

May 13, 1958

J. A. McCARTHY

2,834,900

GRID STRUCTURE

Filed Aug. 30, 1956

FIG. 1

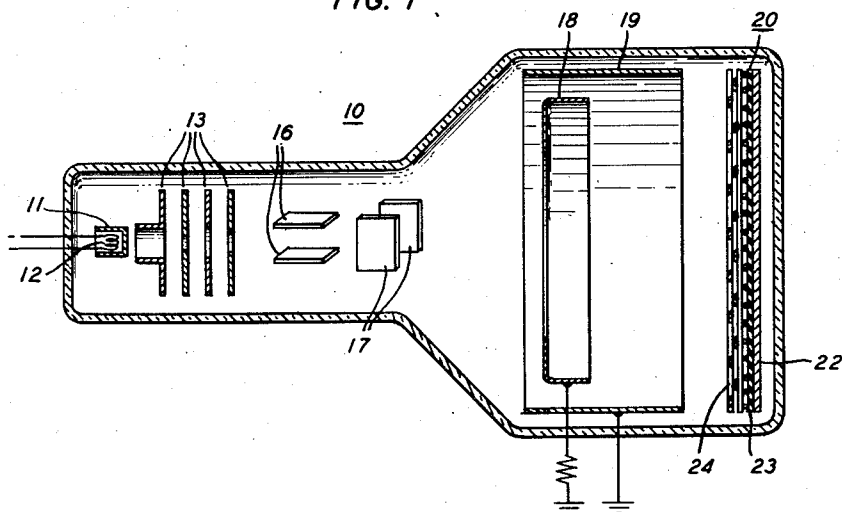
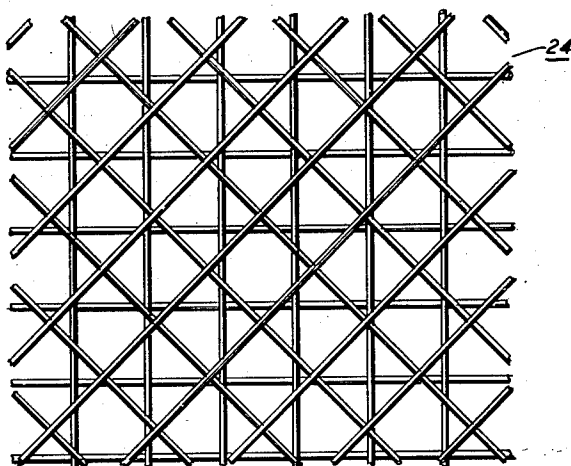


FIG. 2



INVENTOR
J. A. McCARTHY
BY *James J. Falk*

ATTORNEY

1

2,834,900

GRID STRUCTURE

John A. McCarthy, Morristown, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 30, 1956, Serial No. 607,083

5 Claims. (Cl. 313—68)

The present invention relates to electron discharge apparatus and more particularly to grid structures in cathode ray devices of the type commonly referred to as storage tubes, wherein an input signal is stored in the form of a charge distribution on the insulating surface of a target electrode for a period of time and converted into an output signal at a subsequent time.

Barrier grid storage tubes comprise generally, in one form, a target such as a dielectric sheet having a conductive member or backplate, to which the input signal may be applied, in contact with one face thereof, an electron gun for projecting a concentrated electron stream against the other face of the sheet, and a barrier grid adjacent the latter face. In the operation of such a device the beam is deflected in two coordinate directions to impinge any desired discrete area of the dielectric through the barrier grid. The operation involves, basically, two periods or cycles, one "store" or "write" and the other "remove" or "read." The backplate potential may be switched between two values, for example, zero and fifty volts. During the writing period, potential or charge on discrete areas of the bombarded face of the dielectric is varied in accordance with the input signal at the backplate, the charge change on each area being proportional to the input signal at the time the beam impinges a discrete area. During the reading period, the charges upon these discrete areas are resolved into respective potential changes in an output circuit connected to the backplate.

Fundamentally, the charging and discharging of the discrete areas above-noted results from emission of secondary electrons from a discrete area when struck by the electron beam. The dielectric surface has a secondary emission ratio greater than unity, so that on the average each electron from the beam will release more than one secondary electron from the surface. These secondaries may be allowed to escape due to a relatively more positive barrier grid, and the surface potential will rise to an equilibrium point near the barrier grid potential. Conversely, secondary electrons will return to the surface due to a relatively more negative barrier grid until the surface potential has fallen to the equilibrium point. The input signal to the backplate determines the potential of the dielectric with respect to the grid, and the output signal is obtained by detecting the secondary emission current from the dielectric under the influence of the electron beam with the backplate potential held at one of its values, for example, zero. Reading, or detecting the output signal, may be accomplished either by measuring the net target current or the secondary current alone.

