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ELECTRON DISCHARGE DEVICE OF THE VELOCITY VARIATION TYPE

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FIG. 1

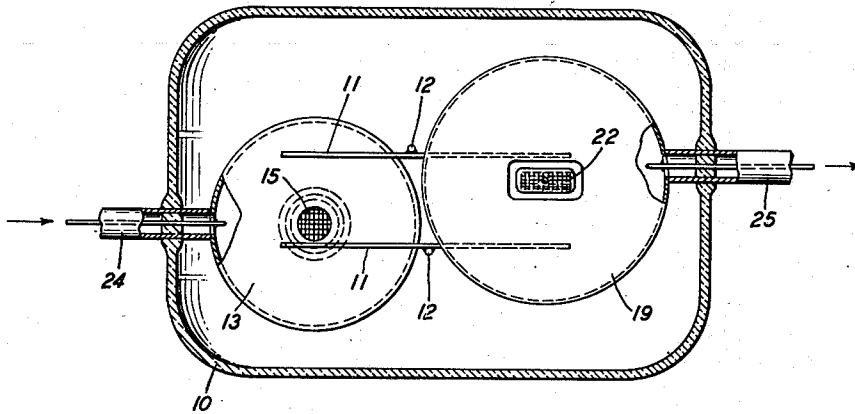
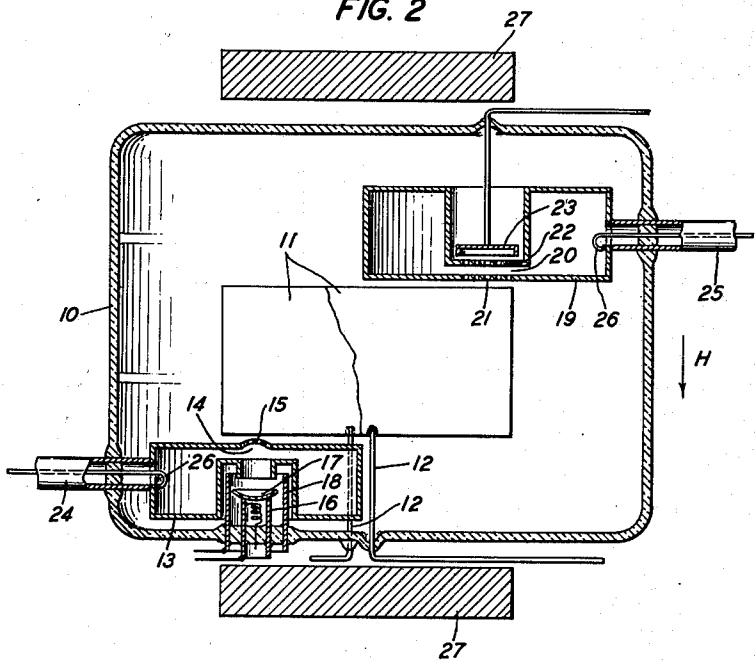


FIG. 2



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ELECTRON DISCHARGE DEVICE OF THE
VELOCITY VARIATION TYPE

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4 Claims. (Cl. 315—6)

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This invention relates to electron discharge devices and more particularly to such devices of the velocity variation type and including spaced input and output circuit elements, such as cavity resonators.

In general, in devices of the above-mentioned type, a concentrated electron stream is velocity varied at the input element, passes through the region between the input and output element and at the latter contributes energy to the output circuit. In the passage of the stream between the two elements, a bunching or grouping of the electrons occurs so that the velocity varied stream is converted into a density varied stream.

The operating efficiency of the device is dependent upon the extent to which the bunching or grouping obtains and also upon the coupling between the stream and the output element. Because electrons are electrically charged particles, mutual repulsion effects occur in their flow between the input and output elements. Consequently, what is known as space charge debunching occurs. Attempts have been made heretofore to decrease such debunching by spreading the beam as it passes from the input to the output element. However, if the transverse dimensions of the beam at the output element are large, and this is particularly true where the output element is a cavity resonator, the coupling between stream and output element is reduced with consequent degradation in the operating efficiency.

One object of this invention is to improve the performance of electron discharge devices. More specifically one object of this invention is to reduce space charge debunching effects in such devices and realize, concurrently, efficient coupling between the stream and the output element.

In accordance with one feature of this invention, in an electron discharge device of the type above described, the concentrated velocity varied electron stream is operated upon in its passage from the input to output elements to produce at the output element a highly bunched or density varied stream of configuration to assure efficient coupling between the stream and the output element.

More specifically, in accordance with one feature of the invention, in the region between the input and output elements, the concentrated velocity varied stream is subjected to the action of crossed magnetic and electric fields such as to bring the stream to a line focus at the output element. The spreading of the stream into a line focus one reduces space charge debunching

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whereby high conversion of velocity variation to density variations obtains. The line focus form of the stream enables use of a narrow slit or aperture in the output cavity resonator whereby high efficiency is realized.

