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ELECTRON MULTIPLIERS

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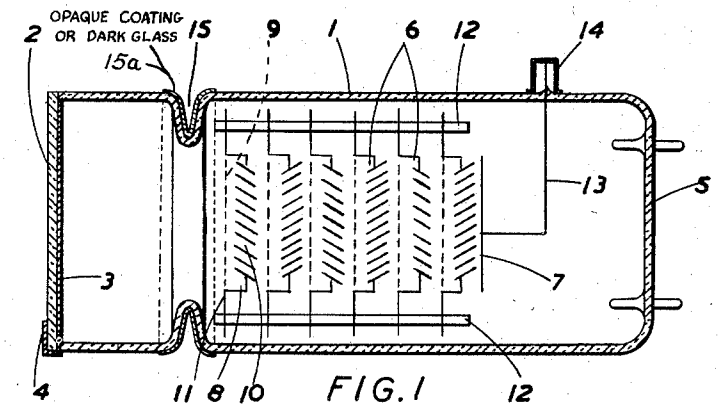


FIG. 1

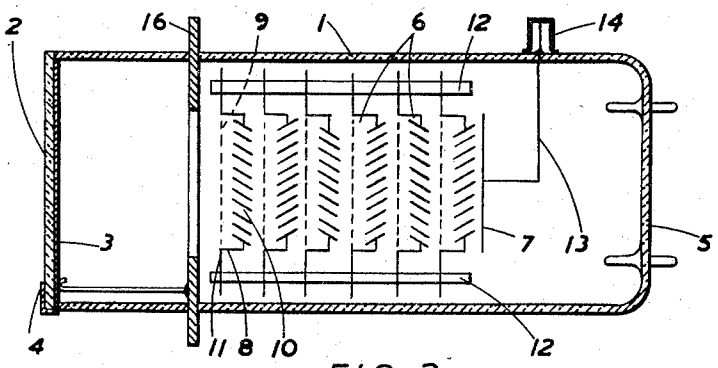


FIG. 2.

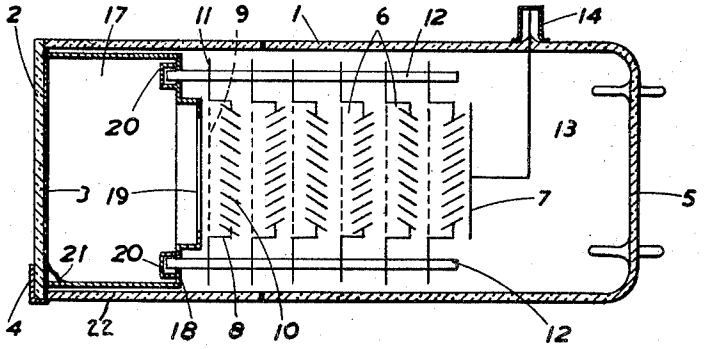


FIG. 3

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5 Claims. (Cl. 313—95)

This invention relates to electron multipliers of the type wherein one or more secondary electron emissive dynode electrodes are disposed within an envelope within which is also disposed a photo-electric cathode and an anode, the arrangement being such that the incidence of light on the photo-cathode causes electrons to be emitted therefrom and the impact of said electrons on the dynode or dynodes causes secondary electrons to be emitted in greater number than the primary electrons whereby the electron current collected by the anode is greater than the electron current proceeding from the cathode. In such multipliers the envelope is normally made of glass and it is sometimes found that spurious signals are set up due to the incidence on the cathode of glow light generated in the vicinity of the anode and passing along the envelope by internal reflection in the wall thereof and/or between said wall and said device or devices. In multipliers of the type referred to moreover, the dynode electrodes are sometimes supported by means of glass rods arranged parallel to the axis of the envelope and spurious effects may also be caused by light transmitted to the cathode via said rods from the anode end of the tube.

The object of the invention is to provide means for reducing these undesirable effects.

According to the invention, an electron multiplier comprises within an evacuated glass walled envelope a photo-electric cathode, at least one dynode electrode and an electron collecting anode, said envelope having a portion disposed between said cathode and said anode including light attenuating means interrupting the transmission of light within said envelope wall making multiple internal reflections therein.

In order that the invention may be more fully understood the same will now be described with reference to the accompanying drawings which show in Figures 1, 2 and 3 various forms of the invention applied to electron multipliers of the above-mentioned type.

The electron multiplier tube shown in Figure 1 is provided with a substantially cylindrical glass envelope 1 one end of which is closed by a substantially flat transparent glass end wall 2 on the inner surface of which is provided a photo-electric cathode 3. Electrical connection to the cathode 3 is arranged by means of a contact member 4 hermetically sealed between the wall 2 and the end of the envelope 1. The other end of the envelope 1 is closed by means of a contact carrying base 5.

