

[54] **PHOTOCHROMIC STORAGE-DISPLAY SYSTEM WITH SELECTIVE ERASE UTILIZING GAS PLASMA PANEL**

[72] Inventor: William Ernest Eichelberger, Raleigh, N.C.

[73] Assignee: Corning Glass Works, Corning, N.Y.

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[56] **References Cited**

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Primary Examiner—John W. Caldwell

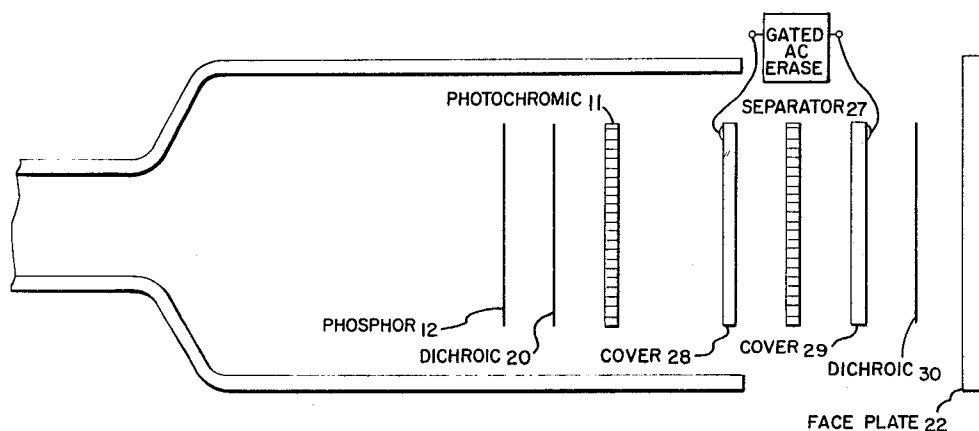
Assistant Examiner—Marshall M. Curtis

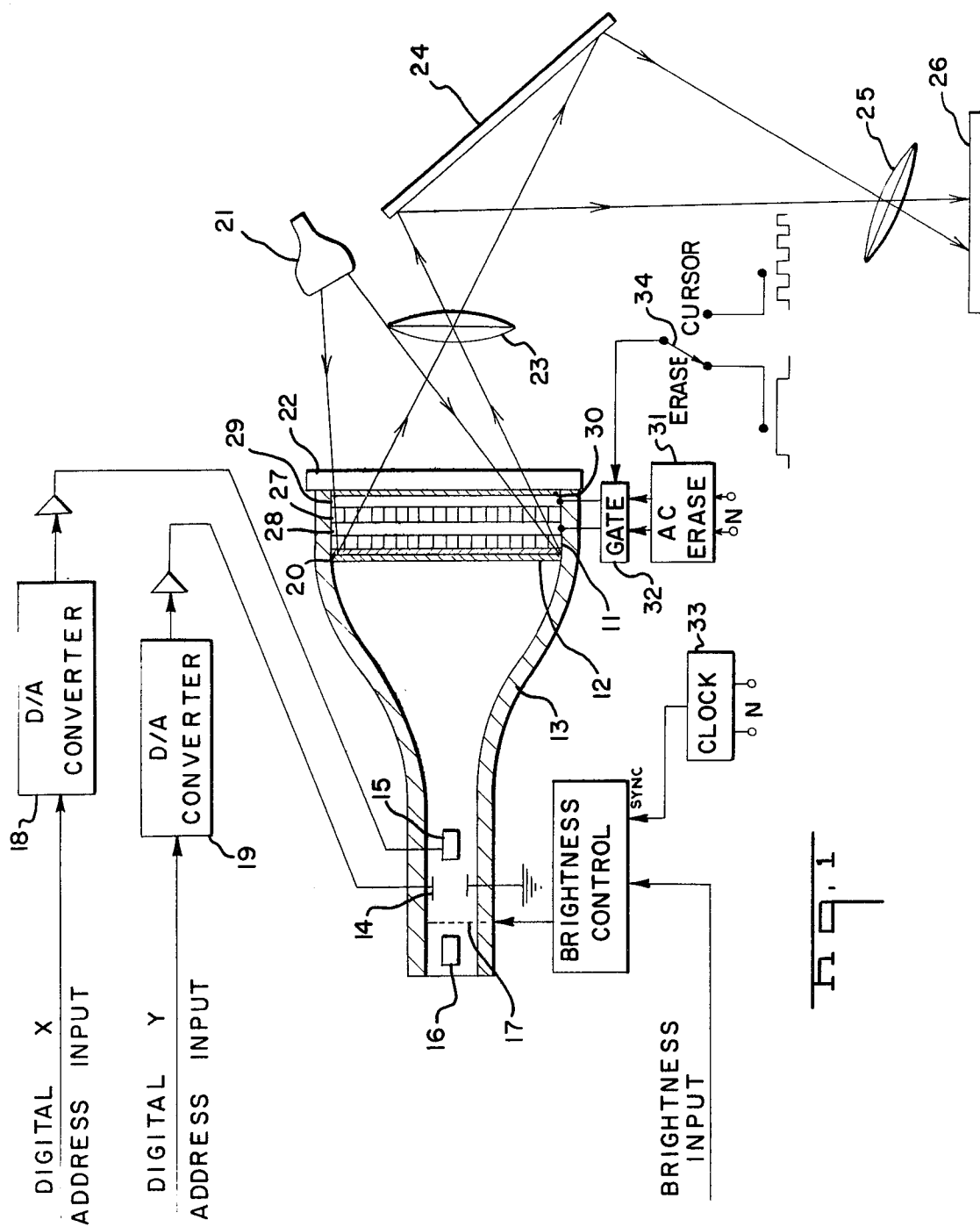
Attorney—Clarence R. Patty, Jr., Walter Zebrowski and Woodcock, Washburn, Kurtz & Mackiewicz

