

Aug. 7, 1934.

C. W. RICE

1,969,578

HIGH FREQUENCY GENERATOR

Filed Aug. 27, 1930

Fig. 1.

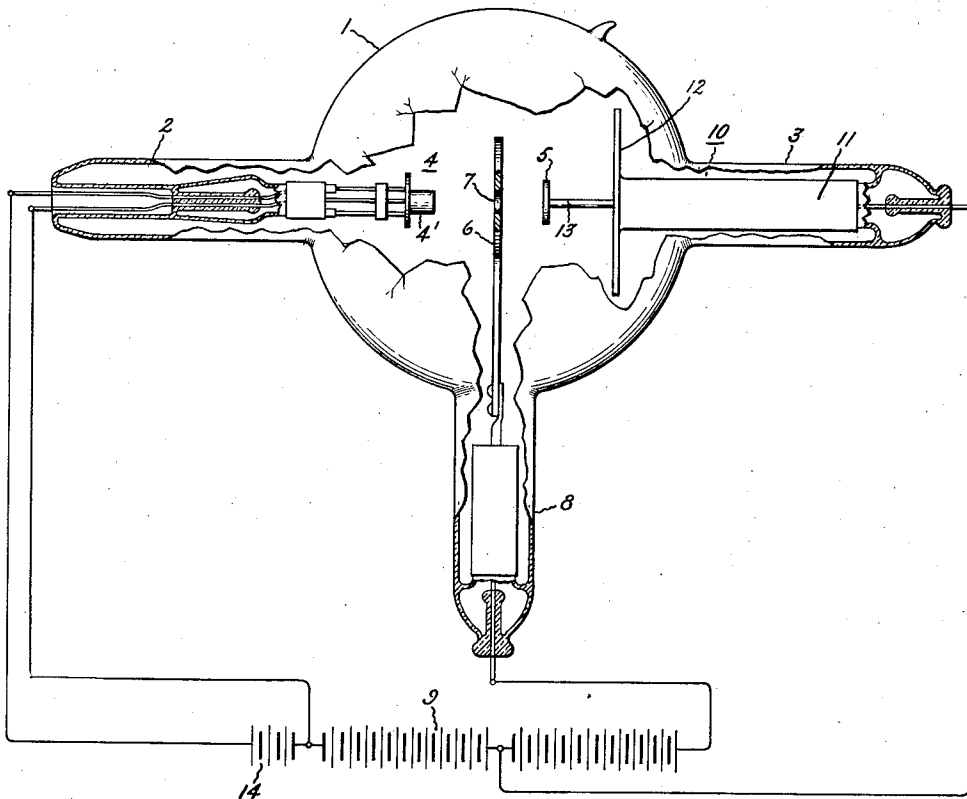


Fig. 2.

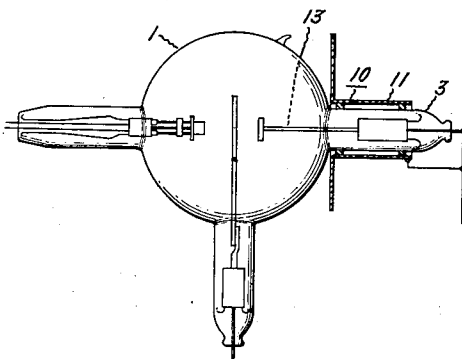


Fig. 3.

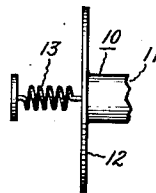
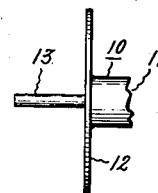


Fig. 4.



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UNITED STATES PATENT OFFICE

1,969,578

HIGH FREQUENCY GENERATOR

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6 Claims. (Cl. 250—27.5)

My invention relates to high frequency generators, and more particularly to generators for producing oscillations of ultra-short wave length as, for example, wave lengths in the order of a few centimeters.

Still more particularly my invention relates to oscillation generators of the general type disclosed by Dr. Albert W. Hull in an article published February, 1918, in the Proceedings of the Institute of Radio Engineers, volume 6. In this article is indicated an electron discharge oscillation generator in which oscillations are set up in an oscillatory circuit connected in series with an electron receiving electrode, which may be designated as the plate, of the discharge device, this oscillatory circuit comprising shunt-connected inductance and capacity. The discharge device is one of the type in which the anode is interposed between the cathode and the said plate, or third electrode, and in which when the anode is supplied with suitable positive potential it imparts to the circuit of the plate, or third electrode, a negative resistance characteristic over a certain range of plate voltage variation.

