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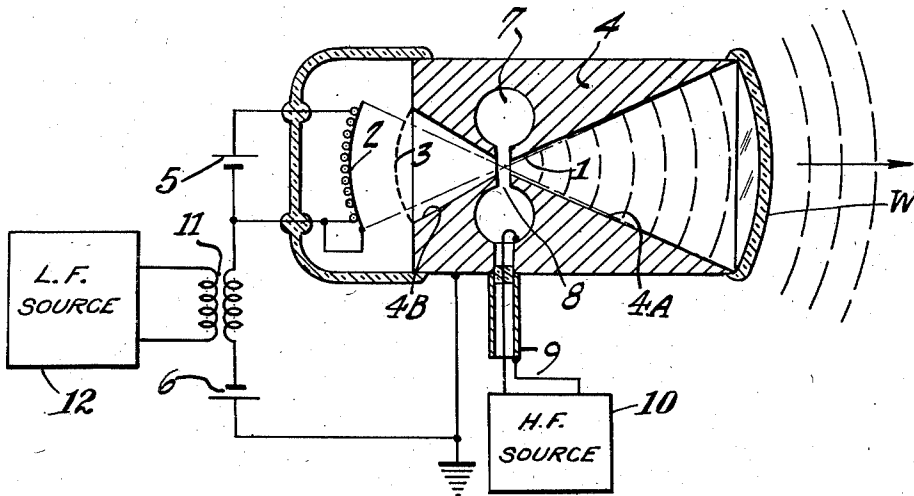
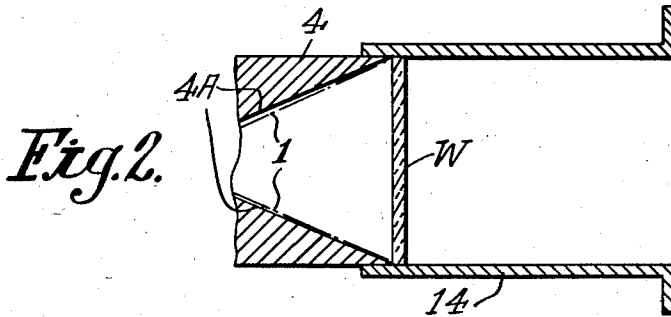
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CAVITY RESONATOR MICROWAVE COUPLING DEVICE

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Fig. 1.



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CAVITY RESONATOR MICROWAVE COUPLING DEVICE

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8 Claims. (Cl. 315-5.34)

This invention is a device for coupling electromagnetic energy from an annular cavity resonator to free space or to a transmission line. The device is also capable of modulating said energy.

The main distinctive feature of the device according to the invention is the incorporation of the cavity resonator in a cathode ray or electron beam tube with an annular slit at and around the apex of a conical diverging electron stream directed towards free space or towards a transmission line. A modulation voltage is suitably applied between the cathode and the acceleration grid of the tube for modulation of the electromagnetic energy.

The device according to the invention is mainly intended for coupling of microwaves and has, compared to hereto known coupling devices for microwaves, the advantage that the transmission medium has very small dielectric losses. Another important advantage of the device is the possibility of modulating the micro-wave energy in a simple way.

One way of utilizing the device according to the invention will be described here in connection with the partially schematic longitudinal cross-section view shown on the accompanying drawing, in which Fig. 1 is a longitudinal sectional view of an electron tube embodying the present invention; and Fig. 2 is fragmentary view similar to Fig. 1 of a modification thereof.

