

[54] **OPERATIONALLY RUGGED DIRECT VIEW STORAGE TUBE**

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[58] Field of Search **313/68, 68 A, 68 B, 89**

[56] **References Cited**

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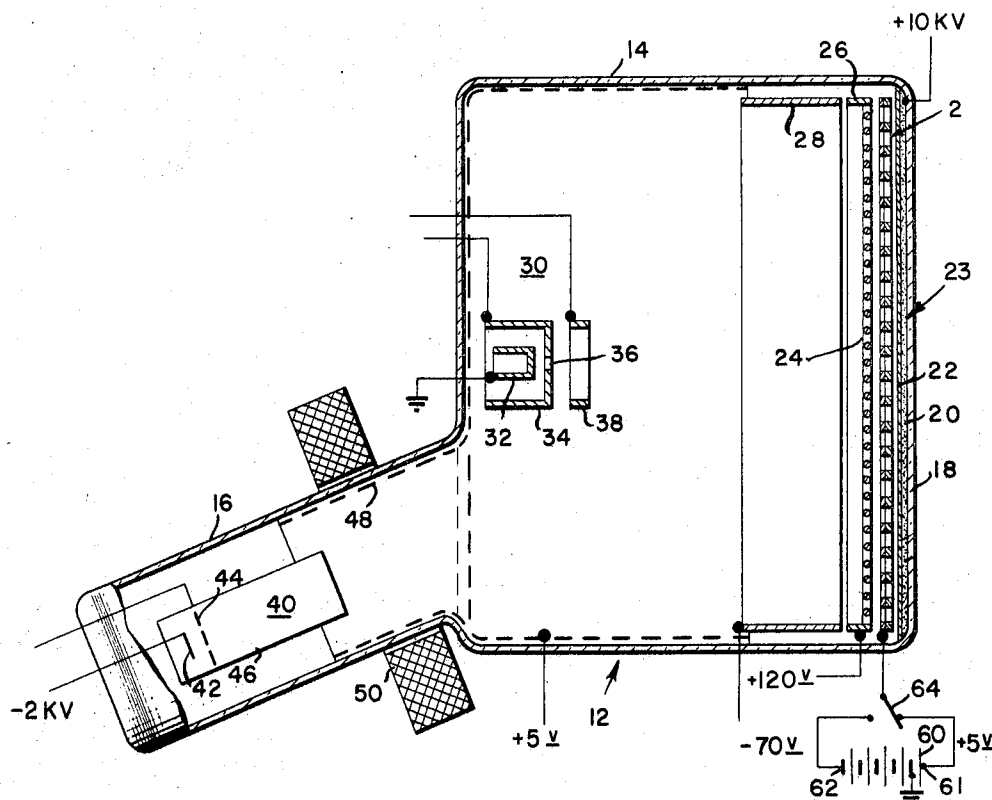
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[57] **ABSTRACT**

The present invention relates to an improved direct view storage tube having a non-storage mode of operation and incorporating an operationally rugged storage target with greatly improved retained image characteristics. This is generally achieved by using an overlay on the storage target having less resistance, a lower secondary emission ratio and a greatly enhanced bombardment induced conductivity effect compared to the characteristics of the storage target dielectric.

