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CONCENTRIC LINE OSCILLATOR

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My invention relates to vacuum tube oscillators for producing radio frequency energy having short wave lengths such as wave lengths in the centimeter wave region.

It is sometimes desirable to employ triodes or other multi-element vacuum tubes rather than magnetrons or the like for producing very high frequency energy. Triodes and similar vacuum tubes have been specially designed for high frequency use, but for some applications it has been found difficult to make them oscillate at a high enough frequency.

One object of my invention is to provide an improved oscillator for producing very high frequency energy.

A further object of the invention is to provide an improved triode oscillator for producing high frequency energy.

A still further object of the invention is to provide an improved oscillator of the "grounded grid" type.

In a preferred embodiment of the invention, there is employed a triode so designed as to reduce the electron transit time and the interelectrode capacities to a minimum. The plate and cathode are connected to two tunable circuits or lines, respectively, comprising concentric conductors. The grid would be grounded if usual practice were followed, but it has been found that oscillations can be obtained at a higher frequency if the grid is connected through some capacity to ground. This capacity provides feedback coupling which functions in phase with the feedback through the plate-cathode tube capacity to maintain high frequency oscillations.

The invention will be better understood from the following description, taken in connection with the accompanying drawings in which

Fig. 1 is a circuit diagram of a preferred embodiment of the invention,

Fig. 2 is a side view, partly in section, of the oscillator shown schematically in Fig. 1 (the view being drawn two times full scale),

Fig. 3 is an enlarged view taken on the section 3—3 of Fig. 2, and

Fig. 4 illustrates another embodiment of the invention.

In the several figures, like parts are indicated by like reference characters.

In Fig. 1 the oscillator comprises a triode 10 designed to have very small interelectrode capacities C_1 , C_2 and C_3 . The particular vacuum tube that is illustrated and described by way of example is the General Electric type ZP446. The values of the tube capacities C_1 , C_2 and C_3 given

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on the drawings are for a particular tube. The cathode, grid and plate are indicated by the reference characters 11, 12 and 13, respectively.

The oscillator circuit basically is of the well known "grounded grid" type, although, in accordance with the present invention, the grid 12 is connected through a capacitor 14 to ground. The capacity of element 14 depends upon the circuit and particular tube employed, but usually will be somewhere between 14 mmf. and 100 mmf. A grid leak resistor 16 is connected across capacitor 14. The plate 13 is connected to one conductor of a line 17—18, which may be tuned by means of a capacity changing element 19 to adjust the oscillator frequency. The cathode 11 is connected to one conductor of a line 21—22 which may be tuned by means of a shorting bar 23.

Fig. 2 shows a preferred construction of the oscillator of Fig. 1. The cathode, grid and plate terminals of the tube 10 are shown at 11', 12', and 13', respectively. The grid terminal 12' is the edge of a washer-shaped piece of metal supporting the grid and sealed to glass sections indicated as such by the shading. The plate terminal plug 13' and the plate itself are supported on a metal disc 15 sealed to the upper glass section. The cathode terminal portion 11' is a metal shell forming the tube base. One cathode heater lead is shown at 25. The cathode and the other side of the cathode heater are connected through a plurality of parallel leads 27 to a metal disc 28.

The tunable line 21—22 comprises two concentric cylinders, the outer cylinder 22 being fastened at the bottom by bolts 29 to the bottom plate 28 and being fastened at the top in screw-threaded relation to a metal cap portion 31. The inner cylinder 21 is supported at the bottom by an out-turned edge soldered to outer disc 28. The upper edge of cylinder 21 is slotted to form fingers that make electrical contact with the cathode through the terminal 11'.

The shorting bar 23 comprises a ring surrounding the cylinder 21 and having fingers that make contact therewith and having other fingers that make contact with the outer cylinder 22. This ring or shorting bar 23 may be slid along the cylinders 21 and 22 by means of rods 32 of insulating material extending through openings in the bottom plate 28.

The tunable line 17—18 also comprises two concentric metal cylinders. In the specific structure shown, the cylinders 17 and 18 are enclosed by a protective cylinder 33 which is supported at the bottom by means of a metal cup-shaped member 34 which it engages in screw-threaded rela-

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tion. The cup member 34 and the cap member 31 preferably are also welded or soldered together.

The cylinder 18 of the line 17—18 preferably is soldered or welded to the cup member 34 and is given further mechanical support by a surrounding ring 36 that is bolted to the bottom of member 34 by several bolts 37, only one of which is shown in the drawings.

The cylinder 17 is supported from the cylinder 18, by means of studs 38 of insulating material, only one of which is shown, each stud 38 being fastened in screw-threaded relation to the cylinder 18. A spacing washer 39 of insulating material is located between the two cylinders 17 and 18.

The lower end of cylinder 17 is electrically connected to both the upper plug portion 13' and the supporting disc portion 15 of the anode terminal by means of contacting rings 41 and 42, respectively, having contacting fingers thereon. Connection is made from the anode terminal to a plate voltage source (not shown) through a conductor 43 and through a choke coil 44 and a conductor 46 supported in and insulated from a metal tube 47.

