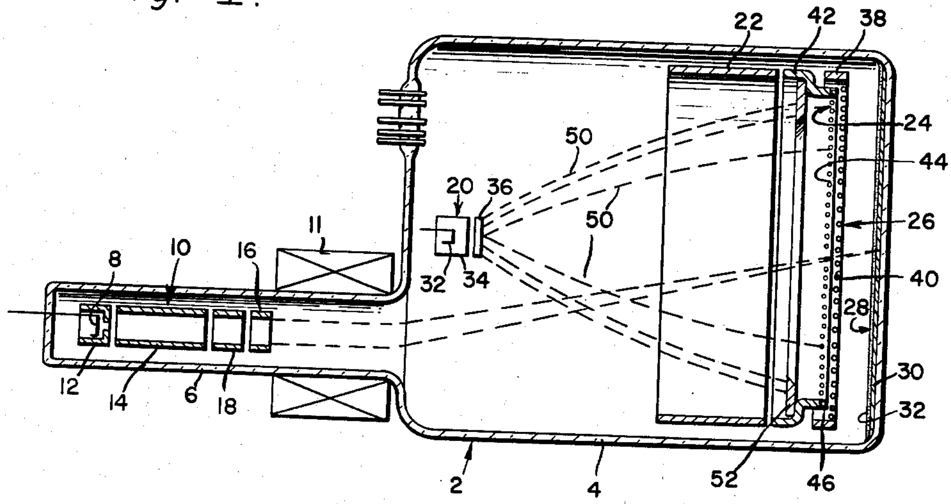
March 15, 1960 K. R. HESSE 2,928,970

ELECTRON DISPLAY DEVICE AND IMPROVEMENT THEREFOR

Filed Oct. 1, 1958

2 Sheets-Sheet 1

Fig. 1.



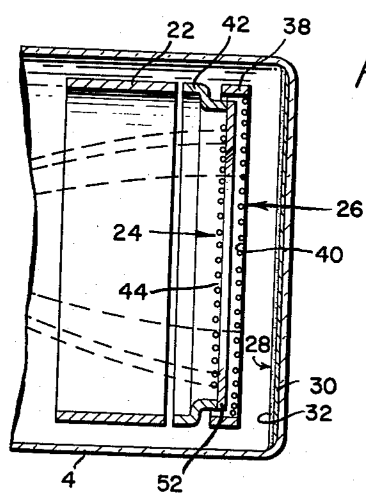


Fig. 2.

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Fig. 3.

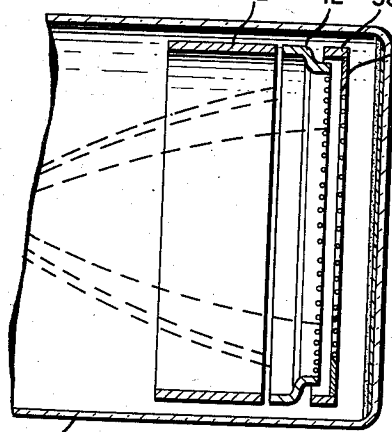


Fig. 4.

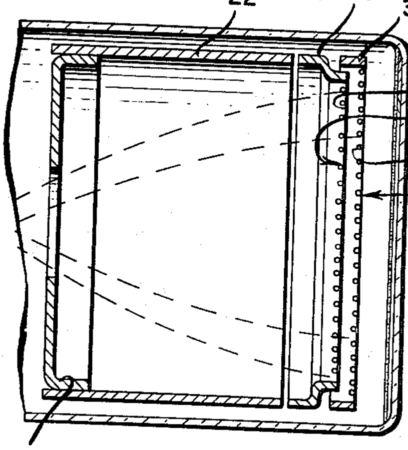
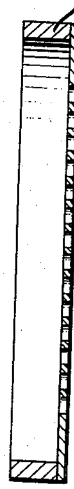


Fig. 5.



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ELECTRON DISPLAY DEVICE AND IMPROVEMENT THEREFOR

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Application October 1, 1958, Serial No. 764,539

1 Claim. (Cl. 313—68)

This invention relates to cathode ray tubes for visually displaying information. More particularly, the invention relates to direct-viewing cathode ray storage tubes and to means for eliminating undesirable illumination effects.

