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Eichelberger et al.

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[54] **PROJECTION STORAGE-DISPLAY SYSTEM HAVING DYNAMIC GRAPHIC CAPABILITY**

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[52] **U.S. Cl.** ..... **340/324 A,** 178/DIG. 31

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

[58] **Field of Search** ..... 340/324 A; 178/7.88, 178/DIG. 31

[56] **References Cited**

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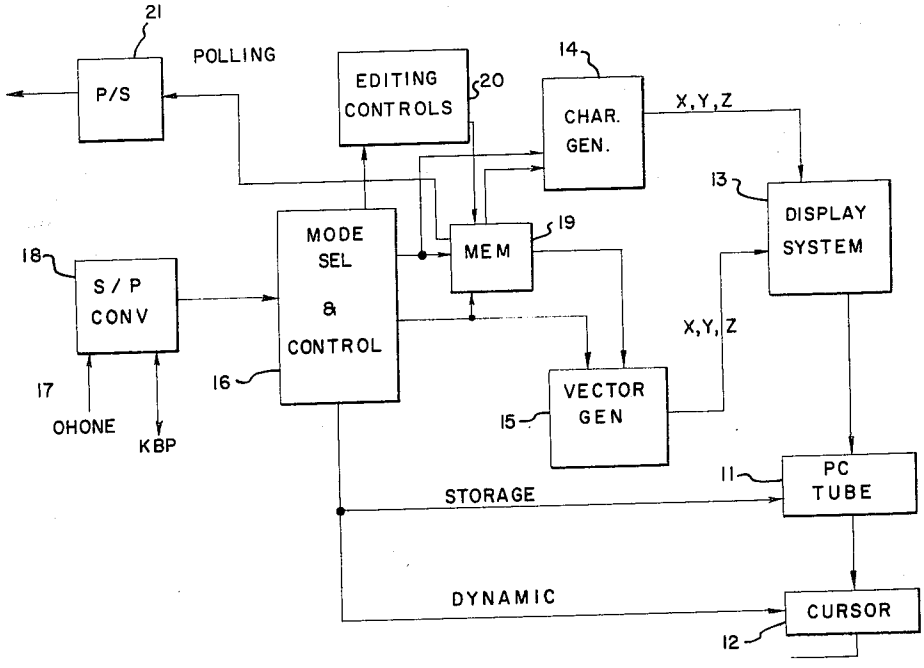
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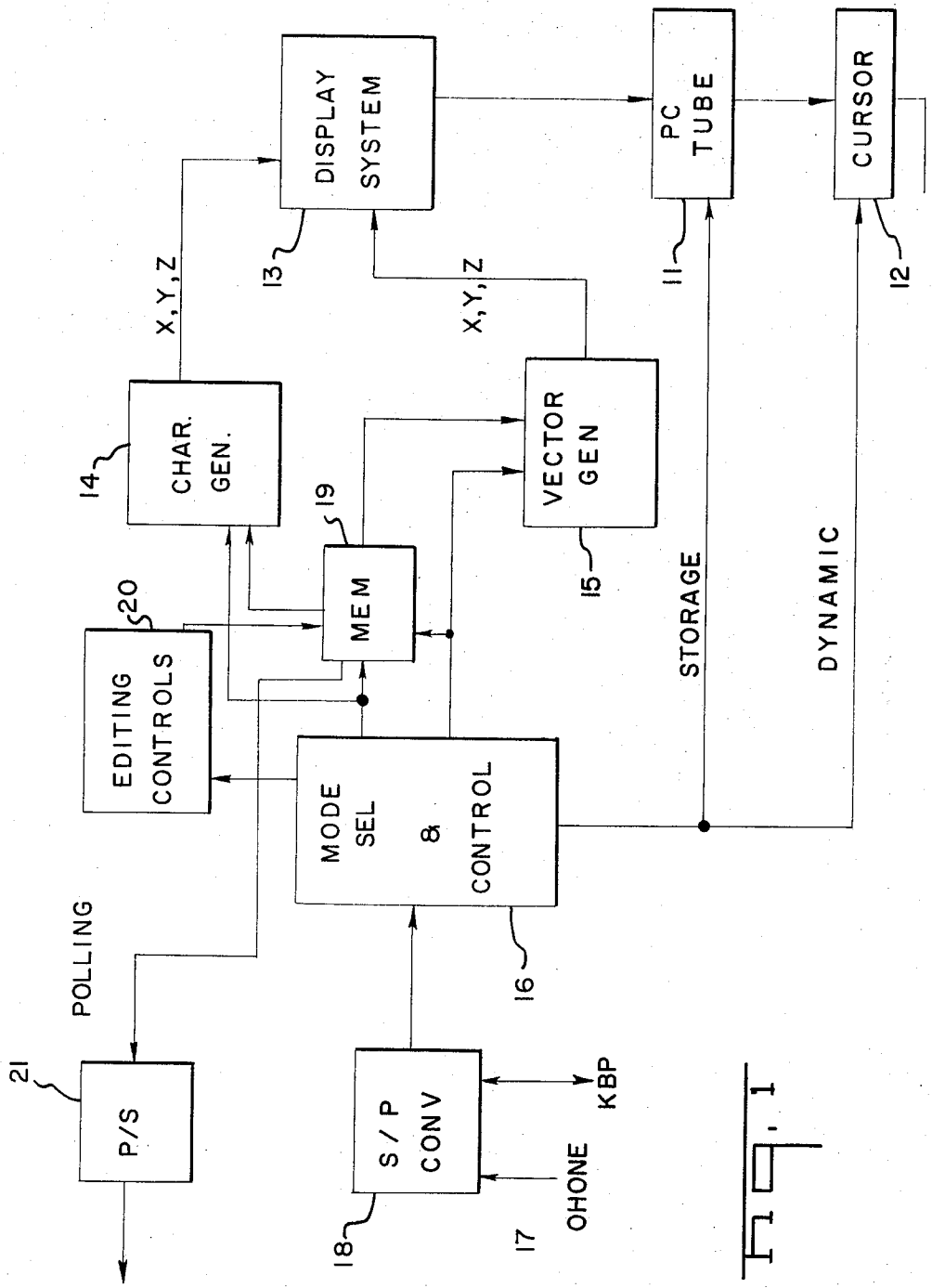
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Attorney—Clarence R. Patty, Jr. et al.

