SEARCH ROOM

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ELECTRON DISCHARGE DEVICE AND ASSOCIATED CAVITY RESONATOR CIRCUITS

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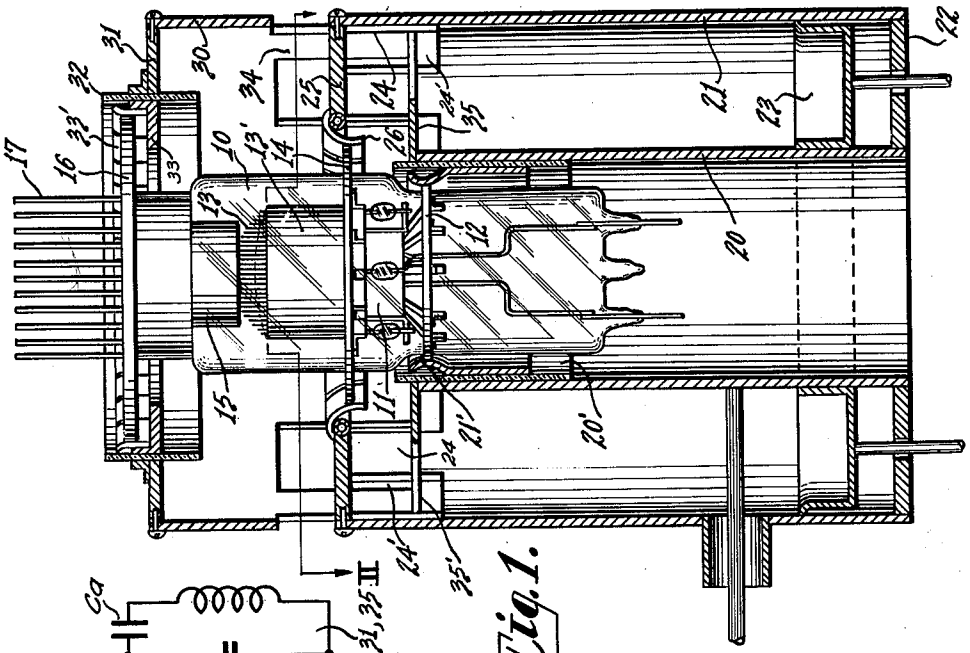


Fig. 1.

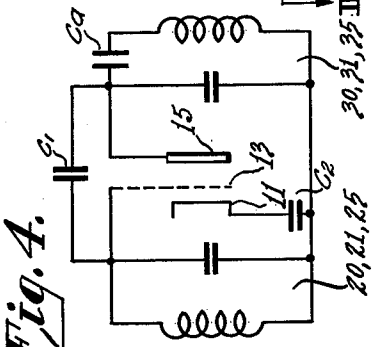


Fig. 4.

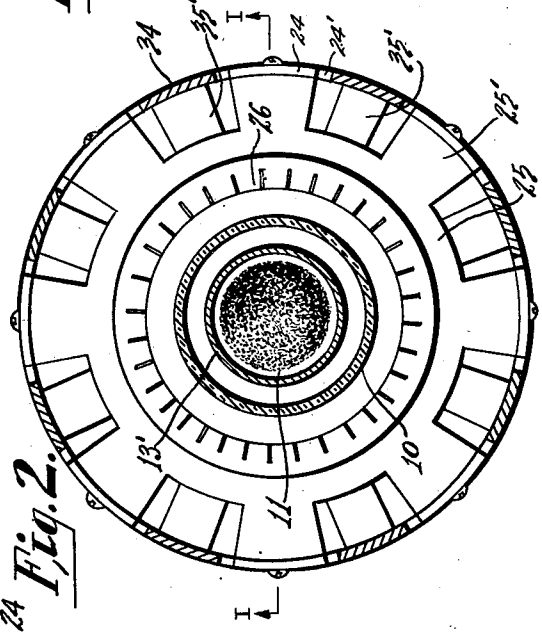


Fig. 2.

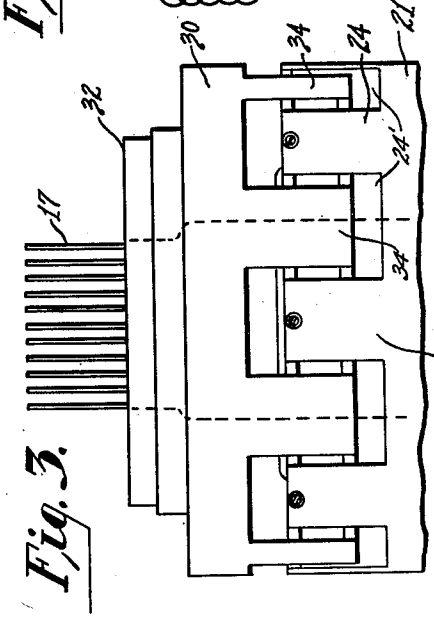


Fig. 3.