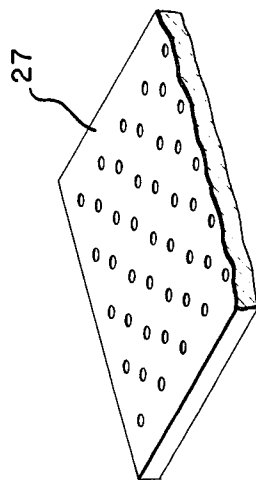
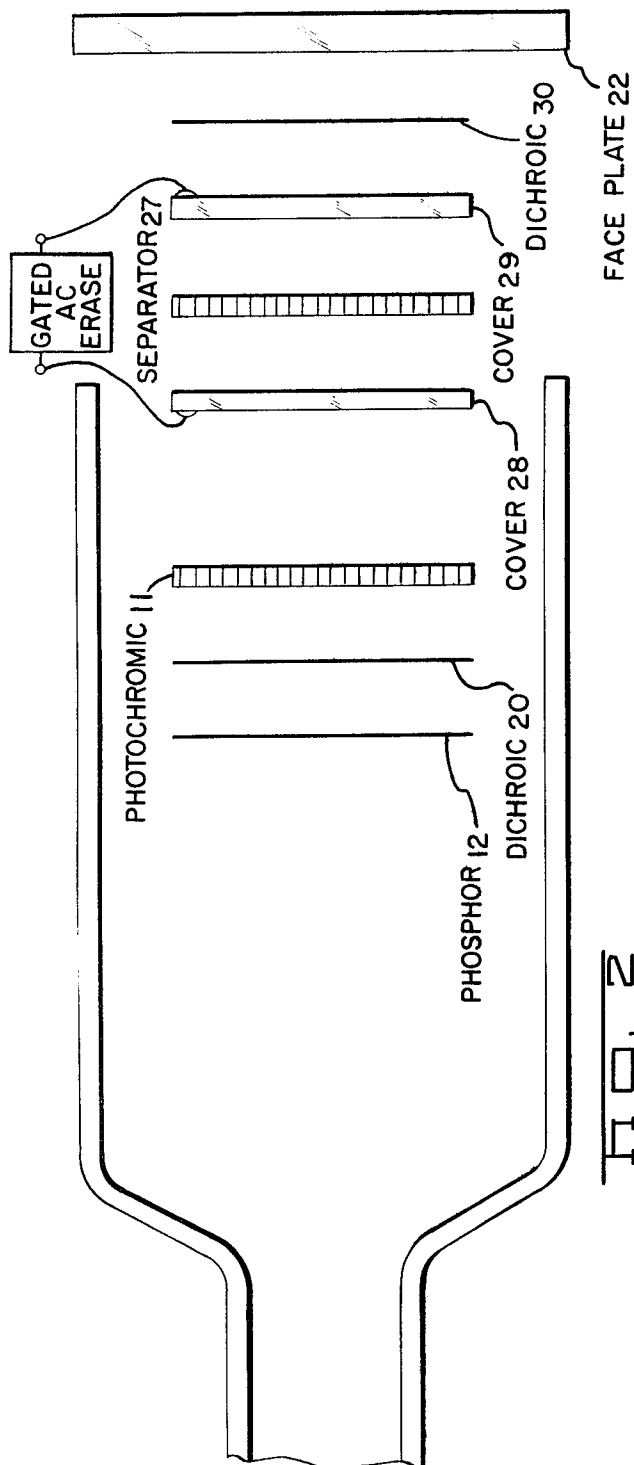
[57] **ABSTRACT**

