Aug. 2, 1938. J. C. BATCHELOR 2,125,599

FLUORESCENT STRUCTURE

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Fig. 1.

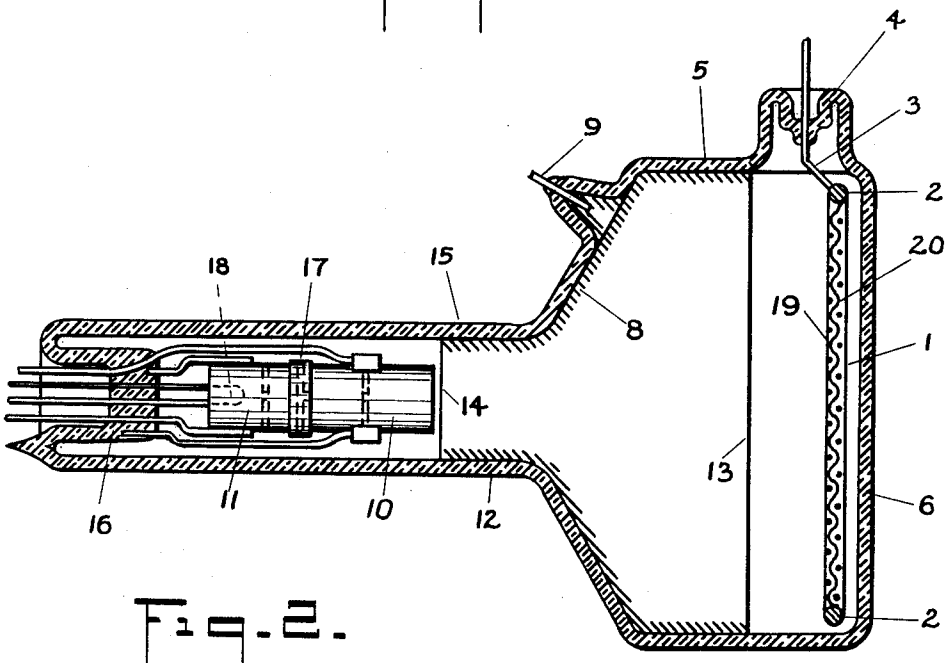
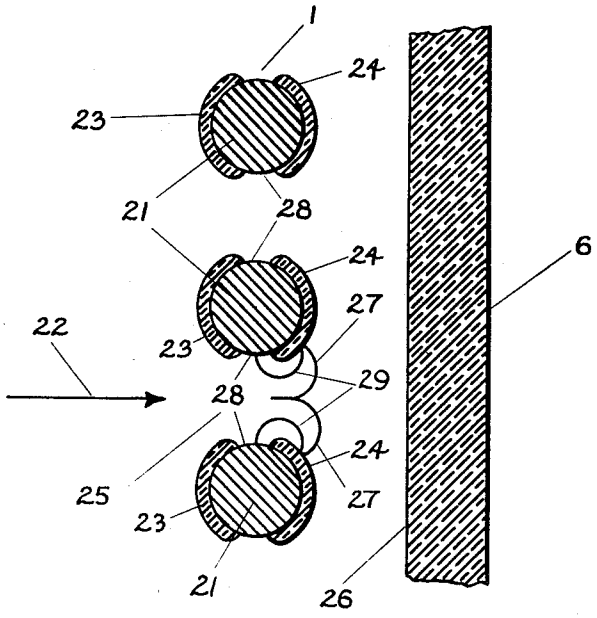


Fig. 2.



INVENTOR.

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FLUORESCENT STRUCTURE

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7 Claims. (Cl. 250—27.5)

My invention relates to a cathode ray tube suitable for use as an image reproducer in television systems and the like, and, more particularly, to improvements in the light producing structure in such tubes.

It is customary in the visual communication arts to provide as an image reproducing member, a cathode ray tube having an electron gun and a fluorescent screen so disposed in an evacuated container that, in cooperation with appropriate associated circuit elements, an image of a remotely analyzed object may be reproduced on the fluorescent screen under the bombardment of an electron beam which is caused to scan the fluorescent screen rhythmically.

