

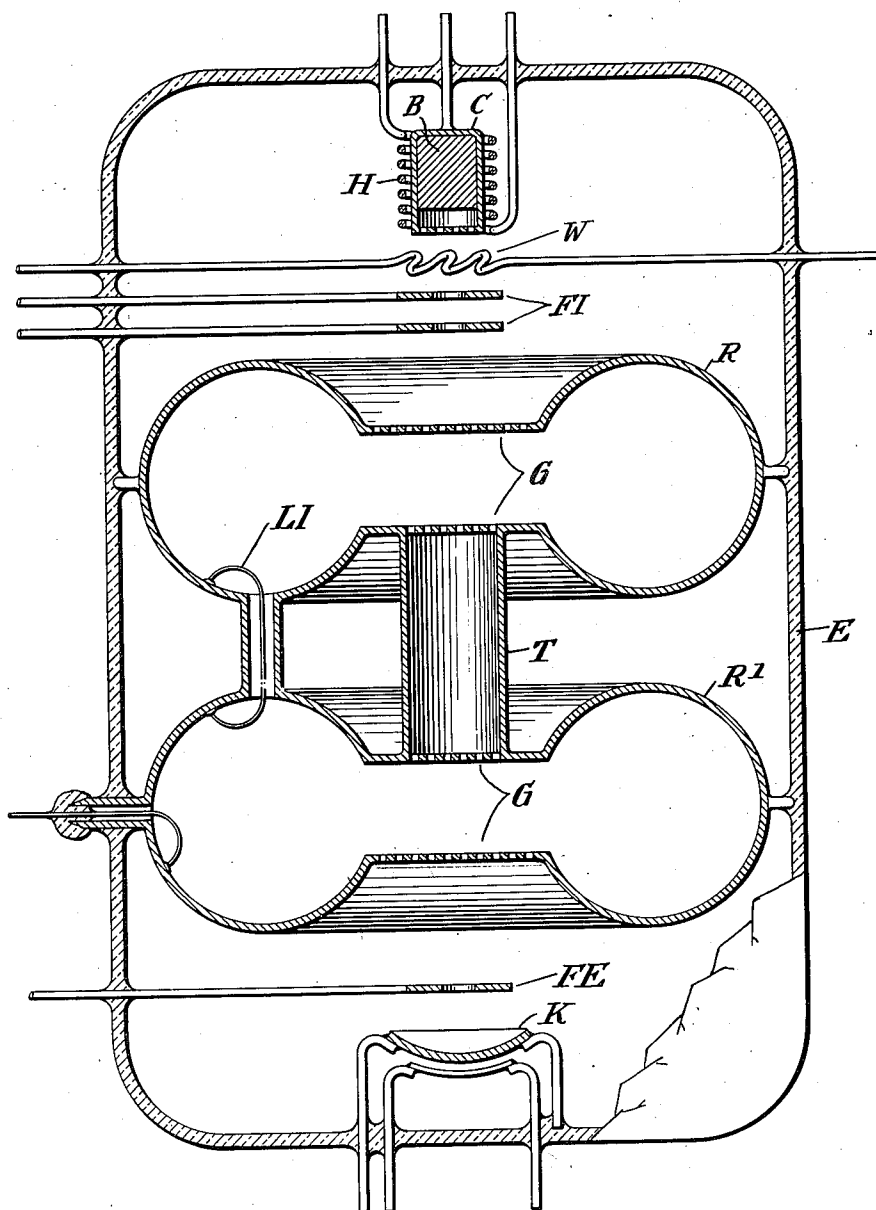
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ELECTRON DISCHARGE APPARATUS

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ELECTRON DISCHARGE APPARATUS

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4 Claims. (Cl. 250—27.5)

This invention relates to electron discharge apparatus utilising concentrated electron beams and has application where it is desirable that the beam current shall have a high intensity and density. It has been found difficult to produce such beams because of the space charge set up by the beam. The space charge tends to decelerate the beam, and in the extreme case stops the beam completely thus forming an unwanted virtual cathode somewhere along the intended path of the beam.

In accordance with the present invention positive ions are utilised for the purpose of neutralising the space charge, the ions being projected in a beam along the electron path in the opposite direction to the electrons.

In one aspect the invention resides in an electron discharge device comprising an electron source and a positive ion source, and means for directing electrons from the electron source towards the ion source and for directing positive ions from the ion source towards the electron source.

In another aspect an electron discharge device utilising a concentrated electron beam is provided with an electron-emissive electrode adapted to function as a cathode and a positive-ion-emissive electrode adapted to function as an anode.