Selective erasing capability is provided in a display system having a photochromic member upon which information is written by an electron beam which addresses a selected portion of a phosphor layer. Light from the addressed portion of the phosphor changes the optical density of the photochromic glass. The information is selectively erased from the photochromic member by light from a gas plasma panel having gas-filled cells. These cells emit predominantly infrared light which bleaches the photochromic glass to erase the information. The gas plasma panel is maintained at a threshold of excitation by an applied AC voltage. Specific cells are addressed by light from the phosphor layer. The electron beam selects a portion of the phosphor layer and light from this portion selectively excites the desired cell, or cells.

11 Claims, 3 Drawing Figures







PHOTOCHROMIC STORAGE-DISPLAY SYSTEM WITH SELECTIVE ERASE UTILIZING GAS PLASMA PANEL

BACKGROUND OF THE INVENTION

This invention relates to storage-display devices and more particularly to the selective erasure of information stored in the device.

Digital information processing systems require devices for efficiently storing and displaying information. One type of storage-display device is the refresh memory type in which information to be displayed is continuously transferred from a digital memory to the display; that is, the display is continuously refreshed.

Another type storage-display device makes use of the internal storage capability which is built into the devices. Secondary emission, electro-static storage, cathodo-chromic storage, and photochromic glass storage are examples of this type device. Photochromic glass storage tubes in particular have been widely and successively used. Such devices are described, for example, in U.S. Pat. Nos. 3,428,396 Megla et al. and 3,431,048 Ludovici et al. and in pending application Ser. No. 677,185 Ludovici et al. The characteristics and production of photochromic glass is described in U.S. Pat. No. 3,208,860 to Armistead and Stookey. The Corning 904 Time Sharing Terminal, manufactured by the Corning Glass Works, Corning, N.Y., is an example of a commercially available system having a photochromic storage-display device.

Bulk, or at best, sectorized block erasing is usually employed in these devices. A need exists for a selective erase capability in these storage devices to take full advantage of the storage display mode of operation.

For example, information can be stored in these devices in an asynchronous mode with no appreciable time limit applied to data entry. In comparison, the refresh cathode ray tube displays have a definite time limit and storage capacity associated with the recirculating memory used for the refreshing operation. Because of this, the photochromic storage-display device has a distinct advantage over the refresh memory types. However, the refresh memory displays can easily implement selective erasure by merely not rewriting the information. A need exists for selectively erasing the photochromic storage device with the same facility that erasure is performed in a refresh memory type device.

Photon erasure of photochromic glass affords the highest possible resolution to selectively erase small areas on the storage medium. Page 7 of the aforementioned Ludovici et al. patent application states that selective erasing can be accomplished by applying photon energy to the photochromic member by a collimated red light.

Gas plasma panels are known in the art and have been used for character generators. For example, it has been proposed that a device having a ceramic plate having holes therein which form cells containing a gaseous mixture of neon and nitrogen be used as a character generator. In such a device an exciting AC voltage is applied across two cover plates on the front and back side of the ceramic plate. A matrix of conductors on the back cover plate is selectively energized to cause the gas in selected cells to break down in a plasma discharge. Such a device is described in British Pat. No. 1,161,833 published Aug. 20, 1969.