Optimum operation of the barrier grid storage tube is dependent to a large extent upon several distinct properties of the barrier grid itself. These properties include high transparency to the electron beam, a grid mesh aperture size which is small in proportion to the electron beam cross section, and a ratio of grid thickness or depth to grid mesh aperture size greater than 0.5.

2

These properties will be analyzed in some detail hereinafter. However, it may be noted for present purposes that barrier grid structures in the prior art have effected improvements in one or two of these properties, but only at a sacrifice in performance with respect to the remaining properties.

One general object of this invention is to improve the performance of cathode ray devices of the storage type. More specifically it is an object of this invention to improve various properties of the barrier grid structure without sacrificing performance due to other properties, thus attaining an overall improvement in barrier grid storage tube performance due to the barrier grid structure.

In prior tubes, as referred to above, the barrier grid may comprise a thin mesh of interwoven wire having upwards of 400 wires per inch in each of two mutually perpendicular coordinates. Such a grid provides requisite high transparency to the electron beam in that the extremely fine mesh permits unobstructed passage of more than half of the incident electron beam to the dielectric surface.

Various prior barrier grid structures also have attained a grid depth to grid aperture size of 0.5 or better, which grid property is essential in order to provide a satisfactory electrostatic shield between adjacent portions of the dielectric surface. In this respect it is imperative in the barrier grid tube that redistribution of secondary electrons across the dielectric be prevented. Thus the barrier grid ideally is placed in contact with the dielectric over its entire surface with no spacings through which secondaries might find a way to reach other parts of the target. Slow secondary electrons leaving the dielectric surface are constrained by the barrier grid to return to the dielectric surface through the same mesh opening from whence they came. Fast electrons are still able to penetrate the barrier grid and be accelerated to the collector. When a barrier grid of lower depth to aperture/size ratio than approximately 0.5 is employed, the positive charges on the dielectric overbalance the barrier grid shielding effect so as to produce excessive redistribution of secondary electrons over adjacent portions of the dielectric, and tube performance is restricted. Attempts to increase this ratio by employing a thicker grid, as through an electroforming process, is expensive and not entirely satisfactory in providing high transparency to the electron beam or in satisfying the third grid property; viz., a grid mesh opening which is small in relation to the electron beam. This third property is important in minimizing signal differences which occur due to variations in the individual storage areas visible to the beam.

I have found that these three barrier grid properties can be satisfied and optimum tube performance attained in so far as the barrier grid function is concerned in a simple, efficient and inexpensive manner. In accordance with this invention a barrier grid comprises more than two layers of closely wound wires. The wires in each grid layer are mutually parallel, and the layers are fastened together in such a manner that wires of each grid layer are angularly displaced with respect to the wires of each of the other grid layers lying in parallel planes.

It is a feature of this invention that the grid structure of a barrier grid storage tube comprise more than two distinct arrays of grid wires.

It is another feature of this invention that each array comprise mutually parallel grid wires positioned in the same plane.

It is another feature of this invention that the arrays be assembled in layers wherein the grid wires are positioned in the same or parallel planes.

It is another feature of this invention that the distinct arrays be mutually angularly disposed.

A complete understanding of this invention and of these and other features thereof may be gained from consideration of the following detailed description and the accompanying drawing in which:

Fig. 1 is a diagrammatic representation of a barrier grid tube incorporating one specific illustrative embodiment of this invention; and

Fig. 2 is a diagrammatic representation of a barrier grid arrangement in accordance with one specific illustrative embodiment of this invention.

Referring now to the drawing, Fig. 1 depicts an illustrative embodiment of this invention utilizing a barrier grid storage tube 10. As known in the art, the tube 10 may advantageously comprise within an evacuated envelope, such as glass, an electron gun including a cathode 11, heater 12, accelerating and focusing electrodes 13 defining an electron lens, deflection plates 16 and 17, a collector electrode 18, a shield 19, and a target assembly 20. The target assembly 20 is a sandwich of three elements including a backplate 22, a dielectric sheet 23, and a barrier grid 24 positioned in front of the dielectric sheet 23.

