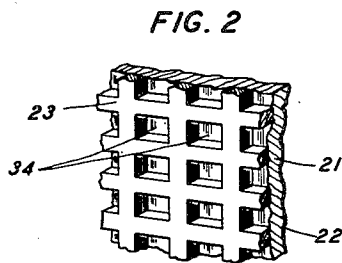
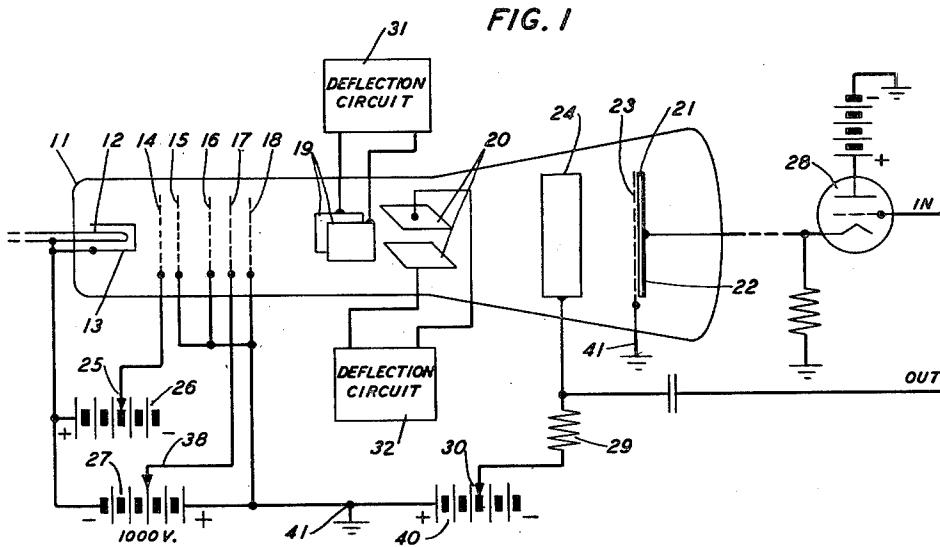


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STORAGE TUBE CIRCUIT

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This invention relates to cathode ray devices and, more particularly, to that class of devices known as barrier grid storage tubes.

It is an object of this invention to improve the performance of barrier grid storage tubes. It is also an object to increase in such tubes the signal-to-noise ratio, a factor particularly significant in devices of this kind.

A typical barrier grid storage tube to which this invention is applicable is described in the compending application of R. W. Sears Serial No. 38,125, filed July 10, 1948, which matured into United States Letters Patent 2,675,499 on April 13, 1954. The conventional barrier grid storage tube consists basically of an electron gun and deflection system for forming and deflecting an electron beam, a storage assembly composed of an insulator, a barrier grid which is a mesh grid in contact with or close to the front surface of the insulator, and a back plate of conducting metal attached to the back surface of the insulator, a signal collector which can be a ring of metal spaced near and coaxial to the storage assembly or optionally a fine mesh grid in front of the storage element, and a suppressor element which may take the form of a wall coating.

In one common mode of operation, signal storage takes place while the beam is sweeping across the surface with an input signal applied to the back plate. The output is derived across a resistance connected between the collector and a source of potential. The signal voltage raises the entire insulator surface exposed in the open spaces between the elements of the barrier grid to a positive potential with respect to the barrier grid. When the beam strikes an element of the storage surface, that element absorbs electrons from the beam and charges the barrier grid potential. When the storing cycle is complete, the signal is removed from the back plate, and the gross portion of the insulating surface returns to zero potential. Elements that were charged while the signal was applied to the back plate will be left charged with negative potentials corresponding to the amplitude of the signal at the time of charging. The stored signal is subsequently removed by scanning the entire surface of the storage cell while the back plate is held at a fixed potential. As the scanning beam moves over the gross portion of the surface, there is no signal as there is no change in conditions. However, when a charged element is reached, secondary electrons are released as the element discharges to barrier grid potential. The major portion of these electrons are captured by the barrier grid but some escape into the region in front of the barrier grid and are drawn off to the collector where they constitute the useful output signal. The total number of "escape electrons" from an element which reach the collector is apparently related to the total number of secondary electrons which discharge the element so that the output current is proportional to the potential charge of the element during discharge.

However, there are unavoidable variations in the secondary emission ratio from point to point of the storage cell, all of which must be scanned in the reproducing cycle. These variations result in spurious signals constituting, in effect, noise.

It is an object of this invention to improve the fidelity of the reproduced signals by minimizing this noise factor. The present invention permits a substantial improvement in the signal-to-noise ratio for the described kind of storage tube.