SUMMARY OF THE INVENTION

In accordance with this invention the unique properties of a gas plasma discharge panel are used to selectively erase cathodo-chromic and photochromic storage display devices by emission of photon energy of an appropriate wavelength. Accordingly, it is an important object of this invention to use photons from a gas plasma panel for selective erasure of a storage display device using photosensitive materials.

It is another object of this invention to use a gas plasma panel having a light output which is predominantly in the infrared spectrum to bleach photochromic materials.

In accordance with a specific embodiment of the invention the information is written on a photochromic memory by a cathode ray beam which selectively addresses a phosphor layer. Light from this phosphor layer is of a wavelength which changes the optical density of the photochromic glass. The gas plasma panel has gas-filled cells which are also selectively excited by light from the phosphor layer. In order to selectively erase, the cathode ray beam addresses a selected area of the phosphor layer which emits light which excites selected cells into a plasma discharge emitting predominantly infrared light. This predominantly infrared light from the gas plasma panel erases the photochromic memory.

Accordingly it is another object of this invention to use the electronic addressing system of a storage-display device to control the selective erase of that device. In this manner digital addressing information can be used to selectively erase unwanted information from the display. (In accordance with another aspect of the invention, dichroic layers which are reflective for infrared light form an optical cavity in which infrared photons are absorbed by the photochromic materials).

In one specific embodiment of the invention the plasma panel is positioned between the storage medium and the viewer. Because of this, the photon energy is visible. A secondary mode of operation is implemented by periodically interrupting the gas discharge and read-dressing with the cathode ray tube beam to implement a flashing pointer cursor.

Accordingly it is another object of the invention to provide a flashing pointer or cursor on a display by interrupting the gas plasma panel discharge.

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

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a photochromic-display device with a gas plasma panel for selective erasing;

FIG. 2 shows the elements of the storage-display tube in an exploded view; and

FIG. 3 shows the structure of the gas plasma panel.

DESCRIPTION OF A PARTICULAR EMBODIMENT

FIG. 1 shows a cathode ray tube controlled storage display device having a photochromic storage member 11. The Corning 904 terminal, previously referred to, has such a photochromic storage member. The invention will be particularly described as a modification of such a system.

The photochromic member includes a plurality of glass optical fibers secured together so that their ends form a first face positioned in proximity to a phosphor layer 12 having an aluminized backing of the type which emits ultra-violet light. Each of the fibers includes a light-conducting core of photochromic glass having a selected refractive index and a cladding on the core of a light transmitting material having a refractive index which is lower than the refractive index of the photochromic glass.

The cathode ray tube addressing system provides means for writing information on the photochromic member 11. The cathode ray tube includes a conventional envelope 13, vertical and horizontal deflection means 14 and 15, an electron gun 16, and a beam intensity control electrode 17.

In the write mode of operation, digital address inputs are converted, in converters 18 and 19, to deflection signals which position the cathode ray beam to the desired position on the phosphor 12. The phosphor 12 provides a source of light the wavelength of which is such that it changes the optical density of the photochromic fibers in the photochromic member 11. Ultra-violet light from the selected, addressed portion of the phosphor passes through the ultra-violet transmitting dichroic coating 20 to darken the photochromic member. The dichroic layer 20 is highly transmissive in the ultraviolet region and is matched to the ultraviolet output of the phosphor 12. The dichroic layer 20 is highly reflective in the green and red portions of the visible spectrum. As will be subsequently described the reflection of green light is necessary to enhance the modulation of the probing light during readout. The reflection of red light is necessary to reflect erasing photons during the erasing mode. Dichroic layer 30 is highly transmissive in the blue-green spectrum and highly reflective in the red spectrum.

One system for reading out information stored on a photochromic memory includes a probing light source 21 which directs a beam of light onto a face plate 22. In one example the wavelength of light emitted by the source 21 is 510 millimicrons, the optimum probing frequency to provide a projected image having high contrast. Light from the source 21 passes through the face plate 22, through the photochromic member 11. The light is reflected by the dichroic layer 20 and again passes through the photochromic member 11. Double passage of the probing light through the photochromic member 11 modulates the light with the information stored in this member. The modulated light is transmitted by a lens 23, is reflected by the mirror 24, and passes through projection lens 25 to a viewing screen 26 for display purposes. The darkened portions in the photochromic glass form a dark character, vector, or curve on a green-yellow background.

