT system. Prior art terminals provide a memory in the remote terminal to receive and store a message transmitted from the remote computer. The entire message, stored in the terminal memory, is then retrieved a line at a time and placed into a recirculating device, such as a delay line. The contents of the delay line are then utilized for the generation of video signals to permit the CRT beam to sweep a sufficient number of scan lines to produce a row of characters across the face of the CRT. Upon completion of the generation of a row of characters, the contents of the delay line are replaced in the memory and a second row of information is retrieved from the memory and placed in the delay line.

This typical prior art system utilizes conventional video raster scan techniques. Under this prior system, complex buffering between the temporary recirculating line store and memory is required and the information transfer in the system is limited since the recirculating line store must recirculate at a frequency which will permit the CRT beam, operating in synchronism with the recirculating store, to successively sweep the scan lines of the first row of characters before the beam may begin the generation of succeeding rows of the message to be displayed.

The utilization, in prior art systems, of conventional CRT raster scanning methods offers the advantage of the availability of mass-produced television elements; however, this conventional raster system exhibits many disadvantages when it is used in a remote terminal dis-

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play. As described above, the recirculating row store must be used to refresh the image on the CRT screen at a rate faster than human visual response; if high quality characters are to be displayed, the vertical resolution available with standard television raster scan systems dictates that either additional buffering is required or the terminal memory must be a random access memory. Also as described above, the usual solution is to utilize one large memory in combination with a smaller recirculating memory which, in turn, is synchronized with the horizontal scan on the screen of the CRT.

It is therefore an object of the present invention to provide a display system incorporating a CRT and utilizing a single display system store or memory.

It is another object of the present invention to provide a CRT display system incorporating a single memory for storing all of the characters to be displayed on the CRT while continuously recirculating the entire contents of the memory.

It is still another object of the present invention to provide a CRT display system incorporating the combination of a single recirculating memory and a scanning arrangement whereby the entire message to be displayed may be recirculated in the memory.

It is still another object of the present invention to provide a CRT display system incorporating a single memory that continuously recirculates the stored information and wherein the frequency of the recirculation varies in accordance with the position of the CRT beam.

These and other objects of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

The present invention may be described by reference to the accompanying drawings, in which:

FIG. 1 is a block diagram of a display system constructed in accordance with the teachings of the present invention.

FIG. 2 is a diagram of a scanning pattern for a typical CRT display.

FIG. 3 is an enlarged view of a portion of FIG. 2, useful in describing the operation of the system of the present invention.

FIG. 4 is a block diagram of a portion of FIG. 1 in greater detail.

FIG. 5 is a schematic illustration of a CRT beam sweep scheme incorporated in the teachings of the present invention.

Referring now to FIG. 1, communication of transmission lines 10 are connected to an interface module 11 to provide appropriate matching between the characteristics of the display and transmission facilities. The information received is in bit serial form and is applied to an input register 12 so that the transmitted character may be assembled and parity checks performed. The information thus contained in the register 12 may also be checked or decoded to ascertain if the information is control information (and not to be displayed) or a character to ultimately be stored and displayed on the cathode ray tube. Information may thus be applied from a remote computer (not shown) to the input register 12; alternatively, information may be supplied to the input register 12 from a keyboard 14. The keyboard may be used to interrogate the remote computer, to place information into the display device for subsequent transmittal to the computer, or to alter or up-

date displayed information received from the computer.

The characters are subsequently transferred from the input register 12 to memory 16. The memory 16 contains all of the characters or information to be displayed by the system and continuously recirculates this information. Unlike prior art display memories, all rows of information continually recirculate at a predetermined first recirculation frequency. The memory comprises a recirculating register of the type commonly known as "metal-oxide-semiconductor integrated shift registers." This shift register continuously recirculates the stored information contained therein at a preselected first recirculating frequency; however, the frequency of recirculation may be changed, provided the frequency does not go below a minimum frequency determined by the register design. In the memory 16, the recirculating register is chosen to recirculate at a frequency in synchronism with the video system of the CRT display, as will be described more fully hereinafter; however, during a portion of the time in operation, the memory 16 will be operated at a lower frequency. Shift registers of the type suitable for use in the system of the present invention are described in the literature and may be found, for example, in *Electronic Design*, March 1, 1969, Volume 17, No. 5, "MOS Delay Lines."

As the characters recirculate in the memory 16, they are sequentially provided to a character register 18 which, in turn, presents the digitally encoded character to a character generator 20 that will generate an appropriate seven bit code for application to register 21, depending on the scan line sweeping the character position at that instant. The register 21 contains the necessary information for the cathode ray tube control 22 to thus generate appropriate dots on the screen of the CRT video display 24. The CRT control includes the video drive, horizontal and vertical drives necessary for the generation of the display.