4 Claims, 3 Drawing Figures



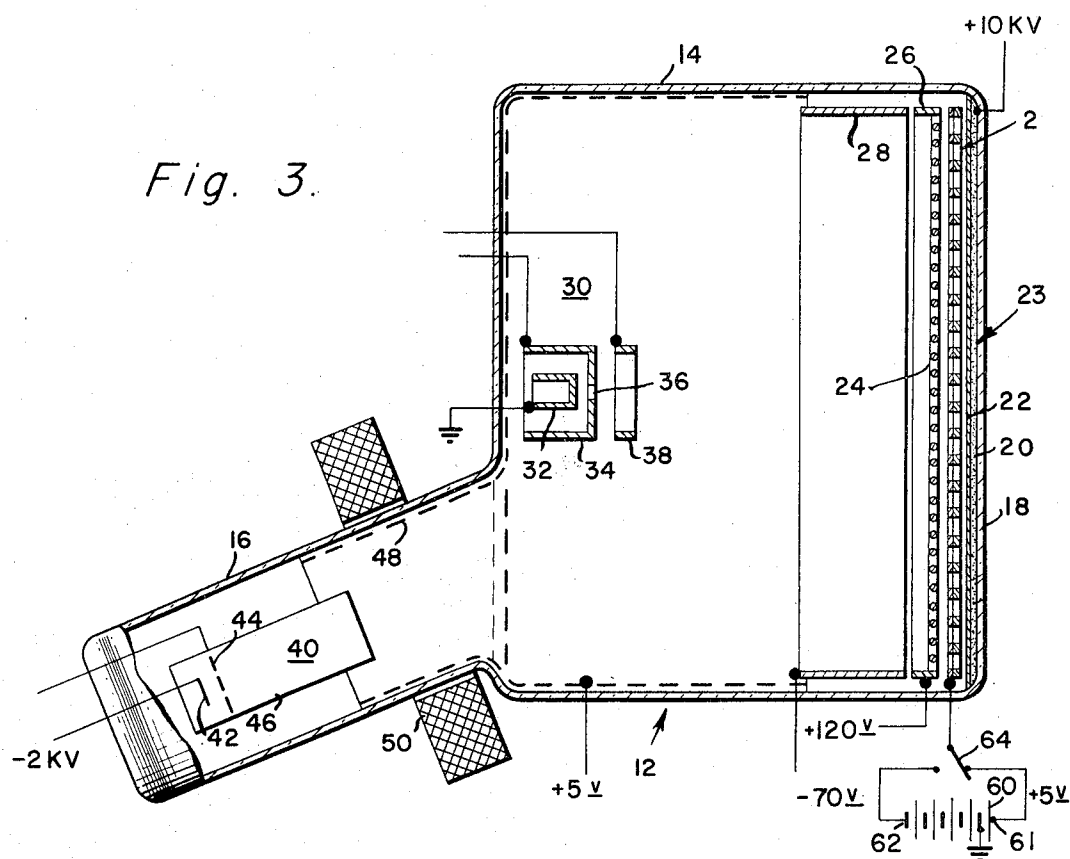


Fig. 2.

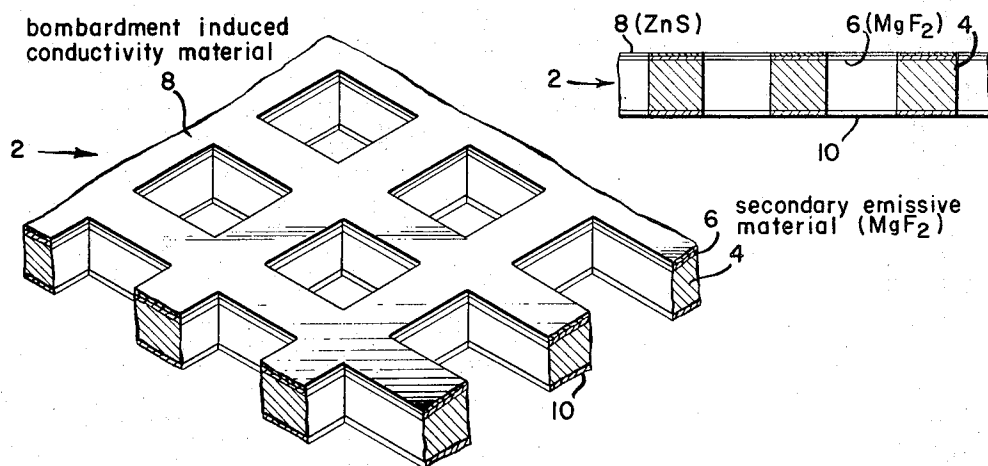


Fig. 1.

OPERATIONALLY RUGGED DIRECT VIEW STORAGE TUBE

BACKGROUND OF THE INVENTION

One of the requirements for a storage tube of the type herein disclosed is to operate under both a store and a non-store mode, i.e., operate as a cathode ray tube and as a direct view storage tube. The non-store mode requires the storage mesh potential to be switched from about +5 volts above the flood beam cathode potential normally used in the storage mode to -70 volts negative thereto while the potential of other electrodes remain unchanged. Although the flood beam is allowed to remain in the "on" condition, the negative potential of the storage target repels all the flood electrons from the viewing screen. A non-store cathode ray tube display is achieved by simply bombarding the viewing screen with a high energy modulated write beam. After several minutes of non-store display operation, however, a contemporary storage target characteristically shows a pronounced bright retained image when the mode of operation is changed back to the storage mode of display. This retained image remains visible from ten to longer than thirty minutes which retention is considered objectionable.

SUMMARY OF THE INVENTION

The design of the disclosed storage target is similar to that found in the contemporary direct view storage tube with the exception that a dual layer storage target is used which consists of a substrate layer approximately one-half micron thick of dielectric that has a high resistance and good secondary electron emission characteristics on one side thereof with an approximate 0.4 micron thick overlay of a dielectric having enhanced bombardment induced conductivity characteristics and a lower resistance and secondary electron emission ratio than the substrate layer. Magnesium fluoride and zinc sulfide have been used successfully as the substrate dielectric and overlay, respectively.

