Sept. 30, 1969 J. D. McGEE 3,470,380

PHOTOELECTRONIC IMAGE DETECTING DEVICES

Filed Dec. 6, 1965

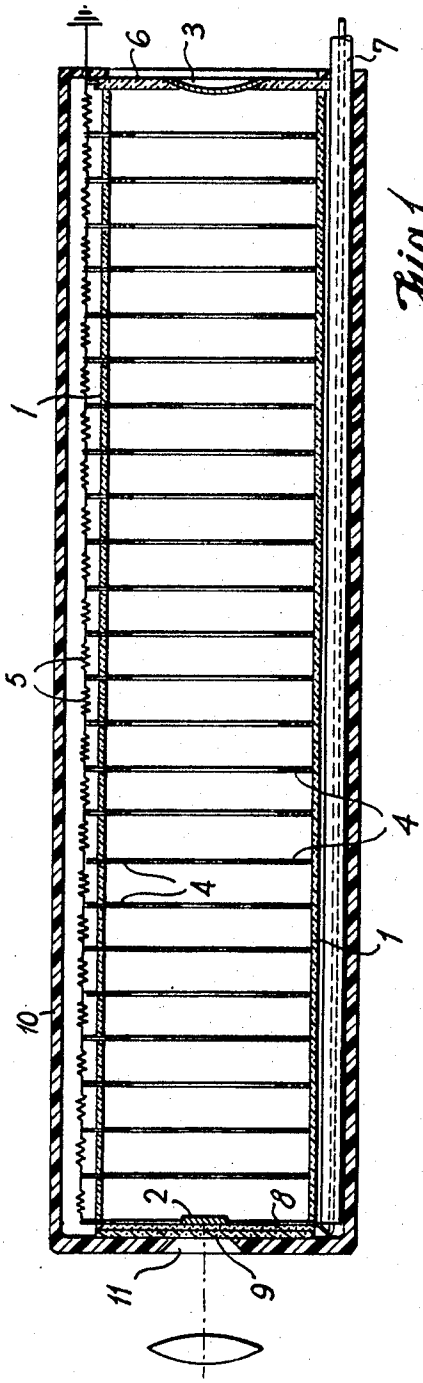

Fig. 1.

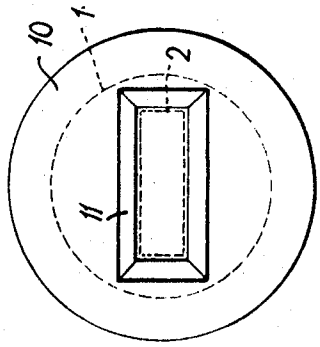

Fig. 2.

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PHOTOELECTRONIC IMAGE DETECTING DEVICES

James Dwyer McGee, London, England, assignor to National Research Development Corporation, London, England, a British corporation

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U.S. Cl. 250—213 3 Claims

ABSTRACT OF THE DISCLOSURE

An image intensifier tube having a cathode window covered by a highly insulating transparent material such as silica, and wherein the tube may also have an insulating casing. By insulating the tube in this way leakage currents through the tube which dispense as corona are reduced, especially at the cathode window, and consequently any parasitic background to the amplified image provided by the tube is also reduced.

This invention relates to electron image intensifier tubes. It is particularly concerned with tubes of the kind comprising a photo-cathode arranged to receive a light image and provide an electron beam distribution which is amplified within the tube to impinge upon the end window.

In the operation of modern image intensifier tubes it is usually necessary to apply a high potential of the order of 20 to 50 kv., between the cathode (input) and anode (output), the former being negative relative to the latter. It is also preferred in many cases to maintain the cathode at a high negative potential and the anode at earth as observations or recording must be done at the output and this can be inconvenient, if not dangerous, if this end of the tube is at say +50 kv.

However, the advantage of operating with the input (cathode) end of the tube at —50 kv. and the output at earth is offset by the fact that spurious background in the recorded image is usually much worse. This is due to the fact that the high potential applied to the cathode inside the glass end window of the tube produces an electrical leak through this glass which charges up to a high potential on its outer surface. It would ultimately reach the same potential as the cathode but if this is —20 to —50 kv. there will be a tendency for the charges on the external surface of the glass window to disperse as a corona discharge into the surrounding air. This corona discharge can be substantially suppressed from the cylindrical body of the tube by encapsulating it in a jacket of highly insulating material such as "silastomer," a highly insulating rubber compounds. However, this cannot be used to cover the cathode window since the optical image must be projected through it onto the photo-cathode. It is found that much undesirable background has its origin in the light from corona discharge from the outer surface of this glass window, the light being produced in a place from which it readily reaches the cathode. This effect is particularly bad in the Spectracon or Lenard window image recording tube since, for various reasons, the window in this case is preferably made of lime-soda glass of comparatively low resistivity. The Spectracon is an image recording tube with a photo-cathode adjacent to a cathode window, and a thin mica output window or Lenard window, allowing electrons to pass outside the tube to an electron sensitive emulsion. It turns out that leakage current of the order of several microamps must be dissipated from the cathode window to the nearest object at earth potential. A discharge current of this magnitude is sufficient to produce enough light to cause appreciable photoemission from the cathode and hence serious parasitic background to the recorded image. This can be prohibitive if such a tube is being used to record optical images so faint that exposures of many hours are required.

