March 10, 1970 M. E. CROST ET AL 3,500,102

THIN ELECTRON TUBE WITH ELECTRON EMITTERS
AT INTERSECTIONS OF CROSSED CONDUCTORS

Filed May 15, 1967

FIG. 1

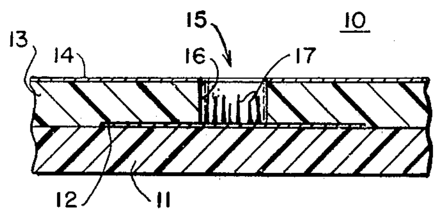


FIG. 2

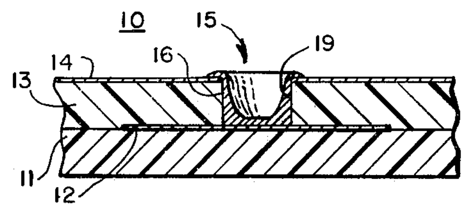


FIG. 3

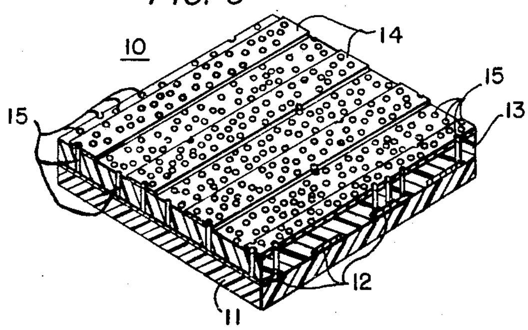


FIG. 4

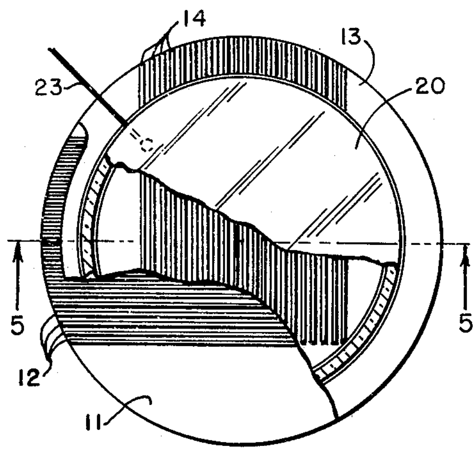


FIG. 5

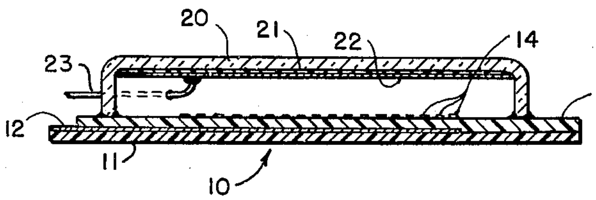
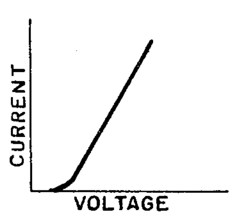


FIG. 6



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THIN ELECTRON TUBE WITH ELECTRON EMITTERS AT INTERSECTIONS OF CROSSED CONDUCTORS

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U.S. Cl. 313—109 2 Claims

ABSTRACT OF THE DISCLOSURE

The thin electron tube is made possible by providing a cathode of an extensive surface area having a large number of densely packed electron emitters spread over the area. A grid of conductors is provided on the cathode for selectively exciting predetermined ones of said emitters. Pulses applied to the conductors of the grid will cause emission at the emitters located at the points of crossing where a coincidence of pulses occur. The cathode is scanned by the pulses thereby eliminating the need for a deflecting beam to produce scanning of a target. An anode is provided at the target to impart a velocity to the emitted electrons in the direction of the target.

Background of the invention

The present invention relates to electron beam devices and more particularly to electron display tubes, storage tubes, and video pick-up tubes.

