Nov. 2, 1948. W. T. GIBSON 2,452,561

ELECTRON DISCHARGE APPARATUS USING VELOCITY MODULATED BEAMS

Filed Oct. 5, 1942

Fig. 2.

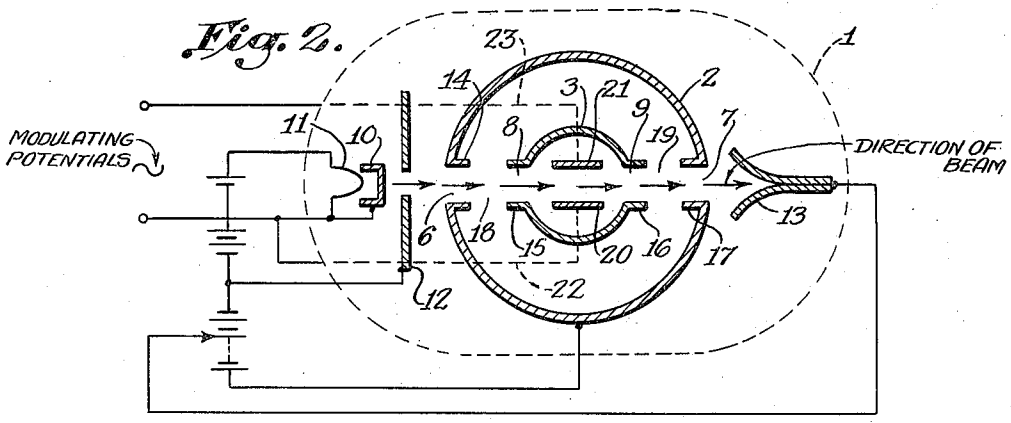


Fig. 1.

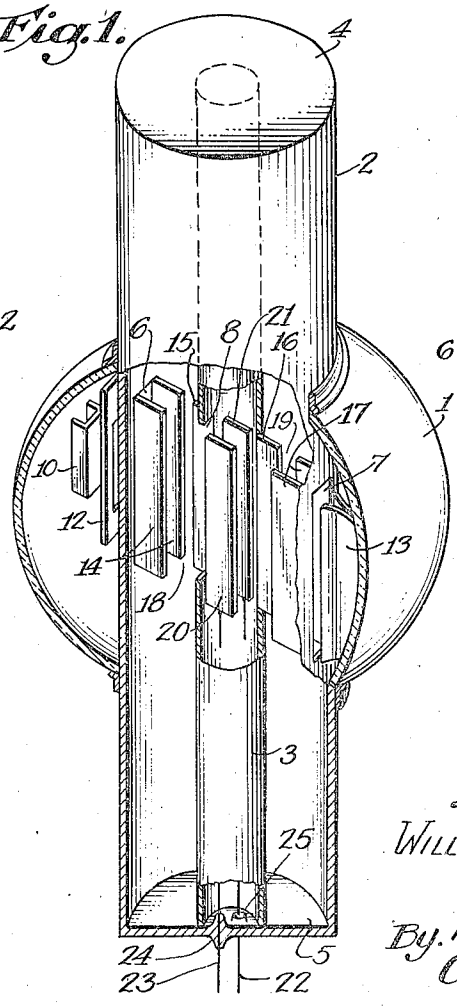


Fig. 3.

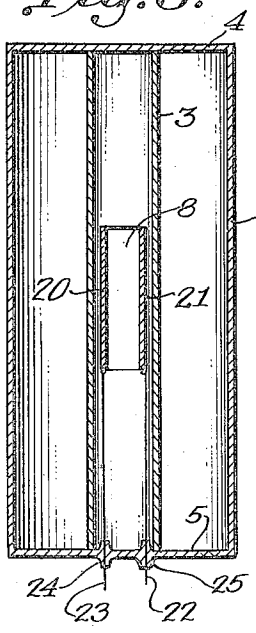
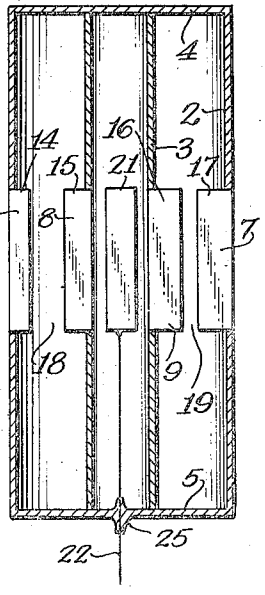


Fig. 4.



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ELECTRON DISCHARGE APPARATUS USING VELOCITY MODULATED BEAMS

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4 Claims. (Cl. 315—6)

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This invention relates to electron discharge apparatus using the principles of velocity modulation of electrons for the excitation of a resonator effective at very high frequencies.

The operation of such apparatus is described more fully in the U. S. Patent No. 2,320,860 issued to John Heaver Fremlin on June 1, 1943, and particulars of known structures and improved arrangements are given. Briefly such apparatus usually comprises a single resonator or a pair of coupled resonators of hohlraum type, electrons being passed through two successive gaps therein to be modulated in velocity in the first gap and to yield energy at the second gap for the maintenance of oscillations.

It is now proposed for the amplitude modulation of the output to provide means for variably deflecting the electrons at a point intermediate the gaps to vary the portion of the electron beam passing through the second gap.

The invention will be better understood with reference to the following description of preferred embodiments and the accompanying drawings in which:

Fig. 1 is a perspective view of a resonator incorporating the invention;

Fig. 2 is a horizontal section through apparatus incorporating the invention and comprising the resonator of Fig. 1; and

Figs. 3 and 4 are vertical sections at right angles of a resonator such as that of Fig. 1.

