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RESONANT CHAMBER CIRCUIT FOR USE ESPECIALLY WITH INDUCTIVE OUTPUT TUBES

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Fig. 1

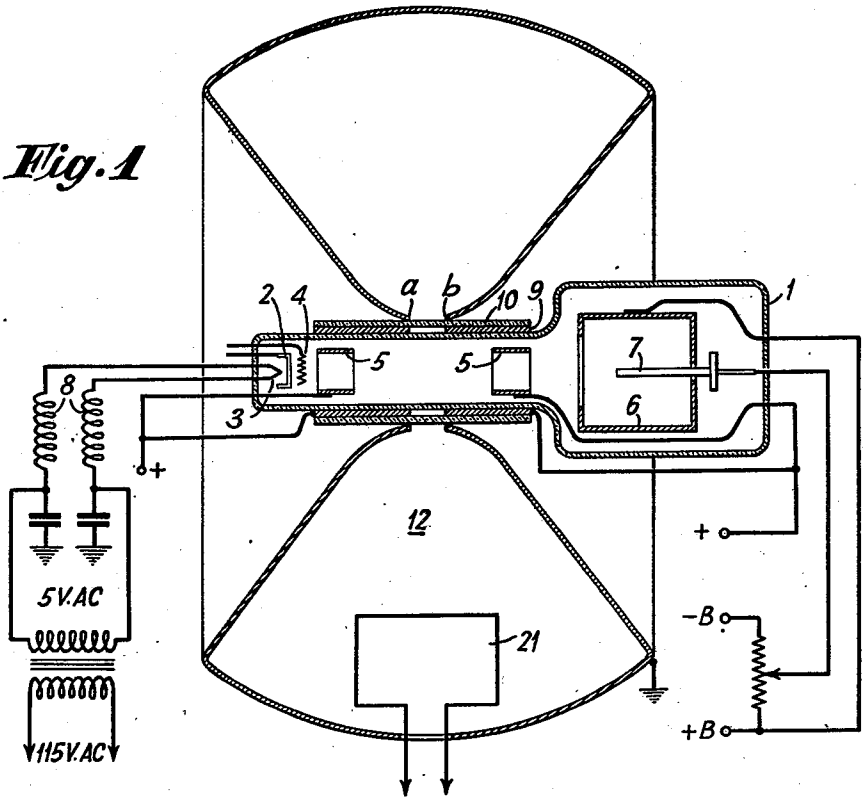
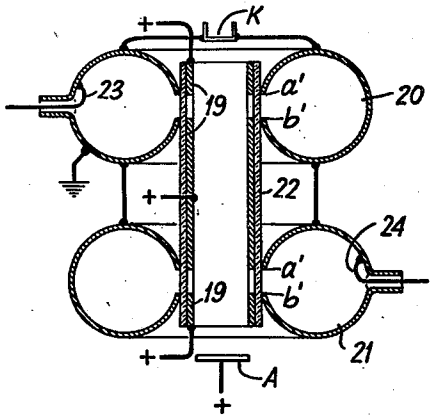


Fig. 2



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RESONANT CHAMBER CIRCUIT FOR USE ESPECIALLY WITH INDUCTIVE OUTPUT TUBES

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8 Claims. (Cl. 178—44)

This invention relates to electron discharge device circuits for use particularly with ultra short waves below five meters, and is particularly useful at wavelengths below one meter.

It is known that cavity resonators may be employed at ultra short wavelengths in connection with oscillators, amplifiers, frequency converters and detectors. These resonators are of high electrical conducting materials and may take the form of an enclosed doughnut or an enclosed hour-glass with a gap or pair of grids at the center. A stream of electrons is caused to pass through the gap or across the pair of grids in order to excite the resonator by induction. When the resonator is excited there is produced an ocillating electric field across the gap or between the grids, parallel to the electron stream and of such strength as to change the speed of the electrons and cause bunching. Suitable examples of such cavity resonators are described in the article by R. and S. Varian, entitled "A high frequency oscillator and amplifier," published in Journal of Applied Physics, May, 1939, page 321 to 327, and in the copending application of Fred H. Kroger, Serial No. 296,045, filed September 22, 1939. Such resonators have been designated in the art as "hohlraums" and "rhumbatrons," and where a pair of these resonators have been used, one to bunch the electrons and the other to absorb energy from the bunched electrons, the term "klystron" has been applied to such apparatus.

