April 26, 1938. G. B. BANKS 2,115,155

ELECTRON MULTIPLIER

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Fig. 1

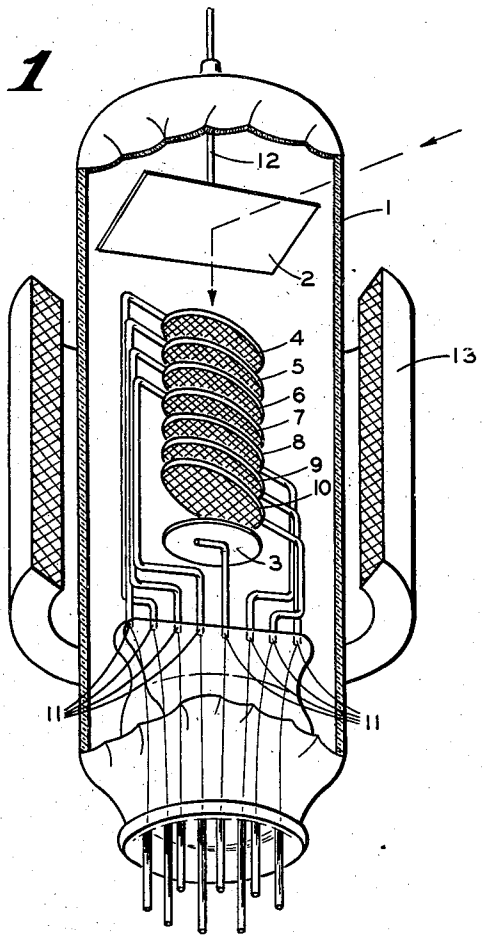
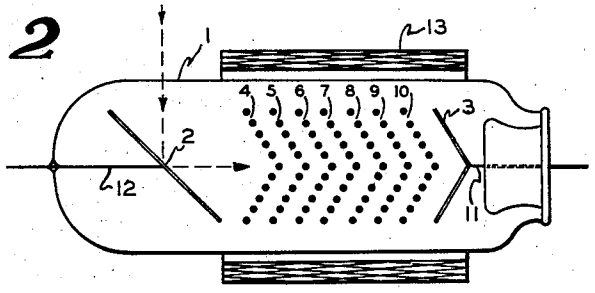


Fig. 2



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ELECTRON MULTIPLIER

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3 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to electron multipliers in which a primary electron stream derived from a photoelectric, thermionic, or other source of primary electrons is multiplied or amplified, by utilizing secondary electron emission.

The object of the invention is to provide improved electron multipliers whch are very simple in construction and which do not require the operating parameters to be critically adjusted for satisfactory operation.

According to this invention an electron multiplier which has a source of primary electrons, an anode or collecting electrode, a plurality of grid-like or perforated secondary electron emitter electrodes interposed in succession in the space between the electron source and the collecting electrode to extend across said space, and means for generating a magnetic field having lines of force running longitudinally of said space is so constructed that by virtue of the applied magnetic field the interposed electrodes will, when the tube is in use, be bombarded by electrons which strike them obliquely and thereby cause secondary electron emission.

The invention is illustrated in the accompanying drawing, which shows diagrammatically two embodiments of the invention, and in which Figure 1 illustrates the use of flat grid emitters and Figure 2 the use of conical or tapered grids.

Referring to Figure 1, which shows one form of tube embodying the invention, a cylindrical evacuated envelope 1 contains a primary cathode 2, an anode 3, and a plurality of secondary electron emitting grids interposed between the cathode and the anode. Seven grids 4 to 10 are shown, but other numbers of grids may be used. The anode and the grids may be carried upon suitable support members 11 sealed through the usual stem at one end of the envelope, and the primary cathode 2, which may be photoelectric, as shown, or thermionic, is carried on a support 12 sealed through the other end of the envelope. The primary cathode and the anode may be plate-like. The anode is preferably a disc at right angles to the axis of the envelope, and the photocathode a rectangular plate photo-sensitized on the face towards the anode and lying as shown in a plane which is oblique to the envelope axis so that it can receive activating light from a point exterior to the envelope and can yet release electrons towards the anode. The secondary electron emitting grids, which are caesiated or otherwise treated to give copious secondary emission, are preferably each a wire meshwork within a circular frame. The grids are parallel to one another and are tilted so as to lie in planes inclined to the axis of the envelope. The envelope is inserted into a solenoid or field coil indicated at 13 which, when energized with direct current, will produce a magnetic field with lines of force extending through the planes of the grids substantially parallel to the longitudinal axis of the envelope.

In use a magnetic field is generated by the field coil and the anode and each of the secondary emitter grids is maintained at a suitable potential—for example 200 volts—positive with respect to and on the cathode side of the next electrode. The operating potentials may be applied from any convenient source—for example by means of a potentiometer (not shown) having suitable tappings. If desired, the potentiometer may be enclosed in the envelope so that the only external leads required are to the ends of the said potentiometer.

In operation the magnetic field causes the electrons in their travel from cathode to anode to follow close-pitch helical paths in the direction of the lines of force. In order to decrease the chance that electrons will pass through a grid without striking it, the grids may be so arranged that the electrostatic fields due thereto are distorted so as to impart a "swirling" motion to the electrons; for example the grids may be tilted so that they do not lie normal to the magnetic lines of force, or the grids may be cone-shaped instead of flat, and as a result each electron path is oblique with respect to the planes of the grids and it is therefore very difficult if not impossible for any electron to pass through a grid without striking it. The bombardment of a grid by the electrons causes secondary electron emission of a greater number of electrons which follow similar paths in the same general direction and bombard the next grid, as the magnetic field substantially wholly prevents electrons from travelling outside the grids direct to the anode. As a result, satisfactory electron multiplication is obtained with a device which is very simple and is easily manufactured. In practice the applied potentials and the value of the applied magnetic field are not at all critical and close adjustment is therefore not required.

Figure 2 illustrates diagrammatically and in longitudinal section a type of construction in which each grid is conical so as to give rise to an electrostatic field having a component normal to the magnetic field so that the electrons follow helical paths in accordance with the well known

laws of electron motion and approach the grids obliquely to the plane of the grids. In this figure the anode 3 is also conical, although it may be flat, if desired. The grid leads and supports are not shown.

Where a thermionic cathode is employed as the source of primary electrons, it will, in general, be employed in association with a control grid and one or more space charge grids not of a secondary electron emitting character.

I claim:

1. An electron multiplier tube comprising a source of primary electrons, an anode, means for generating in the space between said source and said anode a magnetic field of substantially uniform strength having straight lines of force parallel to the longitudinal axis of said space and extending from said source to said anode, and a plurality of spaced grid-like secondary emitter electrodes interposed side by side in the space between said source and said anode and extending across said space and inclined to the lines of force of said magnetic field to cause said interposed grid-like electrodes to be bombarded by electron streams which impinge upon them along paths oblique to the plane of each grid and cause secondary electron emission.

2. A tube as claimed in claim 1 wherein the secondary emitter electrodes are parallel flat grid-like electrodes lying in planes inclined to the longitudinal axis of the cathode-anode space.

3. A tube as claimed in claim 1 wherein the secondary emitter electrodes are grid-like electrodes having parallel surfaces tilted to lie in planes making an angle other than a right angle with the longitudinal axis of the cathode-anode space.

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