A conical diverging electron stream 1 shown by the dash lines in Fig. 1 is obtained in a cathode ray or electron tube having a concave cathode 2, an accelerating grid 3 concentric to the cathode, and a cylindrical anode 4 having a through passage or chamber in the form of a double-cone comprising two cones 4A and 4B with the apices facing each other. The large end of cone 4A is terminated by a wall or window W of dielectric material permeable to electromagnetic waves. The heater of the cathode 2 is heated by a power source 5. A high voltage from a voltage source 6 is applied to the anode 4 and the accelerating grid 3 with respect to the cathode 2. The concave cathode 2, grid 3 and anode 4 constitute means for producing an electron stream that converges from the cathode 2 to a cross-over at the apex of the double-cone passage and then becomes a diverging conical stream in the cone 4A. The electron density of the stream is relatively high at the cross-over point and decreases to a relatively low value near the open end of the cone 4A. The anode 4 has a toroidal cavity 7 which is coupled to the double-cone passage at its apex by means of an annular inside slit or gap 8. The axis of symmetry of the cavity coincides with the axis of the tube. Thus, the slit 8 is situated at and around the apex of the conical diverging electron stream 1, which is directed towards the window W. The cavity 7 is a resonator, the microwave energy being fed into the resonator from a high frequency source 10 by means of a coaxial line 9. Between the voltage source 6 and the cathode 2 may be connected the secondary winding of a transformer 11, to the primary winding of which a modulation voltage can be applied from a low frequency source 12. The conical

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cal region bounded by the grid 3 and the anode 4 is a field-free space in which the space charge of the converging electron stream is neutralized, whereby a stream of great density is produced at the apex of the cone.

If the average density of the electronic medium or electronic plasma formed by the electron stream 1 at the slit 8 is such that the plasma frequency of the medium is equal or nearly equal to the resonant frequency of the cavity resonator 7, the high frequency energy supplied by the coaxial line 9 and source 10 will give rise to high frequency plasma oscillations in the medium. The conical diverging electron stream will have a dielectric constant which continuously increases from a very low value at the cone apex to the value 1 in free space. Hereby the high frequency energy will be coupled to free space through the window W under good matching conditions. The high frequency energy in the diverging electron stream can be modulated by applying a low frequency modulation voltage from source 12 to the transformer 11, whereby the voltage between the cathode 2 and the accelerating grid 3 is caused to vary according to the modulating voltage.

The invention is of course not limited to the form shown in the drawing, but may be modified in several ways without departing from the spirit and scope of the invention. Thus, both the anode and the cavity resonator may be made out of sheet metal. The cavity resonator may be tuned by means of a plunger or, if the cavity resonator is made out of sheet metal, by deforming the sheet metal. The cavity resonator may have a rectangular cross section. The diverging electron stream may of course be directed towards the inside of a hollow waveguide 14, as shown in Fig. 2.

What is claimed is:

1. An electron tube comprising an annular cavity resonator having an annular inside slit facing the longitudinal axis thereof, transmission line means coupled to said resonator for exciting the resonator to produce an axial electromagnetic field across said slit, means for producing a conical diverging electron stream having its apex near the center of said slit, whereby oscillations are generated in said stream by said electro-magnetic field during operation of said tube, and coupling means in the path of said diverging stream in a region spaced from said resonator for utilizing said oscillations.

2. An electrical system comprising an electron tube according to claim 1, in combination with a high frequency source coupled to said transmission line means for exciting said resonator.

3. An electrical system comprising an electron tube according to claim 1, in combination with a high frequency source coupled to said transmission line means, and a low frequency source coupled to said stream producing means, for modulating said stream.

4. An electron tube comprising means defining the boundaries of a region which is closed to electromagnetic waves at the sides and open at one end and has a small aperture at the other end, means for producing within said region an electronic medium the density of which decreases from a relatively high value near said aperture to a relatively low value near said open end, whereby said region has a dielectric constant which increases from a relatively low value near said aperture to substantially unity near said open end, and means for exciting said electronic medium near said aperture at a frequency substantially equal to the plasma frequency of said medium at that point, for generating oscillations in said medium and thereby initiating electromagnetic waves toward and through said open end, said last-named means comprising an annular cavity resonator having an annular inside slit surrounding said region near said aperture.

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5. An electron tube according to claim 4, wherein first-named means defines a cone-shaped region and said second named means produces an electronic medium which is a conical diverging electron stream which substantially fills said region.

6. An electrical system comprising an electron tube according to claim 4, in combination with a high frequency source coupled to said cavity resonator, and a low frequency source coupled to said electronic medium producing means, for modulating said oscillations.

7. An electron tube according to claim 4, further com-

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prising coupling means coupled to said open end for utilizing said oscillations in said medium.

8. An electron tube according to claim 7, wherein said coupling means comprises a hollow waveguide.

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