July 12, 1966 R. LEGOUX 3,260,878

ELECTRON MULTIPLIER

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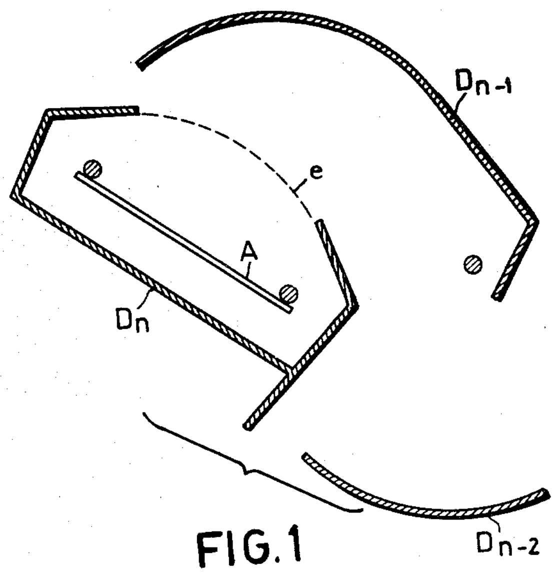

FIG. 1

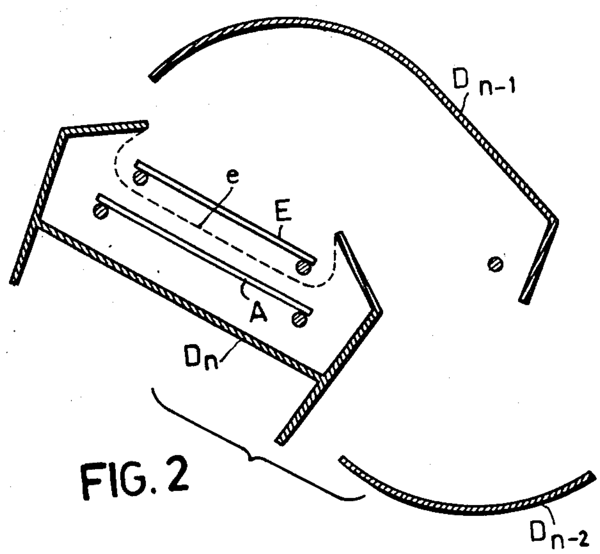

FIG. 2

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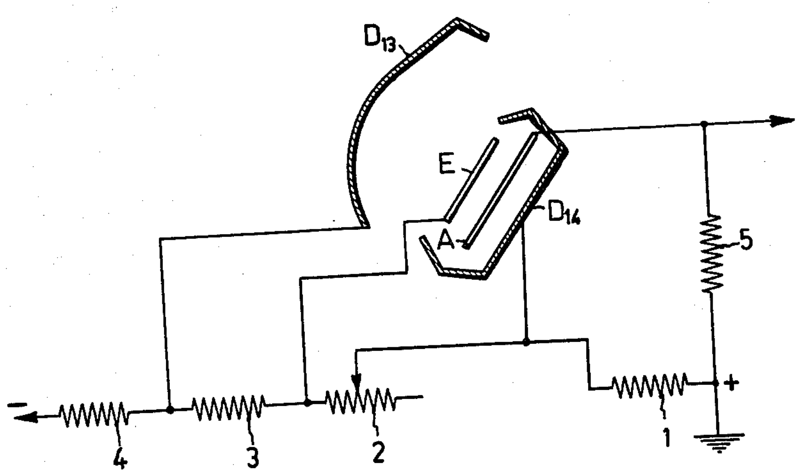

FIG.3

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ELECTRON MULTIPLIER

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4 Claims. (Cl. 313—104)

The invention relates to a device comprising an electron multiplier with a photocathode, in which the grid-shaped anode is located inside the last multiplier electrode constructed in the form of a box open at one end or of a gutter. The invention furthermore relates to an electron multiplier intended for use in such a device.

The disadvantage of the aforesaid, known electron multipliers consists in that the electrons emitted by the last multiplier electrode are, in general, not directly collected by the anode, but swing about the grid wires of the anode, so that, in addition, a space charge is produced. This involves not only a long transit time of the electrons to the anode, but also a large variation of said transit time. Particularly in amplifying short light pulses incident on the cathode of the order of 10^{-9} sec. the undistorted reproduction of the light pulses is not satisfying and particularly the slope of the flanks is too small.

The invention has for its object to provide an improved structure.

In accordance with the invention, in a device comprising an electron multiplier having a photocathode, in which the grid-shaped anode is accommodated inside the last multiplier electrode formed by a box open at one end or by a gutter, a grid-shaped electrode is arranged inside the opening of the last multiplier electrode and in front of the anode, which electrode assumes, in operation, a potential which lies between those of the last multiplier electrode and of the penultimate multiplier electrode.

