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[54] **MICROCHANNEL IMAGING DISPLAY DEVICE**

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[52] **U.S. Cl.**..... **313/103;** 250/213 R; 313/105; 315/12

[51] **Int. Cl.**..... **H01j 43/00;** H01j 31/26

[58] **Field of Search**..... 313/65 R, 103, 104, 105; 315/169 R, 10, 11, 12; 250/213 R, 213 A, 213 VT

[56] **References Cited**

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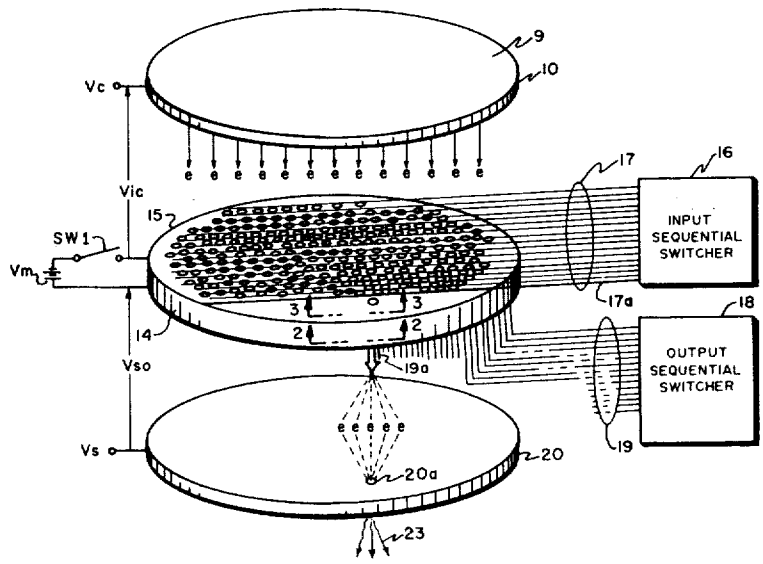
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[57] **ABSTRACT**

A display device using a microchannel plate electron multiplier with a set of fine, closely spaced, parallel continuous metallic lines deposited on each side of the microchannel plate with each set of metallic lines being perpendicular to each other. An input sequential switcher and an output sequential switcher have voltage differentials that are separately swept across each set of lines such that when the voltage differentials are applied on directly opposite sides of the microchannel plate, while the regular bias voltage is applied across the MCP, there is high electron gain. A photoemissive panel, emitting a uniform flow of electrons therefrom, is positioned adjacent the input set of metallic lines, and a luminescent screen, such as phosphor, is positioned adjacent the output set of metallic lines for displaying an image according to electron flow caused by the differential sequential switching voltages.