In accordance with this invention, a selective erase capability is provided by the gas plasma panel which includes a multi-celled separator plate 27 and end covers 28 and 29. The separator plate 27 contains gas within discrete locations. The electrically conductive optically clear glass end covers 28 and 29 seal the gas within the panel.

The photochromic member 11, and the face plate 22 also have conductive, optically clear coatings on both

surfaces. Both surfaces of covers 28 and 29 are antireflection coated so that the optical qualities of the modulated light beam used in the readout mode are not degraded.

During the erase mode an AC voltage from the source 31 is applied to covers 28 and 29. This AC voltage brings the gas contained within the cell up to the threshold of plasma discharge. When photon energy from the phosphor 12 impinges on the gas, the gas ignites in a plasma discharge. During discharge the capacitor which exists between the two covers 28 and 29 is charged to a first polarity. As the AC voltage passes through zero the plasma is extinguished, but on the next half cycle the AC voltage is aided by the charge on the capacitor. Therefore, the gas breaks into a plasma discharge again. In this manner, the plasma discharge is sustained once it is started by the photon energy from the phosphor 20.

The AC voltage from the source 31 is applied through a gate 32 to the end covers 28 and 29. The gate 32 provides a means for timing the erase. Normally, for use in a cathode ray tube storage display device such as that used in the aforementioned Corning 904 Time Sharing Terminal, a time period of approximately one second of erase time will be sufficient.

An additional requirement in the erase mode is to phase lock the electron beam with the AC voltage from the source 31 so that the ultra-violet energy required to trigger the plasma cells enters the cell at the appropriate time on the AC waveform. As shown in FIG. 1 the master clock 33 for the digital system is locked to the same AC waveform from which the voltage from the source 31 is derived.

In order to operate the storage-display device in a cursor operation, the AC sustaining voltage applied to end covers 28 and 29 is periodically turned on and off to extinguish the plasma discharge. The capability for this function is indicated by the select switch 34 which, when in the cursor mode of operation, opens and closes the gate 32 to periodically turn the plasma discharge on and off. This effects a flashing periodic light that can be seen by the operator. Since the cursor indicates the next position to be written in a computer controlled display, the short period of the on or off control of the plasma panel is of a short enough duration so as not to induce appreciable erasing. It serves merely as a pointer indicating where the next address will occur on the overall display. As an example of operation, a typical on-off cycle is of approximately 300 milli-seconds duration.

The multi-cell separator plate 27 is shown in FIG. 3. It consists of a piece of optically clear ceramic or glass which has been etched, or drilled to provide holes therethrough. These holes are spaced apart by a distance which approximates the resolution distance of the storage-display device. In this manner, the erasing resolution approaches the basic resolution of the overall system. As an example, the multi-cell separator plate 27 may typically be of glass ceramic material, that is to be a Fotoform plate, with dimensions of 1.75 inches by 2.375 inches and 0.010 inches thick. Holes of 0.002 inch diameter are etched in the ceramic with a center to center spacing of 0.003 inches.

When the end covers 28 and 29 are sealed to the multi-celled separator plate 27 they form a gas tight

chamber with a mixture of neon and nitrogen gas contained therein. Typically, a mixture of 96 percent neon and 4 percent nitrogen may be used.

The operation of the complete system can be briefly summarized as follows. During the write mode the sustaining AC voltage from the source 31 is not applied to the end covers 28 and 29 so the plasma panel is not operative. The electron beam produced by the gun 16 strikes the phosphor 12 at a location determined by the digital address signals applied as inputs. The phosphor 12 converts the electron energy to ultra-violet energy which passes through the dichroic coating 20. The ultra-violet energy is absorbed by the photochromic member 11 causing a darkening of the photochromic materials in the absorption area.

In order to read this information, an unmodulated probing light in the green portion of the spectrum is directed from the source 21 through face plate 22, dichroic layer 30, end cover 29, separator plate 27, end cover 28, and into photochromic member 11. The light is reflected from the layer 20 and again passes through photochromic member 11. As the light passes through the photochromic member 11 twice it is modulated by the darkened areas of the photochromic glass. The modulated light passes through the projection optics external to the cathode ray tube storage display device.

