

Dec. 13, 1955

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BACKGROUND REDUCTION IN IMAGE TUBE

2,727,173

Filed Jan. 22, 1952

Fig.1.

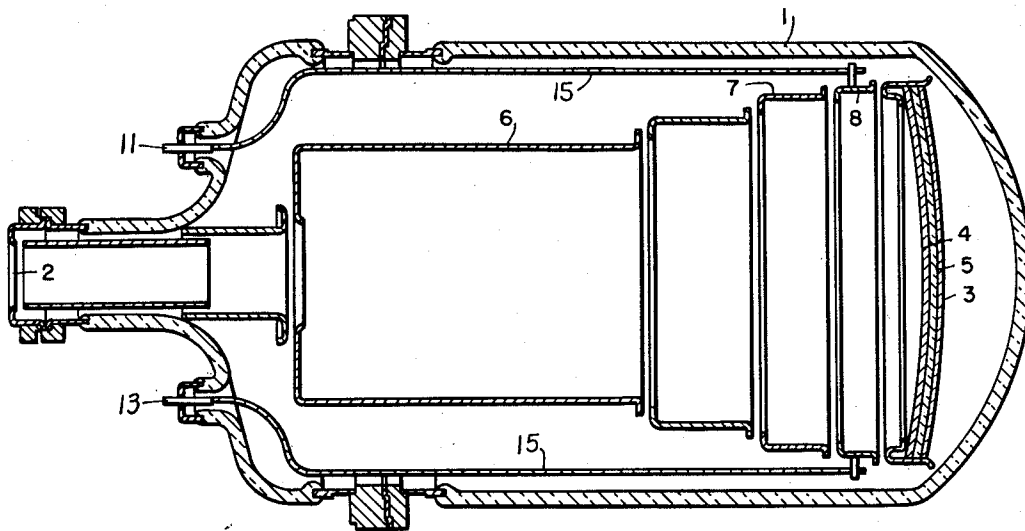


Fig.2.

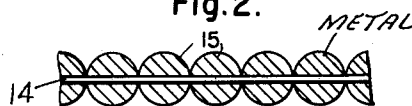
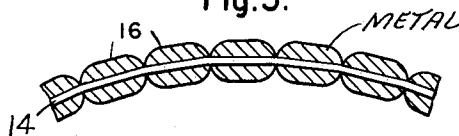


Fig.3.



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BACKGROUND REDUCTION IN IMAGE TUBE

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Application January 22, 1952, Serial No. 267,598

11 Claims. (Cl. 313—101)

Our invention relates to electrical discharge devices and in particular covers an arrangement for minimizing background light in electrical discharge tubes embodying fluorescent screens. Certain features of our invention are, however, applicable to prevention of undesired ionization in high-vacuum electrical discharge tubes of other types. The invention is particularly useful in image intensifier tubes in which electron-images formed by photoelectric screens are accelerated into impact with electron-phosphor screens to produce light images as exemplified in Mason and Coltman U. S. Patent 2,523,132 issued September 19, 1950.

A tube found useful in the image intensifier described in the above-mentioned patent is shown schematically in Fig. 1 and comprises a high-vacuum glass container 1 having an electron-phosphor output screen 2, of zinc-cadmium-sulphide, at one end on which a light-image is produced by impact of electrons which emanate as an electron-image from a photo-electric layer 4 on the input screen 3 at the other end of container 1. The input screen 3 comprises also a layer 5 of fluorescent material supported closely adjacent the photoelectric layer, and a light-image is generated in the layer 5 by X-rays projected onto it through an observed object outside the container. The light-image in layer 5 reacts on photoelectric layer 4 to generate an electron image at its surface, and suitable positive potentials impressed by means not shown on the output screen 2, and on an electron-lens system comprising metal collars 6, 7, 8, accelerate the electron-image into incidence on output-screen 2 to generate a light image of high brightness there. An intensified replica of the light-image of input screen 3 is thus produced on output screen 2.