2 Claims, 3 Drawing Figures



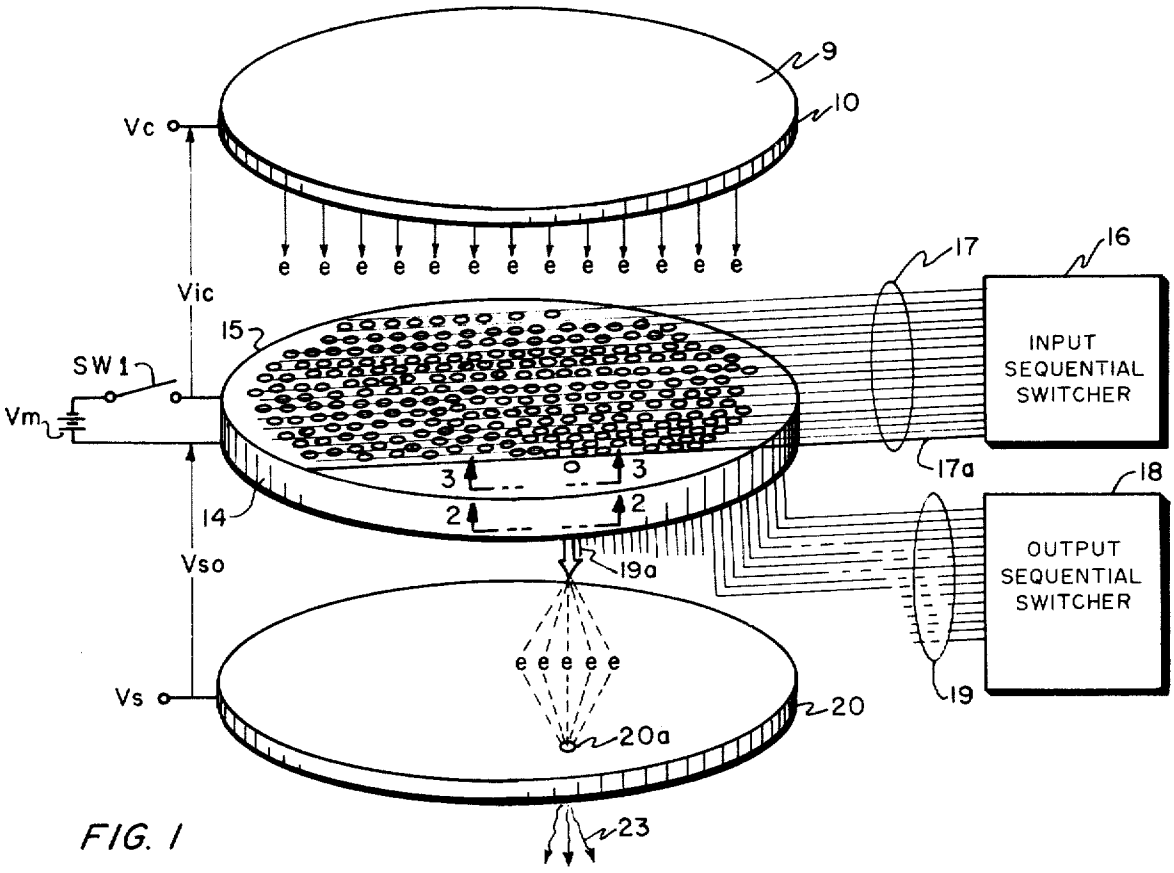


FIG. 1

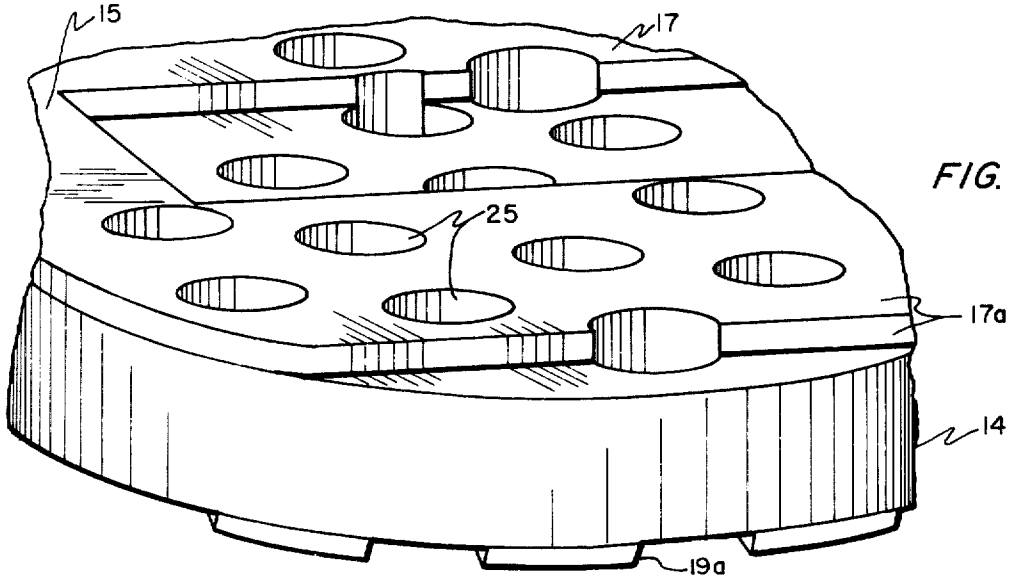


FIG. 2

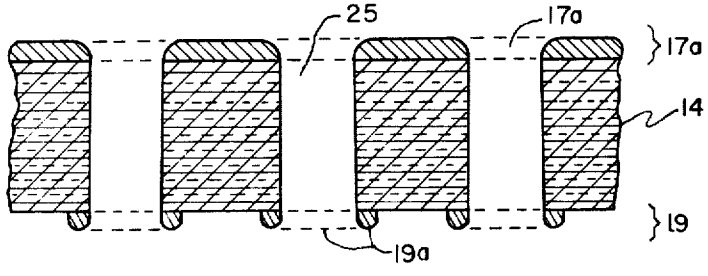


FIG. 3

MICROCHANNEL IMAGING DISPLAY DEVICE

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

BACKGROUND AND SUMMARY OF THE INVENTION

The technology of this invention involves providing an image display by use of a microchannel plate in which each of the input and output electrodes on the microchannel plate comprise a set of long, thin, parallel, metallic lines with the sets of metallic lines perpendicular to each other. Differential voltages are sequentially switched across the input electrode metallic lines and across the output electrode metallic lines. The difference in magnitude of the differential voltages at a crossover point of the two perpendicular electrodes causes an increase in electron multiplication at this particular point. While the sequential voltages are being swept across the input and output electrodes, application of the regular bias voltage in series with the sequential voltages across the MCP causes an intense output at the crossover point of the sequential voltages since the total voltage is much greater only at that point.