An operator's control panel 30 is provided to permit appropriate housekeeping, diagnostic, and special functions to be implemented. A memory control 32 provides the necessary logic to control the recirculating memory 16 while a timing generator 34 controls the overall synchronism of the entire system. The timing generator 34 will include a control oscillator and digital counters for appropriately timing the sweeping of the CRT beam as well as the overall timing control of the display system, as will be discussed more fully hereinafter. A video voltage supply 36 is connected to the video display 24 to accommodate the necessary high voltages required by the display system.

Referring now to FIG. 2, in the embodiment chosen for illustration, a typical display is shown incorporating fifteen rows 40 of characters, each row being of a length 41 sufficient to make available forty character positions. Each row 40 comprises 12 scan lines, as indicated at 42, while only the top eight scan lines, as indicated at 43, are provided for the generation of characters. A vacant space 44 equal to six scan lines is provided between each of the rows 40. An enlarged view of one of the rows 40 may be seen by reference to FIG. 3.

Referring to FIG. 3, the row 42 is shown incorporating twelve scan lines numbered 1 - 12, with the first eight reserved for the generation of characters. In the illustration of FIG. 3, characters DEF and L are shown.

It may be seen that the characters are formed by a plurality of dots 50, each occupying a dot space; each character is allotted an area equal to seven dot spaces 51 in width and eight scan lines in height. An inter character space 52 is provided and is equal to three dot spaces. Thus, scan lines 1 - 8 are utilized for the generation of characters, while scan lines 9 and 10 provide a vertical space between the characters generated in scan lines 1 - 8 and scan lines 11 and 12, which are reserved for an underscore or cursor 53. The cursor is provided on the display and is positionable through the keyboard to indicate the "active" character position, which character position is either being written into or being changed. The vacant space 44 (equivalent to six scan lines 13 - 18, although no scan lines are actually present or used) provide the inner-row space and are followed thereafter by the next succeeding scan line of the following row.

The information contained in the memory 16 is continuously displayed on the CRT video display 24. As each character is presented to the character register 21, the character generator will detect the dot spaces in the first scan line containing dots and will enable the CRT control to energize the beam at its positions. Thus, during the first sweep of the first scan line of the first row, the dots shown in FIG. 3 across the top of the characters "DEF" will be displayed. During the sweep of the CRT beam along scan line 1, the memory recirculates at a frequency synchronized with the CRT beam. Upon completion of the sweep of scan line 1, and during the CRT beam retrace, the recirculation frequency of the memory 16 is reduced through the memory control 32 by the timing generator 34, such that when the beam is ready for its next scan line sweep, the next character to be displayed is present in the character register 21. It may be noted that although the CRT beam has only completed the sweep of scan line 1 of the first row, the character just having been contained in the character register has been replaced by the next character in the next row (rather than waiting for all of the scan lines of a particular row to be completed). The timing generator 34 positions the CRT beam to sweep the first scan line of the second row rather than the second scan line of the first row.

Referring now to FIG. 4, the timing generator is shown in greater detail. The control oscillator 60 is a conventional crystal control oscillator providing an 8.5 megahertz timing pulse. This signal supplied is a master clock to much of the display control logic and also drives a dot start and position counter 61. The dot counter times the output from the character generator 20 to the video drive 22. Again the dot start position counter provides a master character time pulse used extensively in the general control logic. It also feeds a character counter and decoder 62 which counts the number of characters in each row supplying the necessary row start and stop times to the memory control 32. In the implementation shown, a predetermined character time is used to turn on a horizontal drive flip-flop 63 which operates a standard television horizontal sweep circuit. Another predetermined character time is used to reset the flip-flop and to drive a row counter and decoder 64. The row counter and decoder provides discrete row time pulses to the memory control as well as to the line counter and decoder 65. The line counter and decoder provides decoded line location identification to the character generator 20 as well as control

signals to the delay counter 66. The delay counter is used to develop a vertical start delay inversely proportional to the line count. This method is one of many possible schemes which could be used to provide the within described scanning scheme. As the line count is increased by one at the end of the last row, the delay counter 66 is started and provides an output pulse that is used to trigger the start of the vertical sweep period. The vertical sweep circuitry is similar to that used by the television industry.

The delay counter 66 receives information concerning the new line to be scanned in binary coded form from 65. At the end of the last row being displayed, this binary coded information is placed into 66 and 66 starts counting, using timing pulses derived from 62. When the count reaches a predetermined number, the delay counter 66 is reset to zero and a timing pulse is sent to the vertical sweep circuits to initiate the start of the vertical retrace period. Similarly, the same procedure is reinitiated after the beam reaches the top of the screen in order to initiate the vertical movement downward of the CRT beam for the scanning of the next line of all rows. Thus, it can be seen that the resulting delay between the start of the horizontal sweep and the start of the vertical sweep will cause the displacement of the horizontal scan line in a manner necessary to provide the twelve scan lines used within the scanning procedure described herein.