[57] **ABSTRACT**

A visual display system includes a projection type display device. This includes a stored image photochromic type device and a dynamic cathode ray device. The stored image tube is normally used for the display of alpha numerics and vectors in response to digital inputs. The dynamic cathode ray device is normally used to produce a cursor on the display. Dynamic refresh memory for the dynamic cathode ray tube gives this device the capability of selectively erasing, editing and inserting graphic information on the display.

5 Claims, 3 Drawing Figures




DISPLAY SYSTEM
PC TUBE
CURSOR
13
11
12
X,Y,Z
X,Y,Z
CHAR. GEN.
VECTOR GEN
14
19
15
MEM
20
EDITING CONTROLS
STORAGE
DYNAMIC
MODE SEL & CONTROL
16
POLLING
21
P/S
S/P CONV
KBP
OHONE
18
17
1
1

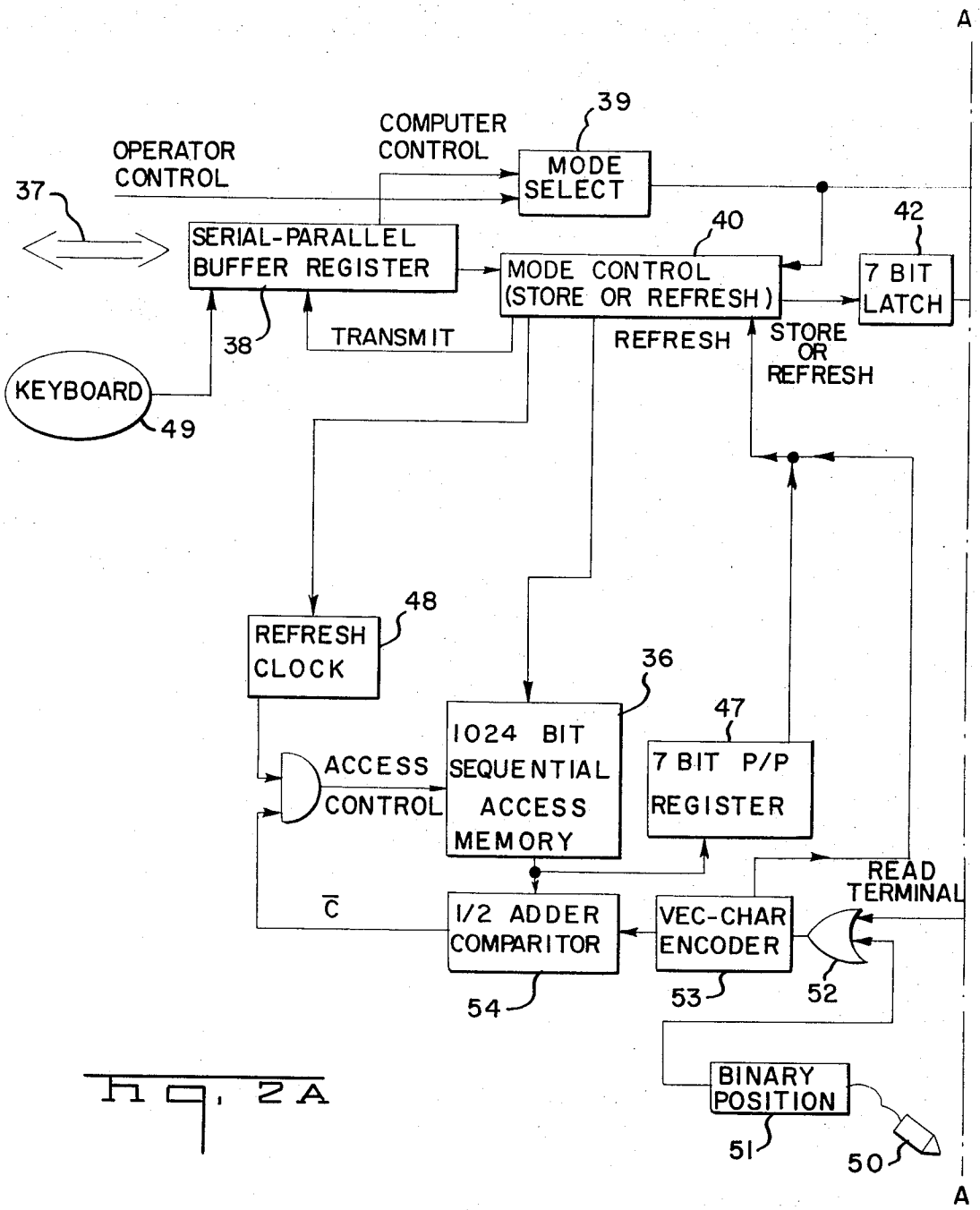

A
39
COMPUTER CONTROL
OPERATOR CONTROL
MODE SELECT
37
SERIAL-PARALLEL BUFFER REGISTER
40
MODE CONTROL (STORE OR REFRESH)
42
7 BIT LATCH
38
TRANSMIT
REFRESH
STORE OR REFRESH
KEYBOARD
49
48
REFRESH CLOCK
36
1024 BIT SEQUENTIAL ACCESS MEMORY
47
7 BIT P/P REGISTER
ACCESS CONTROL
READ TERMINAL
C
1/2 ADDER COMPARITOR
VEC-CHAR ENCODER
54
53
52
BINARY POSITION
51
50
A

