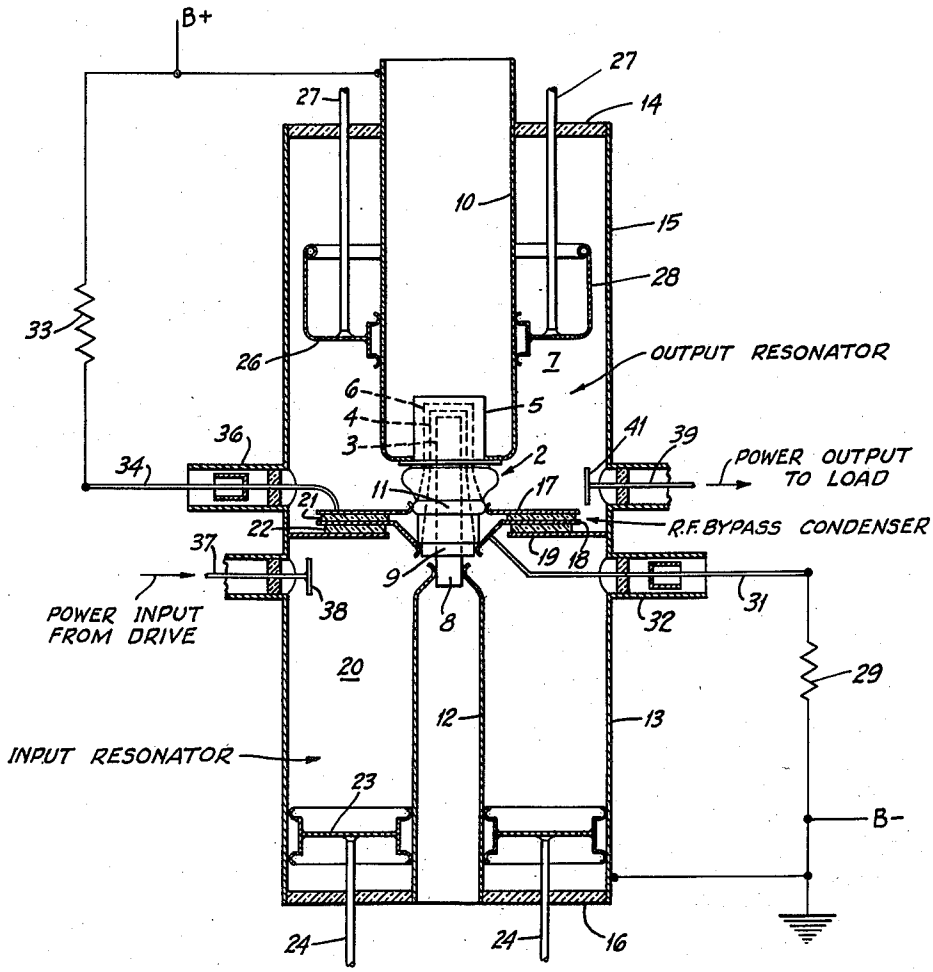
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RADIO FREQUENCY GENERATOR

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INVENTOR.
Donald H. Preist
BY Harold Edney
ATTORNEY

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RADIO FREQUENCY GENERATOR

Donald Henry Preist, Mill Valley, Calif., assignor to Eitel-McCullough, Inc., San Bruno, Calif., a corporation of California

Continuation of abandoned application Serial No. 245,041, September 4, 1951. This application September 18, 1956, Serial No. 610,517

8 Claims. (Cl. 250—36)

This is a continuation of my application Serial No. 245,041, filed September 4, 1951, now abandoned.

My invention relates to an ultra-high frequency power generator, and more particularly to such a generator embodying a tetrode type electron tube.

Radio-frequency generators including oscillators and amplifiers, have been developed for the higher frequencies with negative grid tubes by the use of cavity resonators as circuit elements. Heretofore these cavity circuit generators have been built around triode type tubes since the cavity circuits are most easily adapted to such triodes, although it is generally known that tetrodes have certain advantages over triodes, such as providing increased power gain, which make it desirable to use tetrodes in the generation of radio-frequency power.