We have in practice found that there is present on the output screen 2, in addition to the desired light-image produced by the impact thereon of the electron-image generated at photoelectric layer 4, what may be termed a background glow, which exists even when no X-rays are acting on the fluorescent input-layer 5. This background glow is more or less uniformly distributed over output screen 2, but it seriously impairs the contrasts and general visibility of the desired replica of the X-ray image generated on input screen 3, particularly where the latter is of low intensity. We have found that this background glow arises largely from electrons arising from high electric field emission at electrodes of the tube, or from other causes, at places where the electrical potential gradient is high. These electrons are accelerated by the electric field, some of them directly into impact on the electron-phosphor output screen 2, and others into impact upon other parts of the tube at which they are reflected, to the screen 2, or generate secondary electrons which find their way to screen 2. All such impacting electrons generate background glow on screen 2. Many other of these unwanted electrons strike the glass tube walls and insulation inside the tube, both of which are somewhat fluorescent and produce a background glow which irradiates the photoelectric layer

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4 and generates more unwanted electrons which generate further background glow at output screen 2.

It is accordingly necessary to prevent as far as possible the emission of electrons at and around the electrical components within container 1.

One object of our invention is accordingly to minimize the production of electrons by electrical gradients within electrical discharge tubes which contain fluorescent materials.

Another object is to minimize the production of electrons by electrical gradients within electrical discharge tubes which contain photoelectric materials.

Still another object is to minimize the production of electrons by electrical gradients within electrical discharge devices which contain both fluorescent materials and photoelectric materials.

Another object is to minimize background glow in devices in which electron images are projected by electrical fields into incidence on fluorescent screens.

Another object is to minimize the production of stray fluorescent light in devices in which photoelectric materials are present in company with insulating materials and conductors of high electrical potential.

A further object is to avoid the production of substantial background glow on the output screens of image intensifier tubes.

Other objects of our invention will become apparent upon reading the following description taken in connection with the drawings, in which:

Figure 1 is a schematic showing of an image intensifier tube to which our invention is particularly applicable;

Fig. 2 is a detail view of a conductor provided with one embodiment of our invention; and

Fig. 3 is a detail view of a conductor provided with another embodiment of our invention.

The general structure of Fig. 1 has already been described, but its details will be explained as follows: The input screen 3 and the metal collars 6, 7 and 8 are supplied with proper electrical potentials by leads 11 and 13 sealed through container 1 and the connections within container 1 are, as a matter of tube manufacture, conveniently made by rods or wires 14 of rather small diameter; i. e., a diameter under three millimeters. Since certain of these rods have potentials many thousand volts different from other elements, lines of electric force reach high concentrations at the surfaces of some of the above-mentioned rods and so set free electrons from the electrode metal. It has been found that the primary sources of unwanted electrons are the conducting elements of the tube having small radii of curvature where large potential differences are present.

We have found that background glow on the output screen 2 is practically eliminated by covering all rods and wires within the enclosure 1 with metallic or other conducting beads such as 15 in Fig. 2. Such beads are shaped so as to avoid all edges and points, and to have no portions of their surface of small radius of curvature. Their surfaces should be smooth. Specifically no radius of curvature should be less than 2 mm. It will be noted that the rods or wires may be bent and curved, yet a series of standard beads strung on them will successfully prevent difficulty from background glow at the output screen. The ability to use standard beads which can be produced cheaply in large quantities and combined with wires or rods cut from reels and produced by similarly cheap commercial methods to form electrode structure has enormous practical advantages in tube manufacture compared with the situation which would exist if special conductors of the required size and shape had to be manufactured in integral form. Our invention not only solves the problem of minimiz-

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ing background light but does so in a way which is highly economical and simple in large-scale production. Furthermore, it solves the problem not only for image intensifier tubes, but for other types of apparatus where photoelectric materials or fluorescent materials are present and subject to electric force.

