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2,368,328

HIGH FREQUENCY GENERATOR

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Fig. 1.

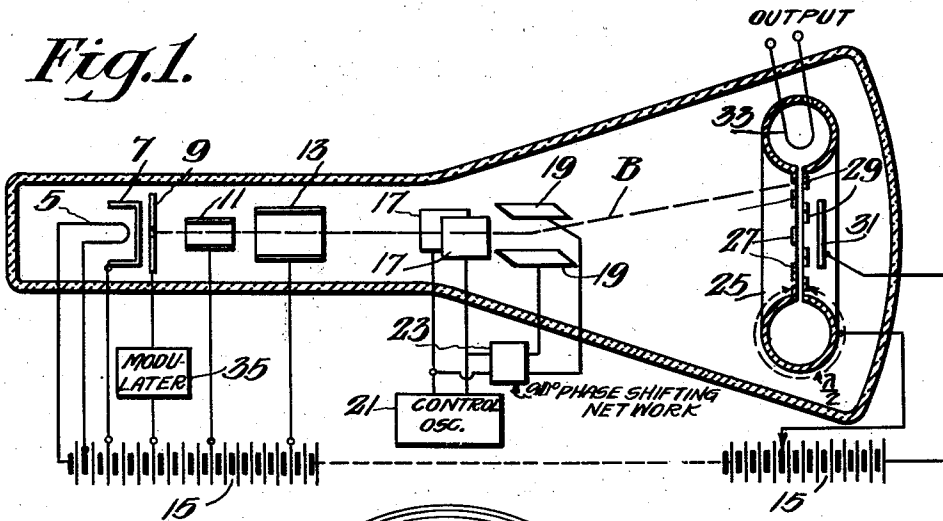


Fig. 2.

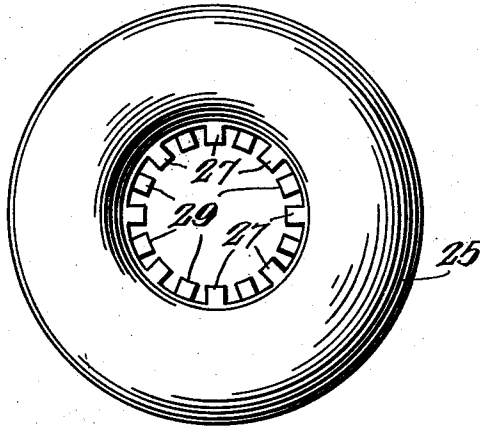
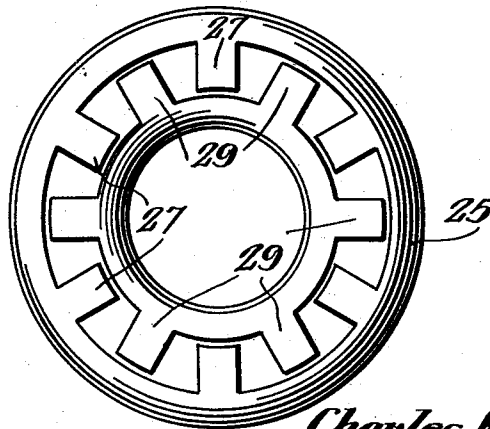


Fig. 3.



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HIGH FREQUENCY GENERATOR

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8 Claims. (Cl. 315-5)

This invention relates to ultra high frequency generators, and particularly to generators of the electron beam type.

Previously known electron beam oscillators are of two general types. The first type is that in which the electron beam is periodically deflected over a predetermined path, usually circular, and intercepted by commutator segments, alternate segments being connected to opposite ends of an external oscillatory tank circuit. Such an arrangement is typified by Patent No. 2,124,973, issued on July 26, 1938, to J. L. Fearing on an application filed November 13, 1936. The second type is that in which the beam is moved over a mask having a series of perforations, the electrons which pass through being collected by a collecting electrode. The resulting pulsating current to the collecting electrode generates oscillations whose frequency is determined by the number of perforations in the mask and the velocity of the beam. Such an arrangement is typified by Patent No. 2,173,193, issued on September 19, 1939, to V. K. Zworykin, on an application filed August 18, 1937.

