

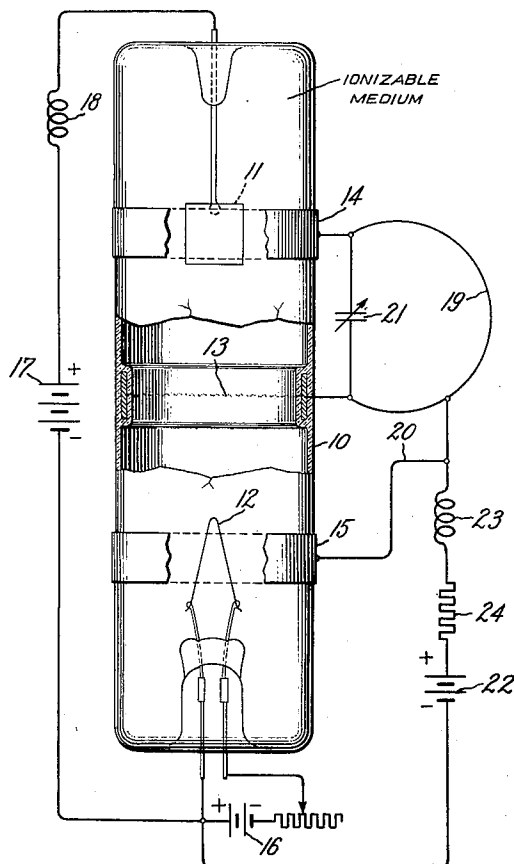
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HIGH FREQUENCY OSCILLATOR

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HIGH FREQUENCY OSCILLATOR

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10 Claims. (Cl. 250—36)

My invention relates to high and ultra-high frequency oscillators, and more particularly to such oscillators utilizing electric discharge devices containing an ionizable medium.

5 In the copending application of Irving Langmuir, Serial No. 717,747, filed concurrently herewith and assigned to the same assignee as the present application, there is disclosed and claimed a high frequency apparatus utilizing an electric
10 discharge device having an envelope containing an ionizable medium at a pressure sufficient to produce ionization without impediment to the free motion of electrons, and an anode, a cathode and a grid element within the envelope. The grid
15 element of this discharge device, which is charged negatively with respect to the anode so as to maintain a substantially continuous positive ion sheath about the grid, is of such magnitude or configuration as to separate adequately the anode
20 plasma from the cathode plasma. A plasma is generally defined as an electrically neutral body comprising an ionized medium. The positive ion sheath about the grid element is capable of preventing or interrupting an electron flow between
25 the two plasmas without the necessity of deionization of the ionizable medium. When the charge on the grid is varied by an alternating potential the edges of the positive ion sheath move back and forth during each cycle so that a small portion of
30 each cycle the edge at one side of the sheath moves up to the immediate proximity of the grid. At this time, the electrons from one plasma pass through the grid to the other plasma. When this device is used in a suitable circuit, continuous oscillations of high and ultra-high frequencies may
35 be generated at a relatively high efficiency so as to produce a high intensity output.

My invention relates to a high frequency apparatus of the type disclosed in the aforementioned application, and constitutes a modification
40 of the arrangement disclosed therein by means of which oscillations may be obtained.

In accordance with my invention, there is provided an electric discharge device having an
45 envelope which contains an anode, a cathode, a grid element and an ionizable medium at a pressure sufficient to permit ionization without impeding the free movement of electrons. On the exterior of that portion of the envelope which
50 encompasses the anode plasma a conductor member or metallic band is provided as a means for coupling capacitively to the anode plasma the output circuit. A similar metallic band is provided for the cathode plasma to operate as a
55 capacitive coupling means between the circuit and

the cathode plasma. It has been found that by means of the capacitive coupling members in the form of metallic bands an improved operation is obtained.

It is an object of my invention to provide an improved oscillator utilizing an electric discharge device containing an ionizable medium which will generate powerful oscillations of high and ultra high frequency.

It is another object of my invention to provide a new and improved electric discharge device.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. My invention
5 itself, however, both as to its organization and method of operation together with further objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawing in
10 which the figure represents an oscillator embodying the preferred embodiments of my invention.

Referring to the figure of the drawing, I have illustrated therein a high frequency oscillation generator utilizing an electron discharge device having an envelope 10 containing an anode 11, a
15 cathode 12, a grid member 13, and an ionizable medium sufficient to permit a degree of ionization which will not present any substantial impedance to electron movement. This ionizable
20 medium may comprise mercury vapor at a pressure preferably within the range of 0.1 to 2 microns or one of the rarer gases such as argon, neon, and the like. In the instance of neon or helium the gas is at a pressure of the order of
25 one millimeter of mercury. It is to be understood that the grid element need not extend to the walls of the envelope, inasmuch as any configuration which will separate adequately the anode plasma from the cathode plasma will suffice. On the exterior of that portion of the envelope which
30 encompasses the anode plasma a conductive member 14 is provided which serves as a capacitive coupling member to the plasma which surrounds the anode 11. This capacitive coupling member may comprise metallic strips partially or
35 totally surrounding the envelope of the discharge device and need not be contiguous to the envelope. A similar conductive member 15 is provided on the exterior of that portion of the envelope which encompasses the cathode plasma and this
40 conductive member serves as a capacitive coupling member to the plasma surrounding the cathode. Although the grid element 13, as illustrated, extends to the walls of the envelope, any other grid configuration will suffice if it separates ade-
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quately the anode plasma from the cathode plasma. One example of such grid configuration would be a cylindrical grid closed at one end and located so as to enclose substantially the anode or the cathode, and this grid need not extend to the walls of the envelope. A suitable source of potential 16 is utilized to energize the cathode 12. The anode to cathode circuit includes a source of anode potential 17 and a choke inductor 18 which prevents high frequency currents from being dissipated in this circuit.

