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T. W. SUKUMLYN

2,035,623

VACUUM TUBE DEVICE

Filed April 15, 1930

Fig. 1

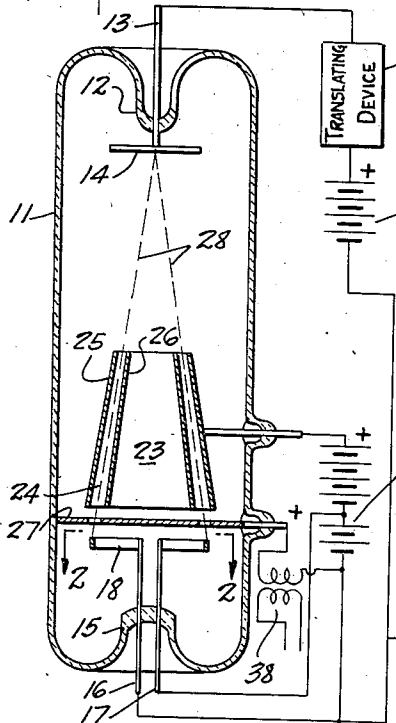


Fig. 2

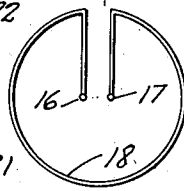


Fig. 3

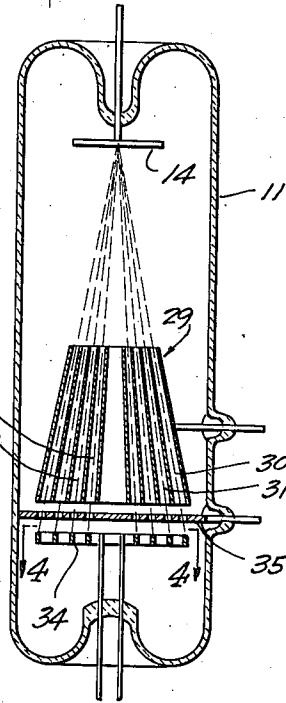


Fig. 4

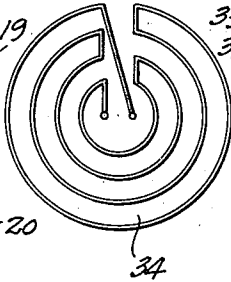


Fig. 5

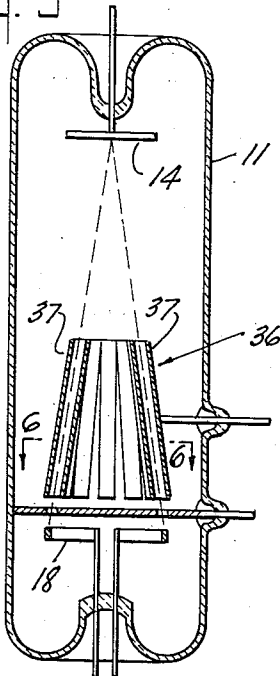
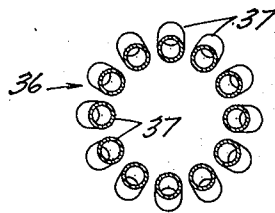


Fig. 6



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VACUUM TUBE DEVICE

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12 Claims. (Cl. 250—27.5)

My invention relates to a device utilizing electron emission, and especially one that can be used for the production of a space current in a vacuum tube, as for the amplification of electrical impulses.

Such devices are now in quite general use in connection with radio systems, and sound recording or reproducing systems, as well as for relays, for magnifying the effects of comparatively minute impulses of any character; and as well for cathode ray oscillograph tubes.

These usually take the form of an evacuated vessel, as of glass, in which several electrodes are sealed. One electrode is a cathode for emitting the electrons; for example a heated filament. These electrons are received upon a plate or anode spaced from the filament and maintained at a potential positive with respect to the cathode. The electron stream thus formed between these two electrodes forms the "space current". The anode and cathode are joined by an external circuit to complete the path for the space current, said external circuit including the source of potential difference for maintaining the anode at a positive potential.