In such tubes the fluorescent screen usually comprises a layer of finely divided fluorescent particles deposited upon an interior wall of the container of the cathode ray tube, and so disposed that its interior surface may be bombarded by an electron beam from the electron gun, and the light produced by the bombardment may be viewed through the wall of the container from a point exterior to the container. Because of the fact that the index of refraction of the particles of fluorescent material is appreciably different from that of the evacuated space in which they are placed, and substantial voids exist between the particles of fluorescent material, appreciable impedance is encountered by light generated at the interior surface of the fluorescent screen as it passes through the screen toward the exterior of the tube. In this discussion I have referred to the effects of internal refraction and reflection within the fluorescent screen as being of impedance to the transmission of light because of the fact that these effects do actually prevent certain of the light from travelling through the screen. Moreover, such light as does succeed in penetrating the fluorescent screen is to an appreciable extent diffused because of these effects, and consequently, the definition of a reproduced image is impaired.

In an effort to overcome these harmful effects, it has been proposed in the art to provide a cathode ray tube having a fluorescent screen prepared on a metal or other target and the target so disposed and the bulb so designed that an image produced on such a fluorescent screen might be viewed from the side of the fluorescent screen from which the electronic bombardment occurs. Invariably, however, tubes designed for this purpose are not of symmetrical shape and are not geometrical figures of rotation, and therefore the manufacturing of such envelopes involves sufficiently great cost and effort of production that it has in general been thought advisable to adhere to the older method of viewing an image on the side of the fluorescent screen opposite that on which it is produced, and, in order to compensate for the poorer efficiency of such a tube, to provide correspondingly higher energy of bombardment.

With the foregoing in mind, it is an object of my invention to provide a cathode ray tube having an envelope of great geometric simplicity and yet having a fluorescent screen whereon an image may be viewed from the side of the screen upon which it is generated.

This and other objects will be apparent from the following description of my invention.

In accordance with my invention, I have provided a cathode ray tube having a fluorescent screen comprising a reticulated metallic member at a position normally occupied by a conventional fluorescent screen, and having electrical insulating material deposited on the side of said member adjacent the electron gun, and having a fluorescent material deposited on the side of said member remote from said gun.

In order to describe my invention more fully, attention is directed to the accompanying drawing of which Figure 1 represents a sectional view of a preferred form of my invention and Figure 2 represents an enlarged schematic sectional view of a portion of the fluorescent screen and envelope of my tube.

Referring to Figure 1, a bulb 5 is prepared by introducing a metallic film 8, which may be silver deposited from a solution of silver nitrate in accordance with the known method, in a uniform film upon the inner surface of the bulb 5 and terminating in a uniform circle 13 in the enlarged portion of the bulb, and in a uniform circle 14 in the neck 15 of the bulb 5.

In the neck 15 is an electron gun 17 carried on the stem 16 and comprising an accelerating anode 10, a control electrode 11 and an electron emitting cathode 18, whereby an electron beam may be ejected toward the fluorescent screen 1. For the purpose of clearer representation, the gun 17 is not shown in section.

The fluorescent screen 1 comprises a woven wire screen or perforated metallic member of any suitable metal such as nickel, copper, platinum or the like, having deposited upon its front side or surface 19 adjacent the gun 17 a thin film of insulating material such as calcium fluoride, which is capable of relatively little secondary emission under electronic bombardment, and having deposited on the rear side or surface 20

adjacent the window 6 of the bulb 5 a film of any suitable fluorescent material such as willemite. The screen 1 is mounted substantially parallel and close to the window 6 of the tube 5 and is carried by the metal ring 2 which is in turn supported by the lead-in wire 3 in the stem 4.

