

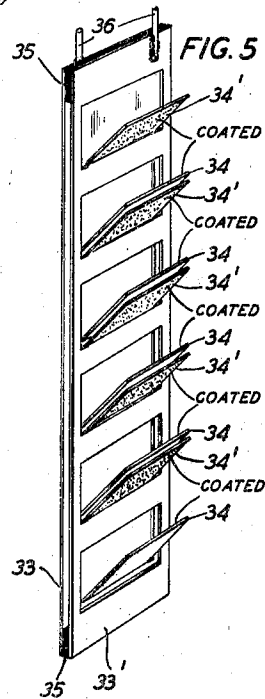
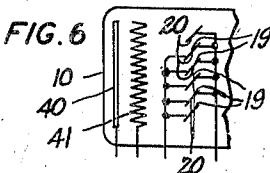
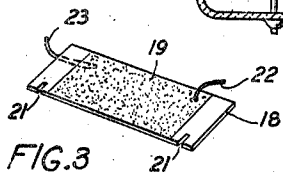
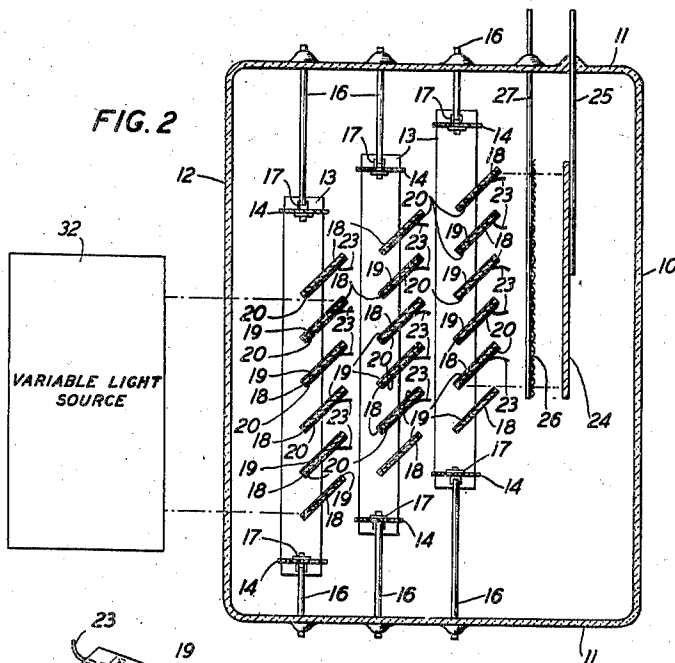
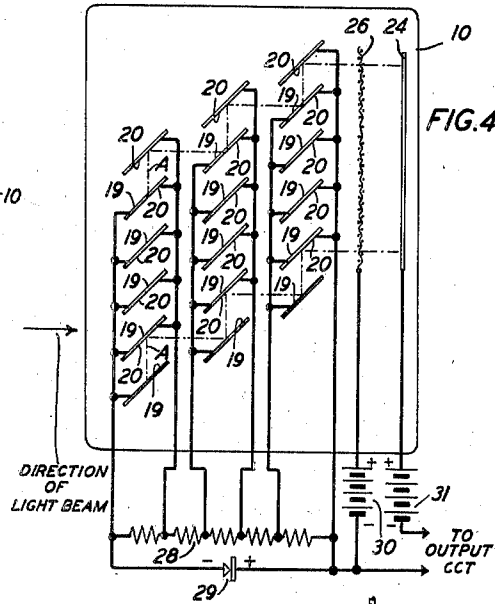
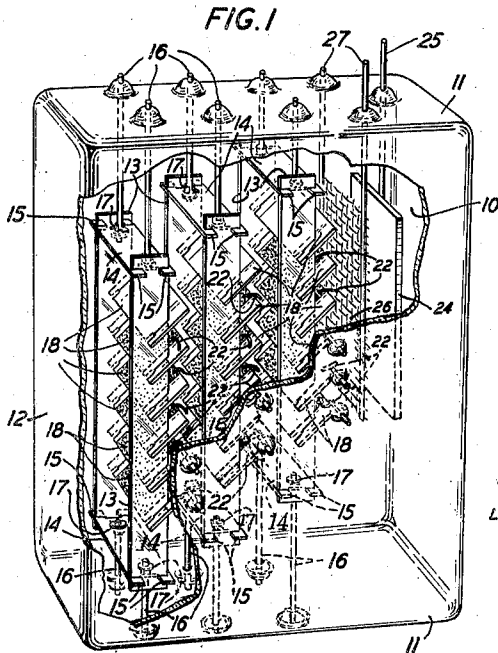
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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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12 Claims. (Cl. 250-175)

This invention relates to electron discharge devices and more particularly to such devices having a plurality of cooperatively associated secondary electron emitting cathodes and generally designated as electron multipliers.

