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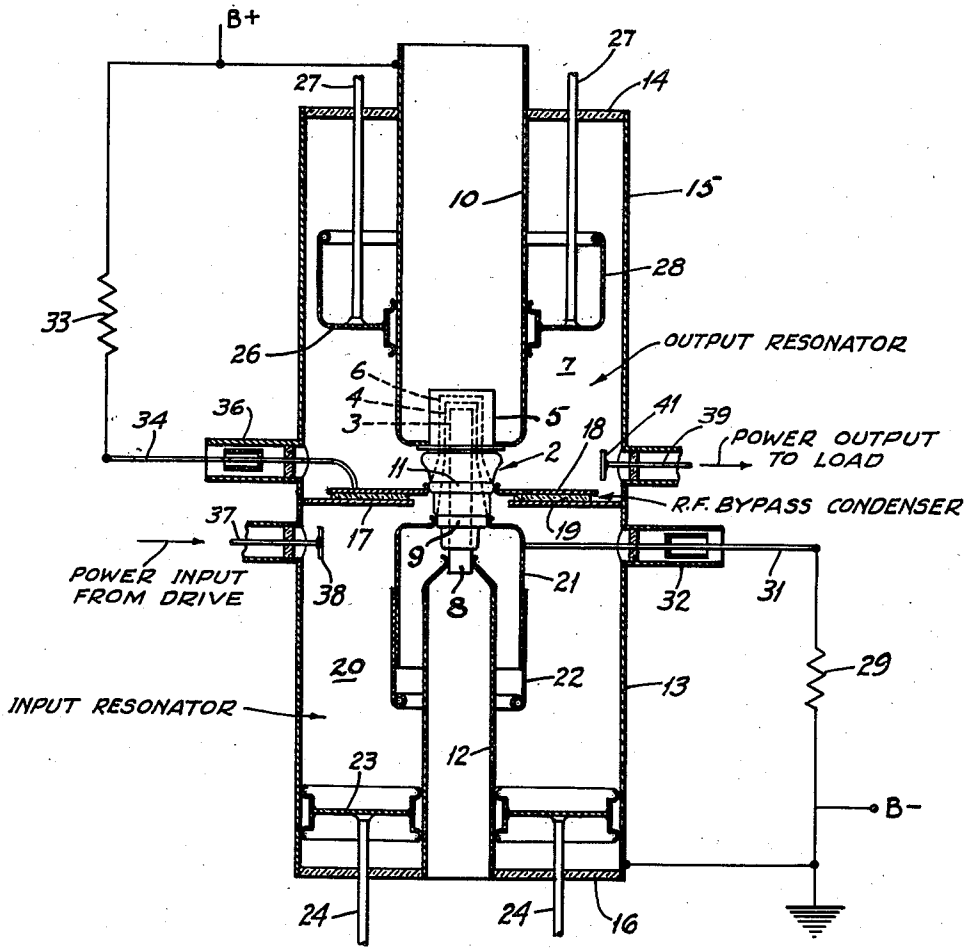
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RADIO-FREQUENCY GENERATOR

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## RADIO-FREQUENCY GENERATOR

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6 Claims. (Cl. 250—36)

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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 an inner conductor of the output resonator and the cathode being connected to the inner conductor of the input resonator, means coupling the screen grid to the outer conductors of the resonators, and a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end. The last mentioned conductor preferably comprises telescoping sections for adjusting the length thereof, and tuning means are also preferably provided in the input and output resonators for adjusting the axial length of such resonators.

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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 ararnged 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.

Screen grid 6 is electrically coupled for radio-frequency current to the outer conductors 15 and 13 of the resonators. In order to isolate the D. C. screen grid bias voltage, the coupling includes an R. F. bypass condenser including a transverse metal plate 17 connected to the outer conductors and a second metal plate or disk 18 connected to screen grid terminal ring 11. These plates are spaced by a suitable insulating layer 19, the capacitance of this bypass condenser being large enough to prevent any appreciable amount of feedback of energy from the output to the input resonator.

From the above structure it will be seen that

an output cavity circuit is provided between the anode and screen grid, and that an input circuit is provided between the cathode and screen grid. In order to establish the third desired circuit for applying the desired R. F. voltage between control grid and cathode, I provide an open ended transmission line within the input resonator. This is conveniently adaptable for a tetrode structure wherein the control grid terminal 9 naturally lies between the cathode and screen grid terminals. As shown, the control grid 4 is connected to an open end hollow metal conductor 21 extending axially of the input resonator and encircling the inner conductor. For purposes of adjusting the axial length of the grid line the hollow conductor is preferably made up of two telescoping sections, the lower section 22 being open ended and the main section 21 being connected to the grid terminal ring 9. For optimum operation the length of the hollow grid conductor is preferably made equal to an integral number of half wave lengths electrically at the operating frequency. The adjustment of this grid conductor is not too critical and may be left fixed over a small frequency band without affecting the efficiency of the amplifier.

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 slideably mounted in the input resonator 20, making slideable 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 slideably 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 slideably 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 line section 21 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 18 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.

In adjusting the amplifier the output cavity resonator 7 between the anode and screen grid is tuned to resonance at the operating frequency, the plate 26 being adjusted so that the axial length of the transmission line formed by the inner conductor 10 and outer conductor 15 is an odd number of quarter wave lengths electrically. The input cavity resonator 20 between the cathode and screen grid is adjusted by plate 23 so that the length of the transmission line formed by the inner conductor 12 and outer conductor 13 is roughly an integral number of half wave lengths electrically at the operating frequency. As already mentioned the length of the open ended grid line 21—22 within the input resonator is also set at approximately an integral number of half wave lengths electrically. By this arrangement, and by the proper adjustment of the lengths of the grid line 21—22 and the input resonator 20, it is possible to achieve the desired amplitudes and phases of the R. F. voltages between the cathode, screen grid and control grid of the tetrode.



Also, by virtue of this relationship, controllable positive feedback is obtained in a tetrode amplifier without any coupling between the input and output cavities other than the electron stream.

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 of the condenser 17—18—19 decreased so as to provide sufficient feedback of energy from the output resonator 7 to the input or excitation resonator 20 to sustain oscillation. Thus, in the oscillator case, the condenser associated with the screen grid would function as a feedback condenser rather than a bypass condenser. 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.

I claim:

1. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, and a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency.

2. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, and a hollow conductor extending axially of the

input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency, the last mentioned conductor comprising telescoping sections for adjusting the length thereof.

3. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency, and tuning means in the input and output resonators for adjusting the axial length of said resonators.

4. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency, the last mentioned conductor comprising telescoping sections for adjusting the length thereof, and tuning means in the input and output resonators for adjusting the axial length of said resonators.

5. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining



an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, said coupling means including a condenser, and a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency.

6. A radio-frequency generator comprising inner and outer conductors defining an output cavity resonator, inner and outer conductors defining an input cavity resonator, 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, means coupling the screen grid to the outer conductors of said resonators, said coupling means including a condenser plate connected to said outer conductors and a second plate connected to the screen grid and spaced from said first plate, and a hollow conductor extending axially of the input resonator and encircling the inner conductor thereof, said hollow conductor being open at one end and connected to the control grid at the other end, and having an electrical length substantially equal to an integral number of half-wave lengths at the operating frequency.

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