In order to understand the construction and operation of my fluorescent screen more clearly, it is convenient to refer to Figure 2 which represents an enlarged schematic sectional view of the fluorescent screen portion of my tube. In this embodiment, a woven wire screen is used as a carrier for the fluorescent material and the wires 21 represent successive wires in such a screen. On the side of the wires 21 approached by the electron beam represented by the arrow 22, is deposited a film 23 of an insulating material. I have found it convenient to apply such a material by disposing the screen 1 in an evacuated container and evaporating from a metal filament within the evacuated container, a sufficient quantity of insulating material, such as calcium fluoride, at a point such that the molecules of the insulating material travel toward and attach themselves to the surface of the mesh in such a way that the film 23 is produced. Under such circumstances, because of the fact that in vacuum the particles of insulating material travel in straight lines, none of the insulating material will be deposited upon the side of the member 1 opposite the surface on which the film 23 is deposited. A wide variety of salts are available for use as insulating material in my invention, and are to be chosen primarily for low vapor pressure, relative freedom from free electrons, relative immobility of ions and low secondary emission. In respect to all of these considerations, I have found the alkaline halides to be satisfactory.

Following the deposition of the insulating material, a film 24 of fluorescent material, such as finely divided willemite, is deposited upon the side of the screen 1 opposite that carrying the insulating material film 23, preferably by spraying from a suspension of fluorescent material in liquid by means of an air brush. Alternately, however, the material may be applied by painting, or in any other suitable manner.

In operation, an electron beam approaches my fluorescent structure along the arrow 22 and a portion of the electrons from said beam strike the film 23. In the absence of secondary emission from the film 23, the incident electrons cause a negative charge to be accumulated upon the surface of the insulating material 23. Certain other electrons penetrate the opening 25 between the wires 21 and strike the interior surface 26 of the window 6, upon which an additional negative charge is deposited by the incident electrons. This charging procedure just described will in general occur only at the moment operating potentials are applied to the tube after a substantial period of inactivity, and the charges on the film 23 and the surface 26 will be built up substantially instantaneously. Following such charging, subsequent electrons approaching along the arrow 22 will be given a component of velocity radially inward toward the axis of the opening 25 by the negative charges existing on the surface of the film 23, so that substantially all electrons in the beam will be caused to penetrate the opening 25 with only enough electrons striking the surface of the film 23 to maintain the charge thereon at its maximum value. The remaining electrons which penetrate the opening 25 will approach the window 26, but, because of the charge existing upon that window, will be repelled in a direction corresponding to the lines 27, following which paths the electrons will strike the fluorescent material 24 where their energy will be largely consumed and fluorescent light will be emitted. Thus, fluorescence is excited by an electron beam following the arrow 22, the fluorescent light being produced on a surface of fluorescent material adapted to be viewed on the side upon which it was bombarded.

In order better to dissipate an electric charge which might otherwise be accumulated on the surface of the fluorescent material 24, I have found it desirable to use a fluorescent material having substantial ability to emit secondary electrons, and to leave a portion 28 of the surface of the wires 21 exposed so that secondary electrons emitted from the surface 24 may be attracted along the lines 29 and drawn to the wires 21 whence they may be carried away through the wire mesh to appropriate conducting electrodes.

In order to ensure that all electrons which pass a given opening will strike the fluorescent material on the wires adjacent that opening, it is important that the screen 1 be mounted in close proximity with the window 6. For example, I have found it advisable in many cases to mount the screen 1 with a spacing of less than one millimeter and still smaller spacing is often desirable. On the other hand, larger spacing is sometimes permissible because of the relatively stiff space charge which builds up adjacent the inner surface of the window 6.

It may be seen that it lies within the scope of my invention to provide a separate member to perform the electron-repelling function of the window 6 when the characteristics of the glass of the window 6 are not wholly satisfactory for the required purpose. For example, an additional plate of mica, or other material, may be carried on the ring 2 in a position adjacent and parallel to the screen 1 and between the screen 1 and the window 6, and in this case, the additional plate performs the electrical function of the window 6.