Referring now to the drawing, the electron discharge device therein illustrated is of the velocity variation type and suitable for use as an amplifier or oscillator. It comprises an evacuated enclosing vessel 10 having therein a pair of parallel deflector plates 11 rigidly supported by leading-in conductors 12 sealed in one wall of the vessel 10. Mounted adjacent the deflector plates and near one end thereof is a cylindrical input cavity resonator 13 having a gap 14 and a circular outlet aperture in one wall across which a grid 15 extends. A concentrated electron stream is projected across the gap 14 and into the region between the deflector plates 11 by an electron gun, which may be of known construction and comprises, for example, an indirectly heated cathode 16 having a concave emissive surface 17, and a cylindrical beam forming electrode 18.

Also mounted adjacent the deflector plates 11 and near the other end thereof is an output cavity resonator 19 having juxtaposed walls defining a gap 20. These walls are provided with rectangular slots or apertures, the major dimension of which is parallel to the length of the deflector plates 11, over which grids 21 and 22 extend. Opposite the grid 22 is a collector electrode 23.

Coupling to the electromagnetic fields within the resonators 13 and 19 may be established through coaxial lines 24 and 25, respectively, the inner conductor of each line terminating in a loop 26 within the respective resonator.

A magnetic field parallel to the deflector plates 11 and of direction indicated by the arrow H in Fig. 2 is produced in the region between the deflector plates as by a magnet the pole-pieces 27 of which are illustrated in Fig. 2.

In the operation of the device, a constant direct-current potential is maintained between the deflector plates 11. Specifically, the upper plate 11 in Fig. 1 is maintained positive relative to the other plate. The concentrated, circular electron stream projected by the electron gun is velocity varied in crossing the input gap 14 and is injected into the region between the deflector plates 11. In this region, the electrons are subjected to the crossed magnetic and electric fields so that there is imparted to each electron a component of motion normal to the direction of injection of the stream into the region noted. The

result is that each electron follows a recurrent cycloidal path in passing from the input gap 14 to the output gap 20, i. e. the electrons move to the right and upward in Fig. 2.

The transit time of any electron through the region between the deflector plates 11 and the number of cycloids it traverses will be dependent upon the velocity of that electron at its point of injection into this region. Thus, the amplitude of displacement of any electron in the direction parallel to the length of the deflector plates, i. e. to the right in Fig. 2, will be determined by the injection velocity of the electron. Those electrons which are accelerated at the input gap will be displaced less than those electrons which are decelerated at the input gap. However, the displacement of the electrons in the direction normal to the deflector plates is independent of the electron velocity. Because of the difference in injection velocities, it will be appreciated that bunching of the electrons is obtained at the output gap. Thus, the cylindrical velocity varied stream issuing from the input gap is converted into a density varied line focus stream flowing into the output gap.

Inasmuch as the electron stream is spread in its passage between the input and output gaps, it will be appreciated that space charge debunching effects are reduced whereby improved, more efficient conversion of velocity variations into density variations is achieved.

In operation of the device as an amplifier, independent input and output circuits are coupled to the resonators 13 and 20; in operation of the device as an oscillator, the output line 25 is coupled to the input line 24 to feed back energy from the output resonator to the input resonator.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention.

What is claimed is:

1. An electron discharge device comprising a cavity resonator having a rectangular inlet aperture in one wall thereof, an electron gun laterally offset with respect to said resonator for projecting a cylindrical electron stream in the direction substantially normal to said wall, means adjacent said gun for velocity varying said stream, and means for converting the cylindrical velocity varied stream into a density varied line focus stream at said aperture comprising means for producing crossed magnetic and electric fields in the region between said aperture and said velocity varying means, the magnetic field being parallel to said direction of projection of said cylindrical stream.

2. An electron discharge device comprising an

output element, means diagonally opposite said element for projecting a cylindrical electron beam, means adjacent said beam projecting means for velocity varying said beam, and means for converting the cylindrical velocity varied beam into a line focus density varied stream at said output element, said converting means comprising means for producing in the region between said element and said velocity varying means crossed magnetic and electric fields, the magnetic field being substantially parallel to the direction of projection of said velocity varied beam.

3. An electron discharge device comprising means including a pair of deflector plates for producing a constant electric field in a prescribed region, means opposite one side of said region and near one end thereof for projecting a velocity varied electron stream into said region, an output element opposite the other side of said region and near the other end thereof, and means including said first means for bringing said stream to a line focus at said element, said focus means including also means for producing in said region a constant magnetic field having its lines normal to said field and parallel to the direction of projection of said stream with said region.

4. An electron discharge device comprising an input cavity resonator having a gap therein and an output cavity resonator having a gap therein and a wall portion having a rectangular aperture therein, said gaps being diagonally opposite each other and the axes of said two gaps being substantially parallel, electron gun means for projecting an electron stream through said gap in said input resonator, parallel to the axis thereof and into the region between said resonators, whereby said electron stream is velocity varied on entering the region between said resonators, and means for converting the velocity varied electron stream into a density varied line focus stream at said rectangular aperture comprising a pair of deflector plates in said region between said resonators and extending between said gaps and means for producing in said region a constant magnetic field parallel to said axes.

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