In the U. S. Patent No. 2,320,860 it is shown to be possible to set up a system in which the principle of velocity modulation is used, but in which a single resonator is employed. What is required to do this is, a single closed hollow resonator including a cylindrical re-entrant shell provided with a diametrical passage therethrough consisting of clots in alignment with each other and having fins or flanges extending from the edges of the slots, so that the electrons can pass across one part of or gap in the circuit in which their velocities are controlled, and they can then, after a considerable space pass across another part of the circuit, in which their energy may be given up.

As shown in Fig. 1 the single resonator may comprise a short length of concentric line comprising hollow conductive cylinders 2 and 3 closed at both ends with copper discs 4 and 5. It is clear that this could oscillate as a half-wavelength section of a long concentric line in which there were standing waves, the two ends of the section being potential nodes and the center of the section being a potential anti-node. A slot is cut straight through the system along a diameter at the anti-

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node in order to obtain the results mentioned as desirable above. In the preferred structure the slots 6, 7, 8, 9 which have been cut both in the outer cylinder of the concentric line and in the center cylinder have metal fins or flanges 14, 15, 16, 17 put on to them for two reasons. One is to prevent the otherwise extensive leakage of the electro-magnetic field out of the cylinder, and the other is to decrease the radial gap between the two cylinders across which the electrons have to pass. Now suppose that an electron beam is fired through the resonator. A suitable arrangement is shown in Fig. 2 where 10, 11 is a heated cathode, 12 a slotted plate or strip serving as an electron beam defining grid and 13 a collector anode. A separate collector anode 13 is not essential; it may be integral with the resonator. The aperture at the outer edge of the fins 17 may be closed to form a collecting surface. The electrons are considered to have left the resonator as soon as they have entered the space between fins 17 since they have no further effect unless they emerge again with substantial velocity. An axial magnetic field or an electron gun including the disc 12 is required to drive the electrons from cathode 10 through the resonator 2, 3 to collector anode 13. It is clear that the electrons passing through the resonator, as they cross the first gap 18, will come into the field if the system is oscillating and will be velocity modulated, as has been described above. During the rather short flight between the fins 15, 16 on the center conductor they will sort themselves out in bunches, which then will give up energy to the electro-magnetic oscillation as they cross the second gap 19. The slots and electrodes are enclosed in envelope 1. Suitable shapes of slots and fins are indicated by way of example in Figs. 3 and 4.

In such a high frequency generator it is proposed that the total electron current passed into the resonator system be kept constant and that modulation of the amplitude of the generated oscillation be obtained by deflection of the electrons between the first and second working gaps, so that a variable electron current is obtained in the second gap. This may be achieved by interposing in the inner conductive cylinder 3 of the resonator deflecting plates 20 and 21, one on either side of the electron stream.

Application of modulating voltage to these plates causes deflection of the beam so that increasing voltage causes reduction of the current through the second gap. The deflected electrons

hit the inside of the inner tube of the resonator and are lost to the beam.

In the absence of modulating voltage, the potential of each plate is the same as that of the resonator system.

Leads 22, 23 to and supports for the plates may be taken through copper-glass seals 24, 25 through the ends of the inner tube.

What is claimed is:

1. Electron discharge apparatus comprising a resonator including a short length of coaxial transmission line having concentric inner and outer tubular conductors electrically connected at their ends, aligned slots narrower than they are long in said inner and outer conductors along a common diameter forming first and second working gaps, means external to said resonator and aligned with said slots for generating an electron beam and for directing it through said slots, and deflecting plates mounted in said inner conductor on either side of the path of the electron beam, said deflecting plates being separated from said inner conductor so as to permit the deflecting plates and the inner conductor to be given different electric potentials.

2. Electron discharge apparatus comprising a resonator consisting of inner and outer concentric tubes electrically connected at their ends, aligned slots narrower than they are long in said inner and outer tubes defining first and second working gaps, means external to said resonator and aligned with said slots for generating an electron beam and for directing it through said slots whereby the electrons in said beam are velocity modulated in passing through said first gap and yield energy to said resonator in passing through said second gap, a pair of deflecting electrodes mounted in and spaced from said inner tube one on each side of the path of the electron beam, and means electrically connected to said deflecting electrodes for applying modulating potentials to said deflecting electrodes.

3. Electron discharge apparatus comprising a single substantially closed hollow resonator including an outer portion and a conductive reentrant portion extending between opposed surfaces of said resonator, said resonator having a set of apertures narrower than they are long along a line passing through said resonator and through said reentrant portion forming successive control and energy abstracting gaps, means external to said resonator and aligned with said apertures for causing a beam of electrons to pass through said successive gaps to form a velocity modulated electron beam and means including deflecting surfaces located within said reentrant portion and separate therefrom, for applying variable deflecting voltages to the beam before its passage through the energy abstracting gap.

4. Electron discharge apparatus comprising a single substantially closed hollow resonator including an outer portion and a conductive reentrant portion extending between opposed surfaces of said resonator, said resonator having a set of apertures narrower than they are long along a line passing through said resonator and through said reentrant portion forming successive control and energy abstracting gaps, means external to said resonator and aligned with said apertures for causing a beam of electrons to pass through said successive gaps to form a velocity modulated electron beam and means located within said reentrant portion for applying a variable voltage across said velocity modulated beam within the reentrant portion so as to vary the density of the beam.

WILLIAM THOMAS GIBSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,259,690	Hansen et al.	Oct. 21, 1942
2,272,165	Varian et al.	Feb. 3, 1942
2,275,480	Varian et al.	Mar. 10, 1942
2,280,824	Hansen et al.	Apr. 28, 1942
2,281,935	Hansen et al.	May 5, 1942
2,320,860	Fremlin	June 1, 1943