The line tuning element 19 is a metal block containing a circular slot so that it is, in effect, a cup that may be moved into the space between cylinders 17 and 18 to change the capacity between them. The tuning cup 19 is supported on an insulated rod 48 which is supported in screw-threaded relation in a disc 49 fastened into the end of the cylinder 18.

As shown in Figs. 2 and 3, the capacity 14 between the tube grid and ground is provided between the inner periphery of the cap 31 and a metal ring or triangular shaped member 51, the surfaces of the two elements being spaced apart the proper amount by a mica washer 52. The grid terminal 12' is connected to the ring 51 through a contacting ring 53 having contacting fingers thereon. The resistor 16 is connected between the ring 51 and the cap 31.

The ring 51 is supported by the bolts 37 which extend through the tab portions extending from the ring. Insulating bushings 54 prevent grounding of ring 51; they also provide the proper spacing to hold the washer 52 and the contacting member 53 in place but, at the same time, permit member 53 to move laterally a slight amount when a tube is inserted whereby it will be aligned for better contact.

The specific oscillator illustrated in Fig. 2 is designed to oscillate at 3,000 megacycles (10 centimeters). The frequency is determined principally by the line 17—18 as tuned by the cup 19 and to a less extent by the line 21—22, the position of the shorting bar 23 on the line 21—22 not being very critical. Since the line 17—18 would be too short for convenient mechanical construction at such a high frequency if made a quarter wave length long, it is made three-quarters of a wave length long in the example described.

In Fig. 4 there is shown an embodiment of the invention in which the outer cylindrical member 61 which forms part of the tuned cathode circuit surrounds the other cylindrical members 62 and 63 that form the tuned anode circuit. In this construction the cylinder 62 functions as one side of each tuned line or tuned circuit and also functions as a portion which isolates the two tuned circuits.

The cylinder 61 is connected to the cathode terminal 11' by contacting fingers 64; the cylinder 62 is coupled to the grid terminal 12' through

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a contacting ring 66 and the capacity between the ring 66 and the end of cylinder 62, the ring and cylinder being separated by a mica washer 67; and the cylinder 63 is coupled to the anode terminal 13' by coupling capacity at the spacing provided by an insulating bushing 68. The anode and cathode circuits may be tuned by shorting bars indicated at 69 and 71, respectively.

From the foregoing, it will be apparent that I have provided a simple oscillator employing a comparatively small and inexpensive vacuum tube that, because of the presence of the capacity 14 between grid and ground, may be made to oscillate at a higher frequency than is possible if the plate-cathode capacity C_1 alone is depended upon to provide the necessary feedback.

I claim as my invention:

1. An oscillator comprising a vacuum tube having a cathode, a control grid and an anode, a tuned circuit having one terminal connected to said anode and having the other terminal connected through a capacity element to said grid, and a second tuned circuit having one terminal connected to said cathode and having the other terminal connected through said capacity element to said grid whereby regenerative feedback is provided both by the anode-cathode capacity of said tube and by said capacity element.

2. An oscillator comprising a vacuum tube having a cathode, a control grid and an anode, a tuned anode circuit having one terminal connected to said anode and having the other terminal connected through a capacity element to said grid, and a tuned cathode circuit having one terminal connected to said cathode and having the other terminal connected through said capacity element to said grid whereby said capacity element is common to said anode and cathode circuits to provide regenerative feedback which aids that provided by the anode-cathode capacity of said tube.

3. An oscillator comprising two pairs of conductors which are isolated from each other by a partition of conducting material, a vacuum tube having anode, cathode and control grid terminals, said anode terminal being connected to one conductor of one of said pairs, said cathode being connected to one conductor of the other of said pairs, the other conductors of said pairs and said partition being conductively connected to each other, and means for capacitively coupling said grid terminal to said partition whereby there is provided additional regenerative feedback coupling to aid the coupling provided by the anode-cathode capacity of the tube.

4. An oscillator comprising two pairs of concentric conductors which are positioned end-to-end along a common axis, a centrally apertured portion of conducting material separating said two pairs and connected to one conductor of each of said pairs, a vacuum tube having anode and cathode terminals at opposite ends and having a control grid terminal positioned intermediate the other tube terminals, said anode terminal being connected to the other conductor of one of said pairs, said cathode being connected to the other conductor of the other of said pairs, and means for capacitively coupling said grid terminal to said partition whereby there is provided additional feedback coupling between said pairs of conductors.

5. An oscillator comprising two pairs of concentric conductors which are positioned end-to-end along a common axis to form a tuned anode

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circuit and a tuned cathode circuit, a centrally apertured portion of conducting material isolating said tuned circuits and connected to one terminal of each of said tuned circuits, a vacuum tube having anode and cathode terminals at opposite ends and having a control grid terminal positioned intermediate the other tube terminals, said anode terminal extending through said aperture and being connected to the other terminal

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of said tuned anode circuit, said cathode terminal being connected to the other terminal of said tuned cathode circuit, and means for capacitively coupling said grid terminal to said partition whereby there is provided additional regenerative feedback coupling from said anode circuit to said cathode circuit.

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