Fig. 3 shows another form of bead which may be employed to carry out the principles of our invention. The beads 16 has the form of a cylinder with the peripheral edges of the end faces rounded, thereby avoiding intense electric field concentration and electron emission which would occur were the edge left sharp. Complete shielding of the underlying conductor is also afforded where the latter is bent into a curve.

We claim as our invention:

1. In combination, in an evacuated vacuum-tight enclosure, a surface of fluorescent material, means to impress a high electrical potential difference in said enclosure between a conductor with a cross-section having a small radius of curvature and another point, and electrically conducting beads having surfaces devoid of portions having small radius of curvature strung on said conductor.

2. In combination in a highly-evacuated vacuum-tight enclosure, a surface of photoelectric material, means to produce a high electrical potential difference in said enclosure between a conductor with a cross-section having a small radius of curvature and another point, and electrically conducting beads having surfaces devoid of portions having a radius of curvature less than 2 times the aforesaid radius of curvature strung on said conductor.

3. In combination, in a highly-evacuated vacuum-tight enclosure, a surface of photoelectric material, means to produce a high electrical potential difference in said enclosure between a wire of not over one millimeter diameter and another point, and electrically conducting beads with surfaces having no radius of curvature less than 2 millimeters strung on said wire.

4. In combination, in a highly-evacuated vacuum-tight enclosure, a surface of fluorescent material, means to produce a high electrical potential difference in said enclosure between a wire of not over 3 millimeters diameter and another point, and electrically conducting beads with surfaces having no radius of curvature less than 2 millimeters strung on said wire.

5. In combination, in a highly-evacuated vacuum-tight enclosure having a glass wall, a surface of fluorescent material, means to produce a high electrical potential difference in said enclosure between a wire not over 3 millimeters in diameter and another point, and electrically conducting beads with surfaces having no radius of curvature less than 2 millimeters strung on said wire.

6. In combination, in a highly-evacuated vacuum-tight enclosure having a glass wall, a surface of photoelectric material, means to produce a high electrical potential difference in said enclosure between a wire of not over

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3 millimeters diameter and another point, and electrically conducting beads with surfaces having no radius of curvature less than 2 millimeters strung on said wire.

7. In combination, in a highly-evacuated vacuum-tight enclosure having a glass wall, a surface of photoelectric material, means to produce a high electrical potential difference in said enclosure between a conductor with a surface having a small radius of curvature and another point, and electrically conducting beads having no radius of curvature less than 2 times the aforesaid radius of curvature strung on said conductor.

8. In combination, in a highly-evacuated vacuum-tight enclosure having a glass wall, a surface of fluorescent material, means to produce a high electrical potential difference in said enclosure between a conductor with a surface having a small radius of curvature and another point, and electrically conducting beads having no radius of curvature less than 2 times the aforesaid radius of curvature strung on said conductor.

9. In combination, in a highly-evacuated vacuum-tight enclosure containing a surface of insulating material, a surface of fluorescent material, means to produce a high electrical potential difference in said enclosure between a conductor with a surface having a small radius of curvature and another point and electrically conducting beads having surfaces with no radius of curvature less than 2 times the aforesaid radius of curvature strung on said conductor.

10. In combination, in a highly-evacuated vacuum-tight enclosure containing a surface of insulating material, a surface photoelectric material, means to produce a high electrical potential difference in said enclosure between a conductor with a surface having a small radius of curvature and another point, and electrically conducting beads having surfaces with no radius of curvature less than 2 times the aforesaid radius of curvature strung on said conductor.

11. In an evacuated electron tube, a screen of zinc-cadmium-sulphide, a source of electrons, leads sealed through said tube walls for impressing a high electrical potential difference between said screen and said source, connecting wires within said tube of diameter not over one millimeter connected to said leads and impressed with said potential difference, and electrically conducting beads having no exposed surface of less than 2 millimeters radius of curvature strung on said wires.

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