One object of the invention is to increase the power capacity of electron discharge devices of the electron multiplier type.

Another object of this invention is to facilitate the manifold amplification of relatively weak signals or impulses corresponding, for example, to electric currents of audio or radio frequencies.

A further object of this invention is to simplify the structure and thereby to expedite the fabrication of electron discharge devices having a multiplicity of electrodes.

In one illustrative embodiment of this invention, an electron multiplier comprises a plurality of substantially parallel rows of aligned electrodes, the electrodes in each row being parallel to one another and mounted oblique to the axis of alignment thereof, and corresponding electrodes in the several rows being aligned. Opposite and opposed surfaces of the various electrodes are treated or coated to render them electron emitting, the emitting surfaces on individual electrodes being spaced and electrically insulated from each other so that they may be maintained at different operating potentials.

During operation of the device, one surface of the electrodes in one of the rows is energized to cause the emission of electrons therefrom. These electrons are attracted to and impinge upon the other or opposed surface of the next succeeding electrodes in the same row to cause the emission of secondary electrons from these other surfaces. The secondary electrons from each of these surfaces are drawn to and impinge upon the opposed surfaces of the corresponding electrodes in the next row and produce the emission of other secondary electrons therefrom. These electrons in turn are drawn to and impinge upon the other or opposed surface of the next succeeding electrodes in the same row to cause the emission of still other secondary electrons therefrom. This phenomenon is repeated throughout the electrodes in each of the rows and between corresponding electrodes in the several rows and the ultimate secondary electron streams are drawn to an anode or collector electrode and constitute the output current of the device.

The surfaces of the electrodes are so constituted that each electron impinging thereon causes the emission of a plurality of secondary

electrons. Consequently, in effect, an electron multiplication occurs at each of the electron receiving surfaces of the electrodes with a resultant amplification of the original electron current.

The invention and the various features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a view in perspective of an electron discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel being broken away to show the electrode structures more clearly;

Fig. 2 is a view in cross-section of the electron discharge device illustrated in Fig. 1, showing also a source for initially energizing the electrodes in one of the rows;

Fig. 3 is a detail view in perspective of one of the electrodes embodied in the device shown in Figs. 1 and 2;

Fig. 4 is a diagrammatic view illustrating a typical electrical association of the various electrodes in the device shown in Figs. 1 and 2, during operation of the device;

Fig. 5 is a detail view illustrating a modification of the electrode or cathode structures incorporated in the device shown in Figs. 1 and 2; and

Fig. 6 is a fragmentary view illustrating another modification of the embodiment of the invention shown in Figs. 1 and 2.

Referring now to the drawing, the electron discharge device illustrated in Figs. 1 and 2 comprises an evacuated enclosing vessel 10 having end walls 11, the vessel preferably being entirely of vitreous material or being of metal and having one plane wall 12 of vitreous material and transparent to light. Mounted within the vessel 10 are a plurality, for example three, of electrode or cathode structures disposed parallel to one another and to the plane wall 12. Each of the electrode structures comprises a relatively rigid insulating frame including parallel arms 13, for example, strips of mica or the like, and end members 14, which also may be of mica or the like, having tabs or projections 15 tightly fitted in slots in the arms 13. The frames may be mounted in proper position in the enclosing vessel 10 by rigid metallic supports 16 sealed in the end walls 11 and affixed to the end members 14 as by eyelets 17.

Supported by the insulating frames 13, 14 are a plurality of equal rows of emitting electrodes or cathodes, the electrodes in the several rows being parallel to one another and corresponding

electrodes in the rows being aligned with one another, as shown clearly in Fig. 2. Each of the electrodes as illustrated clearly in Figs. 2 and 3 comprises an insulating plate 18, for example, a strip of mica, and all but the end electrodes in each row have electron emitting coatings 19 and 20 on opposite faces of the insulating plate. The end electrodes are coated on only one face thereof. For example, the coatings 19 and 20 may include a layer of silver deposited upon the insulating plate 18, sensitized with a negative element such as oxygen and an active element such as caesium to form a matrix including silver, caesium oxide and some free caesium. The insulating plates 18 are fitted in oblique slots in the arms 13 and may be provided with notches 21 for frictionally receiving the arms 13 and locking the plates to the arms. The plates 18 are arranged at an angle, for example 45 degrees, to the longitudinal axis of the arms 13. Each of the coatings 19 has connected thereto a leading-in conductor 22 sealed in and extending from one wall of the enclosing vessel. Likewise, each of the coatings 20 has a leading-in conductor 23 connected thereto and sealed in and extending from the opposite wall of the enclosing vessel.