Fig. 2A

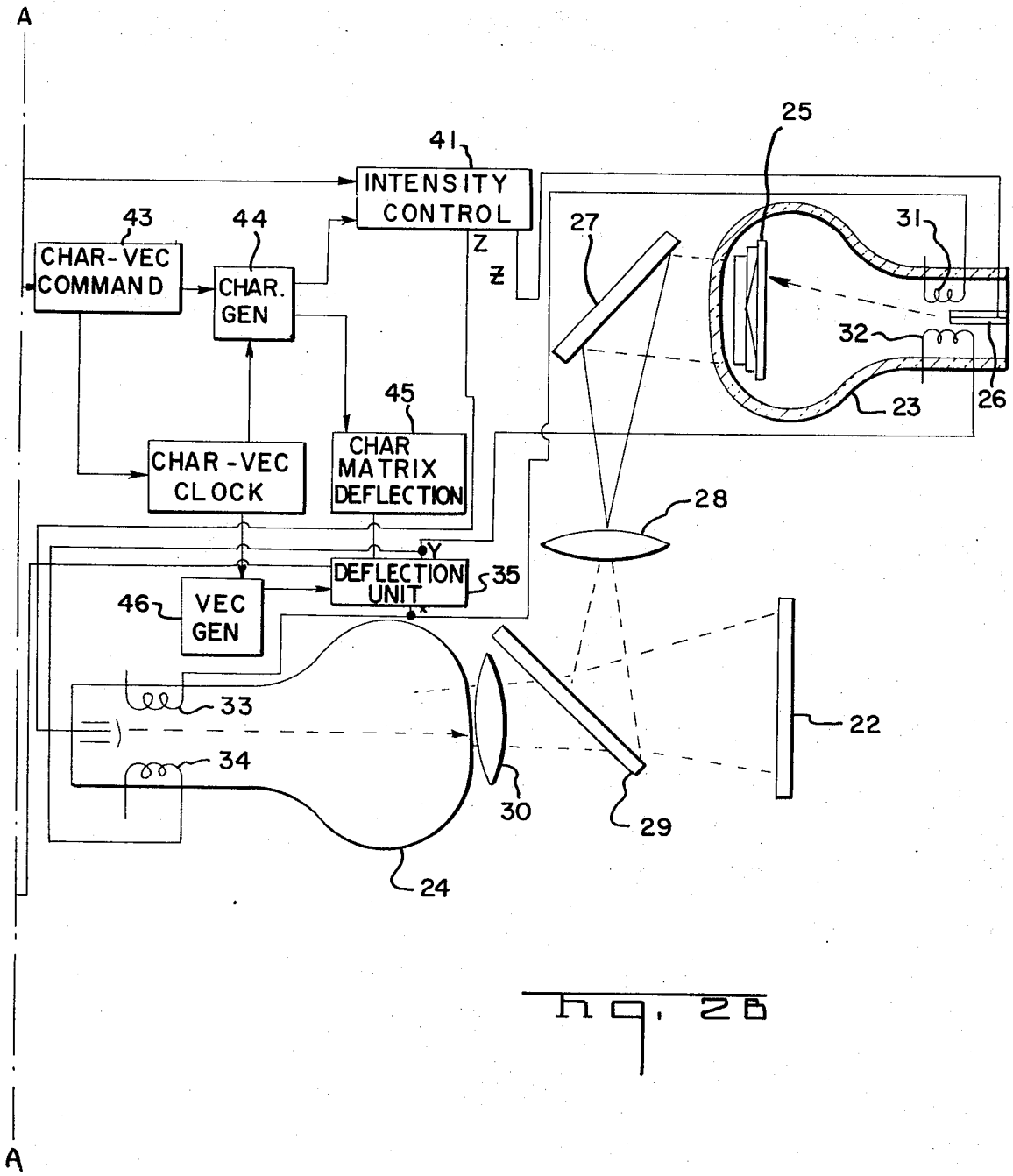

A
41
INTENSITY CONTROL
43
CHAR-VEC COMMAND
44
CHAR. GEN
Z
Z
45
CHAR MATRIX DEFLECTION
CHAR-VEC CLOCK
Y
DEFLECTION UNIT
35
46
VEC GEN
33
34
24
30
29
28
22
25
27
31
32
23
26
A

Fig. 2B

PROJECTION STORAGE-DISPLAY SYSTEM HAVING DYNAMIC GRAPHIC CAPABILITY

BACKGROUND OF THE INVENTION

This invention relates to visual display systems and more particularly to a projection type display system which includes both stored image and dynamic cathode ray devices.