In a further aspect the invention resides in an electron discharge device comprising an electron gun and a positive-ion gun directed toward each other.

As a source of positive ions I may employ a mass or layer of barium, caesium or a compound thereof in or on a suitable carrier, a heater resistance for said mass or layer and an ionising grid in front of said mass or layer adapted to be maintained at a high temperature during operation of the device.

In particular, barium ions may be utilised because they have three other useful effects. Firstly any barium ions which may be neutralised and condensed on any inner surface of the tube act as a getter. Secondly, if a surface coated with a barium compound is used as an electron source, barium from the beam can be used to replenish the barium content of the electron emitting surface. Thirdly, the barium ions also tend to neutralise the space charge near the electron emitting surface and thus make it possible to use dispenser cathodes or electron emitting surfaces of complex shape, such as cathodes comprising vanes or tubes coated with emissive material and located within an enclosing metal cylinder open at one end.

Caesium ions are also suitable for reasons similar to the ones stated above. Caesium ions have an advantage in that the caesium after use in the ionised state may be recovered by bringing different parts of the tube to such temperatures that caesium is evaporated from these surfaces which are kept warm, and condensed in a specially arranged cooled region.

The electron beam may be made to heat the ion source; conversely the ion beam may be used to heat the electron source; the amount of heating current for the ion or electron sources can then be reduced once the tube is running.

The ion beam may be produced by various methods. In one method those substances are used which, when heated, generate a vapour which can be ionised by the hot wire method. In particular the vapour can be made to pass a hot wire mesh and the ions formed can be focussed by the usual electric and magnetic lenses.

An electron discharge device of the klystron oscillator type modified in accordance with the invention is shown diagrammatically in the single figure of the accompanying drawing.

R and R1 are the toroidal resonators of the klystron with central grids or apertures G and back-coupling L1. The resonators are joined by drift tube T. Electrons from a cathode K are concentrated in a beam by focussing electrodes represented by FE. In passing through the resonator R1 (that is, across the first gap in the resonator system), they are modulated in velocity. They subsequently become bunched in the drift tube T and are retarded in the second resonator R (that is, in traversing the second gap of the resonator system), thereby yielding energy to the resonator R. Part of the energy in resonator R is fed back over the coupling L1 to excite resonator R1.

In applying the invention to the above described structure, a positive-ion gun is provided at the end of the electron path for projecting positive ions towards the cathode.

In the structure shown, a barium compound such as barium beryllate or barium metal B is provided in a container C surrounded by a resistance heater H. A series of wires W forming a grid and adapted to reach a high temperature during operation (either by bombardment or by means of an external current supply source) is arranged in front of the container C for ionising barium vapourised from the container, the grid electrode W thus serving as an anode. The wires W, in the case of barium are composed of a material such as oxidised tungsten having a work

function when hot, which is larger than the ionisation potential of the gas to be ionised. The barium ions in the structure shown are concentrated in a beam towards the cathode by means of a focussing electrode system represented by F1.

The whole structure shown may be enclosed in a vacuum-tight envelope E with suitable leading-in conductors sealed in it. Alternatively the various beam-forming electrodes may be disposed at the ends of a narrow glass or like tube projecting through the resonator system. In this case simple apertures are provided in the resonators instead of grids.

Various modifications within the scope of the appended claims will be readily appreciated.

What is claimed is:

1. Electron discharge device for operation at extremely high frequencies comprising electron gun means, a first resonator chamber, a second resonator chamber, said chambers having apertures for permitting the passage of the electron beam emitted by said gun means, collector electrode means disposed in the path of said beam, said collector electrode means comprising a source of positive ions, and means for focusing positive

ions from said collector electrode in a path through said resonator chambers.

2. An electron discharge device according to claim 1 in which said source of positive ions comprises a mass of alkaline earth metal, and a heater electrode for high temperature operation intermediate said mass and said second resonator.

3. An electron discharge device according to claim 1 in which said source of positive ions comprises a mass of alkaline earth metal, a heater electrode for high temperature operation intermediate said mass and said second resonator, and ion focusing electrode means intermediate said heater electrode and said second resonator.

4. An electron discharge device, including a cathode to serve as an electron source, an anode to serve as a positive ion source, electrode means to focus electrons from said cathode on said anode, further electrode means to focus positive ions from said anode on said cathode, said anode including a mass of an alkaline earth metal, a heater for said mass, and a heater grid for high temperature operation in front of said mass for ionizing vapor therefrom.

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