

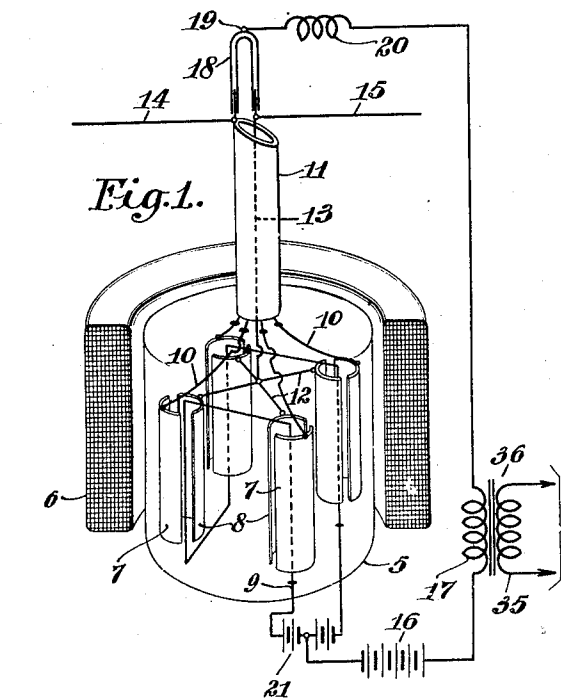
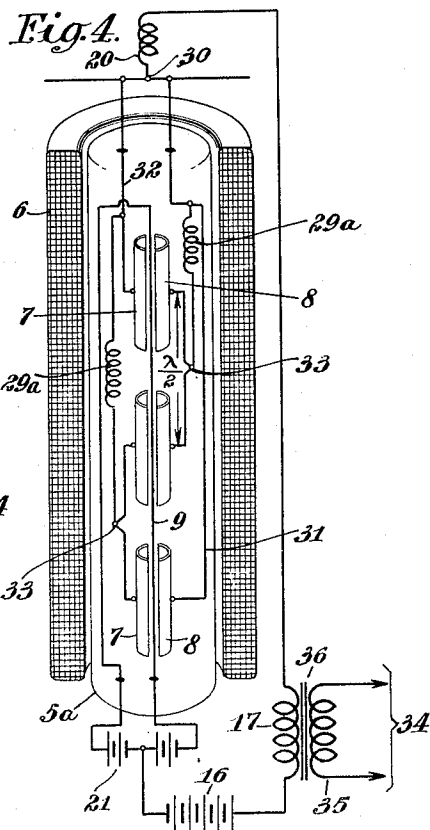
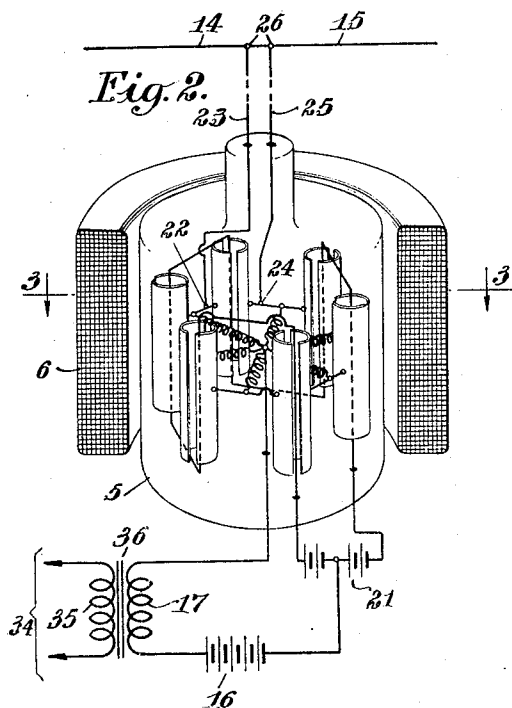
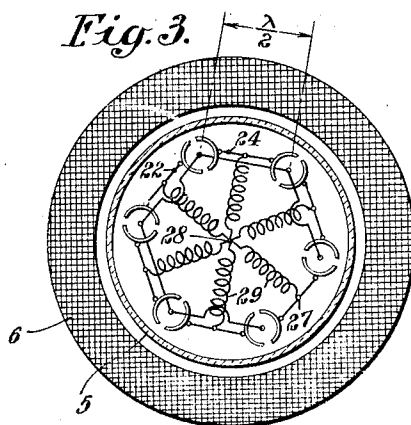
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MAGNETRON TYPE OSCILLATOR

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2,037,804

MAGNETRON TYPE OSCILLATOR

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12 Claims. (Cl. 250—17)

This invention relates to means and a method for generating and modulating high frequency oscillations, and particularly oscillations of ultra-short wave length.