Remote digital computer terminals having a display device for graphically displaying alphanumerics and vectors are widely used. Cathode ray tubes with phosphor display screens have been widely used for this purpose. In such systems there is the requirement for continuously refreshing the display. That is, the image must be recreated and redisplayed at a rate which is commensurate with the persistence of the phosphor so that the image is not degraded. A large amount of electronics and memory capacity is normally required to refresh these dynamic cathode ray tube display devices.

For this reason, attempts have been made to use stored image type display devices which do not require a continuous refresh of the image being displayed. Stored image display devices include electrostatic charge tubes, dark trace tubes, cathodo-chromic tubes and photochromic storage tubes. Photochromic storage tubes have been particularly useful as remote computer terminals. Photochromic display devices suitable for this use are shown in U.S. Pats. Nos. 3,431,048 — Ludovici et al. and 3,428,396 — Megla et al. An example of a commercial computer system using such a display device is the Corning 904 computer terminal.

In stored image systems such as these, display capacity is not limited by dynamic refresh storage capacity; therefore, more information can be displayed for a given cost. However, stored image devices lack one important operating mode that the dynamic refresh devices inherently have. In dynamic refresh systems, selective erasing, editing, inserting and dynamic graphic capabilities are easily implemented whereas these capabilities are not so easily implemented with stored image devices.

Systems using both stored image and dynamic cathode ray devices are in use. The aforementioned Corning 904 system has a dynamic cathode ray tube which is used to produce the cursor on the visual display. A parallel projection system superimposes the cursor upon the visual image produced by the stored image device. The cursor tube in combination with the stored image type tube is described in copending application, Ser. No. 104,244, filed Jan. 6, 1971 Douglas A. Cotter now U.S. Pat. No. 3,715,619. In systems such as the Corning 904 system the only storage at the terminal is the memory of the stored image tube. Because of this, it is necessary to operate such a system with a direct connection to the computer. That is, the terminals are not operated on a time-shared basis with the central computer.

A display system having the capability of generating a stored and a non-stored display is produced by the Tektronix Company as their graphic display system Model No. 4002. In such a system the principal display is produced on a display screen divided into two parts, one part displaying a stored image and the other part displaying a non-stored image. A one line dynamic display is produced in the non-stored area. This one line cannot display vectors. Further, this system does not have the capability for superimposing the two displays one on top of the other so that editing and insertion and deletion can be performed by manipulating the two displays.

RELATED CASES

Application Ser. No. 103,257, filed Dec. 31, 1970, Optimization Of Vector Commands Generation, Wood et al, now abandoned, shows the generation of vector commands at the central computer and the manner in which these vectors are displayed on a display device at a remote terminal.

Application Ser. No. 104,244, filed Jan. 6, 1971 now U.S. Pat. No. 3,715,619, shows a projection type display system which includes both a photochromic stored image tube and a dynamic cathode ray tube used to display the cursor.

SUMMARY OF THE INVENTION

In accordance with an important aspect of this invention dynamic alphanumeric and graphic capabilities are provided in a visual display system by using a dynamic refresh memory with the cursor tube in the system.

In one embodiment the system includes a parallel projection scheme for the cursor and the visual image produced by the stored image tube. By independently controlling and refreshing the cursor tube at a suitable rate to eliminate flicker, dynamic alphanumeric and vector drawing operations are achieved. A memory unit has the capacity to store 187 ASCII characters. This memory also has the capacity to allow generation of vectors for a dynamic vector display.