The operational principle involved in the dual-layer storage target is one of balancing a negatively charged retained image with a positively charged retained image. The bright retained image of a contemporary storage target with a magnesium fluoride dielectric is caused by positive space charge buried within the dielectric by the high energy beam bombardment in conjunction with the high secondary electron emission ratio of the magnesium fluoride. With more secondary electrons leaving the dielectric surface than primary electrons arriving, a positively charged region forms beneath the dielectric surface which can gradually go deeper as the gradient increases within the dielectric. Because of the long relaxation time for insulators, this positive space charge causes a bright retained image when the tube is again operated in the storage mode.

When a material of the type described above for the overlay material is used as the storage dielectric, a dark retained image forms even when operated in the same manner which gave a bright retained image with a magnesium fluoride storage target. In this instance a negative space charge forms within the material when continuously bombarded by the high energy beam which gives a dark image which gradually fades during a sub-

sequent storage mode due to gradual relaxation of the concomitant space charge.

In accordance with the present invention the composite retained image of a dual mode direct view storage tube is minimized by balancing the bright retained image of the substrate dielectric on the storage target with a dark retained image provided by an overlay material that has an enhanced bombardment induced conductivity ratio and lower resistivity than the substrate dielectric. It is essential that the substrate and overlay dielectric materials be evaporated on the storage target in the order described above for effective cancellation of the retained image.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cut-away perspective view of the storage target of the present invention;

FIG. 2 is a cross-sectional elevational view of the storage target shown in FIG. 1; and

FIG. 3 is a partially cross-sectional and partially schematic view of a cathode ray storage tube employing the storage target of the present invention.

DESCRIPTION

Referring now to FIGS. 1 and 2 a storage target 2 according to the invention is shown comprising a nickel mesh 4, which may be electroformed, having disposed on one side thereof a thin layer or film 6 approximately 0.5 micron thick of magnesium fluoride which has secondary electron emission properties and a resistivity greater than 10^{15} ohm-centimeters. The magnesium fluoride film 6 may be formed on the mesh 4 by an evaporation process performed in a conventional manner. Further, a thin overlayer 8 approximately 0.4 micron thick of dielectric material having greatly enhanced bombardment induced conductivity effect compared to magnesium fluoride such as zinc sulfide is disposed over the magnesium fluoride film 6. Thus, for example, a thin 0.4 micron thick film 8 of zinc sulfide may be evaporated onto and over the layer 6 of magnesium fluoride.

In addition to the above, it may also be advisable to evaporate a thin film 10 of gold onto and over the side of mesh 4 opposite the side on which the layer 6 of magnesium fluoride is disposed in order to cover any dielectric particles which may have inadvertently been deposited on this side. Such particles tend to charge in an irregular pattern making the display non-uniform.

Referring now to FIG. 3, a half-tone visual display cathode ray tube 12 is shown incorporating the storage target 2 of the present invention. The tube 12 comprises an evacuated envelope formed by a comparatively large cylindrical section 14 and a narrower neck portion 16 communicating therewith at one side thereof (hereinafter referred to as the neck or gun side). The neck section 16 may be disposed, as shown, at an angle with respect to the main longitudinal axis of the larger cylindrical section 14. The side of the large cylindrical section 14 opposite the neck side comprises a face-plate 18 over the inner surface of which is a layer 20 of phosphor material covered with a thin film of aluminum 22 to provide a viewing screen 23. Adjacent and coextensive with the viewing screen 23 is the storage target 2 as described previously and shown in FIGS. 1 and 2. Continuing to proceed from the viewing screen end of the tube toward the gun section, a collector grid 24 is disposed adjacent and coextensive with the stor-

age target 2. The collector grid 24 comprises a conductive screen supported about its periphery by an annular ring 26. The transparency of this screen is preferably of the order of 80 percent; the function of the grid 24 is to collect secondary electrons emitted from the storage target 2. During operation, the grid 24 is maintained at 120 volts positive relative to ground. Adjacent the collector grid 24 is a collimating electrode 28 in the form of a cylindrical can, the purpose of which is to collimate flood or viewing electrons from a flood gun 30 which is disposed at the gun side of the tube section 14. The flood gun 30, which may be on the longitudinal axis of the larger cylindrical portion 14 of the tube 12, comprises a cathode 32 which is referenced directly to ground and an intensity electrode 34 which encloses the cathode 32 except for a small aperture 36 disposed over the central portion of the cathode 32. An annular electrode 38 is disposed adjacent the intensity electrode 34 and coaxially with respect to the longitudinal axis of the tube 12 which also passes through the center of the aperture 36 in the intensity electrode 34.

