

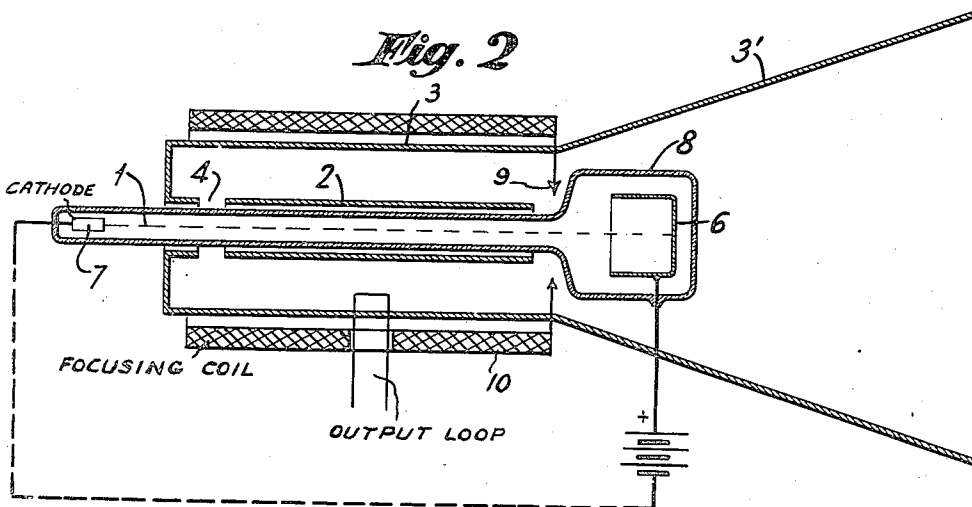
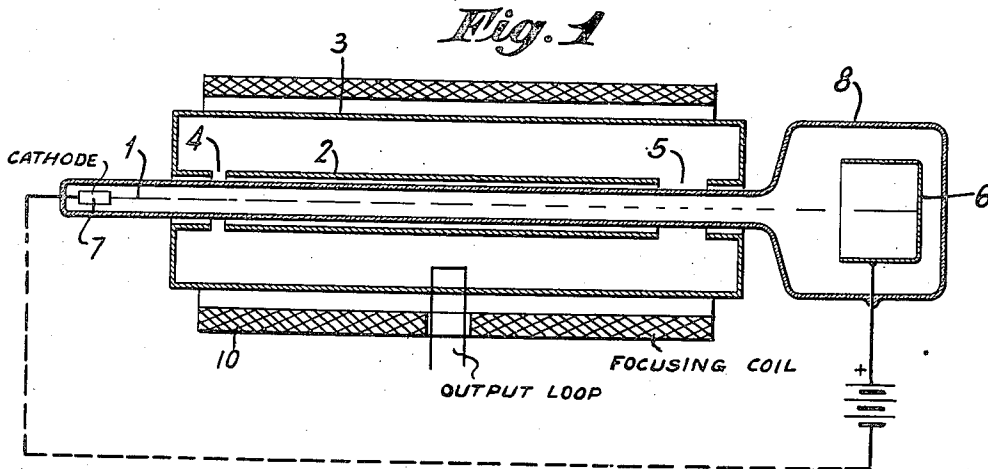
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OSCILLATION GENERATION SYSTEM

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OSCILLATION GENERATION SYSTEM

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12 Claims. (Cl. 250—36)

One object of the present invention is to provide a self-excited oscillator of the type wherein energy is transferred from an electron beam by electrostatic induction to a resonant circuit.

A further object is to provide in connection with such an oscillator an electromagnetic wave horn for radiating energy produced by said oscillator.

It is known that a beam of electrons whose density has been modulated by a high frequency wave (that is, an electron beam that has been broken up into a series of bunches of electrons) will deliver high frequency power to a resonant tank circuit if the beam is caused to traverse a portion of the electrostatic field of the tank along the direction of the lines of force and if the natural frequency of the tank is such that as each bunch of electrons passes the above mentioned field it moves against the field existing at the moment of passage, thus doing work upon the tank system. An amplifier built on these lines is described by Dr. A. V. Haeff in "Electronics" for February, 1939. Amplifiers of a similar sort have also been described employing feed back of oscillations between a pair of tanks, one of which utilizes its coupling with the electron stream to cause the electrons to bunch together in the manner prerequisite to delivering high frequency power to the second tank.

In accordance with the present invention the generation of oscillations is simplified by the utilization of a single tank both for the bunching of the beam and also for absorbing power from the beam. In the preferred form of the invention the tank consists of a concentric line whose inner conductor is a particular length and spaced axially at both ends from the outer conductor. An electron stream is caused to traverse the interior of the inner conductor across the gaps at both ends. By selection of a suitable relation between the electron transit time and the length of the inner tube, there will be set up voltage differentials across both gaps sufficient in the one case to produce bunching of the electrons and in the other case to sustain oscillations in the tank.