In the field of television and radar, it has been the general practice to employ cathode ray tubes having one or more electron guns which product electron beams for exciting a phosphor screen in some predetermined pattern to display information thereon. The screen is scanned by deflecting the electron beams as the information is displayed by modulating the electron density of the beam. In the television field, the modulating information is obtained originally from a camera tube such as a vidicon tube in which a charge density pattern is formed by photoconduction and stored on that surface of the photoconductor which is scanned by the deflecting electron beam.

Such prior art cathode ray tubes, camera tubes, and the like usually take the form of a rather long, funnel-shaped vacuum tubes, to provide sufficient room for deflecting the beams of electrons. Those concerned with the development of such tubes have long recognized the need for a tube which would be relatively thin. The advantages of a thin display or camera tube are rather obvious from a geometrical point of view. However, thin electron tubes are advantageous from an electrical point of view also. For example, standard color displays use three electron beams which pass through an aperature mask before striking a phosphor dot screen. Proper deflection of the beam is important to insure that the beam passes through the aperatures properly and is not aborted by the mask. It has been found, however, that standard color display devices are useless when moving in the earth's magnetic field which causes unwanted deflections of the beam and degration of the color display. Of course, if the flight time of the beam was decreased to a negligible amount there would be little or no unwanted deflections.

One of the most critical problems confronting designers of thin electron tubes has been the elimination of the need for deflecting the electron beams for scanning purposes and reducing the flight time of the electrons. The present invention overcomes this problem.

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Summary of the invention

The general purpose of the invention is to provide an electron display or camera tube which includes a cathode having an array of electron emitters extending over a considerable area which are excited by a grid of conductors. Scanning of the screen is accomplished by signals applied to the grid of conductors in such a way as to selectively cause electrons to be emitted at a point opposite the point on the screen which is to be excited.

Brief description of the drawings

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following detailed description of preferred embodiments of the invention as illustrated in the accompanying sheet of drawings in which:

FIGURES 1 and 2 show a sectional view of two different types of electron emitters used in the present invention;

FIGURE 3 shows an isometric sectional view of a portion of the cathode used in the present invention;

FIGURE 4 shows a top view of a preferred embodiment of the present invention;

FIGURE 5 shows a sectional view taken on the line **5—5** of FIGURE 4, and

FIGURE 6 shows a graph of I vs. V.

Description of the preferred embodiments

Referring now to the drawing, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIGURES 1–5 a cathode **10** having a dielectric substrate **11** for receiving a plurality of spaced, thin-film conductors **12** which may be deposited or painted thereon in a well-known manner. A thin layer **13** of dielectric material covers the conductors **12**. A second plurality of thin-film conductors **14** are spaced on the surface of film **13**. A large number of electron emitters **15** are provided on the cathode **10**. The structure of an electron emitter **15** may be of several different forms two of which are shown in FIGURES 1 and 2. An emitter **15** generally consists of an opening **16** which extends through the upper conductors **14** and the dielectric **13** to the surface of the lower conductor **12**. Provided in the opening **16** is a means which will emit electrons therefrom as a result of a sufficient voltage difference between the conductors **14** and **12**.

FIGURE 1 shows an emitting means which is made up of a plurality of conductive asperities **17** which extend into the opening **16** and terminate in a relatively sharp pointed tip. Field emission of electrons from the tips of these asperities, which may be microscopic or less in size, is possible because of the extremely high field strength or field gradient which exists at the tips thereof when a voltage is applied to conductor **14**. Of course, the voltage difference between conductors **12** and **14** may be relatively low while the field strength at the tips of asperities **17** may be extremely high as a result of the microscopic dimensions of the asperities **17**, the relatively small spacing between conductors **12** and **14**, and because the tips of asperities **17** extend close to the aperture of openings **16**.

The emitter shown in FIGURE 2 consists of a semiconductor **19** such as barium oxide placed in opening **16**. The semiconductor **19** is placed in contact with the conductors **12** and **14**. Transverse field emission will flow from semiconductor **19** when current of a proper value is passed therethrough. Electron emission of this type was reported in EDN, April 1967, pp. 14 and 15.