That is, for example, as the voltage of the plate is increased from zero the current in the plate circuit will increase until a point is reached at which emission of secondary electrons from the plate takes place, due to bombardment of the plate by electrons emitted from the cathode, these secondary electrons being attracted to the more positive anode. Upon further increase in the plate potential the plate current starts to decrease and may continue to decrease to zero, depending upon the potential of the anode, at which time the number of secondary electrons emitted from the plate equals the number of primary electrons which hit the plate. Upon further increase in plate potential the plate current reverses and increases to a maximum in the opposite direction. At this latter maximum the potential of the anode is no longer sufficient to draw all of the secondary electrons away from the plate. The plate current accordingly decreases to zero and then builds up in the opposite direction.

In that range of plate voltage variation between the two maxima, the circuit of the plate has negative resistance; that is, the plate current-plate voltage characteristic has a negative slope and in this range, oscillations may be produced dependent upon the amount of inductance, capacity and resistance in the circuit.

My invention relates to certain improvements in generators of the type indicated, and it has for one of its objects to construct a generator of this type capable of producing oscillations of ultra-high frequency.

My invention relates more particularly to the structure of the discharge device employed, and it has for a further object to provide a discharge

device capable of operating in the manner above explained and which includes either within itself, or as a part of its structure, the elements of the necessary oscillatory circuit.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention, and Figs. 2, 3 and 4 represent modifications thereof.

Referring to Fig. 1 I have shown therein an electron discharge device comprising an evacuated envelope 1 having oppositely extending protuberances 2 and 3. Within the envelope 1 are a cathode structure 4, an electron receiving electrode 5, which I have above referred to as the plate, and an additional electron receiving electrode, or anode, 6 interposed between the cathode and plate. The cathode structure 4 is of well known form, and is supported from the protuberance 2. The cathode is arranged within a cylinder 4' whereby the emitted electrons are focused in a stream directed toward the plate 5. It is arranged to be heated to incandescence by means of a source of potential 14. The plate 5 is supported from the protuberance 3 and is arranged opposite the cathode structure 4. The anode comprises an annular conducting member 6 having an aperture 7 therein, this aperture being arranged in alignment with the cathode and the plate thereby to permit electrons emitted from the cathode readily to pass through the aperture 7 to the plate 5. This annular electrode 6 is supported from a third protuberance 8 of the envelope 1. Lead-in conductors for the different electrodes extend through the ends of the respective protuberance of the envelope 1.

The electrode 6 is maintained at a high positive potential with respect to the cathode by means of a source of potential 9, the negative side of which is connected to the source 14 and to the cathode. The plate is connected to an intermediate point upon the source 9, such that its potential is positive with respect to the cathode but negative with respect to the third electrode.

In accordance with my invention I so arrange the elements of the discharge device that the oscillatory circuit in which oscillations are produced by the device may be entirely enclosed within the envelope 1. This oscillatory circuit comprises the plate 5 and a member 10 which may be suitably mounted within the protuberance 3 and which may have a tubular portion extending from the protuberance and terminat-

ing in a plate member or disc 12 which extends laterally of the device and preferably parallel to the surface of the plate 5.

The plate electrode 5 is constituted by the end of a rigid bar member 13 extending from the disc 12 to which it is secured. If desired the plate electrode 5 may comprise a plate like top member secured to the end of the bar 13 thereby to give the electrode an electron receiving area of desired dimensions. The surface thereof may be treated in any suitable way to produce a maximum of emission of secondary electrons. Thus the plate electrode structure may take the form of a stool projecting from the disc 12, the bar portion 13 forming the single leg of the stool and the structure serving as the radiating member of the system.

The member 10 has a large surface area and thereby forms a capacity counter-poise for the device in that its large capacity to ground prevents rapid variations in the potential of this member during operation of the system. The bar 13 has inductance sufficient to resonate at a very high frequency with the capacity existing between the plate members 5 and 12 and the capacity element 10, this capacity comprising principally that between the parallel plates 5 and 12. The dimensions of the plate 5 and the bar 13 may be such that the frequency at which this inductance and capacity resonates is very high as in the order of a few centimeters of wave length.

With the potentials impressed upon the plate 5 and third electrode 6 such that the device operates upon the negative resistance portion of its characteristic curve, the device is in a state of unstable equilibrium described in the above-mentioned article with the result that high frequency oscillations will be excited in the resonant circuit comprising the plate members 5, 13 and the capacity element 10. The bar 13 together with the plate 5 will then operate as an antenna or radiator, to radiate into space the high frequency oscillations generated, these oscillations having a frequency determined by the inductance and capacity of the oscillatory circuit.

