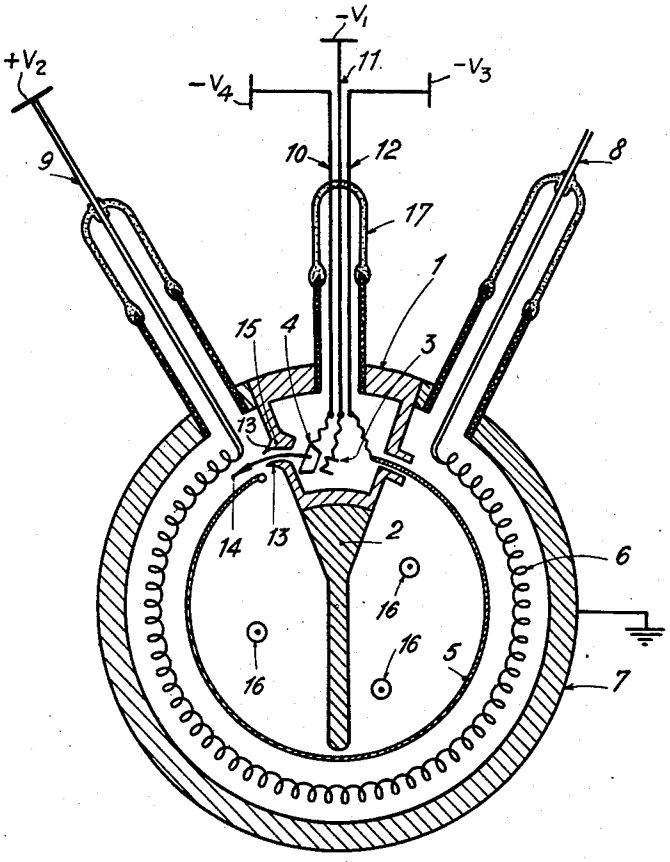
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TRAVELING-WAVE AMPLIFYING TUBE

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INVENTORS
ROBERT WARNECKE
DANIEL CHARLES

By: Hamilton, Lake & Co.
AGENTS

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TRAVELING-WAVE AMPLIFYING TUBE

Robert Warnecke and Daniel Charles, Paris, France, assignors to Compagnie Generale de Telegraphie Sans Fil, a corporation of France

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5 Claims. (Cl. 315—3)

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In our co-pending patent application Serial No. 794,164, filed on December 27, 1947, and now Patent No. 2,511,407, we described an amplifying tube provided with a retardation line wound in a circumference and an interacting beam of electrons describing an adjacent concentric circumference.

The preesnt invention relates to the provision of a suitable source of electrons for such a tube and in particular of a source of electrons that supplies a beam of adjustable intensity perfectly adapted to the desired interaction.

The phase velocity of the wave having been chosen, it is necessary for the electrons to describe a circumference at that velocity or very nearly at that velocity, in a radial electric field and a transverse magnetic field.

The equation which connects these three quantities is:

$$v=\frac{E}{B}$$

The field E is the one which, in the region through which the beam passes, exists between the retardation line raised to a positive potential and an inner cylindrical electrode raised to a negative potential. The stability of the trajectory makes it necessary to introduce the beam of electrons into this field at the velocity v on the equipotential surface which corresponds to that velocity.

Our invention consists of an arrangement which essentially comprises an electron gun of the usual type for flat beams, housed in a casing adapted to screen it from the magnetic field, so that the trajectories of the electrons in the gun depend only on the geometry of and the voltages applied to the electrodes.

The screening case is necessarily provided with an opening for the outlet of the beam and consequently there is a slight encroachment of the magnetic field; on the other hand, said screening case substantially deforms the equipotential surfaces in its vicinity. These two effects are taken into account by the choice of the shape of the outer wall of the screening case towards the point at which the electron beam is introduced and by the choice of the orientation of the axis of the gun relatively to the circle described by the beam.