In accordance with a further aspect of this invention, the memory capacity at the remote terminal provides the system with the capability for operating in a "polled" mode as well as a time-shared basis with the central computer. Because of this memory, the terminal can be polled so that information can be interchanged with the computer on a line-at-a-time basis.

In accordance with an important aspect of this invention, editing and deletion of alphanumeric and graphic information can be conveniently performed on a visual display system which nevertheless has the advantage of displaying large amounts of information by a stored image tube which does not require refresh.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a block diagram of the system; and

FIGS. 2A and 2B show a more detailed block diagram of the computer terminal.

DESCRIPTION OF A PARTICULAR EMBODIMENT

This invention is directed to a system of the type shown in FIG. 1. Such a display system includes a stored image display tube 11 for displaying visual information on a display screen. A dynamic display device 12 is used to produce the cursor on the display screen. The deflection systems of the tubes 11 and 12 are connected in series so that the same deflection signals position the beams in both tubes. In normal operation, such as that obtainable with the aforementioned Corning 904 system, the display system writes graphic or vector information on the stored image tube 11. As it does so, the cathode ray beam of the tube 12 follows the writing to produce the cursor which always indicates the position on the display screen at which information is being written. A display system 13 produces x and y deflection signals and a z brightness control signal for

each tube. These are produced in response to digital characters produced by character generator 14 or in response to vector commands from the vector generator 15. Mode selection and control circuitry 16 controls the flow of information and the operation of the system.

The system operates in response to digital commands received from a central computer. These commands are typically received over telephone line 17 and applied to the serial to parallel converter 18.

What has been described thus far is typical of a system such as the Corning 904 system. In accordance with the present invention a dynamic memory 19 is added for use in providing dynamic operations with the cursor tube 12. The presence of this memory allows operation of the system under control of the editing controls 20 so that the functions of deleting and editing information can be performed. The presence of this memory allows digital signals to be transferred from the memory, through the parallel to serial converter 21 and over the telephone line to the computer as the terminal is polled by the computer.

Referring to FIGS. 2A and 2B, there is shown a remote terminal visual display system for displaying either character or vector information transmitted from a digital computer. The system includes a display screen 22 for displaying images from a stored image type display device 23 and from a dynamic cathode ray tube display device 24.

While various stored image type tubes are suitable for use, the particular one shown includes a photochromic element 25 for storing and displaying information written by the cathode ray beam produced by the gun 26. Devices of this type are described in U.S. Pats. Nos. 3,431,048 — Ludovici et al. and 3,428,396 — Megla et al. In such a device the photochromic memory is probed with green light to produce an image reflected by the beam splitter 27, projected by projection lens 28, and reflected by beam splitter 29 into the display screen 22.

The image produced by the dynamic cathode ray tube 24 is superimposed upon the image from the stored image tube 23 by the projection system which further includes the projection lens 30.

Each of the tubes 23 and 24 has deflection means. X deflection coil 31 and *y* deflection coil 32 are shown for the tube 23. The tube 24 has *x* deflection coil 33 and *y* deflection coil 34. The deflection coils are concurrently driven by the deflection unit 35. While the deflection coils have been indicated to be connected in parallel, they could also be connected in series. The deflection means control the position on the display screen 22 at which information is displayed. The images produced by the two devices are superimposed one upon the other.

In accordance with this invention, both devices have at least a limited capability for displaying graphic information. The cathode ray tube 24 is given the capability for limited graphic operation by a dynamic refresh memory 36. As shown, the memory is a 1024 bit capacity memory which is sufficient to store two lines of information of 72 characters per line, the standard line format used in time-shared computer systems. This capacity in dynamic refresh memory 36 also allows the generation of thirty six long vectors of the type produced by the aforementioned Corning 904 system. The generation of the vector characters is more fully described in the aforementioned Wood et al patent application. The vectors stored in memory 36 can be used for a limited graphic display.