Implementation of the present scanning scheme may be more readily understood by reference to FIG. 5. In starting a new picture, assume that the beam starts sweeping in the horizontal direction past 67, past 70, past 69, and at 68 the vertical sweep was initiated. The beam starts moving downward in such a manner as to sweep from 68 to 71. It should be noted that the horizontal sweep direction 80 is adjusted with respect to the vertical direction 81 to cause the beam to sweep slightly upward. When both horizontal and vertical sweep voltages are simultaneously applied, a true horizontal direction results. At 71, one horizontal sweep is completed and horizontal retrace occurs bringing the beam back and down to line 1 of row 74. It should be noted that 74 would be the first displayable row of characters. In like manner, the beam sweeps the top line of each row of characters until it reaches the last row of the displayable characters 75. When the first line retraces its position from the last displayable row 75, the beam proceeds along the top line of the 76th row until it reaches the point at which vertical retrace begins, noted by 77. At this point, the beam moves back up the screen to point 67, proceeding up the line from 67 to 69. At 69, the vertical sweep again starts. The vertical sweep starts the beam moving downward at 69. At 72 one horizontal sweep for the second line is completed. The beam moves to a position down and to the left of the screen to start the sweep of line 2 of the first displayable row, 74. Line 2 of each successive row is swept in succession through the last displayable row, 75, and onward to 76. The beam sweeps along row 76 until vertical retrace starts at 78, and the beam moves upward again to 67 at the top of the screen. The third line would be positioned by starting the vertical sweep at a point somewhat before 69. This procedure is repeated for each successive line until the last line is completed. The last line is shown completing at 79 where vertical retrace begins moving the beam upward to 67. This time vertical sweep is not applied until the

horizontal beam reaches 68, starting the display of a new line 1. Note that each time a new line position is to be swept, the vertical sweep is stopped and started at successively earlier periods until the last line is completed.

Thus, the beam sweeps the first scan line of each succeeding row until all the first scan lines of all the rows have been scanned, whereupon the second scan line of each succeeding row is scanned. By scanning the character rows "in parallel" (i.e., scan line 1, row 1, scan line 1, row 2, etc., then scan line 2, row 1, scan line 2, row 2— until all scan lines of all rows have been scanned — no inter-row space is scanned) rather than completing a character row before proceeding to the next character row, the recirculation frequency of the memory 16 is substantially higher, even though it is synchronized with the CRT beam sweep. The utilization of the higher recirculating frequency permits considerably higher communications rates without the addition of complex buffering and also permits the utilization of dynamic MOS shift registers of the type described above. Further, only a single memory is utilized to store the entire message to be displayed upon the CRT screen and no supplementary or auxiliary memory is required for the recirculation of a character row.

The circuitry or specific logic incorporated in each of the schematic blocks of FIG. 1 may be conventional and may be formed in accordance with well-known and readily available techniques. For example, the CRT control 22, CRT video display 24, and video voltage supply 36 may be formed of conventional components readily available on the market, while the interface 11 may be conventional interface designs tailored to meet the requirements of the communications or transmission system to which the present display system is to be connected. The keyboard 14, the input register 12, and the operator's control panel 30 may vary widely and may taken the form of commercially available equipment. The utilization of a single memory for recirculating the entire message to be displayed coupled with variable recirculation frequency and the scanning of scan lines from successive character rows without scanning between the character rows enables the system of the present invention to provide high communication rate capabilities, and high resolution display, while greatly reducing the cost of the system over a comparable performing prior art display system.

I claim:

1. In a CRT display system for displaying information, said information comprising one or more rows of characters formed by generating dots on the CRT while sweeping a plurality of scan lines for each row of characters with the beam of said CRT, said system connected to a transmission line for receipt of bit serial information, the improvement comprising:

- a. an input register for receiving bit serial information and transferring said information in character serial form;
- b. a memory connected to said input register to receive said character serial information, said memory comprising a recirculating register having a first and a second recirculation rate;
- c. a character generator connected to said memory to serially detect characters recirculating in said memory and to successively generate codes in response to each character;

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- d. a CRT control means connected to said character generator for generating dots on said CRT in accordance with said codes during the sweep of said beam along a scan line;
- e. said memory, when operating at said first recirculation rate, serially presenting all characters in a row of characters to the character generator during the time said beam sweeps a single scan line of said row of characters;
- f. said memory, when operating at said second recir-

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ulation rate, presenting no characters to the character generator during the time said beam retraces to the start of another scan line.

2. The combination set forth in claim 1, wherein said CRT control means includes a timing generator for directing said beam to sweep the first scan line of all rows of characters, then the second scan line of all rows of characters, and then the succeeding scan lines of all rows of characters.

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