In the selective erase mode of operation, the sustaining voltage waveform from the AC source 31 is applied to the end covers 28 and 29. The electron beam is addressed to a selected position on the phosphor 12 by the same addressing means as utilized during the write mode. The phosphor provides a source of ultra-violet light which excites gas in the plasma panel into a plasma discharge. The sustaining AC voltage applied to plates 28 and 29 sustains the periodic discharge and light emission from the plasma panel. Since the gas discharge is high in the red region of the spectrum, photons directed onto the photochromic member 11 bleach, or erase, the information stored thereon. Those photons not trapped during the first pass through photochromic member 11 are reflected by dichroic layer 20 back into photochromic member 11 thereby increasing the probability of full time trapping for erase. In addition, the reflectance of dichroic layer 30 re-directs those photons emitting toward the face plate back toward the photochromic member 11. In essence, the dichroic coatings 20 and 30 form an optical cavity which allows multi-passing of the red rich photons through the photochromic member 11. This increases the probability of photon trapping.

By controlling the length of time that the voltage from AC source 31 is applied, the various bleaching or erasing sensitivities of the photochromic member 11 can be accommodated.

While a particular embodiment of the invention and certain modifications have been described, other modifications may be made. The following claims are, therefore, intended to cover any such modifications within the true spirit and scope of the invention.

I claim:

1. A display system comprising:

a photochromic storage member having a first and a second face,

a source of light including address means for selectively illuminating selected areas on said first face

of said photochromic storage member, said light having a wavelength such that the optical density of said photochromic member changes at said selected areas whereby information is written thereon, and

a plasma panel located adjacent said photochromic storage member, said panel containing a gas excited by said light when raised to the threshold of plasma discharge so as to produce a plasma discharge emitting predominantly infrared light at said selected areas of said photochromic storage member whereby information written thereon is erased therefrom, and

a means for selectively applying a voltage to said plasma panel while erasing so as to raise said gas to the threshold of plasma discharge.

2. The display system recited in claim 1 wherein said source of light comprises a layer of phosphor adjacent said first face.

3. The display system recited in claim 2 wherein said source of light further comprises a cathode ray beam device having deflection means for selectively directing a cathode ray beam to areas of said layer of phosphor adjacent addressed areas of said photochromic storage member.

4. The system recited in claim 2 wherein said phosphor is of the type which emits predominantly ultra-violet light, said system further comprising:

a first dichroic layer between said phosphor and said photochromic storage member, said dichroic layer having optical characteristics which transmit light in the ultra-violet region and reflect light in the visible region.

5. The display system recited in claim 4 wherein said first dichroic layer also reflects light in the infrared region and wherein said gas plasma panel emits light in the infrared region when excited, said system further comprising:

a second dichroic layer positioned on the opposite side of said gas plasma panel and said photochromic storage member from said first dichroic layer, said first and second dichroic layers forming an optical cavity through which photons in the infrared spectrum traverse and are captured by said photochromic storage member.

6. The display system recited in claim 1 wherein said gas plasma panel comprises:

a separator plate having a plurality of cells filled with said gas, and

first and second end covers constructed of electrically conductive, optically clear glass, said first and second end covers being sealed to said separator plate to provide a gas chamber.

7. The display system recited in claim 6 wherein said means for selectively applying a voltage includes a source of AC sustaining voltage connected across said first and said second end covers, said AC sustaining voltage having a magnitude which excites said chamber to the threshold of a plasma discharge.

8. The display system recited in claim 6 wherein said multi-cell separator plate comprises an optically clear glass plate having holes therein which form gas cells, said holes having a spacing which approximates the resolution distance of said display system.

9. The display system recited in claim 1 further comprising:

a probing light source means for directing a beam of light to said second face, the wavelength of said probing light source means being such that it does not affect the optical density of photochromic glass.

10. The display system recited in claim 1 further comprising:

means for periodically interrupting said AC voltage to periodically extinguish said plasma discharge, the interrupted plasma discharge producing a periodic visible light at a position on said display device selected by the cathode ray beam.

11. The display system recited in claim 1 wherein said photochromic storage member comprises:

a plurality of glass optical fibers secured together in side by side relation so that opposite ends of the fibers define said first and said second faces, each of said fibers including a light conducting core consisting of photochromic glass having a selected refractive index and a cladding on said core of a light transmitting material having a refractive index which is lower than said selective refractive index.

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