The neck portion 16 of the tube 12 houses an electron gun 40 which may be of conventional construction. The gun 40 comprises a cathode 42, an intensity electrode grid 44, and a cylindrical beam-forming section 46. During operation, a potential of -2,000 volts relative to ground is maintained on cathode 42. An equipotential region is maintained throughout the neck portion 16 and the larger cylindrical section 14 of the tube 12 by means of a conductive layer 48 which may be coated over the interior surfaces of the tube as shown. During operation, a potential of about 5 volts positive may be maintained on this conductive layer. The beam from electron gun 40 is scanned over the storage target 2 by means of a magnetic deflection coil 50 disposed about the neck portion 16 of tube 12 coextensive with a portion of the beam from electron gun 40.

Switching from the direct-viewing mode to the non-storage mode is achieved by switching the voltage applied to metal mesh 4 of storage target 2 from 5 volts positive to seventy volts negative relative to ground. This may be achieved by referencing an intermediate terminal of a battery 60 to ground in such a manner as to provide a 5 volts positive terminal 61 and a 70 volt negative terminal 62. Terminals 61, 62 of battery 60 are connected through a double-throw single-pole switch 64 to the metal mesh 4 of storage target 2, thereby enabling either +5 volts or -70 volts to be applied to mesh 4 of storage target 2 by selecting an appropriate position of the switch 64.

In the direct-viewing storage tube mode of operation, the mesh 4 of storage target 2 is maintained at +5 volts relative to ground by appropriate positioning of switch 64. The writing beam from gun 40 is scanned over storage target 2 and concurrently modulated with information to produce a charge pattern thereon in a conventional manner. This charge pattern controls the flow of electrons from flood gun 40 to viewing screen 23 to produce a visual display. In the non-storage mode of operation, the switch 64 is positioned to apply -70 volts to mesh 4 which acts to repel these flood electrons whereby the charge pattern on storage target 2 is not displayed. The high energy beam from electron gun 40, however, penetrates through the storage target 2 and produces a visual display on the viewing screen 23. In doing this, a positive space charge is buried within the

dielectric as a result of the bombardment by the two kilovolt beam from electron gun 40 and the concomitant high secondary electron emission ratio of the MgF_2 layer 6. With more secondary electrons leaving the dielectric surface than primary electrons arriving, a positively charged region forms beneath the dielectric surface of storage target 2 which can gradually go deeper as the voltage gradient increases within the dielectric. Because of the long relaxation time for insulators, this positive space charge causes a bright retained image when the tube is again operated in the storage mode.

In accordance with the invention, this bright retained image is balanced, i.e., neutralized by a dark retained image developed in the overlayer 8. The enhanced bombardment induced conductivity of overlayer 8 allows the high energy electrons to penetrate through and impinge on the substrate layer 6. The lower secondary electron emission ratio of overlayer 8 together with its intercepting some of the secondary electrons from substrate layer 6 results in a negative charge build-up which causes the dark retained image in the storage mode. The overlayer 8, since it is on top of the substrate layer 6, tends to balance the light with the dark retained image, thereby essentially neutralizing the overall retained image. Thus, in addition to the overlayer 8 being of an appropriate thickness, it should have an enhanced bombardment induced conductivity characteristic, a lower secondary electron emission ratio than that of the substrate layer 6 and a lower resistivity than that of the substrate layer 6. As previously specified, a suitable dielectric material for overlayer 8 is zinc sulfide in which case the thickness of overlayer 8 should be of the order of 0.4 micron.

What is claimed is:

1. A direct-viewing cathode-ray type tube having storage and non-storage modes of operation, said tube comprising a storage target including a conductive support mesh having a first layer of dielectric material disposed on one side thereof and a second layer of dielectric material disposed over said first layer of dielectric material said second layer of dielectric material having a lower resistivity, enhanced bombardment induced conductivity characteristics and a lower secondary electron emission ratio than said first layer of dielectric material;

a viewing screen disposed adjacent to and coextensive with said storage target on the side of said conductive support mesh opposite said one side thereof;

an electron source of predetermined potential level for directing flood electrons uniformly over said storage target from said one side of said conductive support mesh;

means for collecting secondary electrons from said storage target; and

means for scanning said storage target with a high-energy amplitude-modulated electron beam from said one side of said conductive support mesh thereby to produce a charge pattern on said storage target and to penetrate through said storage target to produce a visual image on said viewing screen.

2. The storage target for a storage tube as recited in claim 1 wherein said first dielectric material is magnesium fluoride and said second dielectric material is zinc sulfide.

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3. The storage target for a storage tube as recited in claim 2 wherein said layer of magnesium fluoride is no more than 0.5 micron thick and said thin layer of zinc sulfide is no more than 0.4 micron thick.

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4. The storage target for a storage tube as recited in claim 2 wherein a layer of metal is evaporated on said mesh on the side opposite said magnesium fluoride.
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