A photoemissive panel close to the input electrode furnishes a uniform flow of electrons into the channels at the input side of the microchannel plate. This uniform flow of electrons is changed into a specific pattern at the output of the microchannel plate according to the switching of the regular bias voltage and the sequentially switched differential voltages that are applied to the input and output electrodes.

The electrons from the output of the microchannel plate strike a electroluminescent screen, such as a phosphor screen. The phosphor screen is proximity focused with the output electrode of the microchannel plate to form an object image pattern that is the same as the electron multiplication pattern from the microchannel plate.

The input and output electrode metallic lines may be formed on the input and output sides of the microchannel plate by various methods, such as evaporation through a mask for laying the parallel lines or evaporating a continuous electrode and then photoetching the parallel lines therein in a manner similar to that used to produce printed circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a side view of the imaging display device of the present invention;

FIG. 2 shows a partial side view of the microchannel plate and the electrode attached thereto; and

FIG. 3 illustrates a sectional view of the microchannel plate.

DESCRIPTION OF PREFERRED EMBODIMENT

FIG. 1 illustrates a diagrammatic side view of the microchannel imaging display device in which all elements are enclosed in a vacuum environment, except sequential switches **16** and **18.** An electron emitting panel **10,** such as a thermionic panel or a luminescent-photoemissive composite panel, is used to generate an even flow of electrons therefrom toward an input side of a microchannel plate **14.** The electrons may be evenly emitted from **10** by even heating of the panel in

case the panel is thermionic or by flooding the input side **9** of the panel in case of a luminescent-photoemissive composite panel. Instead of microchannel plate **14** having the usual one solid input electrode and one solid output electrode, a unique pattern of long, thin parallel input and output electrodes is provided on the microchannel plate with the input and output electrodes being perpendicular to each other. This novel pattern of electrodes are formed on each side of the basic channeled microchannel plate by evaporation methods well known in the art, such as evaporation through a mask or evaporating a continuous electrode and then photoetching lines therein. The separate parallel input electrodes **17** are connected to input sequential switcher **16,** and common input electrode **15** is connected to all of the input electrodes **17** and back to the negative side of a regular MCP bias voltage source V_M, through switch **SW1.** Electrodes **15** and **17** are evaporated on the input side of **14** simultaneously. Separate parallel output electrodes **19** and a common output electrode connected to electrodes **19** on the output side (with the output side not shown) are likewise simultaneously evaporated on the output side of the microchannel plate. Output electrodes **19** are connected to output sequential switcher **18,** and the common output electrode is connected to all of the electrodes **19** and back to the positive side of a regular MCP bias voltage source V_M. These electrodes may be made of any good conduction material which is easy to evaporate, such as gold, silver, aluminum, etc. The material that the microchannel plate is made of may be glass, aluminum oxide, or some other semiconductor material used in producing the channeled wafer. The channels are first produced in the wafer and then the electrodes are formed on each side thereof. In the method of evaporating the metallic lines on the wafer, some of the metal will go into the outer edges of the channels but not enough to appreciably hinder any electrons entering the channels on the input electrode side or exiting from the output electrode side of the wafer.

A light emitting screen **20,** preferably coated with some good light emitting source such as phosphor, is positioned to be proximity focused in the well known manner, with the output side of the microchannel plate **14** when proper bias voltages are applied to the microchannel plate and to screen **20.** In operation of the image display device, electron emitting panel **10,** microchannel plate **14,** and light emitting screen **20** are all enclosed in a vacuum envelope or housing (not shown). The display device has the advantages of being very thin and having high resolution. The display device may be as thin as ¼ inch. The overall width may be increased without increasing the thickness more than ¼ inch.

Using FIG. 2 as a reference, when a suitable voltage is applied on input metallic line **17***a* and output metallic line **19***a* simultaneously (with both lines shown heavier than the other lines in FIG. 1 for representative purposes), electrons entering channels **25,** which are at the crossing point of **17***a* and **19***a* will be accelerated and multiplied through channels **25** when voltage V_M is also switched on by closing switch SWI. These multiplied electrons emitted from the output side of microchannel plate **14** at the crossing point is proximity focused on electroluminescent panel **20** at a point represented by **20***a*, resulting in a visible output on the opposite side of screen **20,** represented by **23.**

By sequentially scanning the input electrodes **17** with voltages from **16** and sequentially scanning the output electrodes **19** with voltages from **18**, the crossover point of the differential voltages from **16** and **18** may be determined by momentarily switch in the MCP bias voltage V_M in series therewith and observing a digital output from screen **20.** Any crossover point between the multiple electrodes **17** and **19** may be chosen by selectively switching V_M across the MCP resulting in visible amplification at the chosen point at the output of the screen **20.** The sequential switching voltages from **16** and **18** may be relative slow or fast. For example, switching may be as fast as 100 millisecond total scan time by use of electronic switching.