During the normal operation of the terminal, characters from the central computer are transmitted serially over transmission line 37 to the serial-parallel buffer register 38. Control characters from the computer set the mode select 39 which places mode control 40 in the mode for storing data in the stored image tube 23. The intensity control 41 is also set to produce a *z*, intensity control, signal for the stored image tube 23. Seven bit characters are set into the latch 42 from which they are translated, by the character vector command circuitry 43 into signals for displaying either the specified alphanumeric characters or the specified vectors. The character generating circuit 44 commonly is a 35 dot matrix character generator. This controls the intensity control 41 and the character matrix deflection circuit 45 to cause the cathode ray beam in the stored image tube 23 to trace out the desired character on the memory element 25. Vectors are generated by the vector generator 46 which is commonly a type of binary rate multiplier for converting input characters into deflection signals which produce line segments on the memory unit of the stored image tube 23. The characters or vectors stored in the photochromic stored image unit 25 will be continuously displayed until they are erased from the memory. During this time the terminal may be operated in other modes. First, consider the refresh mode. In the refresh mode incoming characters are transferred to the sequential access memory 36. The characters are continuously recirculated through the 7 bit parallel-to-parallel register 47 and back into the memory 36. This recirculation is under the control of the refresh clock 48. In the refresh mode the intensity control 41 and the deflection unit 35 supply *x*, *y* and z deflection and intensity information to the cathode ray tube 24. In this mode of operation the system has the capability for editing alphanumeric information by use of the keyboard 49. Also, dynamic graphics can also be performed in this mode using any of the well known graphic input devices. As an example the input pencil 50 has been shown, but other analog position input devices can be used. The position of these devices is converted to a binary number as indicated at 51.

When the position of the input pencil 50 matches the position on the screen 22 at which information is being recorded, as indicated by the "read terminal" signal from the deflection unit 35, the AND gate 52 enables the vector character encoder 53 to encode the information being inputted. This information is inserted, through mode control 40 into the sequential access memory 36. A comparator 54 indicates when the correct information is recirculating in the memory.

During the interactive mode, especially in an engineering design exercise, the operator may choose to change selected certain values to view the resultant operational characteristic change. As an example, a new plot can be generated and superimposed momentarily over the original plot displayed by the stored image tube 23.

Another mode of operation is possible. In the transmit mode, characters recirculating in the sequential access memory can be transmitted through the buffer 38 to the transmission line 37 for transmission to the central computer. The provision of this memory allows high speed synchronous transmission techniques to be

employed. This permits more terminals to share a phone line, thereby lowering communication costs and improving the effectiveness of message concentrators.

While a particular embodiment of the invention has been shown and described, other modifications will be apparent and are within the scope of the appended claims.

What is claimed is:

1. A display system comprising:

a display screen,

a stored image display device including:

means for generating a cathode ray beam,

a photochromic element responsive to said cathode ray beam for storing and for displaying visual information on said display screen, and

deflection means for controlling said cathode ray beam to control the position on said display screen at which said information is displayed,

means for producing deflection signals and a brightness control signal for said display device in response to digital signals representing said visual information,

a dynamic display device for displaying visual information superimposed on the information displayed by said stored image display device on said display screen, said dynamic display device having deflection means for controlling the position on the display screen at which said information is displayed,

means for concurrently driving the deflection means of said stored image and said dynamic display devices, and

a dynamic refresh digital memory for said dynamic display device, said dynamic refresh memory containing and controlling the information displayed by said dynamic storage device.

2. The system recited in claim 1 wherein said display devices each produce visual images and wherein said system includes a projection system for superimposing the two visual images on said display screen.

3. The system recited in claim 1 further comprising an analog position input device for generating digital signals indicating the position that the device is moved to by the operator, said digital signals being applied to said dynamic refresh memory so that said system can be operated in a dynamic graphic mode of operation.

4. The system recited in claim 1 further comprising:

a key board for generating digital signals in response to operator actuation of the keyboard, said keyboard generated digital signals being inserted into said dynamic refresh memory so that said system can be employed to edit alphanumeric information displayed by said stored image display device.

5. The system recited in claim 1 wherein said stored image display device has a photochromic memory element.

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