In the systems of the prior art, the oscillatory output circuit is located outside the tube and is connected between the mask and the collecting electrode or between groups of alternate commutator segments. In either case, the maximum resonant frequency of the output circuit is limited by the length of the necessary leads and the capacity between the mask and collecting electrode or between the groups of commutator segments. As a result, the practical limit of the output frequency is determined by the oscillatory circuit constants. It is the principal object of this invention to overcome this limitation by providing a self-resonant collecting electrode.

Another object is to control the generation of high frequency currents by means of lower frequency currents.

Another object is to provide a rotating beam oscillator having a collecting electrode which is both a commutator and an oscillatory tank circuit.

Other objects of this invention are to provide an improved rotating beam frequency multiplier, and to provide an improved tank circuit for rotating beam oscillators.

Briefly, these objects are accomplished by utilizing a hollow toroidal collecting electrode having a circumferential slot, the opposing edges of which constitute alternate commutator segments which are successively impinged by a rotating electron beam. High frequency currents flow along the minor circumference of the electrode, the length of which is sufficient to produce a resonant condition at the output frequency.

The invention will be better understood from the following description when considered in con-

nection with the accompanying drawing, and its scope is indicated by the appended claims. Referring to the drawing, Figure 1 is a view of the improved rotating beam oscillation generator; Figure 2 is the plan view of a collecting electrode; and Figure 3 is a plan view of an alternative form of collecting electrode.

Referring to the drawing, Figure 1 shows a cathode ray tube having the conventional heater 5, cathode or emitter 7, and beam-forming electrodes 9, 11 and 13, all of which are suitably energized by a battery 15, or the like. The pencil-like electron beam, indicated by the broken line B, passes between horizontal and vertical deflecting electrodes 17 and 19, which are positioned on opposite sides of the beam axis. It is to be understood that the equivalent magnetic deflecting coils or other suitable means may be substituted for the electrostatic deflecting electrodes, if desired.

The electron beam is caused to rotate about its normal axis by applying alternating voltages from a suitable source, such as a control oscillator 21, to the deflecting electrodes. These deflecting voltages are in phase quadrature relation, as is well known. By way of example, the desired phase relation may be achieved by connecting a suitable 90° phase-shifting network 23 between the oscillator 21 and the vertical deflecting electrodes 19.

The collecting electrode 25 is shown in cross section in the tube assembly of Fig. 1, and a plan view is shown in Fig. 2. The electrode comprises a hollow metallic toroid having a circumferential slot, the opposed edges of which form interposed commutator segments upon which the beam impinges during its cyclic rotation. Half of the commutator segments, designated by the reference numeral 27, for example, are connected to and extend radially inward from one edge of the electrode, while alternate segments, designated by reference numeral 29, are connected to and extend radially inward from the other edge of the electrode. The two groups are offset from each other so that one group lies in the spaces between the segments of the other group. As a result, the electron beam impinges first on a segment which is connected to one edge of the electrode and then on a segment which is connected to the opposing edge, and this alternation is repeated at a rate which is determined by the speed of rotation of the beam and the number of commutator segments.

The collecting electrode is given a high positive potential with respect to the cathode potential by means of a connection to a high potential point on battery 15. A fixed anode electrode 31 is provided behind the collecting electrode in order to collect electrons which pass through the spaces between the commutator segments, or which do

not strike the segments for other reasons. This anode also serves to collect secondary electrons which may be dislodged from the commutator segments. The anode 31 is also connected to a point of relatively high positive potential on the battery 15.

The dimension of the toroidal electrode measured between opposite edges around the minor circumference is determined by the desired output frequency. The minor circumference of the electrode is the circumference of either of the small circles produced by passing a plane through the center of the electrode as shown in Fig. 1. The length of this dimension should be approximately equal to a half wave length at the output frequency, although it will be appreciated that there may be a slight discrepancy in the calculated dimension due to the capacity between the opposed edges. However, an oscillatory tank circuit is effectively formed between each pair of opposed commutator segments, and oscillatory currents initiated by the electron beam will flow along the paths between opposed segments. Output currents are derived from a coupling loop 33 which is placed within the toroid at any convenient point.