A more detailed description of the invention follows in conjunction with a drawing, wherein Figs. 1 and 2 schematically illustrate two embodiments of the invention.

In Fig. 1, which shows so much of the construction of an oscillator in accordance with the present invention as is necessary for an understanding thereof, there is shown a high velocity electron beam 1 produced by an electron gun 7, 55

arranged to travel along the axis of a concentric line type of tank comprising inner conductor 2 and outer conductor 3. Inner conductor 2 is designed to be electrically one-half wavelength long ($\lambda/2$) or a multiple thereof at the operating frequency. At the input end of the line there is provided a narrow gap 4 while at or near the output end there is a larger gap 5. It should be noted that the narrow gap 4 is located between that end of the inner conductor 2 nearest the electron gun and a flange which is connected to the outer conductor 3 and turned in on the same straight line as the inner conductor. Assuming that the tank circuit 2, 3 is oscillating, which will occur due to inequalities of electron emission or due to thermal agitation or other transients, there will be produced an alternating field at gap 4 which will initiate the bunching of the electron beam by variably impulsing the passing electrons. As the beam moves along within the inner conductor 2, the effect of these impulses is to cause the electrons to shrink together into a series of bunches. With a suitable relation between the magnitude of the impulses and the time of travel between gaps 4 and 5, the electron bunches are made sufficiently pronounced to deliver enough power to the tank to sustain oscillations. The velocity of the beam can be controlled by the potentials applied to the accelerating electrodes, not shown; thus by varying the velocity of electron beam 1 we can get proper electron transit time so that the groups of electrons pass gap 5 and move in opposition to the instantaneous electric field along the axis of the tube, thereby delivering power to the tank. By designing the inner conductor 2 to have a length which is a multiple of half the length of the resonant period of the tank, there may be obtained oscillations at some higher mode of oscillation of the tank than its fundamental. The beam, after passing through the tank, is received upon a collector electrode 6 which is maintained at a sufficiently positive potential to insure collection. The electron gun 7, beam 1 and collector electrode 6 are inclosed in an evacuated glass envelope 8. The means for generating the beam may be any suitable cathode, and the means for constraining it to travel along the axis of the tube may comprise suitable focussing and accelerating electrodes, not shown, as well as electromagnetic focussing coil 10, all of which are well known and described in the literature, as for example in the Haeff article, supra.

Fig. 2 shows an oscillator similar to that of Fig. 1, except that its output end is arranged to

radiate power directly into the ether through the medium of an electromagnetic wave horn 3'. The field at the output end of conductor 2 is worked against by the bunched beam 1 to sustain oscillations exactly as in Fig. 1, but in Fig. 2 the outer conductor instead of shielding the oscillatory field within the tank is flared out into a conical horn 3' through which the lines of force tend to slide out without reflection, and hence result in the radiation of power. If the radiation of power is more than desired, for example if the system will not continue to oscillate under the radiation load, an iris diaphragm 9 may be installed at the small end of the horn to reduce the radiation to the extent desired. This diaphragm regulates the ratio of energy radiated per cycle to the circulating energy in the tank.

This invention finds particular application in the ultra short wave field below five meters, especially below one meter.

What is claimed is:

1. An electron discharge device circuit having a tank, said tank being comprised of an outer conductor and a single hollow inner coaxially arranged conductor separated axially at both ends from said outer conductor by gaps, the length of said inner conductor between said gaps being a multiple including unity of one-half the length of the operating wave corresponding to the resonant period of said tank, a source of electrons for projecting a stream of electrons through the entire length of said hollow inner conductor and across said gaps in succession, and means for attracting and collecting the electrons crossing the last gap to be traversed by said electrons.

2. An electron discharge device having a cathode for supplying electrons, a collector electrode spaced from said cathode for receiving said electrons, means including a single oscillating tank circuit having a pair of spaced coaxial tubular members arranged to provide a pair of spaced gaps of unequal length between said coaxial tubular members, said gaps being located substantially at the ends of said tubular members, the smaller one of said gaps being nearer said cathode than said other gap and located between one end of the inner tubular member and a flange which is connected to the outer conductor and turned in on the same straight line as the inner conductor, said tubular members being so positioned between the cathode and collector electrode that electrons moving from the cathode to the collector electrode will be modulated by said first gap and pass axially through the tubular members and deliver energy to said tank by virtue of the second gap to be traversed by said electrons.

3. An electron discharge device having a cathode for supplying electrons, a collector electrode spaced from said cathode for receiving said electrons, means including a single oscillating tank circuit having a pair of spaced coaxial tubular members arranged to provide a pair of spaced gaps of unequal length between said coaxial tubular members at or near the ends thereof, the length of the inner tubular member between said gaps being electrically a multiple, including unity, of one-half the length of the operating wave of said tank, said tubular members being so positioned between the cathode and collector electrode that electrons moving from the cathode to the collector electrode will pass axially through the tubular members and across said gaps in succession.