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ELECTRON DISCHARGE DEVICE AND ASSOCIATED CAVITY RESONATOR CIRCUITS

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8 Claims. (Cl. 315—39)

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My invention relates to electron discharge devices and associated circuits useful at ultra high frequencies, and more particularly to such devices employing cavity resonators.

In one known type of ultra high frequency tube utilizing cavity resonators, the cathode, grid and anode are mounted in that order and provided with ring type seals and supports serving as external contacts to the cavity resonators proper. One cavity resonator, which may be of the coaxial line type, is coupled between the cathode and grid leads and supports, and the other cavity resonator is coupled between the grid and anode leads and supports. A high frequency tube having this general arrangement of electrodes and cavity resonators is disclosed in Figs. 4 and 5 of U. S. Patent No. 2,353,742, granted July 18, 1944 to E. D. McArthur. The equivalent of this arrangement is a Colpitt's circuit, so far as the basic oscillating circuit is concerned. In the Colpitt's circuit, feedback occurs through the cathode-plate interelectrode capacity, indicated in Fig. 5 of said McArthur patent by the capacitance element 128. However, in the tube arrangement referred to above such interelectrode capacity is usually too small to provide efficient oscillation under the required operating conditions. Feedback may be increased by an external means which may be in the form of a coaxial line coupled between the two cavity resonators. At high frequencies, where external cavities are small, it is not always easy to provide external feedback of this kind because of voltage breakdown difficulties between feedback loop at the end of the coaxial line walls and the cavity resonator walls.

In the "tuned-grid tuned-plate circuit," feedback occurs through the grid-plate capacity. Since this capacity is relatively large, there is no difficulty in obtaining adequate feedback without external means. However, in the tube described above the grid lies between the cathode and anode. Hence, when the tube is to function as a tuned-grid tuned-plate circuit using cavity resonators for high frequencies the cathode-anode tuned circuit must in some way be brought through the grid, the grid terminal or its external tuned circuit.

It is, therefore, an object of my invention to provide an improved type of electron discharge device and associated circuit of the cavity resonator type and useful as an oscillator.

It is another object of my invention to provide such an electron discharge device and circuit which functions as a tuned-grid tuned-plate

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circuit with grid-anode feedback, thereby eliminating the need for external feedback means.

More specifically it is an object of my invention to provide such an electron discharge device and circuit in which the resonators are designed so that the cathode-anode circuit is brought through the grid-anode circuit to provide the necessary coupling of each circuit to the electrodes associated therewith.

These and other objects will appear hereinafter.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a longitudinal section of an electron discharge device and its associated resonators made according to my invention, Figure 2 is a section taken along the line 2—2 of Figure 1, Figure 3 is a side view of the upper portion of an electron discharge device and associated resonators shown in Figure 1 and made according to my invention, and Figure 4 is an equivalent circuit diagram of Figure 1.

In accordance with my invention I utilize an electron discharge device comprising an envelope 10 having within it a cathode 11 supported from a ring seal 12 extending through the envelope, and a grid 13 enclosing cathode 11 and supported on a grid collar 13', which in turn is connected to a ring seal 14 sealed through the envelope. An anode 15 closes the end of the envelope and is oppositely disposed to the cathode and is provided with an anode ring 16 and radiating fins 17.

In accordance with my invention I provide a cavity resonator circuit coupled between the cathode and the grid and including an inner tubular member 20 and an outer tubular member 21 closed by a conducting ring 22, the resonator being tuned by means of a tuning ring 23. The cathode is capacitively coupled to the inner tubular member 20 through an insulating collar 20' carrying spring fingers 21' contacting ring seal 12. The upper end of the resonator is closed by means of a metal ring 25 having radial arms 25' and carrying spring contact fingers 26 in contact with the grid ring 14. The upper end of the resonator is provided with a plurality of spaced fingers 24 which are connected to the arms 25', the spacing being provided for purposes to be described.

The output resonator comprises an external member 30 provided with a plurality of fingers 34

extending within the notches **24'** between the fingers **24** and connected to the inner tubular member **20** by means of a ring member **35** provided with the radial fingers **35'**, the lower ends of fingers **34** of the member **30** being connected to fingers **35'**. Thus the two groups of fingers interlace with each other but are out of contact with each other. The upper end of the member **30** is closed by a ring member **31** supporting a ring **33** having spring contact fingers **33'** contacting the anode ring **16**. The spring contact fingers **33'** are insulated from member **31** by means of the insulating collar **32**. Thus the second or output resonator is coupled for radio frequency currents between the cathode and the anode. This arrangement provides a pair of cavity resonators having a part in common. This common part must be kept to a small value because the magnetic fields due to circulating currents oppose, which causes degeneration. However, with this construction the conditions required of a tuned-plate tuned-grid arrangement utilizing cavity resonators are made possible.