It has been found that the volume of electron flow can be readily controlled by the aid of a third electrode, usually termed a control electrode or grid, which is interposed between the other two electrodes. Furthermore, in order to confine the stream of electrons more closely to the anode, sometimes a directing anode is used. This anode, in prior devices, takes the form of a tube coaxial with the stream of electrons and maintained at a potential positive with respect to the cathode either at the same potential as the main anode or lower. Such directing anodes have been used in connection with tubes operating at comparatively high anode voltages, such as in the well-known Braun tubes. These tubes are usually evacuated to almost a perfect vacuum. Although such a tubular directing anode serves to some extent, to confine the stream of electrons, yet in actual practice it has been found that this stream disperses transversely, due to their mutual repulsion, and are not confined to any restricted area on the plate.

It is one of the objects of my invention to make it possible to focus a stream of electrons to a restricted area at great concentration, and in spite of the tendency of electrons, due to their mutual repulsion, to fan out.

My invention can be utilized in connection with either a highly evacuated tube or a tube in which there is a small residual gas content. Some-

times this gas content is purposely placed in the tube; as for example, one of the inert gases such as nitrogen, or any one of the noble monatomic gases.

When a controlling electrode or grid is interposed between the anode and the cathode, the device can be utilized for amplification, rectification, or detection. In some instances the grid can be dispensed with, and accordingly my invention is not to be restricted to any definite arrangement of supplemental or control electrodes.

In a gas filled tube, as for cathode ray oscillograph uses, the main anode can be dispensed with, and in its place a regular fluorescent screen could be used, as one formed by calcium tungstate.

I accomplish this object by providing a directing anode of such construction that the tendency for dispersion of the electron stream is minimized. This can be produced by providing a path through the directing anode for the electrons that is convergent toward the center of the anode. Accordingly it is another object of my invention to provide an electronic emission device in which there is a directing anode providing a converging path for the stream of electrons toward the anode.

My invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of my invention. For this purpose I have shown a few forms in the drawing accompanying and forming part of the present specification. I shall now proceed to describe these forms in detail, which illustrate the general principles of my invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of my invention is best defined by the appended claims.

Referring to the drawing:

Figure 1 is a diagrammatic sectional representation of a vacuum tube embodying my invention, and its associated circuits;

Fig. 2 is a plan view of the electron-emitting electrode, taken along 2—2 of Fig. 1;

Fig. 3 shows diagrammatically a modified form of vacuum tube embodying my invention;

Fig. 4 is a plan view of the cathode shown in Fig. 3, and taken along plane 4—4 of this figure;

Fig. 5 is a diagrammatic section of a still further modification of my invention; and

Fig. 6 is a section taken along plane 6—6 of Fig. 5.

In Fig. 1 there is shown an evacuated vessel 11 in which the various electrodes comprising my

device can be sealed. For example, a re-entrant stem 12 is shown at one end of the tube 11 which serves as a support for a rod 13 sealed in the stem 12 and supporting the anode 14. At the other end of the tube 11 a similar re-entrant stem 15 is shown for supporting the leading in wires 16 and 17 for the filament or cathode 18.

This filament 18 is shown as heated by the passage of an electric current through it, and supplied from a source 19. The anode 14 is connected to the cathode 18 as by a conductor 20. A source of plate potential 21 is included in this connection. A translating device 22 also can be interposed in this external circuit. This translating device represents a general class of devices, which can utilize or transmit the space current variations; for example a transformer or the like.

Interposed in the space between the electrodes 14 and 18 there is a directing anode structure 23. This structure is such that it converges the stream of electrons from the cathode 18 toward the center of the plate or anode 14. To facilitate this effect the cathode 18 is shown as annular in form. The plane of the cathode is substantially perpendicular to the axis of the electron stream. In the present instance the cathode is shown as a ribbon with its edge disposed toward the anode 14. Close to and conforming with this edge, an annular space 24 is formed between the two truncated hollow cones 25 and 26 which comprise the directing anode structure 23. It is also desirable to include a shield 27 between members 18 and 23, and which could be used as a controlling grid. It can be either negative or positive with respect to the cathode 18. In this instance, I show it used with a negative bias, as by being joined to the negative terminal of the heating battery 19, and the connection including an input coil or transformer 38.