The invention will be more clearly understood by referring to the single figure of the accompanying drawing, which shows by way of example a transverse section of a tube according to the invention.

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1 is the case which contains the electron gun and which acts as a screen with respect to the magnetic field, said case 1 being made of a suitable metal such as iron for example and also serving, together with the member 2 which is made of any metal such as copper for example, for the radio-frequency separation of the inlet 9 and the outlet 8 of the retardation line, which is represented in the figure by a helix.

The magnetic field directed along the axis of the tube is represented by the circles 16.

The screening case 1 is provided with two noses 13 that serve for connecting the electric field that exists between the helix 6 and the cylinder 5 that forms a non-emitting cathode.

Inside the screening case 1 is located at 3 the emitting source or cathode and at 4 the electron optical means or Wehnelt electrode, the anode of the electron gun being formed by the wall 15 of the case 1. The cathode 3 and the Wehnelt electrode 4 and also the cylinder 5 are electrically brought out at 11, 10 and 12 through an insulating wall 17.

The electron gun inside 1 has its axis inclined with respect to the circle along which the electrons travel and the beginning of which is represented by the arrow 14. The envelope 7 that forms with the case 1 a vacuum-tight enclosure, is made of a neutral metal such as copper for example.

Between the helix 6 and the non-emitting cathode 5 a constant potential difference is maintained, such that in the region through which the beam passes:

$$v=\frac{E}{B}$$

The case 1 and also the whole envelope 7 is kept at an intermediate potential V_0 in volts which is calculated as a function of the velocity v so as to satisfy approximately the known equation:

$$v=6.10^7\sqrt{V_0}$$

(the potential of the cathode being taken as the origin of the potentials).

The chief advantages of the arrangement according to the invention are the following:

1. Use of an electron gun for flat beams of the usual calculable type, and consequently possibility of obtaining the desired current.

2. Possibility of effecting a modulation of the intensity of the beam by means of the Wehnelt electrode or of an additional grid without appreciable alteration of the shape of the trajectories in the energy exchange portion.

3. Possibility of adding the velocity of the electrons to the phase velocity of the wave, independently of the fulfillment of the condition.

$$v=\frac{E}{B}$$

4. Screening of the electron gun and also of its lead-in wires, not only from the magnetic field but also from the radio-frequency field.

The invention is not restricted to the example which has been described and illustrated, or in particular to the use of a single electron gun. On the contrary, it covers the tubes which not only use one electron gun but also two or more of same, that supply two or more beams which are independent at the start.

What we claim is:

1. A travelling-wave tube comprising a cylindrical envelope, a source of magnetic field so positioned in relation to the tube that the field is directed parallel to the axis of said envelope, a pair of electrodes having separate input and output extremities and disposed circularly about the axis of said cylindrical envelope, at least one of said electrodes having the properties of a retardation line, means coupled with said input extremities for introducing an electromagnetic wave into said line, means coupled with said output extremities for collecting the amplified energy in said line, decoupling means between said input and output extremities of the retardation line, means comprising terminal connections to said electrodes and a source of potential for producing an electric field in the space between said electrodes, a source of an electron beam located near the entrance to said space with electron-optical means spaced therefrom for introducing said beam into said space perpendicularly to said electric and magnetic fields, and a magnetic screen surrounding the space between said beam source and said electron-optical means for preventing said magnetic field from penetrating into said space.

2. Tube according to claim 1, wherein means are provided for concentrating the emission of the electron beam source into a flat beam.

3. Tube according to claim 1, wherein the axis of the electron beam source is slightly inclined with respect to the direction of introduction of the beam into the space between said electrodes.

4. Tube according to claim 1, wherein the magnetic screen is a casing of ferromagnetic material incorporated in the walls of the envelope, said envelope being of non-magnetic material, and said casing being provided with slots for allowing the beam to pass.

5. Tube according to claim 1, in combination with means for independently applying D. C. potentials to the source of the electron beam, to the retardation line and to the magnetic screen.

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