Disposed parallel to the axis of alignment of the cathodes 13, 19, 20 is an anode or collector electrode 24, which may be a metallic plate supported by a rigid leading-in conductor 25 sealed in and extending from one of the end walls 11 of the enclosing vessel 10.

A shield electrode is mounted between and parallel to the anode or collector electrode 24 and the row of emitting electrodes or cathodes in juxtaposition thereto and comprises a metallic screen 26 supported by a pair of rigid leading-in conductors 27 sealed in and extending from one end wall 11 of the enclosing vessel 10.

As illustrated in Fig. 4, during operation of the electron discharge device, the coatings 19 of the cathodes in each of the rows are connected together electrically and the coatings 20 of the electrodes are similarly connected. The coatings 20 of the electrodes in each of the rows are maintained at a potential, for example, of the order of 75 volts, positive with respect to the coatings 19 on the electrodes in the same rows. Similarly, the coatings 19 upon the electrodes in the second and third rows, to the right in Figs. 2 and 4, are maintained at a potential, for example of the order of 75 volts, positive with respect to the coatings 20 upon the electrodes in the next preceding row. The requisite potentials may be obtained through the agency of a potentiometer device including a resistance 28 connected across a suitable source such as a rectifier 29.

The shield electrode 26 may be maintained of the order of 75 volts positive with respect to the adjacent row of coatings 20, as by a battery 30, and the anode or collector electrode 24 may be operated at a potential of the order of 75 volts positive with respect to the shield electrode by a source such as a battery 31.

The coatings 19 upon the first row of electrodes, to the left in Fig. 2, may be energized to cause the emission of electrons therefrom, by a beam of light emanating from a source 32 of light of variable intensity, and focussed upon these coatings. The electrons emitted from each of these coatings 19 are attracted to and impinge upon the coatings 20 in juxtaposition thereto, the paths followed by the electrons emanating from two of the surfaces 19 being as

indicated approximately by the dotted lines A in Fig. 4. The electrons impinging upon these surfaces 20 cause the emission of secondary electrons therefrom and these secondary electrons flow to and impinge upon the opposed surfaces 19 of the electrodes in the second row, traversing paths as indicated by the dotted lines A in Fig. 4. This action is repeated at each of the succeeding coatings 19 and 20 and the electrons emanating from the coatings 20 in the last row of cathodes are drawn to the anode or collector electrode 24 and constitute the output current of the device.

Inasmuch as the coatings 19 and 20 have good secondary electron emitting characteristics, the secondary currents emanating therefrom will be several times greater than the primary or secondary electron streams impinging thereon. Consequently, the electrons emanating from the surfaces or coatings 19 in the first row of cathodes, in effect, will undergo a series of multiplications so that the current received by the anode or collector electrode 24 will represent a large amplification of the original electron streams. Furthermore, inasmuch as the various cathodes, and particularly those in the first row, have relatively large area individually and in aggregate, devices constructed in accordance with this invention are capable of handling relatively high powers without deleterious heating of the electrodes.

In the modification illustrated in Fig. 5, each of the cathode structures may comprise a pair of superposed metallic sheets or strips 33 and 33' each having a plurality of parallel vanes 34 and 34' respectively disposed at an angle, for example 45 degrees, to the plane of the sheets or strips. As shown in this figure, each of the vanes 34' may have an electron emitting coating upon one face thereof and the vanes 34 may have an electron emitting coating upon the opposite face thereof. A suitable coating is one including silver, caesium oxide and some free caesium. The two sheets or strips 33 and 33' may be maintained in spaced relation by insulating members 35 and may be supported by rigid rods 36. The rods 36 may be sealed in and extend through one of the end walls 11 of the enclosing vessel and serve as leading-in conductors for the cathodes.