Hitherto, it was thought desirable to raise the collector

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element to a potential more positive than the barrier grid to insure the collection of a large fraction of the emitted secondary electrons. The use of a positive collector potential results, however, in very noisy operation. The present invention provides an arrangement for the operation of the collector at barrier grid potential or even at a few volts negative to it. This results in reducing the noise in some instances by as much as a factor of 100. Moreover, though it may be difficult to understand why there should be any escape electrons at all to comprise the output signal when the collector is at a negative potential with respect to barrier grid, it has been discovered that there is little deterioration of the signal even when the collector is a few volts negative. As a result, the signal-to-noise ratio is materially improved.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof in which:

Fig. 1 is a schematic diagram of a cathode ray tube and associated circuit elements constituting an illustrative embodiment in accordance with the invention; and

Fig. 2 illustrates, on an enlarged scale, a portion of the target and barrier grid structure of the tube of Fig. 1.

Referring more particularly to the drawings, the cathode ray tube illustrated in Fig. 1 comprises an evacuated enclosing envelope 11 having at one end thereof an electron gun which includes a cathode heater 12 for the thermionic cathode 13 (the primary source of the electron beam), a control grid 14, accelerating anodes 15, 16, and 18, and a focusing electrode 17. The electron gun produces a concentrated electron beam which is projected centrally between the horizontal deflection plates 19 and the vertical deflection plates 20 mounted in spaced quadrature.

The electron beam is projected against a target mounted at the other end of the envelope 11, the target comprising an insulating sheet of dielectric material 21, characterized by a secondary emission ratio greater than unity (for example mica), having on the back surface thereof a back plate or electrode 22 which may be a metal coating (for example aluminum evaporated on the back surface of the dielectric sheet), and, on the front face of the dielectric sheet 21, a barrier grid 23 which comprises a fine screen (for example 400 mesh, 0.001 inch thick, and of stainless steel) placed in smooth contact with the insulating sheet 21. Interposed between the electron gun assembly and the target assembly, and in close proximity with the latter, is the collector electrode 24, normal to the axis of the tube and rectangular in axial cross-section. The cathode 13 is connected to the negative terminal of the voltage source 27 which may be of the order of 700 to 1000 volts. The positive terminal of source 27, which is connected to ground 41, is connected to the accelerating anodes 15, 16, and 18 and supplies the accelerating potentials. Focus control is achieved by connecting the focusing electrode 17 to a tap 38, which may be varied, across source 27. The intensity of the electron beam is varied by adjusting the tap 25 which connects the beam control grid 14 to the negative terminal of the voltage source 26, the positive terminal thereof being returned to the cathode 13. Blocking signals, if desired, may be impressed on the control grid 14 in accordance with common practice. The deflecting plates 19 and 20 are connected to the deflection circuits 31 and 32 respectively, which may comprise sweep circuits, well known in the cathode ray tube art, for sweeping the beam across the face of the target in the manner desired. The input signals are applied to the back plate 22. Here, by way of example, for purposes of illustration, the signal is supplied by a cathode follower circuit 28. The output voltage is derived across the output resistance 29, one terminal of which is connected to the collector 24, the other of which is connected to the tap 30 (which may be varied) across the voltage source 40 whose positive terminal is also fixed at ground potential. This permits the voltage on the collector 24 to be varied from approximately ground to a negative voltage substantially equal to the voltage of source 40, which is of the order of 10

volts. The barrier grid 23 is connected to ground 41.

The advantage of this circuit over those of the prior art lies in the increased signal-to-noise ratio obtainable and results from the operation of the collector 24 at the same potential or at one slightly negative with respect to the barrier grid 23, in contradistinction to the conventional and superficially more logical mode of operation which consists of keeping the signal collector 24 positive with respect to the barrier grid 23. Though, in fact, the signal output is slightly reduced when operated in accordance with the invention, this reduction is considerably smaller than might be anticipated and is more than compensated by the large reduction in noise level, resulting in a decided improvement in the signal-to-noise ratio.

Referring now to Fig. 2, there is shown, on an enlarged scale, a portion of the target assembly. The elements 34 are those elemental areas of the surface of dielectric sheet 21 between the wires of the barrier grid 23 which are bombarded by the scanning beam.