It will be appreciated that the output frequency may be made many times higher than the frequency of the source 21 by providing a large number of commutator segments. In the present instance, the collecting electrode is itself actually resonant at the output frequency, thus greatly increasing the operating efficiency.

In order to provide a large number of commutator segments with a collecting electrode of a given size, the circumferential slot may be made in the outer major circumference of the toroid, the segments then extending radially outward from the toroid. This makes possible a greater frequency step-up, permitting the control oscillator frequency to be lower than before without reducing the output frequency.

An alternative embodiment is illustrated in Fig. 3, in which the commutator segments 27 and 29 are in the face of the toroidal collecting electrode which is toward the beam. In such case, the segments need not be bent out from the electrode, thus simplifying the construction.

It is possible to produce amplitude modulated ultra high frequency oscillations by modulating the intensity of the beam. Such a system is indicated in Fig. 1, in which "Modulator" 35 is inserted in the potential lead to the electrode 9, or any suitable intensity-controlling electrode. This modulator comprises any well known scheme for varying the amplitude of the applied voltage in accordance with modulating signals, and may include a resistor in series with the lead which is also in the anode-cathode circuit of an amplifier tube. Variations in anode current of the tube produce a changing voltage on the control electrode which similarly modulates the beam intensity.

I claim as my invention:

1. A device of the character described comprising means for producing an electron beam, means for rotating said beam at a predetermined frequency, a toroidal collecting electrode having a slot around its inner circumference, the distance around said electrode between opposed edges of said slot being a resonant length at the output frequency of said device, and means for causing said beam to impinge alternately on opposite edges of said slot to thereby induce output frequency currents in said electrode.

2. A device of the character described comprising means for producing an electron beam, means for deflecting said beam over a substantially circular path at a predetermined frequency, a resonant toroidal electrode having commutator segments thereon, the shortest distance between adjacent segments, measured around the toroid, being substantially an electrical half wavelength at the resonant frequency of said electrode, and means for mounting said electrode in said electron beam so that said segments are successively impinged by said beam whereby oscillatory currents are induced in said electrode.

3. A device of the character described in claim 2 having more than two commutator segments and in which the resonant frequency of said electrode is a multiple of said predetermined frequency.

4. A device of the character described comprising means for producing an electron beam, means for rotating said beam at a predetermined frequency, a resonant collecting electrode adapted to be impinged by said electron beam, said electrode being toroidal in shape and with a circumferential slot having serrated edges, said beam traversing said slot so that it successively impinges its opposite edges to induce resonant output frequency currents in said electrode and means coupled to said electrode for deriving high frequency output currents therefrom.

5. A device of the character described comprising means for producing an electron beam, means for deflecting said beam over a substantially circular path, a target electrode resonant at the output frequency located in said path and perpendicular to the undeflected axis of said beam for intercepting said beam, said electrode having interposed commutator segments lying in said circular path for inducing an oscillatory current in said electrode whose frequency is determined by the dimensions of said electrode.

6. A device of the character described comprising means for producing an electron beam, means for deflecting said beam over a substantially circular path at a first frequency, and an output electrode resonant at the output frequency of said device located in the path of said beam for intercepting said beam, said electrode having commutator segments lying in said path, the impact of said beam on successive segments causing oscillatory currents to flow in said electrode at an output frequency higher than said first frequency.

7. A device of the character described comprising means for producing an electron beam, means for deflecting said beam over a substantially circular path at a first frequency, a hollow toroidal electrode located in the path of said beam for intercepting said beam, said electrode having an opening coincident with said circular path, the opposed edges of said electrode at said opening having commutator segments alternately connected to said edges, the impact of said beam on successive segments causing oscillatory currents to flow around the minor circumference of said toroid at a second frequency determined by the dimensions of said toroid and means for deriving output currents from said oscillatory currents.

8. A device of the character described in claim 7 in which the length of the minor circumference of said toroidal electrode is an electrical half wave length at said second frequency.