In using such cavity resonators it has been customary to apply a high positive voltage to the resonator relative to the cathode, thus exposing the personnel working with the equipment to danger from shock, and also in some forms of circuits causing a potential gradient to exist between the positively biased resonator and certain electrodes (usually the accelerator electrodes) within the evacuated tube envelope.

The primary object of the present invention is to provide an electron discharge circuit employing a cavity resonator which is grounded, thus taking the high voltage off the resonator and reducing the hazard to the personnel.

Another object is to provide an electron discharge device employing a grounded hour-glass type of cavity resonator so arranged as to remove all potential gradients between the resonator and the accelerator electrodes.

A more detailed description of the invention follows in conjunction with a drawing, wherein Figs. 1 and 2 illustrate two different embodiments of the invention.

Referring to Fig. 1 in more detail, there is shown an electron discharge device circuit employing a beam type of vacuum tube circuit of the type described in the Kroger copending application supra. The vacuum tube structure includes an evacuated glass envelope 1 containing within it a cathode 2, a heater 3, a grid or control electrode 4, ring-like accelerator electrodes 5, 5, and collector electrode 6 and a suppressor 7. The heater is supplied with energy from a suitable alternating current source, as shown, through choke coils 8. Connected to the cathode 2 and grid 4 is a suitable input (not shown) which may comprise a suitable source of high frequency energy.

Surrounding the exterior of the glass envelope 1 and located intermediate the two accelerator electrodes 5, 5, there is provided a low loss grounded tank circuit 12 in the form of a surface of revolution constituting a section approximating the sector of a circle with the vertex angle adjacent the electron beam, and whose central plane is perpendicular to the electron beam emanating from cathode 2. This tank circuit is symmetrically arranged around the glass envelope 1, and is provided with a central aperture represented by gap *a*, *b*, across which the electrons pass. The dimension of the tank circuit 12 as measured from the center of the glass envelope 1 toward the arc of the sector is approximately one-quarter the wavelength at the resonant frequency.

For focusing the electron beam there may be provided a pair of magnetic lenses in series relation, not shown, in the manner described in the Kroger copending application, supra. The magnetic path requires a field coil or solenoid excited by a direct current source of supply.

Also surrounding envelope 1 there are two copper cylinders 9, 9 which, although spaced apart for the length of gap *a*, *b*, extend therefrom to the accelerator electrodes 5, 5. An insulator ring 10 prevents the grounded resonator 12 from contacting the cylinders 9, 9 from a direct current standpoint. Cylinders 9, 9 are positively biased at the same potential as are accelerating electrodes 5, 5 thus preventing a potential gradient from existing between the resonator 12 and the electrodes 5, 5. The grounded tank 12 renders it safe for the personnel working around the equipment to touch the exterior of the tank.

In the operation of the circuit, the grid 4 may be maintained at a given negative bias, while the collector electrode 6 will be maintained at a

positive potential which is less than that applied to the accelerator electrodes 5, 5 and cylinders 9, 9. Energy from the tank circuit may be taken off by means of coupling coil 21 which transfers the energy induced in tank 12 to a suitable load, such as an antenna or an amplifier stage. Where the circuit is an oscillator, then coil 21 will be coupled back to the grid 4 and cathode 2.

In Fig. 2 there are shown two cavity resonators 20 and 21, both grounded and connected to each other and to the cathode which is also grounded. The general form of this structure without my improvements is known in the art as a "klystron," and is described in the article by R. H. and S. G. Varian, identified above, particularly pages 324 and 325 thereof. It is intended to operate this circuit within a vacuum.

The improvements produced by the present invention enable operating the resonators 20, 21 at ground potential. The copper cylinders 19, 19 are insulated from the resonators by means of insulation ring 22, and these copper cylinders are spaced apart at the gap portions a', b' of the resonators. The coupling loop 23 supplies the resonator 20 with high frequency power which maintains a radio frequency field inside the resonator. This field alternately accelerates and retards the electrons passing through and causes the bunching of the electrons emanating from the cathode K. The electrons are drawn over to the collector A and during their passage through the gap of resonator 21 induces high frequency voltage in this last resonator. Coupling loop 24 abstracts the energy induced in the resonator 21 and supplies a suitable utilization circuit, not shown, or if connected back to loop 23 provides a feed-back circuit for an oscillator. Here again, the grounded resonators reduce the hazard to personnel working with the equipment.