The equivalent circuit of the tube and associated cavity resonator tuned circuits is schematically shown in Fig. 4, wherein the numerals refer to corresponding parts in Figs. 1–3. The interelectrode capacitance between the grid and the anode, which provides the necessary feedback to sustain oscillations, is represented by the condenser C_1. The condensers C_2 and C_3 represent the blocking capacitances at the insulating collars **20'** and **32**, respectively. The cathode-grid and the cathode-anode cavity resonators are schematically represented by two tuned circuits each made up of a capacitance and a parallel inductance. The inter-linked relationship between the two resonators is not indicated in Fig. 4.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims. The term "anode" as used in the specification and claims means an electrode through which a principal stream of electrons leaves the inter-electrode space, as distinguished from a positively-charged electrode which serves only as an electron accelerator.

What I claim as new is:

1. An electron discharge device having a cathode, grid and anode, in that order, and a pair of adjacent cavity resonators respectively coupled between said cathode and grid and between said cathode and said anode, each of said resonators comprising a plurality of spaced conductors extending through but out of contact with the other resonator.

2. An electron discharge device having a cathode, grid and anode, in that order, a cavity resonator coupled between said cathode and said grid, and a cavity resonator coupled between said anode and said cathode, each of the adjacent portions of said resonators comprising a plurality of fingers interlaced with but out of contact with the fingers of the other portion and extending through the interior of the other portion.

3. An electron discharge device having an envelope containing cathode, grid and anode electrodes, each of said electrodes being provided with ring contacts extending through said envelope, a

cavity resonator having one side coupled to the cathode electrode ring contact and the other side coupled to the grid electrode ring contact, the grid electrode side of said resonator being provided with a plurality of spaced parallel fingers and a second cavity resonator coupled between the anode electrode ring contact and said cathode electrode ring contact and having fingers extending between and out of contact with the fingers of said first resonator and coupled to said cathode electrode ring contact.

4. An electron discharge device having a cathode, grid and anode, in that order, a cavity resonator having one side coupled to said cathode and the other side coupled to said grid, the coupling between the grid side and the grid being provided by a plurality of spaced fingers, and a second cavity resonator coupled between said anode and said cathode, the coupling between the cathode side of said second resonator and the cathode comprising fingers extending between and out of contact with the fingers of said first resonator.

5. An electron discharge device having an elongated envelope containing a cathode, grid and anode, said cathode, grid and anode each being provided with a ring contact and support extending and sealed through said envelope, the outer portions of said ring contacts being external to said envelope and a coaxial line type cavity resonator coupled between said cathode ring contact and said grid ring contact, the portion of said resonator coupled to said grid ring contact being provided with a plurality of spaced fingers, and a cavity resonator coupled between said anode ring contact and cathode ring contact and provided with a plurality of fingers interleaved with but out of contact with the fingers on said grid-cathode resonator and coupled to said cathode ring contact.

6. An electron discharge device having a cathode, grid and anode, in that order, a coaxial line type cavity, resonator coupled between said cathode and said grid, the coupling between said resonator and said grid being provided by a plurality of spaced fingers, and a cavity resonator coupled between said anode and cathode, the coupling between the second resonator and said cathode comprising a plurality of fingers interleaved with but out of contact with the fingers directly.

7. An electron discharge device comprising an envelope containing a cathode, grid and anode, in that order, said grid being provided with a ring contact extending through said envelope, said cathode and anode having leads extending through said envelope on each side of said grid ring contact, a cavity resonator coupled between said cathode lead and said grid ring contact, and a second cavity resonator coupled between said cathode lead and said anode lead, each of said cavity resonators comprising a portion thereof extending through the interior of but out of contact with the other resonator.

8. An electron discharge device comprising an envelope containing a cathode, grid and anode, in that order, said grid being provided with a ring contact extending through said envelope, said cathode and anode having leads extending through said envelope on each side of said grid ring contact, a first cavity resonator coupled between said cathode lead and said grid ring contact, and a second cavity resonator coupled between said cathode and said anode lead, each of said first and second cavity resonators comprising a portion extending through the interior of

but out of contact with the other portion and coupled to said grid ring contact and said cathode lead, respectively.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,272,211	Kohler	Feb. 10, 1942
2,312,723	Llewellyn	Mar. 2, 1943
2,353,742	McArthur	July 18, 1944
2,409,222	Morton	Oct. 15, 1946
2,421,636	McArthur	June 3, 1947
2,428,888	Nelson	Oct. 14, 1947
2,432,466	Burns	Dec. 9, 1947