Direct-viewing cathode ray storage tubes generally employ a relatively high velocity electron beam which scans a storage target in accordance with intelligence signals to establish a charge pattern on the storage target corresponding to the information to be stored and presented. The storage target is sprayed or flooded with a relatively broad beam of electrons which pass through the storage target according to the potentials of the discrete areas thereof defining the stored charge pattern and are then accelerated to impinge upon the viewing screen to create a visual replica of the stored charge pattern. The operation of such cathode ray tubes is well-known and a full description thereof may be found in U.S. Patent No. 2,790,929, issued to E. E. Herman and G. F. Smith, entitled "Direct-Viewing Half-Tone Storage Device." In flooding the storage target with the broad beam of electrons (sometimes called "viewing" electrons), it will be appreciated that a uniform distribution over the storage surface of these electrons is desirable, and further that all of the "viewing" electrons have substantially the same velocity, and further that the viewing electrons impinge substantially normally on the storage surface, or else variations in the intensity and accuracy of presentation will result. To achieve these ends, the flood or viewing electrons are collimated over the entire area of the storage surface by means of a collimating electron lens system, as is also well understood in the art.

It has been observed in operation of direct-viewing storage tubes of the character described that the visual display is often surrounded at the periphery thereof by a bright ring of light. This peripheral illumination is apparently produced in part by flood electrons which are reflected from the walls of the collimating lens system as well as from the walls of the collector electrode employed in these tubes. It is also suspected that this peripheral illumination is due in part to non-reflected flood electrons which, for one reason or another, have suffered deviations in their paths, perhaps because of their proximity to the edge of the collimated beam.

This peripheral illumination appears as a ring approximately 1/32" in width in a storage tube having a 5" display, for example. Very often the width of this ring is not as wide on one side of the presentation and hence an unpleasant off-center effect is created. The ring also creates a halo of about 3/8" wide by light from the ring which is internally reflected within the glass faceplate of the tube. This halo effect degrades contrast at the edge of the display.

It is therefore an object of the present invention to provide an improved direct-viewing cathode ray tube of the type utilizing a collimated beam of flood electrons with means to prevent stray flood electrons from reaching and exciting undesired portions of the viewing surface.

Another object of the invention is to provide improved means in direct-viewing cathode ray storage tubes of the type utilizing a collimated beam of flood electrons for preventing stray or "off-path" flood electrons from reaching and exciting undesired portions of the viewing surface.

These and other objects and advantages of the invention are realized by providing an inwardly extending ring or skirt on the ring support for the collector grid, for example, in a direct-viewing storage type cathode ray tube. This inwardly extending ring may be butt-welded, for example, to the collector ring support with the collector mesh therebetween so as to serve the objects of the invention as well as to anchor or secure the collector mesh to the collector ring support. Other embodiments of the invention are also contemplated which will be described hereinafter.

The invention will be described in greater detail by reference to the drawings in which:

Fig. 1 is an elevational schematic diagram of a direct-viewing cathode ray storage tube showing one embodiment of the invention;

Fig. 2 is an elevational schematic diagram of a portion of the tube of Fig. 1 showing a second embodiment of the invention in which the shield ring is mounted on the support ring for the collector electrode so as to secure the collector mesh thereto;

Fig. 3 is a elevational schematic diagram of a portion of the tube of Fig. 1 showing a third embodiment of the invention in which the shield ring is mounted on the support ring for the storage electrode;

Fig. 4 is an elevational schematic diagram of a portion of the tube of Fig. 1 showing another embodiment of the invention in which the shield ring is mounted on a collimating electrode; and

Fig. 5 is an elevational sectional view of a unitary shield ring and collector or storage mesh assembly.

Referring now to Fig. 1, a direct-viewing storage tube of the type in which the invention has particular use comprises an evacuated envelope 2 having an enlarged cylindrical portion or bulb 4 and a neck portion or stem 6. Disposed in the neck portion 6 is a "writing" beam cathode 8 and an electron gun 10 for producing an electron beam of elemental cross-sectional area. An electromagnetic deflection coil 11 is disposed around the neck 6 for deflecting the "writing" beam both horizontally and vertically as is well understood in the art. The electron gun 10 comprises the cathode 8, an intensity grid 12 (which modulates the beam intensity in accordance with intelligence signals impressed thereon), accelerating electrodes 14 and 16 and a focusing electrode 18. As the construction and operation of such electron guns is well understood, further description thereof will not be given herein.