What is claimed is:

1. An electron discharge device circuit including a tank circuit in the form of a surface of revolution having a gap, a source of electrons for projecting a stream of electrons across said gap, metallic tubes on opposite sides of said gap and surrounding said electron stream for at least part of its length of travel, said tubes being insulatingly mounted with respect to said tank circuit, means for biasing said tubes positively relative to said source, and a connection from said tank circuit to ground.

2. An electron discharge device circuit including a tank circuit in the form of a surface of revolution having a gap, a source of electrons for projecting a stream of electrons across said gap, a pair of accelerating electrodes on opposite sides of said gap, said source of electrons and said accelerating electrodes being enclosed in a glass envelope, said tank circuit being external of said envelope, a pair of metallic cylinders on opposite sides of said gap and adjacent to said envelope, insulation means adjacent said cylinders and located between said cylinders and said tank, a connection from said tank to ground, and means for positively biasing said cylinders and said accelerator electrodes to substantially the same potential.

3. An electron discharge device circuit including a tank circuit in the form of a surface of revolution having a gap in the center thereof, means for projecting a stream of electrons across said gap at right angles to the central plane of said surface, tubular electrically conducting surfaces on opposite sides of said gap and surrounding said stream, said tubular surfaces being located between said tank circuit and said stream and being insulated from said tank circuit, means for maintaining said tubular surfaces at a positive potential relative to said cathode, and a connection from said tank circuit to ground.

4. A circuit in accordance with claim 3, characterized in this that said surface of revolution constitutes a section approximating the sector of a circle with the vertex angle adjacent said stream of electrons.

5. In combination, a tank circuit in the form of a surface of revolution having an aperture in the center thereof providing a gap, an electron discharge device having within an evacuated envelope a source of electrons near one end and an electron collector near the other end, and an accelerator electrode intermediate said source and said collector, said envelope being located within said aperture of said tank such that said gap is located between said source and said collector and adapted to be traversed by the electrons projected from said source, means for maintaining said accelerator electrode at a positive potential relative to ground, a connection from said tank circuit to ground, and means adjacent to and surrounding said envelope for preventing a potential gradient from existing between said tank circuit and said accelerator electrode.

6. In combination, a tank circuit in the form of a surface of revolution having an aperture in the center thereof providing a gap, an electron discharge device having within an evacuated envelope a source of electrons near one end and an electron collector near the other end, said envelope being located within said aperture of said tank such that said gap is located between said source and said collector and adapted to be traversed by the electrons projected from said source, a control electrode and an accelerator electrode in the order named within said envelope located between said source and said gap, and another accelerator electrode within said envelope between said gap and said collector, a connection from said tank circuit to ground, means for applying to said accelerator electrodes a predetermined potential relative to ground, and means adjacent to and surrounding said envelope for preventing a potential gradient from existing between said tank circuit and any of said named electrodes.

7. An electron discharge device circuit including a pair of tank circuits each in the form of a surface of revolution having a gap in the center thereof and both placed adjacent each other such that there is an unobstructed space in a line directly between said gaps, means for projecting a stream of electrons across both gaps in succession at right angles to the central planes of said surfaces, a tubular electrically conducting surface surrounding said stream of electrons and extending between said tanks from the interior edge of one gap to the nearest edge of the other gap, a pair of tubular electrically conducting surfaces positioned on the same straight line as but shorter than said first tubular surface and extending outwards from the other edges of said gaps, whereby adjacent tubular surfaces are separated by the widths of said gaps, said tubular surfaces being insulated from said tank circuits, means for positively biasing said tubular surfaces, and connections between said tank circuits and ground.

8. In combination, a tank circuit in the form of

a surface of revolution having an aperture in the center thereof providing a gap, an electron discharge device having within an evacuated envelope a source of electrons near one end and an electron collector near the other end, and an accelerator electrode intermediate said source and said collector, said envelope being located within said aperture of said tank such that said gap is located between said source and said collector and adapted to be traversed by the electrons projected from said source, means for maintaining said accelerator electrode at a different potential than ground relative to said cathode, a connection from said tank circuit to ground, and means adjacent to and surrounding said envelope for preventing a potential gradient from existing between said tank circuit and said accelerator electrode.

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