It is an object of the invention to provide a tube in which the effects of background light due to the high negative potential of the cathode is reduced as far as possible.

According to the present invention in an electron image intensifier tube of the kind comprising a photo-cathode arranged to receive a light image and provide an electron beam distribution which is amplified within the tube to impinge upon an end window at earth potential, the face of the tube adapted to receive light image is shielded by means of a light transparent plate of insulating material.

Preferably the plate is formed of silica.

In order that the invention may be more fully understood reference will now be made to the accompanying drawing in which:

FIGURE 1 illustrates an embodiment thereof in side elevation, and,

FIGURE 2 is an end view of the tube illustrated in FIGURE 1.

Referring now to FIGURE 1 there is shown therein an image intensifier comprising a cylindrical tube **1** of soda glass or similar material to one end plate **8** of which there is secured a photo-cathode **2** and the other end plate **6** includes a mica window **3**. A succession of ring electrodes **4** are provided spaced apart along the length of the tube and a potential divider chain **5** is connected to the electrodes **4**. The end plate **6** of the tube containing the mica window **3** is designed to be held at earth potential and an insulated e.h.t. lead **7** at a potential of —40 kv. is connected to the end plate **8** to which the photo-cathode is attached.

In order to reduce effects of corona discharge from the end plate **8** a further plate **9** is cemented to the external surface of end plate **8**. Plate **9** is formed of silica a few millimetres thick and since it has a resistivity of between 10^7 and 5×10^4, the resistivity of soda glass, the leakage current and hence the corona discharge is reduced by approximately these factors.

To still further reduce electrical leakage into the air a casing **10** of "Perspex," a poly-methyl methacrylate, is provided surrounding the tube except for a slot **11** which is provided in the front end face of casing **10** to allow impingement of an optical image on photo-cathode **2**. It is also convenient to bring the e.h.t. lead **7** along the length of the tube casing **10** and out of the tube adjacent the rear end window **6** in order to reduce the effects of discharge from lead **7** in the neighbourhood of the photo-cathode.

The background can be further reduced by coating the external surface of the silica plate **9** with a conducting layer of, say, metal or Aquadag, leaving free only that area through which the light must enter. This is for example a window 10 x 30 mm. in the case of the Spectracon. This window can also be surrounded by an opaque mask or hood projecting some distance from the surface of the window, say 2 cm. in the case of the Spectracon. A small foil, say 1 cm. x 1 cm., of metal coated with a low intensity source of α- or β-ray (say, strontium 90, about 1μ curie of β-rays) emitting radioactive substance is fixed to the conducting coating on the silica plate and is preferably placed near its outer edge. The β-radiation from this source will produce ionization of the air in its immediate neighbourhood so that as the potential of the conducting coating of the silica begins to rise due to the minute electrical leak through it these ions will discharge

it before its potential can reach a level at which it can produce uncontrolled corona discharges into the air. Any small light emission in the neighbourhood of the radioactive foil will be screened from the photocathode by the hood surrounding it.

To summarize, the electrical leakage that produces serious background by causing corona discharge in the neighbourhood of the cathode is greatly reduced by the interposition of a silica plate and any residual charge is disposed of by a controlled ionization discharge.

I claim:

1. An electron image intensifier tube, including:

an envelope which is transparent in at least one area;

a photo-cathode arranged to receive a light image through the said area and to provide an electron beam distribution;

supply means for supplying the photo-cathode with a highly negative voltage of the order of tens of kilovolts; and

a light transparent plate of highly insulating material compared with the material of said area positioned in the path of light received by said photo-cathode,

external to said envelope and in contact with said area.

2. A tube as claimed in claim **1** in which the said plate is formed of silica.

3. The tube as claimed in claim **1** in which an outer casing of insulating material is provided surrounding the tube.

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JAMES W. LAWRENCE, Primary Examiner

RAYMOND F. HOSSFELD, Assistant Examiner

U.S. Cl. X.R.

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