Disposed in the bulb portion 4 is a "flood" gun 20, a collimating electrode 22, a collector electrode 24, a storage target 26, and a viewing screen 28. The viewing screen 28 comprises a transparent conductive coating 30 of stannous oxide, for example, with a layer 32 of phosphor material coated thereover. The transparent conductive coating 30 serves as an accelerating electrode for "flood" electrons penetrating the storage target 26 as will be explained more fully hereinafter. The "flood" gun 20 comprises a cathode 32 surrounded by an intensity modulating grid 34 and an annular electrode 36 which serves as an accelerating electrode. The "flood" gun 20 develops a broad beam of electrons which is directed towards the storage target 26. In the operation of the tube it is desirable that the "flood" electrons be collimated so as to arrive on the storage target 26 at approximately normal incidence. Collimation of the flood electrons is achieved by means of the collimating lens produced between the cylindrical electrode 22 and the collector electrode 24. More than one cylindrical electrode constituted by conductive coatings of graphite on the inside of the bulb 4 may be employed in conjunction with the electrode 22 shown as taught in the aforementioned patent to Herman and Smith.

The storage target 26 comprises a ring support member 38 having an electroformed nickel screen 40 welded thereacross. The nickel screen may have a thickness of 0.001 inch and about 250 meshes per inch, for example. A storage surface is constituted by a thin layer (not shown) of secondary electron emissive material coated on the side of the screen facing the "writing" gun 10. The secondary emissive material may be magnesium fluoride, for example, applied by evaporation and deposition thereof and having a thickness of 20,000 to 50,000 Angstroms, for example.

The collector electrode 24 likewise comprises a ring support member 42 having an electroformed nickel screen 44 tautly stretched thereacross and welded thereto. In the embodiment shown in Fig. 1, the collector grid 44 is sandwiched between the ring support member 42 and a shroud ring 46 which is welded to the collector ring support 42. The collector grid 44 may have a thickness of about 0.0004" to 0.0008" and about 250 openings per inch.

In operation an elemental stream of electrons is generated by the "writing" electron gun 10 and intensity modulated in accordance with intelligence signals representing information to be stored and displayed. As is well understood in the art, the "writing" beam, upon being deflected to desired portions of the storage target 26, establishes a charge pattern thereon according to the information to be stored and displayed. More specifically, the storage target 26 is normally maintained at a uniform negative potential level with respect to the "flood" gun cathode 32. Bombardment by the relatively high velocity "writing" beam causes impinged areas of the storage target 26 to become more positive with respect to the "flood" gun cathode 32 by the phenomenon of secondary electron emission. These secondary electrons are collected by the collector electrode 24. In order to render the stored information visible, a relatively low velocity broad beam of electrons is provided by the "flood" gun 20 and is collimated by the collimating electrode 22 as is also well understood in the art. The "flood" electrons are continuously distributed evenly over the entire storage target and pass therethrough wherever more positively charged areas are encountered to strike the viewing screen 28 and thereby excite the impinged areas thereof to luminescence. "Flood" electrons which encounter comparatively negatively charged portions of the storage target are prevented from passing there through. In this manner information may be stored and presented relatively indefinitely.

Referring now to Fig. 1, the dotted lines 50 represent "flood" electrons emanating from the "flood" gun 20. These electrons are subjected to the influence of the collimating electrode 22 and approach the storage target substantially perpendicularly thereto. It is believed that some of the "flood" electrons, particularly those in peripheral portions of the "flood" beam, are apparently able to penetrate the periphery of the storage target 26, striking the viewing screen and producing the aforementioned bright ring of light surrounding the display area. This may be due to the fact that electrons in the peripheral portions of the "flood" beam travel in somewhat distorted paths due to being reflected from the walls of the collimating electrode or electrodes as well as from the walls of the collector electrode. According to one embodiment of the invention such action may be prevented by securing a ring shield 52 which is impervious to electrons inside and to the collector support ring 42 which

acts to intercept peripheral electrons, traveling in distorted paths, from reaching the storage target and viewing screen. In this embodiment, the inside diameter of the ring shield 52 may be made just slightly larger than the minimum useable display area of the viewing screen. For example, a 5" diameter tube having a 4" diameter display would require a ring shield having an aperture diameter of about 4.01". It is generally preferable to bevel the "under" side of (or the side which is "away" from approaching electrons) so that a knife edge is produced to limit the electron beam. In addition the collimating voltage may be adjusted so that the area of the "flood" beam just barely overlaps the aperture diameter of the ring shield.