4. An electron discharge device having a cathode for supplying electrons, a collector electrode spaced from said cathode for receiving said electrons, means including an oscillating tank circuit having a pair of coaxial tubular members spaced axially to provide a pair of spaced gaps of unequal length between said coaxial tubular members, the length of the inner tubular member between said gaps being electrically a multiple, including unity, of one-half the length of the operating wave, said tubular members being so positioned between the cathode and collector electrode that electrons moving from the cathode to the collector electrode will pass axially through the tubular members across said gaps, said outer tubular conductor at the end nearest the last gap to be traversed by said electrons being flared to approximate the shape of an electromagnetic horn.

5. Oscillation generator comprising a single concentric line resonator having an outer conductor and a single hollow inner conductor which is a multiple including unity of one-half of the length of the operating wave, the outer conductor of said resonator being provided with flanges at both ends turning in on the same straight line as the inner conductor to provide gaps at both ends between the flanges and the inner conductor of the resonator, means for causing an electron beam to traverse said resonator along its axis and to pass across both gaps in succession, and means for collecting the emerging beam.

6. In combination, a hollow conductor resonant tank circuit, a hyperfrequency load circuit of the guided wave type coupled to said tank circuit for energy transfer therebetween, the coupling between said load and tank being sufficiently loose so that a considerable sharpness of resonance of said tank circuit is maintained, a variable diaphragm comprising the output end of said tank circuit for regulating the ratio of energy radiated by said load circuit to the circulating energy in the tank, and means for projecting electrons through the interior of said tank in a direction to cause the electrons to emerge at the end to which said load circuit is coupled for exciting short wave oscillations in said tank circuit.

7. In combination, a hollow conductor resonant tank circuit, a load circuit in the form of an electromagnetic wave horn coupled to one end of said tank circuit for energy transfer therebetween, the coupling between said load and tank being sufficiently loose so that a considerable sharpness of resonance of said tank circuit is maintained, a variable diaphragm comprising said one end of said tank circuit for regulating the ratio of energy radiated by said load circuit to the circulating energy in the tank, and means for projecting electrons through the interior of said tank in a direction to cause the electrons to emerge at the end to which said load circuit is coupled for exciting short wave oscillations in said tank circuit.

8. A concentric line resonant tank having an inner and an outer conductor, said outer conductor being flared out at one end in the form of an electromagnetic horn, and a flange at the other end of said outer conductor and turned in on the same straight line as said inner conductor to provide a gap thereacross.

9. Oscillation generator comprising a single concentric line resonator having an outer conductor and a single hollow inner conductor which

is a multiple including unity of one-half of the length of the operating wave, the outer conductor of said resonator being provided at one end with a flange turning in on the same straight line as the inner conductor to provide a gap therebetween, said outer conductor being electrically spaced from said inner conductor at the other end to provide another gap, means for causing an electron beam to transverse the resonator along its axis and to pass across both gaps, and means for collecting the beam emerging from said resonator.

10. A concentric line resonant tank having an inner and an outer conductor, said outer conductor being flared out at one end in the form of an electromagnetic horn, an iris diaphragm at said one end of said outer conductor, and a flange at the other end of said outer conductor and turned in on the same straight line as said inner conductor to provide a gap thereacross, and means for projecting a stream of charged particles along the axis of said inner conductor and through the entire length of said inner conductor.

11. In combination, a concentric line resonant tank having an inner and an outer conductor,

said outer conductor being flared out at one end in the form of an electromagnetic horn, a flange at the other end of said outer conductor and turned in on the same straight line as said inner conductor to provide a gap thereacross, an electron gun for projecting electrons across said gap and axially through the interior of said inner conductor, and a collector electrode for collecting the electrons emerging from the tank.

12. In an electronic apparatus having means for producing an electron beam, a resonant electrode system including a conductive structure surrounding the beam for a substantial portion of its path length, and including a single conductive tubular element a multiple, including unity, of a half wave long concentrically positioned within said structure so as to be axially traversed by the beam and spaced at its extremities from said conductive structure to provide a pair of gaps to be traversed by said electron beam, the length of said tubular element being correlated to the average velocity of the beam and to the desired frequency of operation of the apparatus.

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DISCLAIMER

2,263,248.—*Walter van B. Roberts*, Princeton, N. J. OSCILLATION GENERATION SYSTEM. Patent dated November 18, 1941. Disclaimer filed July 24, 1942, by the inventor; the assignee, *Radio Corporation of America*, assenting.

Hereby disclaims claims 1 and 12 of said patent.

[*Official Gazette August 25, 1942.*]

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