A representative portion of the cathode **10** is shown in FIGURE 3. The electron emitters **15** are densely spread over the surface of the cathode **10**. Emission from a particular group of electron emitters may be accomplished by pulsing simultaneously one of the conductors **12** and one of the conductors **14** with voltages of a proper value. The coincidence of these two voltages at the point of crossing of the conductors **12** and **14** which have been pulsed, will produce emission, as explained above, from those emitters **15** which are located at the point of crossing. By sequentially pulsing the conductors **12** and **14** in some predetermined manner, the cathode **10** may be scanned in any of the well-known fashions. The grid of conductors **12** and **14** may also be arranged to obtain a radial scanning effects common to ppi radar scopes. For example, conductors **14** may be arranged as concentric circles and conductors **12** may be arranged radially.

The electron tube may take the form shown in FIGURES 4 and 5 which shows an electron display device having a glass envelope **20** placed over the cathode **10**. On the inside surface of envelope **20** and opposite conductors **14** may be placed a target of a phosphor screen **21** having a thin aluminied coating **22**. A conductor **23** extends through envelope **20** and into contact with coating **22**. Coating **22** may act as an anode by placing an accelerating voltage on conductor **23**. The envelope **20** is hermetically sealed (with an insulating seal material) to the top surface of cathode **10** after which the space in the envelope **20** is then evacuated.

When electrons are emitted from the emitters **15**, as a result of applying signals to the ends of conductors **12** and **14** which extend out of the vacuum through the seal between envelope **20** and the cathode **10** thereof, the anode **23** will accelerate these electrons toward the screen **21**. The number of electrons emitted or the electron density at a particular emitter will depend on the particular voltage difference between the particular conductors **12** and **14** as determined by the I–V characteristic. A typical I–V characteristic for a field emitter is shown in FIGURE 6. Therefore, information in the form of a video display may be produced on the screen **21**.

It is pointed out that the screen **21** may also be made up of an array of phosphor dots or a series of phosphor lines which will emit at three different colors when excited and the conductors **12** and **14** scanned accordingly to provide a color picture. With certain obvious modifications, the tube may be adapted to be a camera tube or a storage tube. For example, in the case of a camera tube, accelerating and decelerating devices may be incorporated to perform their usual function. With two cathodes placed on opposite sides of a single storage target a storage tube may be provided which will permit scan conversion or other storage tube functions to be carried out. In all cases, however, the result is a tube which does not require a deflection device and the necessary space required for deflection; there will be a short flight path and an extremely thin geometry.

Obviously many other modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. The device according to claim **2** and wherein said semiconductor means is barium oxide.

2. An electron tube comprising a relatively flat extended dielectric substrate; a first group of spaced thin film conductors mounted on one surface of said substrate; a thin layer of dielectric material mounted on said one surface and covering said first group of conductors; a second group of spaced thin film conductors mounted on the surface of said thin layer of dielectric material and substantially transverse to said first group of spaced thin film conductors; said second group of conductors and said thin layer of dielectric material having a plurality of concentric openings extending therethrough to form a plurality of cavities; the base of each said cavity including a portion of one of said first group of conductors; electron emitter means comprising a semiconductor means mounted in each said opening and in contact with said conductors of said first group and said second group for emitting electrons upon the application of a predetermined potential difference between the conductors of said first and said second groups; a transparent envelope mounted on said thin layer of dielectric material and spaced from said openings to form an evacuated chamber; the surface of said envelope inside said chamber and opposite said emitters being covered with a thin conductive film and a fluorescent screen; and a conductive electrode connected to said thin conductive film and extending through said envelope whereby electrons are accelerated from said emitters toward said screen upon the application of a voltage to said electrode.

References Cited

UNITED STATES PATENTS

2,595,617	5/1952	Toulon.	
2,117,842	5/1938	George	313—336
2,858,480	10/1958	Shadowitz.	
3,091,719	5/1963	Dyke et al.	313—336 X
3,334,269	8/1967	Heureux	313—108 X

OTHER REFERENCES

EDN (Electrical Design News); April 1, 1967; pp. 14–15.

ROBERT SEGAL, Primary Examiner

U.S. Cl. X.R.

313—299, 309