The broad object of my invention is to provide a radio-frequency generator incorporating a novel arrangement of cavity circuitry with a tetrode type tube, whereby the higher frequency capabilities of such circuitry are combined with the other advantages afforded by a tetrode.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawing:

The single figure is an axial sectional view of apparatus embodying the improvements of my invention.

In terms of broad inclusion, my improved radio-frequency generator comprises an output cavity resonator having inner and outer conductors, an input cavity resonator having inner and outer conductors, a tetrode having a cathode and control grid and screen grid and anode, the anode being connected to the inner conductor of the output resonator and the cathode being connected to the inner conductor of the input resonator, and a condenser having a first plate connected to the screen grid and a second plate connected to the control grid and a third plate connected to the outer conductors of the resonators.

In greater detail and referring to the drawing, my radio-frequency generator constructed as an amplifier comprises a tetrode type of electron tube 2 having a cathode 3, control grid 4, screen grid 6 and anode 5. The tube illustrated has coaxial electrodes and an external anode, it being understood that the electrode structure of the tube may be varied. The preferred tube used with my circuitry has coaxial terminals for the electrodes, such as cathode terminal 8 opposite the anode and control grid terminal ring 9 and screen grid terminal ring 11 interposed in the envelope wall between the cathode terminal and anode. This sequence of terminals on the envelope is a natural and customary terminal arrangement in tetrode type tubes. The heating structure for the cathode is not shown but may comprise any suitable means such as an inner filament for heating the cathode

cylinder 3 by electron bombardment, in which case the filament leads preferably extend out through the tubular cathode terminal 8.

The amplifier comprises an output resonator 7 having an inner conductor 10 and an outer conductor 15, and an input resonator 20 having an inner conductor 12 and an outer conductor 13. These resonators are coaxially aligned and in the structure illustrated are arranged end-to-end with the tube 2 interposed between the resonators. Cathode 3 is connected to the inner conductor of the input resonator by having its terminal 8 plugged into the end of tubular conductor 12, and anode 5 is similarly connected to the inner conductor 10 of the output resonator.

The inner conductors 10 and 12 of the resonators are mechanically held in position by disk supports 14 and 16 of suitable insulating material fastened to the upper and lower ends of outer conductors 15 and 13, respectively. Any suitable metal such as brass may be used for the conductors.

In my improved apparatus a special three-plate condenser structure is provided comprising a first or upper plate 17 connected to the screen grid terminal ring 11, a second or intermediate plate 18 connected to the control grid terminal ring 9, and a third or lower plate 19 connected to the grounded outer conductors 13 and 15 of the resonators. As illustrated, the series of parallel plates 17–18–19 are located adjacent tube 2 and extend transversely of the resonator structure, the plates being apertured to receive the tube. Plates 17 and 18 are disk-shaped to reduce the series inductance and are shaped with fingers along the inner peripheries to engage the grid terminal rings on the tube. Plate 19 is a transverse member and also functions as a dividing wall between the resonators. The condenser plates are preferably spaced by insulating layers 21 and 22, the plates being relatively closely spaced so that the capacitances therebetween are fairly large. The plate spacings are exaggerated in the drawing for purposes of clarity of structural illustration.

With this R. F. bypass condenser structure the control and screen grids are capacitively coupled together for R. F. current, with a minimum of series inductance, so that the two grids operate at the same R. F. voltage. Likewise, the two grids are capacitively coupled to the outer conductors of the resonators which are preferably at ground potential. In the case of amplifier operation the large capacitance between plates 18 and 19 provides an effective R. F. bypass and limits feedback from the output to the input resonator to prevent oscillation.