The grid to cathode plasma circuit comprises a portion of an inductor 19 and the lead 20 which is connected to the capacitive coupling member 15. The anode plasma to cathode plasma circuit includes the remaining portion of the inductor 19, and the lead 20 which is connected to the capacitive coupling member 15. A variable capacitor 21 is connected between the grid 13 and the anode plasma coupling member 14 so as to provide a means for determining the frequency at which the oscillator will operate. In order to maintain the grid at a suitable potential, a circuit including a source of potential 22, a choke inductor 23 and a resistor 24 is connected between the cathode and a point on the grid circuit. The choke inductor 23 prevents high frequency current from being dissipated in this circuit. The resistor 24 operates as a means for automatically initiating the generation of oscillations upon initial energization of the cathode 12 by the source of potential 16.

In explaining the operation of the above described oscillator, it will be assumed that initially the cathode 12 is not energized. At this time a positive potential is impressed upon the anode 11 by the source of potential 17 and a positive potential is also impressed upon the grid 13 by the source 22. The potential impressed by the source 22 is the full value of the source of potential inasmuch as no current is flowing in the grid to cathode circuit with the result that the resistor 24 does not produce an IR drop. As soon as the cathode 12 is energized it liberates free electrons which flow to the other elements of the discharge device with the result that ionization occurs to cause plasma formation and current flows through the grid-to-cathode circuit. This flow of current through the circuit produces a potential drop across the resistor 24 with the result that the grid 13 becomes sufficiently negative with respect to the anode 11 so as to produce about the grid a positive ion sheath. This positive ion sheath divides the plasma into cathode and anode plasmas and interrupts the electron flow between the cathode and the anode. This initiation and interruption of an electron flow between the cathode and the remaining elements of the discharge device has induced energy in the circuit 19, 21, which will cause further variations of the grid voltage at a frequency determined by the inductance of 19, the capacity 21, and the capacities existing between the elements 13, 14 and 15 of the discharge device. During each portion of the cycle of the alternations impressed upon the grid 13 which cause the grid to assume a potential sufficient to vary the positive ion charge about the grid, a flow of electrons occurs between the anode and cathode. Thus, upon energization of the cathode 12 the resistor 24 operates as a means for automatically initiating the generation of oscillations.

It is to be understood that any other means may be substituted for the circuit comprising the elements 22, 23 and 24, it being only necessary

to provide some means for maintaining normally under operating conditions a potential upon the grid 13 sufficient to produce the proper positive ion sheath, and some additional means for temporarily changing the potential upon the grid upon initial energization of the cathode so as to initiate the oscillations.

While I have shown in particularity a specific arrangement suitable for the generation of high frequency oscillations, it will be obvious that the arrangement is capable of modification so that the grid to cathode plasma circuit may be used as an input circuit, and a circuit between the anode and cathode plasmas as an output circuit.

While the theory and explanation of operation given in the above explanation are believed to be correct, I do not wish to be limited thereto.

The arrangement disclosed and described herein is believed to have greater efficiency and greater stability of operation than the arrangement disclosed in the above-identified copending application of Irving Langmuir, and has the further advantage of separating the oscillating portions from the non-oscillating portions of the circuit.

While I have shown and described my invention in connection with certain specific embodiments, it will, of course, be understood that I do not wish to be limited thereto, since it is apparent that the principles herein disclosed are susceptible of numerous other applications, and modifications may be made in the circuit arrangement and in the instrumentalities employed without departing from the spirit and scope of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A high frequency apparatus including a discharge device comprising an envelope containing an ionizable medium at a pressure sufficient to permit a degree of ionization suitable for plasma formation without materially impeding free electron movement, an anode, a grid and a cathode included within said envelope, a source of potential connected between said anode and said cathode, means for impressing a potential upon said grid with respect to one of the other of said electrodes to produce normally a substantially continuous positive ion sheath around said grid, said grid being of such configuration that said sheath separates said ionizable medium into anode and cathode plasmas, means capacitively coupled to said cathode plasma, means capacitively coupled to said anode plasma, a circuit connected between said grid and said cathode plasma coupling means, and a circuit connected between said cathode plasma and said anode plasma coupling means.