As pointed out in the above mentioned article, the conditions for oscillation in a circuit of the type indicated are such that the negative resistance r must be less than

$$\frac{L}{RC'}$$

in which L , C and R represent the inductance, capacitance and the resistance of the oscillatory circuit respectively, the resistance, of course, including both the ohmic resistance and radiation resistance. By varying the proportions of the radiating circuit, that is, the length and diameter of the bar, or stem 13, and the size of the end portion, or top thereof, the radiation resistance of the structure can be adjusted and, therefore, the value of

$$\frac{L}{RC'}$$

so as to meet the conditions required for oscillation. The inductance of the circuit may also be increased by making the stem 13 in the form of a coil.

The oscillations radiated from the system may be detected in any of the usual ways for detecting short wave oscillations in space.

In Fig. 2 is shown a modification of my invention in which the member 10 is mounted outside

of the envelope 1 the tubular portion 11 thereof being supported about the protuberance 3 of the envelope. The member 10 is connected to the outer end of the radiating member 13 thereby to maintain it at a substantially constant potential.

In Fig. 3 I have shown as above indicated a further modification of the invention in which the radiating member 13 is given a certain amount of additional inductance by arranging it in the form of a helix or coil.

In Fig. 4 I have shown an arrangement in which the end of the radiating member 13, which serves as the plate electrode, is reduced in its dimensions to the cross-sectional area of the radiating member. In this way the capacity between the plate and the member 10 may be reduced.

To modulate the oscillations produced in a generator of the type indicated a fourth electrode, not shown, may be interposed between the electrode 6 and the cathode, and its potential varied in accordance with desired signals. This method of modulation is described in the above-mentioned article. Other means for modulating the oscillations produced may also be employed.

While I have shown particular embodiments of my invention it will of course be understood that I do not wish to be limited thereby, since many other modifications in the form and arrangement of the elements may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent, is:

1. An electron discharge device having a cathode and a capacity element, said capacity element being spaced apart from said cathode and having a member projecting therefrom toward the cathode to form an electron receiving electrode, said member having inductance sufficient to resonate at a desired frequency with the capacity existing between the capacity element and said member.

2. The combination, in an electron discharge device, of a cathode, a conducting member disposed apart therefrom, a second conducting member mounted within said discharge device to form a radiator, said conducting member being conductively connected at one end to said first member and mounted to receive electrons at the other end from said cathode, said first member having sufficiently large surface area to prevent substantial high frequency variation in potential during operation of said device and said second member having sufficient inductance to resonate with the capacity between the two members.

3. In combination, an electron discharge device comprising a cathode, an electron receiving electrode spaced apart therefrom, and a second electron receiving electrode interposed between said cathode and said first mentioned electron receiving electrode and mounted to attract electrons from the first electron receiving electrode when electrons are emitted therefrom by reason of bombardment of electrons from the cathode, a capacity member having large surface area, and a conductive connection between the first mentioned electron receiving electrode and said capacity member having inductance sufficient to resonate at high frequency with the capacity between said capacity member, said first electron receiving electrode, and connection, the area of said capacity member being sufficient to prevent

substantial variation in potential thereof at said high frequency.

4. In combination, an electron discharge device having a cathode, an electron receiving electrode, a radiating member mounted to support said electron receiving electrode at one end thereof, means for maintaining the opposite end of said radiating member at ground alternating potential, a third element disposed in proximity to said electron receiving electrode, said third element and electron receiving electrode being adapted to have potentials impressed thereon of such value that said device operates upon an unstable portion of the characteristic expressing the relation between current flowing in said electron receiving electrode and the voltage impressed thereon, and said radiating member being mounted to oscillate at high frequency thereby to cause said electron receiving electrode potential to oscillate through the value corresponding to said unstable portion of the characteristic, whereby high frequency oscillations are maintained upon said radiating member.

5. In combination, an electron discharge de-

vice, comprising an envelope and a plurality of electrodes enclosed within said envelope, said electrodes comprising a cathode, a radiating member mounted to receive primary electrons from said cathode, and an additional electrode mounted to receive secondary electrons from said radiating member, thereby to produce a negative resistance between said cathode and said radiating member, said radiating member being a self-contained oscillatory circuit.

6. The combination, in an oscillation generator of an oscillatory circuit, comprising a rigid conducting member having sufficient shunt capacity to resonate with the inductance thereof at the frequency of oscillations to be produced, a cathode, and means for focusing primary electrons emitted from said cathode upon one end of said member, an additional member mounted to receive electrons from said first member when said first member is bombarded with electrons from said cathode whereby when electromotive force is supplied to said electrodes of desired value oscillations are generated on said rigid member.

CHESTER W. RICE.

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60	135
65	140
70	145
75	150