Nov. 17, 1959 J A. HENDERSON ET AL 2,913,610

PHOTOEMISSIVE TUBE

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Fig. 1.

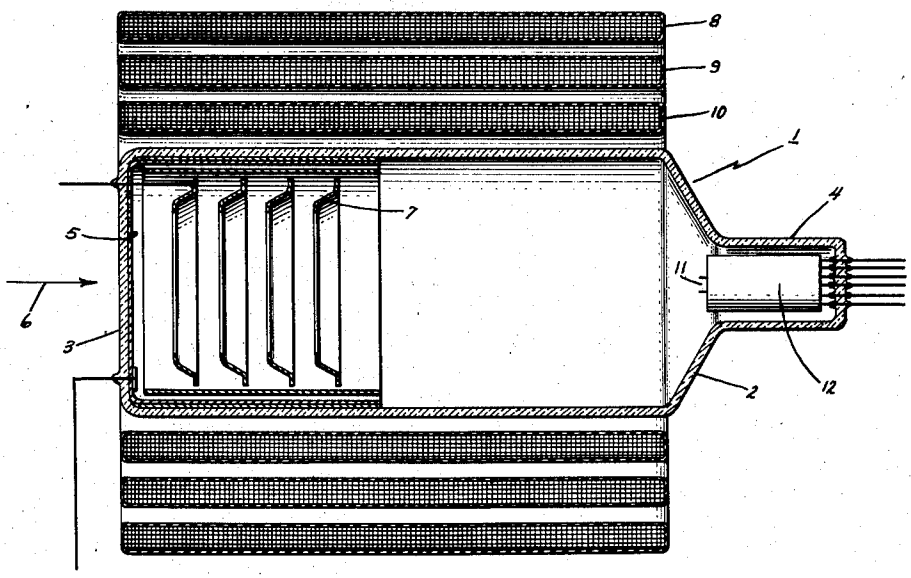
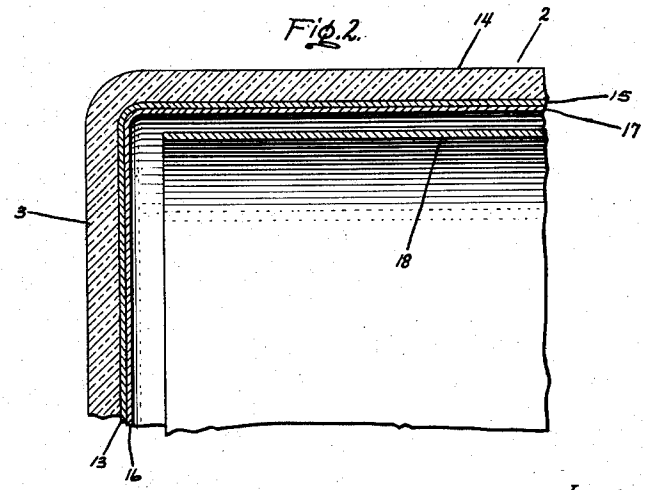


Fig. 2.



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PHOTOEMISSIVE TUBE

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This invention relates to photoemissive tubes, and more particularly to means for eliminating cathode fatigue of the photoemissive cathode of such tubes.

Many types of photoemissive tubes are provided which employ a relatively large-area photocathode formed of photoemissive material; when a radiation image is impressed upon the photocathode, the photocathode emits electrons corresponding to the radiation image. The so-called image dissector tube is a typical example of a tube employing a photoemissive cathode. The image dissector tube is commonly employed as a television image pick-up tube and conventionally comprises an elongated generally tubular evacuated envelope with a photocathode formed of photoemissive material formed on the inner surface of an end wall. An optical image focused on the end wall of the tube causes the photocathode to emit electrons having an image pattern corresponding to the impressed optical image. This electron image caused by the emission of electrons from the photocathode is focused and deflected across an electron multiplier disposed at the opposite end of the tube from the photocathode which provides an electrical output signal responsive to the impressed optical image, this signal then being employed as a modulating signal for the television transmitter.

The photoemissive cathode of photosensitive tubes, such as image dissector tubes, is commonly formed of translucent caesium-oxide-silver. Cathodes of this type exhibit the phenomenon of fatigue, i.e. of a reduction in sensitivity after being exposed to a high light level for too long a time. Since only electrons which are already in relatively high energy level can be emitted under the influence of light, this fatigue must mean that the number of electrons in such levels has been depleted. The sensitivity of such photoemissive tubes could therefore be improved by elimination of the cathode fatigue problem and it is therefore desirable to provide a photoemissive tube in which cathode fatigue of the photoemissive cathode is eliminated.