2. A high frequency oscillator including a discharge device comprising anode, cathode and grid elements enclosed within an envelope containing an ionizable medium at a pressure sufficient to permit ionization without material impediment to electron movement, a source of potential connected between said anode and said cathode, means for impressing a potential upon said grid with respect to one of the other of said electrodes to produce normally a substantially continuous positive ion sheath around said grid, said grid being of such magnitude and configuration as to separate said envelope into anode and cathode compartments, means for capacitively coupling circuits to said anode and said cathode compartments, a circuit connected between said grid and said cathode compartment coupling

means, a second circuit connected between said anode compartment coupling means and said cathode compartment coupling means, and means for transferring a portion of the energy in said second circuit to said first circuit whereby oscillations are generated.

3. A high frequency oscillator including a discharge device comprising an envelope containing an ionizable medium at a pressure sufficient to permit a degree of ionization suitable for plasma formation without materially impeding free electron movement, an anode, a grid and a cathode included within said envelope, a source of potential connected between said anode and said cathode, means for impressing a potential upon said grid with respect to one of the other of said electrodes to produce normally a substantially continuous positive ion sheath around said grid, said grid having such configuration that said sheath separates said ionizable medium into anode and cathode plasmas, means capacitively coupled to said cathode and said anode plasmas, a circuit connected between said grid and said cathode plasma coupling means, a circuit connected between said cathode and said anode plasma coupling means, and means for transferring a portion of the energy in said latter circuit to said former circuit.

4. A high frequency oscillator including a discharge device comprising an envelope containing an anode, a cathode, a grid element, and an ionizable medium at a pressure sufficient to permit ionization without material impediment to free electron motion, a source of potential connected between said anode and said cathode, means for energizing said cathode, means operable upon energization of said cathode for producing about said grid a substantially continuous positive ion sheath, said grid having such configuration that said sheath divides said ionizable medium into anode and cathode plasmas, a plurality of metallic members capacitively coupled to said anode and said cathode plasmas, a circuit connected between said grid and said cathode metallic member, a second circuit connected between said anode metallic member and said cathode metallic member, means for tuning at least one of said circuits, means for transferring a portion of the energy of said second circuit to said first circuit, and means for confining the high frequency energy to said circuits.

5. A high frequency oscillator including a discharge device comprising an envelope containing an anode, a cathode, a grid element of such configuration as to divide said envelope into anode and cathode compartments and an ionizable medium at a sufficient pressure to permit ionization and the formation of plasma without materially impeding the motion of electrons, means including a source of anode potential for producing plasmas surrounding each of said cathode and anode elements, a plurality of conductive members capacitively coupled to said anode and said cathode plasmas, means for producing normally a positive ion sheath about said grid to separate said plasmas thereby normally restricting the flow of electrons therebetween, a circuit connected to said grid and capacitively coupled

to said cathode plasma by one of said conductive members, a second circuit capacitively coupled to said anode and said cathode plasmas by said conductive members, means for tuning at least one of said circuits, and means for transferring energy from said second circuit to said first circuit whereby said positive ion sheath will be altered periodically to cause a flow of electrons between said plasmas.

6. A high frequency oscillator including a discharge device comprising an envelope containing an anode, a cathode, a grid element and an ionizable medium at a pressure sufficient to permit ionization and plasma formation without materially impeding the motion of free electrons, means including a source of anode potential for producing plasmas surrounding each of said cathode and said anode elements, a conductive member capacitively coupled to said cathode plasma, a circuit connected between said member and said grid, a conductive member capacitively coupled to said anode plasma, a circuit connected between said latter member and said cathode plasma member, means for transferring a portion of the energy of one of said circuits to the other of said circuits, means for tuning at least one of said circuits, means for confining the high frequency energy to said circuits, means for energizing said cathode, and means for producing normally upon energization of said cathode, a charge on said grid negative with respect to said anode.

7. An electric discharge device comprising an envelope containing a control grid element, at one end an anode, and at the other end a cathode, and an electrically conductive member mounted exteriorly adjacent to said envelope in the proximity of said cathode, and a second electrically conductive member located exteriorly adjacent to said envelope in the proximity of said anode.

8. An electric discharge device comprising an envelope containing an ionizable medium at a pressure sufficient to permit ionization without material impediment to free electrons, a control grid element, an anode at one end, and a cathode at the other end, and a plurality of metal members mounted exteriorly adjacent to said envelope in the proximities of said anode and said cathode, respectively.

9. An electric discharge device comprising an envelope containing an ionizable medium, an anode, a cathode and a control grid element, said grid element having such configuration as to separate said envelope into anode and cathode compartments, and a metallic member mounted on the exterior of said envelope in the proximity of said anode.

10. An electric discharge device comprising an envelope containing an anode, a cathode and a grid element, said grid element being of such configuration as to separate said envelope into anode and cathode compartments, and a plurality of metal bands mounted on the exterior of said envelope, one of said metal bands being located in the proximity of said anode and the other of said metal bands being located in the proximity of said cathode.

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