The truncated cones 25 and 26, being arranged to converge toward the anode 14, provide a continuous annular space through which the electrons travel toward plate 14. I have indicated by the dotted lines 28 the path of these electrons under ideal conditions. In practice, however, there is still some divergence from the true conical form, due to the mutual repulsion effect between the electrons. However, the converging path 24 materially restricts the electrons against spreading out, and the result is that an electron stream of comparatively large concentration is obtained.

It is apparent that other types of converging anodes could be utilized in place of the structure 23. For example, in the form illustrated in Figs. 3 and 4, I show a directing anode structure 29 similar in general to the structure 23, but utilizing more than two truncated cone elements. Thus there are defined no less than four annular spaces, 30, 31, 32, 33, which direct the streams of electrons from a cathode or filament or filament structure 34. This filament structure as shown most clearly in Fig. 4, comprises a series of concentric circular elements, each conforming to its associated space 30, 31, 32, 33, so that it is directly opposite that space. The shield structure 35 is similar to the structure 27, especially in that it has a series of circular openings corresponding to the configuration of the cathode structure 34.

In both forms described it is seen that a large length of cathode structure is spaced substantially uniformly from the anode 14. This induces substantially uniform emission from the whole length of the cathode, and especially since this

active surface is closely spaced to the directing anode and conforms therewith.

The anode structures 23 and 29 form continuous annular paths for the electron stream. However, substantially the same result could be obtained by a discontinuous annular path, as shown in Figs. 5 and 6. In this instance, the directing anode structure 36, instead of being formed of concentric conical tube elements, utilizes an annular series of cylindrical tubes 37 (Fig. 6) which slant toward the axis of the stream of electrons. These serve as directing tubes preventing material spread of the electron stream.

I claim:

1. An electron emission device, comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and anode, the directing anode having a pair of spaced walls providing a path between the walls for the stream of electrons, and the cathode having its active length conforming to the cross-section of the space defined by said walls.

2. An electron emission device comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and anode, the directing anode having walls providing for the electron stream an annular path between the walls that causes the stream to converge at the anode.

3. An electron emission device comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and anode, the directing anode having a pair of spaced walls providing a converging path between the walls for the electron stream, and the cathode having its active surface conforming in contour and magnitude to the cross section of the space defined by said walls.

4. An electron emission device comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and anode, the directing anode providing a converging annular path for the electron stream, defined between a pair of annularly spaced walls, and the cathode having its active surface opposite the path and conforms in contour and magnitude to the cross-section of the path.

5. The combination as set forth in claim 1, with the addition of a control electrode interposed between the cathode and the directing anode, said control electrode having a slot conforming with the shape of the cathode.

6. An electron emission device comprising a cathode and anode for generating a stream of electrons, and means forming a continuous annular space including walls converging toward the anode for directing the electron stream between these electrodes in a converging path.

7. An electron emission device comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and anode, said directing anode having a pair of walls between which walls an annular space is formed for the electron flow, and said cathode being spaced opposite the said annular space and conforming in shape thereto.

8. An electron emission device comprising a cathode constituted of a concentrically looped element, an anode, and a directing anode constituted of a plurality of coaxial tubes defining annular spaces conforming in contour with the cathode loops.

9. An electron emission device comprising a

cathode constituted of a concentrically looped element, an anode, and a directing anode constituted of a plurality of converging tubes defining coaxial converging annular spaces, the openings at one end of the directing anode registering with the cathode loops.

10. An electron emission device comprising a cathode and an anode for generating a stream of electrons, and a directing anode between the anode and the cathode, said directing anode providing a narrow path for the electrons, said narrow path being formed between a pair of spaced walls of the directing anode, and the cathode being opposite the path and having a configuration conforming in contour and magnitude to the path to direct electrons mainly into the path.

11. The combination as set forth in claim 10, with the addition of a control electrode interposed between the cathode and the directing anode, said control electrode having an opening conforming with the shape of the cathode.

12. An electron emission device, comprising a cathode and anode for generating a stream of electrons, and a directing anode between the cathode and the anode, the directing anode having a plurality of spaced walls providing a plurality of coaxial annular paths converging at the anode for the stream of electrons, and the cathode having its active length conforming to the cross section of the space defined by said walls.

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