In some instances, moreover, it is possible to provide a screen 1 without the insulating material 23, in which case it is advisable to maintain the ratio of the diameter of the openings 25 to the diameter of the wires 21 at a value somewhat smaller than is desirable in the presence of the insulating material. In this case a certain quantity of the bombarding electrons strike the exposed surface of the wires 21, but the preponderance of the electrons penetrate the openings 25 and are concentrated with greater specific density upon the surface of the fluorescent material 24 because of the smaller area of the surface 24. In the absence of the insulating material film 23, it is not important that care be used in preventing the deposition of fluorescent material on the surface of the screen adjacent the gun; actually the entire surface of each of the wires 21 may be coated by dipping, painting, spraying or otherwise applying fluorescent material.

Still further, it is possible in some cases to dispense with the electron repelling surface 26 adjacent the screen, in which case, advantage is taken of the relatively great space charge which accumulates in the space adjacent the screen on the side remote from the electron gun.

Thus it is clear that many modifications are

possible without departing from the spirit of my invention, and such modifications should not be construed as limiting the scope of the claims which follow.

I claim:

1. In a cathode ray tube, a fluorescent screen and an electron gun adapted to project electrons toward said screen, said screen comprising a reticulated metallic member, fluorescent material on the surface of said member remote from said gun, insulating material on the surface of said member adjacent said gun, the surface within the reticulations of said member being uncoated metal.

2. In a cathode ray tube, a fluorescent screen comprising a reticulated metallic member, fluorescent material on the surface of said screen, an electron gun adapted to project electrons toward said screen, a transparent window adjacent said screen, said window adapted to be bombarded by a portion of the electrons penetrating the reticulations of said screen, said window adapted to hold an electrical charge deposited by said incident electrons whereby the remainder of said penetrating electrons may be repelled to the surface of said screen adjacent said window.

3. In a cathode ray tube, a fluorescent screen comprising a reticulated metallic member, an electron gun adapted to project electrons toward said screen, fluorescent material on the surface of said reticulated member remote from said gun, insulating material on the surface of said reticulated member adjacent said gun, said insulating material adapted to receive an electrical charge from a portion of the electrons from said gun whereby the remainder of the electrons from said gun may be repelled from said insulating material and caused to penetrate the reticulations of said screen, a transparent window adjacent said screen on the side remote from said gun, said window adapted to be bombarded by a portion of the electrons penetrating the reticulations of said screen, said window adapted to hold an electrical charge deposited by said incident electrons whereby the remainder of said penetrating electrons may be repelled to the surface of said screen adjacent said window.

4. An electron discharge device comprising a tube provided with a screen and with means in front of said screen for developing a ray of electrons and directing the ray at the adjacent side of said screen, said screen being provided with relatively small openings through itself to permit free passage of electrons of said ray in direct paths from said means to the remote side of said screen by way of said openings, said screen being characterized by the fact that the individual elemental areas on the rear side thereof become fluorescent upon bombardment by the electrons of said ray which pass directly by way of said openings to the rear side of said screen.

5. In apparatus for producing radiation by electronic bombardment, an envelope, a screen mounted within said envelope having fluorescent material upon one surface thereof and openings therethrough, and an electron gun positioned upon the other side of said screen to project electrons toward said screen and through said openings, said envelope having means associated therewith to deflect electrons toward said fluorescent material after they pass through said openings.

6. In apparatus for producing radiation by electronic bombardment, the combination of a luminescent screen having openings therethrough, an electron gun positioned on one side of said screen to project electrons toward said screen and through said openings, and controlling means for causing said electrons to impinge the surface of said screen after passing through said openings.

7. In apparatus for producing radiation by electronic bombardment, the combination of a luminescent screen having openings therethrough, an electron gun positioned upon one side of said screen to project electrons toward said screen and through said openings, controlling means for causing said electrons to impinge the surface of said screen after passing through said openings, and luminescent material on the surface of said screen remote from said gun and so positioned that it is activated by the electrons.

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