For the purpose of simple analysis, suppose that a repeating saw-tooth sweep voltage is applied between the horizontal deflection plates 19 to sweep the beam across the face of the insulator 21, that input signals are applied to the back plate 22 only during the odd-numbered time intervals of the sweep, and that, during the even-numbered time intervals, the back plate 22 is maintained at the barrier grid or ground potential. Now, let a positive signal be applied during the odd-numbered time intervals to the back plate 22. By electrostatic coupling, this raises the face of the dielectric sheet 21, which is composed of the elements 34, to a positive potential. Those elements 34 of the surface of dielectric 21 which are bombarded by the scanning beam will be discharged to barrier grid potential by the absorption of electrons from the beam, and the gross portion which is not so bombarded will remain unchanged. Now, at the end of this sweep interval, let the signal to the back plate 22 be removed, allowing the latter to return to the barrier grid potential. The gross portion of the surface of dielectric 21 will return to the barrier grid potential. Those elements 34 which were bombarded, however, will be at a negative potential because of an accumulation of negative charge. Thus, there will be a charge distribution on each elemental area 34 of the surface of dielectric 21 corresponding in intensity to the amplitude of the input signal at the time the scanning beam impinged thereon during the storing interval. Since the storage insulator 21 has very high resistivity, the charge pattern will remain relatively stable for some time, constituting storage. This constitutes the charging or storing interval. This process, described above, is well known in the art and fully explained in the R. C. A. Review of March 1948, page 112, in an article entitled "Barrier Grid Storage Tube and its Operation." The reading is somewhat simpler and is done during the even-numbered sweep intervals. The back plate 22 is kept at the barrier grid potential as the scanning beam sweeps over the surface of dielectric 21 again. There will be a dynamic signal only when those elements 34 which were charged to a negative potential with respect to the barrier grid are discharged during the even-numbered time intervals of the sweep and return to the initial quiescent condition. Since there was an accumulation of electrons on the elements 34, these must now be given up during this reading cycle. This is possible because the secondary emission ratio of the surface of dielectric 21 is greater than unity. Most of these emitted secondary electrons are captured by the barrier grid 23, but some escape to the collector 24. These latter constitute the useful output signal which is developed across the load resistance 29 in the collector circuit.

On first appearance, it would seem logical, and it is indeed normal, to operate the signal collector

24 at a potential positive with respect to the barrier grid 23 to obtain the maximum collection efficiency. This, however, has been found to result in a high noise level resulting from variations in the secondary emission as the beam moves in its scanning pattern. A considerable portion of this noise is a result of variations in the secondary emission from the barrier grid 23 itself. Operation of the collector 24 at approximately zero or even at negative potentials with respect to the barrier grid 23 minimizes the attraction field and deters the collection of secondary electrons. Though it might be expected that the collection of all secondary electrons would be limited in the same way, experimentally this has been found not to be the case. Actual tests have indicated that the collection of noise electrons is appreciably more retarded. One explanation for this apparent inconsistency may be that the whole collection operation is marginal and that the influence of the collector field has hitherto been overemphasized. Even with a positive potential on the collector 24, the field produced thereby must be very small at the surface of the insulator 21 due to the shielding effect on individual elements 34 contributed by the barrier grid 23. At the end of the storing cycle, a charged element 34 is considerably negative with respect to the barrier grid 23. Hence, during the reading cycle, one can easily believe that a large portion of the secondary electrons from the charged elements 34 are drawn to the barrier grid 23 because of its strong field caused by its close proximity. Those that do escape to the collector may be either those with velocity components lying very close to the axis of the scanning beam or those with very high velocities corresponding to the energy of the bombarding primary electrons, or both. It is reasonable to believe that if these electrons escape at all, they will do so regardless of the potential of a relatively remote collector. Having escaped, they may be collected, though the collector, with respect to the barrier grid, is at the same or at a small negative potential.

It is to be understood that the above-described arrangement is illustrative of the principles of the invention. Other specific arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In combination, a cathode-ray device comprising a dielectric sheet, a first electrode upon the back face of said sheet, a barrier grid adjacent the front face of said sheet and parallel thereto, means for projecting and deflecting an electron beam across said front face, and a collector electrode adjacent said barrier grid, and a voltage supply having positive and negative terminals, the positive terminal being connected to said barrier grid and the negative terminal to said collector electrode.

2. The combination of claim 1 in further combination with an input circuit connected to said first electrode and an output circuit connected to the collector electrode.

3. In combination, a cathode-ray device comprising a dielectric sheet, a first electrode upon the back face of said sheet, a barrier grid adjacent the front face of said sheet and parallel thereto, means for projecting and deflecting an electron beam across said front face, and a collector electrode adjacent said barrier grid, and biasing means connected between said collector electrode and said barrier grid for maintaining the collector electrode at a negative potential with respect to said grid.

4. The combination of claim 3 in further combination with an input circuit connected to said first electrode and an output circuit connected to the collector electrode.

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