Within the evacuated envelope 1 between the cathode 3 and the base 5 there are arranged a number of secondary electron emitting dynodes 6 and an electron collecting anode 7. Each of the dynodes 6 comprises a box like structure 8 with the side facing the cathode covered by a wire mesh 9, the other side having a number of obliquely disposed louvres 10 each dynode 6 being provided with flanges 11 whereby a series of them can be assembled as a unitary structure by means of glass rods 12, with the louvres 10 of adjacent dynodes 6 oppositely directed

as shown. In the drawing six dynodes 6 are shown by way of example although it will be understood that the number provided may be varied for different tubes depending upon the degree of amplification required. The anode 7 is supported by an arm 13 sealed through the wall of the envelope 1 and electrically connected to a contact cap 14.

Between the cathode 3 and the first dynode 6 the envelope 1 is formed with a re-entrant portion 15, the inner and/or outer surfaces of which are rendered opaque for example by painting as illustrated by the external coating 15a. If desired the glass employed for the portion 15 of the envelope 1 may be of dark colour such that it will provide a light attenuator in this region.

In operation of the device with light incident on the cathode 3 and the dynodes 6 and anode 7 maintained positive with respect to the cathode, electrons which are emitted by the cathode 3, impinge on the first dynode 6 producing secondary electrons, which impinge on the next dynode of the series and release further secondary electrons and so on, the secondary electrons emitted by the last dynode 6 of said series being collected by the anode 7.

During operation of the device, even though it is highly evacuated, a glow light is liable to occur in the region of the anode 7, the light from which, if allowed to reach the cathode 3 gives rise to unwanted emission of electrons. By providing a light barrier such as 15, light passing from the region of the anode 7 towards the cathode 3 either along the envelope 1 by internal reflection or through the glass rods 12 is intercepted at least partly and the incidence of said light on the cathode 3 is thereby reduced.

In a modification shown in Figure 2 instead of forming the envelope 1 with an annular re-entrant portion 15 the light barrier may be formed by an annular metal ring 16 sealed into the cylindrical wall of the envelope 1.

Said ring 16 may, for example be made from material known by the registered trademark "Kovar," the envelope 1 being made from two portions each of a glass capable of being sealed to "Kovar" and being sealed respectively to the two sides of the metal ring 16. The ring 16 is arranged so that it projects inwardly to a sufficient extent to intercept light which would otherwise reach the cathode 3 from the region of the anode 7 by passing along the tube between the cylindrical wall thereof and the dynodes 6 or along the glass support rods 12. The metal ring 16 may be connected to the cathode 3 either internally or externally of the tube. In all other respects the tube is the same as that previously described in connection with Figure 1 and the component parts have been given the same reference numbers.

An alternative construction is shown in Figure 3, in which in addition to the light barrier forming part of the envelope there is provided a further light barrier within the envelope arranged between the cathode 3 and the first dynode 6.

Referring to Figure 3 the envelope 1 of the device is of uninterrupted cylindrical form along its length from the contact base 5 to the end wall 2. Supported from the glass rods 12 is a cylindrical member 17 arranged so as to substantially enclose the space between the cathode 3 and the first dynode 6. The member 17 is of metal with a diameter just slightly less than the internal diameter of the cylindrical envelope 1. One end of the member 17 is arranged to be adjacent the surface of the cathode 3 the other end being provided with an inwardly directed circular flange 18 which has a circular aperture 19 to allow electrons from the cathode 3 to pass to the first anode 6. The ends of the rods 12 which pass through the

apertures in the flange **18** are covered by means of cup shaped eyelets **20** each of which is welded to the flange **18**.

The member **17** is maintained at the potential of cathode **3** by means of an internal connecting strap **21** and in operation of the device, the electrostatic field conditions set up by the inclusion of said member **17** between the cathode **3** and the first dynode **6** is such that a uniform withdrawal of electrons from the whole of the surface area of the cathode **3** is obtained.

The member **17** together with the eyelets **20** will effectively intercept light which would otherwise reach the cathode **3** by passing along the tube between the internal cylindrical wall thereof and the dynodes **6**, or along the glass rods **12** but will not prevent light passing to the cathode by internal reflection within the glass envelope **1**. Therefore in order to complete the light barrier it is necessary to construct at least a part of the envelope **1** adjacent the end wall **2** of a light attenuating glass as indicated at **22**.

What I claim is:

1. An electron multiplier tube comprising an evacuated envelope, a photoelectric cathode therein, a plurality of dynode electrodes mounted in said envelope on a plurality of light transmitting insulating rods having ends facing said cathode, and an anode for collecting the electrons emitted by said dynodes, said envelope having a substantial portion of its body lying between said cathode and said rod ends composed of light transmitting glass, and

having an annular light attenuating portion forming an internal projection extending towards the axis of the envelope and disposed between the cathode and said ends of said rods.

2. An electron multiplier in accordance with claim 1, in which said rods are made of glass.

3. An electron multiplier in accordance with claim 1, in which said annular portion is made of light absorbing glass.

4. An electron multiplier in accordance with claim 1, in which said light attenuating portion includes a coating of opaque material.

5. An electron multiplier tube in accordance with claim 1, in which said internal projection comprises an opaque annular disc sealed into the envelope wall and extending inwardly toward the tube axis a sufficient distance to shield the said rod ends optically from said cathode.

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