Voltage V_{ic} is about 5 to 100 d.c. volts with the input side of **14** being positive relative to the cathode **10.** If the input side of **14** is at ground potential, voltage V_c may be a negative 5 to 100 d.c. volts and serve the same purpose. The spacing between elements **10** and **14** is not critical since image focusing of the uniform flow of electrons is not involved in this space. Voltage V_{ic} is used to maintain a slight electric field between **10** and **14** to accelerate the uniform flow electron toward the input of **14.** Using the above noted voltage values of V_{ic}, typical spacing between **10** and **14** is about ⅛ of an inch.

The voltage of V_M plus the voltage across electrodes **17** and **19** caused by switching on switches **16** and **18** should total about 300 to 1,000 volts. As for the individual voltages, the differential voltages may be such that the voltage on the active electrode **19** may be about 300 to 1000 d.c. volts positive when the total voltage on the input side of **14,** i.e. on electrode **15** and the active electrode **17,** is at ground potential. Alternately if the voltages on electrode **15** and active electrode **17** are above ground potential by 5 to 100 d.c. volts then the voltage on active electrode **19** may be positive 305 to 1050 d.c. volts. Now with these sequential differential voltages from **16** and **18** scanning the electrodes on opposite sides of **14,** voltage V_M may be switched by switch **SW1** into common electrode **15** in series with these differential voltages. Preferably the value of V_M is about 500 d.c. volts positive on the output common electrode (notshown) and is in series with the differential voltages from **16** and **18** of about 500 d.c. volts. Only the channels at the crossover point where voltages on lines **17** and **19** intersect will there be high electron gain. when voltage V_M is switched in series therewith. The remaining channels will have gains that are less than unity. Therefore, the rate of switching V_M within one complete cycle of a sweep of differential voltages from **16** and **18** on electrodes **17** and **19** respectively determines the total image at the output of screen **20.** Also, the variation of the total voltage determines the magnitude of electron gain and the intensity of the digital output image from screen **20.** Any suitable switching device may be used to switch sequential switching voltages **16** and **18,** and that of switch **SW1.** These switching devices may be mechanically controlled for slow switching, or electronically controlled for much faster switching. Electronic switching may use integrated circuit technology for the scanning circuits since these integrated circuits satisfy the need for small size and high switching speeds.

The screen voltage V_s is a positive voltage of about 5,000 d.c. volts and is used to establish the proper voltage V_{so} between the output of **14** and the screen for proximity focusing the electrons on screen **20.** The spacing between the output of **14** and **20** is about ⅛ of an inch. However, proper proximity focusing may be acquired by changing the spacing of **14** and **20** and voltage V_{so} simultaneously to appropriate valves.

A television type presentation can be provided with full contrast. The resolution capability is only limited by the spacing of the thin input and output electrodes and the spacing of the channels. Even though the overall thickness may be about ¼ of an inch the display size may be increased without increasing the thickness or sacrificing display resolution. Display size limitations appear to be limited only to the measurements that a microchannel may be fabricated.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

I claim:

1. An image display device comprising:

an electron producing means for producing a uniform flow of electrons;

a microchannel plate electron multiplier positioned adjacent said electron producing means;

means for selectively sequentially switching electron accelerating voltages across said microchannel plate electron multiplier, said means for selectively sequentially switching electron accelerating voltage further comprising:

a set of thin parallel input electrodes on the input side of said microchannel plate that are attached to an input sequential switcher for cyclically sweeping instantaneous input sequential voltages across each of said input electrodes;

a set of thin parallel output electrodes on the output side of said microchannel plate that are perpendicular to said input electrodes and are attached to an output sequential switcher for cyclically sweeping instantaneous output sequential voltage across each of said output electrodes wherein said cyclically sweeping instantaneous input and output sequential voltages cyclically produce a sweep of cross-over voltage points over the entire face of said microchannel plate; and

a common input electrode connected to all of said set of thin parallel input electrodes;

a common output electrode connected to all of said set of thin parallel output electrodes;

a regular bias voltage connected in series with said cyclically sweeping instantaneous input and output sequential voltages through a switch across said microchannel plate wherein said regular bias voltage is connected between said common input electrode and said common output electrode to serially add said regular bias voltage to said cyclically sweeping instantaneous input and output side of said microchannel plate at said crossover point of said input and output sequential voltages and whereby said regular bias voltage is repeatedly switched on within one complete cycle of said cyclically sweeping instantaneous input and output sequential voltages to selectively provide said high electron density area in a desired pattern; and means for converting electronic en-

ergy into visible energy at said output side of said microchannel plate for producing an image display according to said sequentially switched electron accelerating voltages.

2. An image display device as set forth in claim 1 wherein said means for converting electronic energy into visible energy is a phosphor screen.

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