Adjustable means are provided for tuning the output and input resonators for adjusting the circuits to the desired operating frequency. An annular metal plate or shorting bar 23 is preferably slidably mounted in the input resonator 20, making slidable contact with the inner and outer conductors 12 and 13 so as to define the end wall of the resonator. Axial adjustment of the shorting bar is achieved by means of plunger rods 24 extending through support 16. Likewise an annular metal plate 26 is slidably mounted in the resonator 7 to define the end wall of the output resonator, external adjustment being accomplished by plunger rods 27 extending through support 14. Plate 26 is preferably slidably connected only to the inner conductor 10 and has a cylindrical flange 28 spaced from the outer conductor 15. This flange is made effectively a quarter wave length long at the operating frequency so that the device functions as a choke to confine the R. F. and isolate the D. C. anode voltage. If desired, a telescoping sleeve (not shown) may be provided on the flange 28 for adjusting its length.

In the apparatus illustrated the cathode is operated at ground potential and positive anode voltage is applied

by connection to the inner conductor **10**. The control grid bias voltage is supplied from a suitable source, as through a resistor **29**, and is connected to the grid disk **18** by a wire **31** entering the resonator through a suitable R. F. choke **32**. In a like manner the screen grid voltage is supplied from a suitable source, as through a resistor **33**, and is connected to the grid disk **17** by a wire **34** entering the resonator through a suitable R. F. choke **36**.

Driving power is fed into the input resonator by any suitable means, as by a coaxial transmission line having an inner conductor **37** terminating at a probe **38** in the resonator. In a similar manner power is taken from the output resonator by a coaxial line having an inner conductor **39** terminating at a probe **41**.

For operation as an amplifier, as previously mentioned, the capacitance between plates **18** and **19** is made large enough to limit feedback and therefore prevent oscillation. If desired, the capacitance may be decreased to introduce some positive feedback, since such will reduce the driving power required.

The principal advantage of my improved R. F. generator is that the desired cavity type circuitry is provided in conjunction with a tetrode type tube, the construction and arrangement of cavity parts being well adapted to fit with the electrode terminal arrangement on such a tetrode.

While I have described my apparatus as an amplifier, it is understood that the generator may be operated as an oscillator. In the latter case the input transmission line **37—38** would be omitted and the capacitance between plates **18—19** materially decreased so as to provide sufficient feedback of energy from the output resonator **7** to the input or excitation resonator **20** to sustain oscillation. In other respects the structure of the R. F. generator would remain unchanged.

For purposes of illustration I have shown the output resonator arranged end-to-end with the input resonator. If it were desirable to have a more compact construction the output cavity could be folded back over the input cavity as will be readily understood by those skilled in the art.

Having thus described my invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors with both inner conductors being axially aligned and both outer conductors being axially aligned, an electron discharge device having at least anode, cathode, control grid and screen grid electrodes positioned within said resonators and between said inner conductors, said anode being connected directly to the inner conductor of the output resonator and said cathode being connected directly to the inner conductor of the input resonator, a condenser positioned between said inner conductors including three annular condenser plates stacked in a parallel and spaced relationship with respect to one another transverse to the longitudinal axis of said resonators and having a solid dielectric between adjacent condenser plates, said stack of condenser plates having a central aperture through which said electron discharge device passes, the centermost condenser plate being connected directly to the control grid and the condenser plate adjacent said output resonator being connected directly to said screen grid whereby both of said grid electrodes assume substantially the same radio-frequency potential, and the condenser plate adjacent said input resonator being connected directly to said outer conductors to provide a feedback circuit between the output and input resonators to effect an oscillatory circuit condition or a radio-frequency bypass with feedback limited below the value required to produce an oscillatory circuit condition depending upon the magnitude of the capacitive coupling introduced between the control grid and the outer conductors.

2. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least anode, cathode, control grid and screen grid electrodes positioned within said resonators and between said inner conductors, said anode being connected to the inner conductor of the output resonator and said cathode being connected to the inner conductor of the input resonator, a condenser positioned between said inner conductors including three condenser plates stacked in a parallel and spaced relationship with respect to one another transverse to the longitudinal axis of said resonators and having a solid dielectric between adjacent condenser plates, said stack of condenser plates having a central aperture through which said electron discharge device passes, the centermost condenser plate being connected to the control grid and the condenser plate adjacent said output resonator being connected to said screen grid whereby both of said grid electrodes assume substantially the same radio-frequency potential, and the condenser plate adjacent said input resonator being connected to said outer conductors to provide a feedback circuit between the output and input resonators to effect an oscillatory circuit condition or a radio-frequency by-pass with feedback limited below the value required to produce an oscillatory circuit condition depending upon the magnitude of the capacitive coupling introduced between the control grid and the outer conductors.

3. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least anode, cathode, control grid and screen grid electrodes, said inner conductors being connected one to the other through the anode-cathode space path, a condenser comprising a pair of spaced conductors directly shunting the control grid-screen grid space path whereby both of said grid electrodes assume substantially the same radio-frequency potential, and a condenser connected between said control grid and both of said outer conductors capacitively coupling said control grid to said outer conductors to provide a feedback circuit between the output and input resonators to effect an oscillatory circuit condition or a radio-frequency bypass with feedback limited below the value required to produce an oscillatory circuit condition depending upon the magnitude of the capacitive coupling introduced between the control grid and the outer conductors.

4. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least anode, cathode, control grid and screen grid electrodes, said inner conductors being connected one to the other through the anode-cathode space path, a condenser comprising a pair of spaced conductors shunting the control grid-screen grid space path whereby both of said grid electrodes assume substantially the same radio-frequency potential, and a condenser connected between said control grid and both of said outer conductors capacitively coupling said control grid to said outer conductors.

5. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least a control grid, an anode, an electron emitting electrode, and an electrode interposed between said control grid and anode, said inner conductors being connected one to the other through the space path defined by the anode and the electron emitting electrode, a condenser shunting the space path defined by the control grid and the electrode interposed between the control grid and anode, whereby both of said shunted electrodes assume substantially the same radio-frequency potential, and a condenser connected between said control grid and both of said outer conductors capacitively coupling said control grid to said outer conductors, said latter condenser including a plate connected to said outer conductors and which plate ex-

tends transversely between said inner conductors to separate said resonators one from the other.

6. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least a control grid, an anode, an electron emitting electrode, and an electrode interposed between said control grid and anode, said inner conductors being connected one to the other through the space path defined by the anode and the electron emitting electrode, a condenser comprising a pair of spaced conductors shunting the space path defined by the control grid and the electrode interposed between the control grid and anode whereby both of said shunted electrodes assume substantially the same radio-frequency potential, and a condenser connected between said control grid and both of said outer conductors capacitively coupling said control grid to said outer conductors.

7. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least a control grid, an anode, an electron emitting electrode, and an electrode interposed between said control grid and anode, said inner conductors being connected one to the other through the space path defined by the anode and the electron emitting electrode, a condenser comprising a pair of spaced conductors shunting the space path defined by the control grid and the electrode interposed between the control grid and anode whereby both of said shunted electrodes assume substantially the same radio-frequency potential, and a condenser connected between one of said grids and both of said outer conductors capacitively coupling said control grid to said outer conductors.

8. A radio-frequency circuit comprising coaxial type input and output resonators each having inner and outer conductors, an electron discharge device having at least a control grid, an anode, an electron emitting electrode, and an electrode interposed between said control grid and anode, said inner conductors being connected one to the other through the space path defined by the anode and the electron emitting electrode, a condenser comprising a pair of spaced conductors directly shunting the space path defined by the control grid and the electrode interposed between the control grid and anode whereby both of said shunted electrodes assume substantially the same radio-frequency potential, and a condenser directly connected between one of said grids and both of said outer conductors capacitively coupling both of said grids to said outer conductors.

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