We have discovered that this cathode fatigue of the photoemissive surfaces in photoemissive tubes is not restricted to areas which have been illuminated but is exhibited in neighboring areas as well. It thus follows that the fatigue would be greatly diminished if an ample unilluminated area were provided which offers a reservoir for electrons in the proper energy level. The latter condition means that this area has to consist of the same kind of caesium-oxide-silver as the photocathode proper. More specifically, in accordance with this invention, we provide a photoemissive tube in which the photoemissive cathode material not only covers the radiation-image receiving portion of the tube envelope, but extends onto adjacent areas of the envelope thereby to provide a source of electrons to replenish electrons lost from the photoemissive surface upon which the incident radiation impinges. More particularly, the photoemissive material is coated upon an end wall of the tube and is translucent, thereby to receive the radiation image and to provide

the resulting electron image, this photoemissive coating extending onto the adjacent side wall of the tube with means being provided for rendering the side wall coating opaque so that it does not emit electrons in response to ambient light.

It is therefore an object of this invention to provide an improved photoemissive tube.

Another object of this invention is to provide an improved photoemissive tube in which cathode fatigue is eliminated.

A further object of this invention is to provide an improved photoemissive tube having a translucent photoemissive surface for receiving a radiation image and providing an electron image responsive thereto, the photoemissive surface being extended to an adjacent surface of the tube for supplying electrons to replace those deleted by photoemission, the extended portion of the photoemission surface being opaque.

The above mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a cross-sectional view of a typical image dissector tube incorporating our improved photoemissive cathode arrangement for eliminating cathode fatigue; and

Fig. 2 is an enlarged fragmentary cross-sectional view further illustrating the construction of Fig. 1.

Referring now to the drawing, there is shown an image dissector tube, generally identified as **1**, having an enclosing envelope **2**, generally formed of glass, and also being of generally tubular form, having an end wall **3** and a neck portion **4** at the end opposite from the end wall **3**. A photoemissive cathode **5** is formed on the inner surface of the end wall **3** and thus receives an incident radiation image, which may be an optically focused light image, as shown by the arrow **6**. The photoemissive cathode **5** emits electrons responsive to the incident radiation **6**, the emitted electrons being accelerated by conventional accelerating electrodes **7**. The electron image emitted from the photocathode **5** is focused by a conventional focusing coil **8** and deflected by conventional deflection coils **9** and **10** across an aperture **11** of an electron multiplier **12**, thereby providing an output signal responsive to the electron image emitted from the photocathode **5**. It will be readily understood that the image dissector tube thus far described does not form a part of my invention and is shown here for illustrative purposes only.

The photoemissive coating **5** on the inner surface of the end wall **3** of envelope **2** is conventionally formed by evaporating a very thin layer of silver onto the surface of the glass, this silver layer then being oxidized in air. The tube is then evacuated and heated caesium vapor introduced into the tube. This caesium vapor migrates onto the silver oxide coating and chemically combines therewith to form the photoemissive caesium-oxide-silver surface. In accordance with our invention, the silver layer **13** evaporated or otherwise deposited upon the inner surface of the end wall **3** is extended a substantial distance onto the adjacent inner surface of the side wall **14**, as at **15**, the coating **15** on the side wall **14** being substantially thicker than the coating **13** on the end wall **3**. The caesium-oxide-silver layer or coating **16** is likewise extended onto the inner surface of the side wall **14** in the envelope **2**, as at **17**. By virtue of the thinness of the silver layer **13** on the end wall **3**, the resulting photosensitive caesium-oxide-silver coating **16** is translucent, however, by virtue of the relatively thicker silver coating **15** on the inner surface of the side wall **14**, the resulting caesium-oxide-silver coating **17** is formed

on an opaque support so that ambient light which might impinge upon the photoemissive layer through the side wall of the envelope does not cause a resulting emission of electrons from the side wall coating **17**. In order that light may not impinge upon and thus excite the side wall photoemissive coating **17** from the interior of the tube, it may also be found desirable to provide a light shield **18**, shown here as being in the form of a metal cylinder disposed between the accelerating electrodes **7** and the side wall photoemissive coating **17** as shown.