Referring to Fig. 2, an alternative embodiment of the invention is shown wherein an electron impervious ring shield 52 is welded to the collector support ring 42 over the collector mesh thus eliminating the need of a separate shroud ring for this purpose. The shield ring 52 in this embodiment thus serves the dual function of shielding the viewing screen from stray electrons and of securing the collector mesh tautly to the collector support ring.

In Fig. 3 another embodiment is shown wherein an electron impervious shield ring 52 is welded to the support ring 38 for the storage target 26. As shown, the shield ring 52 is welded so as to secure the storage target mesh 40 to the support ring 38 therefor. The shield ring 52 may alternatively be welded to the inner surface of the support ring 38 separately from the storage mesh 40 much as is shown in the embodiment of Fig. 1 wherein the shield ring is mounted inside the collector electrode support ring.

It is also possible to achieve the objects of the invention by mounting an electron impervious shield ring 52 on the collimating electrode 22 as shown in the embodiment of Fig. 3. In this embodiment it will be observed that the internal or aperture diameter of the shield ring is considerably smaller than in the embodiments described thus far. As shown in the various figures of the drawings the "flood" beam is divergent as it travels from the "flood" gun 20 toward the collimating and collector electrodes 22 and 24 respectively, and that the lens action of the collimating electrode 22 ultimately brings the "flood" beam into a path substantially normal to the storage target 26. Hence it will be appreciated that the mean diameter of the "flood" beam is dependent upon the distance from the source thereof until it is no longer diverging and is on a path substantially normal to the storage target 26 as the beam emerges from the collimating lens. Hence the internal or aperture diameter of the shield ring is determined to a certain extent by its location with respect to the "flood" electron gun 20; that is, for positions whereat the "flood" beam is still diverging and not fully collimated, as for example, the position thereof shown in Fig. 4, the internal diameter of the shield ring is dependent upon its location with respect to the "flood" gun, and the nearer the shield ring is mounted to the "flood" gun, the more nearly its internal diameter will approach that of the flood gun structure itself. For positions whereat the "flood" beam has been collimated and is no longer diverging, the internal or aperture diameter of the shield ring is relatively independent of the position of the shield ring and may be substantially constant for any position. In any case, the internal or aperture diameter of the shield ring is always selected to be just sufficient to intercept electrons in the peripheral portions of the "flood" beam. To sum up the relationship between the internal diameter of the shield ring and its position with respect to the "flood" gun or beam, it may be said in general that if the shield ring is positioned on a collimating electrode or at any location nearer the "flood" gun than the collimating electrode or electrodes, the internal diameter of the shield ring required to achieve the objects of the invention will be dependent upon its location. If the shield ring is positioned on the collector or storage electrode supports or any other location further from the "flood" gun than the collimating electrode or electrodes, the internal diameter of the shield ring required to achieve the objects of the invention is independent of its location.

It is also possible according to another embodiment of the invention to make the shield ring an integral part of either the collector or storage meshes **44** or **40**, respectively, as shown in Fig. 5. This may be accomplished by masking the periphery of the mesh member prior to electroforming the mesh area itself so as to have a solid or electron impervious unmeshed boundary portion **52** around the mesh structure **44** to serve as the shield ring and which may be welded or otherwise secured to the support rings **42**, **38** for collector or storage electrodes, respectively.

What is claimed is:

A direct-viewing storage tube comprising a storage screen including a conductive mesh, said conductive mesh having an integral electron impervious portion about the periphery thereof, and a layer of secondary

electron emissive dielectric material disposed over one side of said conductive mesh thereby to provide storage surface; means for scanning said storage screen with an electron beam of elemental cross-sectional area to produce a charge pattern on said storage surface; a viewing screen disposed adjacent to and coextensive with said conductive mesh and said integral electron impervious portion on the side thereof opposite from said one side; and means for directing a collimated flow of flood electrons through the interstices of each elemental area of said storage screen in proportion to the charge thereon to said viewing screen to produce a visual presentation of said charge pattern.

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