Owing to the arrangement and the applied potential shown the equipotential plane with the potential of the last multiplier electrode lies between the anode and the additional, grid-shaped electrode. Since this equipotential plane is located near the anode, the distance may be acted upon at will by the arrangement and the applied potentials, the oscillations performed by the electrons around the anode are strongly restricted in amplitude and duration, so that the slope of the flanks of an amplified light pulse on the cathode is materially improved.

In an electron multiplier according to the invention it is particularly advantageous to arrange the wires of the additional grid and of the anode, viewed from the penultimate multiplier electrode, one in the shadow of the other, so that the electrons from the penultimate multiplier electrode are not partly captured by the anode. It is thus in particular avoided that the directly captured electrons would so to say provide a preliminary pulse of the amplified pulse, which would reduce the slope of the flank. If the voltage difference between the anode and the last multiplier electrode is $2V_o$, the voltage difference between the anode and the additional electrode is, in accordance with the invention $X+2V_o$ and that between the anode and the penultimate multiplier electrode $X+3.75V_o$, wherein X lies between zero and $2V_o$ and is preferably equal to $2V_o$.

The invention will now be described more fully with reference to the accompanying drawing, in which FIGS. 1 and 2 are sectional views of the anode and the ultimate multiplier electrode of an electron multiplier with and without the additional, grid-shaped electrode respectively in accordance with the invention and

FIG. 3 shows the connections of the electrodes.

Referring to FIG. 1, the anode of an electron multiplier with a photocathode is designated by A. It consists of two rods, on which grid wires are stretched. The ultimate multiplier electrode D_n is shaped in the form of an elongated, open box or channel and the penultimate multiplier electrode D_{n1} is shaped in the form of a curved plate. The section of the equipotential plane containing the potential of the ultimate multiplier electrode is indicated by *e* in broken lines. It will be evident that the equipotential plane bends over the outside, so that the electrons from D_n can oscillate with a fairly large amplitude around the anode wires, before they are collected.

As shown in FIG. 2, the additional, grid-shaped electrode E is arranged so that, as will be seen from the figure, the equipotential plane *e* bends over strongly to the inner side. The electrons can therefore perform only small oscillations around the anode wires, which greatly improves the fidelity of the reproduction of luminous pulses on the photocathode.

FIG. 3 shows a number of resistors **1** to **4**, connected in series so that together they constitute a potentiometer. One end of the resistor **1** is connected to ground, to which is also connected the positive terminal of the supply source for the multiplier. One end of the resistor **4** is connected to that part of the potentiometer which is intended for the electrodes of lower number. The anode is fed via the output resistor **5**. The resistor **2** is variable, so that the voltage difference between *e* and **D14** is adjustable. In a given case the voltage difference between the anode and **D14** was 240 v., that between the anode and the electrode E 480 v. and that between the anode and **D13** was 690 v. With the voltages indicated an improvement in the slope of the flank of an amplified pulse of 20% was obtained as compared to the arrangement in which the electrode E is not provided.

The effectiveness of the provision of the additional electrode at a separate potential can be readily proved by deconnecting said electrode, in contrast to the manner described either to the potential of the anode A or to the potential of the ultimate multiplier electrode.

What is claimed is:

1. An electron multiplier device comprising a photocathode and a multiplier chain of dynode electrode elements, the last dynode element in said chain comprising an open channel-shaped member, a grid-shaped anode disposed within said channel-shaped member, a grid-shaped electrode located between said anode and the open side of said channel-shaped member, means to apply given potentials to each of said dynode elements in said chain and said anode, and means to apply a potential to the grid electrode disposed within the channel-shaped member intermediate that applied to the anode and that applied to the preceding dynode of the chain.

2. An electron multiplier device comprising a photocathode, and a multiplier chain of dynode electrode elements, the last dynode element in said chain comprising an open channel-shaped member, a grid-shaped anode disposed within said channel-shaped member, a grid-shaped electrode located between said anode and the open side of said channel-shaped member, means to apply given potentials to each of said dynode elements in said chain, means to apply a potential to said anode differing from that applied to the last dynode in the chain by an amount $2V_o$, means to apply a potential to the grid electrode which differs from the potential applied to the anode by an amount equal to $X+2V_o$, the potential applied to the next preceding dynode differing from that applied to the anode by an amount equal to $X+3.75V_o$, X having a value from 0 to $2V_o$.

3. An electron multiplier device as claimed in claim **2** in which X has a value equal to $2V_o$.

4. An electron multiplier device comprising a photocathode, and a multiplier chain or dynode electrode elements, the last dynode electrode element comprising an open channel-shaped member, a grid-shaped anode electrode disposed within said channel-shaped member, a grid-shaped electrode located between said anode and the open side of said channel-shaped member, said grid-shaped electrode being further located so that the wires thereof and those of the anode lie in the shadow of each other, means to apply given potentials to each of said dynode elements in said chain and said anode, and means to apply a poten-

tial to the grid electrode disposed within the channel-shaped member intermediate that applied to the anode and that applied to the preceding dynode of the chain.

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