It will be readily apparent that the side wall photoemissive coating **17** may be rendered opaque by virtue of the arrangement of the focusing and deflecting coils **8**, **9** and **10** directly on top of the envelope **2** and further that the accelerating electrodes **7** may be suitably arranged to prevent ambient light from striking the side wall of photosensitive coating **17** from the inside of envelope **2**. Further, while the relatively thicker silver layer **15** is a preferred means of rendering the side wall photoemissive coating **17** opaque, an obvious alternate is to make part of the sidewall of solenoid silver on which the sensitive layer **17** is formed by conventional means. Also, it will be readily apparent that the same result may be achieved by painting an opaque substance, such as enamel, on the exterior surface of the side wall portion **14** of envelope **2**.

It will now be seen that the extended side wall photoemissive coating **17**, which is not subjected to incident radiation and thus directly to photoemission, constitutes a source of electrons to supply those electrons which may have been deleted from the translucent photoemissive cathode surface **16** due to an exceptionally bright spot of light impinging thereupon. In essence, we have provided a considerably enlarged photoemissive cathode with only a portion of the total area being subjected to incident radiation, Thus, there is a much larger area than has heretofore been provided from which electrons may migrate to replenish the areas from which electrons have been depleted due to photoemission and thus the cathode fatigue and resulting loss of sensitivity is eliminated.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention.

What is claimed is:

1. A photoemissive tube comprising: an envelope; translucent photoemissive cathode means disposed on a portion of the inner wall of said envelope and adapted to receive radiation; and opaque photoemissive cathode means disposed on another portion of the inner wall of said envelope and connected to said translucent photoemissive cathode means for supplying electrons to said translucent photo-emissive cathode means to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said translucent photoemissive cathode means.

2. A photoemissive tube comprising: a generally tubular envelope having a transparent radiation image-receiving end wall; and photoemissive cathode means disposed on the inner surface of said end wall and extending onto the inner surface of the side wall adjacent said end wall, the portion of said photoemissive cathode means on said end wall being translucent and the portion on said side wall being opaque, said photoemissive cathode means on said side wall supplying electrons to said photoemissive cathode means on said end wall to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said photoemissive cathode means on said end wall.

3. A photoemissive tube comprising: a generally tubular envelope having a transparent radiation-receiving end wall; a relatively thin layer of photoemissive cathode material on the inner surface of said end wall and extending onto the adjacent side wall of said envelope, said cathode material on said end wall being translucent; and means to shield said cathode material on said side wall from light; said cathode material on said side wall supplying electrons to said cathode material on said end wall to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said cathode material on said end wall.

4. A photoemissive tube comprising: a generally tubular envelope having a transparent radiation-receiving end wall; a relatively thin layer of opaque material on the inner surface of the side wall of said envelope adjacent said end wall, and a relatively thin layer of photoemissive cathode material on the inner surface of said end wall and extending onto said side wall overlying said layer of opaque material, said layer of cathode material on said end wall being translucent, said layer of cathode material on said side wall supplying electrons to said cathode material on said end wall to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said cathode material on said end wall.

5. A photoemissive tube comprising: a generally tubular envelope having a transparent radiation-receiving end wall; a relatively thin layer of opaque material on the inner surface of the side wall of said envelope adjacent said end wall, a relatively thin layer of photoemissive cathode material on the inner surface of said end wall and extending onto said side wall overlying said layer of opaque material; and light shield means in said envelope arranged to shield light from said cathode material on said side wall; said layer of cathode material on said side wall supplying electrons to said cathode material on said end wall to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said cathode material on said end wall.

6. A photoemissive tube comprising: a generally tubular envelope having a transparent radiation-receiving end wall; a relatively thin layer of silver on the inner surface of the side wall of said envelope extending a substantial distance therefrom; a relatively thin photoemissive film composed of silver-oxide-caesium on the inner surface of said end wall and extending onto said side wall overlying said silver layer whereby said photoemissive film on said side wall is opaque, said photoemissive film on said end wall being translucent and forming a photoemissive cathode; and a metal cylinder in said envelope spaced radially inward from said photoemissive film on said side wall thereby forming a light shield for shielding light from said photoemissive film on said end wall; said photoemissive film on said side wall supplying electrons to said photoemissive film on said end wall to replace electrons deleted therefrom by photoemission thereby to eliminate cathode fatigue of said photoemissive film on said end wall.

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