The vanes 34' in each row may be maintained at a positive potential with respect to the adjacent vanes 34 as described heretofore in connection with the device shown in Figs. 1 and 2 and the vanes 34 in the second and third rows may be maintained at a positive potential with respect to the vanes 34' in the next preceding row. The operation of a device embodying cathode structures of the form shown in Fig. 5 is substantially the same as that of the device shown in Figs. 1 and 2.

Although specific embodiments of the invention have been shown and described, it will be understood, of course, that these embodiments are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims. For example, although three rows of cathodes have been shown, each row including six plate members, a greater or lesser number of rows including more or less than six plate members may be employed. Also, although the primary electron emitting surfaces of the first row of electrodes have been described as energized by a variable light beam, they may be energized by electrons emanating from a ther-

thermionic cathode 40, as shown in Fig. 6, in cooperative relation with these surfaces and a control electrode 41 may be provided for varying the electron streams emanating from the thermionic cathode.

What is claimed is:

1. An electrode structure for electron discharge devices, comprising a row of parallel, aligned secondary electron emissive surfaces mounted obliquely to the axis of alignment thereof, means electrically connecting only alternate surfaces into two groups, each surface of one group facing a surface of the other group, and means supporting said surfaces as a unit.

2. An electrode structure for electron discharge devices, comprising a plurality of aligned, parallel plate members mounted obliquely to the axis of alignment thereof, electron emitting coatings upon opposed faces of said plate members, and separate leading-in connections for said coatings.

3. An electrode structure for electron discharge devices, comprising a frame, a plurality of parallel aligned insulating members carried by said frame and mounted obliquely to the longitudinal axis thereof, and electron emitting coatings upon opposite faces of said insulating members.

4. An electrode structure for electron discharge devices, comprising a supporting frame having parallel arms, a plurality of parallel, insulating plate members mounted between said arms and affixed thereto, said insulating members being disposed obliquely to the longitudinal axis of said arms, and electron emitting coatings upon opposed faces of said insulating members.

5. An electrode structure for electron discharge devices, comprising a pair of superposed plate members each having a plurality of parallel aligned vanes disposed obliquely to the axis of alignment thereof, an electron emitting coating upon one face of the vanes of one of said plate members, and an electron emitting coating upon the opposite face of the vanes of the other of said plate members.

6. An electrode structure for electron discharge devices, comprising a pair of superposed metallic members each having a plurality of aligned parallel vanes, said vanes being oblique to the longitudinal axis of said members and the vanes of one of said members being immediately adjacent the corresponding vanes of the other of said members, an electron emitting coating upon one face of the vanes of one of said members, and an electron emitting coating upon the opposite face of the vanes of the other of said members.

7. An electron discharge device comprising a pair of aligned, superposed, parallel plate members mounted obliquely to the axis of alignment thereof, opposed surfaces of said plate members being electron emissive, a second pair of superposed aligned plate members parallel to said first plate members and having opposed electron emissive surfaces, one of said second plate members being directly opposite and in alignment with one of said first plate members, and a collector electrode opposite the emissive surface of the other of said second plate members.

8. An electron discharge device comprising an enclosing vessel housing a collector electrode, a plurality of parallel plate members opposite said collector electrode, said plate members being aligned and mounted obliquely to the axis of alignment thereof, electron emissive coatings upon opposed faces of said plate members, and lead-in means for energizing the corresponding surfaces of said plate members away from said collector electrode.

9. An electron discharge device comprising an anode, a plurality of rows of aligned electrodes mounted in succession to one side of said anode, the electrodes in each of said rows being mounted obliquely to the axis of alignment thereof and corresponding electrodes in said rows being in alignment and having opposed surfaces, and electron emissive coatings upon the opposed surfaces of the electrodes in each of said rows.

10. An electron discharge device comprising an anode and a plurality of parallel rows of electrodes to one side of said anode, the electrodes in each of said rows including aligned parallel plate members disposed obliquely to the axis of alignment thereof and having opposed electron emitting surfaces, and corresponding electrodes in said rows having opposed electron emitting surfaces and being in alignment with and parallel to one another.

11. An electrode structure for electron discharge devices, comprising a plurality of aligned parallel plate members disposed obliquely to the axis of alignment thereof, opposed surfaces of said plate members being electron emissive, and means electrically connecting only corresponding of said surfaces into two groups.

12. An electrode structure for electron discharge devices, comprising an insulating frame including parallel arms having parallel oblique slots therein, a plurality of plate members fitted in said slots, and electron emitting coatings upon opposed surfaces of said plate members.

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