The dielectric sheet 23 holds an electrostatic charge deposited on its surface by the electron beam for extended periods of time, thereby performing the storage function of the tube. The backplate 22 is insulated from the barrier grid 24, and its potential may be varied to control the charge pattern laid down by the electron beam. The charge deposited at any discrete area of the dielectric sheet 23 is subsequently detected by returning the electron beam to the discrete area.

The particular barrier grid structure employed in this illustrative embodiment of this invention, as shown in Fig. 2, comprises four distinct layers of grid wires lying in parallel planes, each layer comprising a plurality of mutually parallel fine wires. As seen in Fig. 2, each layer is positioned so that wires in adjacent layers are angularly displaced; for example, oriented at 45°, 90° and 135° with respect to the wires of the other layers.

In contrast with the grid mesh known in the prior art, wherein an array of mutually parallel wires is interwoven with a second array of mutually parallel wires oriented at 90° to the first array, the grid structure in accordance with the illustrative embodiment of this invention, as depicted in Fig. 2, accomplishes all of the necessary functions of the barrier grid to a degree unobtainable by the interwoven two array grid.

A particular grid designed in accordance with this illustrative embodiment of this invention comprises four distinct layers of 0.0003 inch diameter tungsten wire wound in a single direction with 500 wires per inch and oriented at 0°, 90°, 45° and 135°, respectively, using the grid array closest to the electron gun as a reference axis. The four layers are in contact with each other and with the dielectric storage surface.

The grid is constructed by winding one array on a frame, rotating the frame 90° and winding a second array. Two such frames are fastened together with the wound arrays in physical contact as shown in Fig. 2.

As discussed hereinbefore, storage of charge on the dielectric surface of a barrier grid tube can only be achieved on those portions of the dielectric which are visible to the electron beam through the barrier grid. Thus a high transparency to the electron beam is a desirable property of the barrier grid. The described structure achieves a transparency of 52 percent, which compares favorably with that of contemporary structures.

Uniformity of performance in the barrier grid tube demands a barrier grid having apertures or mesh openings which are small compared to the beam size. This property serves to minimize signal differences due to variations in the number of individual storage areas visible to the beam. Thus, in a simple two array or woven mesh grid known in the art, a different signal is produced when the electron beam is centered over a grid opening than when it is centered at an intersection of grid wires. The four layer grid having wires of adjacent grids angularly displaced as shown in Fig. 2 is superior in performance in this respect to the two array grid in that it presents smaller mesh openings to the incident beam.

Finally, a ratio of grid depth to grid spacing greater than 0.5 is a necessary property both for minimizing redistribution of secondary electrons and for shielding of the input writing signal. The ratio for the grid structure of Fig. 2, dimensioned as described, is greater than 0.6 and is thus highly satisfactory in achieving the desired effects.

Although a four layer grid structure has been described, the concept of this invention is equally applicable to grid structures having any number of layers greater than two.

Accordingly, it is to be understood that the described arrangement is merely illustrative of the application of the principles of the invention. Numerous other arrangements may be made by those skilled in the art without departing from the spirit and scope of this invention.

What is claimed is:

1. A barrier grid storage tube comprising a dielectric target, an electrode upon one face of said target, electron gun means for projecting a stream of electrons against the opposite face of said target, and a multilayer barrier grid adjacent said opposite face and through which said electrons are projected, said barrier grid comprising four arrays of parallel wires, the wires of each array being oriented at 45°, 90° and 135° with respect to the wires of the other arrays.

2. A barrier grid storage tube comprising a dielectric target, an electrode upon one face of said target, means for projecting an electron beam against the opposite face of said target, and a multilayer barrier grid in contact with said opposite face and through which said beam is projected, said barrier grid comprising four arrays of parallel wires, the wires of each array being oriented at 45°, 90° and 135° with respect to the wires of the other arrays.

3. A barrier grid storage tube comprising a dielectric target, an electrode upon one face of said target, electron gun means for projecting an electron beam against the opposite face of said target, and a multilayer barrier grid in contact with said opposite face and through which said beam is projected, said grid comprising four arrays of parallel wires, and having a ratio of grid depth to grid spacing greater than 0.6.

4. A barrier grid storage tube in accordance with claim 3 wherein said wires are each of 0.0003 inch diameter and said arrays each have 500 wires per inch.

5. A barrier grid storage tube in accordance with claim 3 wherein said grid has a transparency of greater than 50 percent.

References Cited in the file of this patent

UNITED STATES PATENTS

2,538,836 Jensen Jan. 23, 1951