High frequency oscillations have heretofore been generated by means of a magnetron type of oscillator comprising an evacuated container having an electron emitting cathode and a plurality of anodes disposed about the cathode, together with means for subjecting electrons to a magnetic field approximately perpendicular to their path from the cathode to the anode.

According to a co-pending application of N. Lindenblad, Serial No. 469,364, filed July 21, 1930, a structure may be provided which comprises a plurality of anodes arranged in the form of targets about a common cathode. Lindenblad teaches how these targets may be arranged longitudinally of the lines of magnetic flux which are derived from a solenoidal element so that the action of the electrons is such as to create standing waves upon the targets. The targets are then interconnected by conductors having effectively one-half a wave length, so that adjacent targets may be oppositely phased with respect to one another. In Lindenblad's arrangement, the connections between the targets both for the alternating currents and for the direct current anode potential may be distinguished from what is practiced by the applicant, as will be noted in the claims of this case.

I have found that other arrangements of the split anode units have certain advantages. Accordingly, it is an object of my invention to provide means and a method for generating ultra-high frequency oscillations, the invention being characterized as to the manner in which these oscillations are fed into a suitable transmission line or antenna system.

A further object of my invention is to provide suitable connections between the anodes of a magnetron type high frequency oscillator such that the several split anode units may co-operate to build up oscillations of considerable amplitude on the antenna system.

These and other objects of my invention will be more fully understood from the following detailed description with reference to the accompanying drawing, in which

Figure 1 is a view partly in section of a magnetron type oscillator of my invention showing the split anode units disposed in parallel arrangement with respect to one another;

Figure 2 is a view partly in section of a modified form of my magnetron type oscillator in

which the several split anode units are formed into a series loop while magnetically they are disposed in parallel;

Figure 3 is a cross-sectional view along the line 3—3 of Figure 2; and

Figure 4 is a view partly in section of a further modification showing the split anode units arranged in series and co-axially with respect to the magnetic lines of force.

Referring now to Figure 1, I show more or less conventionally an evacuated envelope 5 surrounded by a solenoid 6. Within the envelope are mounted a number of pairs of anodes 7 and 8 each pair surrounding a portion of a cathode element 9. The axes of the several split anode units are preferably arranged on the circumference of a circle. Figure 1 shows four pairs of semi-cylindrically shaped anodes. It will be understood that the same arrangement may be followed in disposing any number of pairs of the split anode units about a closed curve within the envelope. Leads 10 are provided for connecting each outer anode 7 with a tubular conductor 11. Other leads 12 are provided for connecting the inner anodes 8 with a conductor 13 which is concentric with the tubular conductor 11. The leads 10 and the leads 12 are of the same effective length, preferably a whole number of quarter wave lengths.

The conductors 11 and 13 are brought out of the tube and connect with an antenna system comprising one portion 14 which connects with the tubular conductor 11 and another portion 15 which connects with the centrally disposed conductor 13.

In order to provide suitable anode potential in the output circuit a source 16 for such potential is connected through the secondary 17 of a transformer 36 to a loop conductor 18 which interconnects adjacent ends of the antenna system 14—15. Modulating energy from any suitable source 34 may be impressed upon the primary 35 of the transformer 36. The point of connection 19 of the output circuit with the antenna loop 18 is at an oscillating voltage node and this connection is made through a suitable high frequency choke 20. The loop 18 is preferably of the so-called "trombone slide" type so that it can be tunably adjusted.

The cathode current may be brought into the tube from a source of energy 21. The filament itself may be supported at suitable points (not shown) above and below the split anode units and carried across at the top between two such adjacent units also at the bottom between other two such adjacent units. The inactive portions

of the cathode may each be shielded in any suitable manner as by insulating material, or they may be made inactive by increasing their diameter.

5 According to the modification shown in Figure 2 a system of split anode units is disposed within the evacuated envelope 5 in such manner that the anodes form a series loop electrostatically related as between the anodes of each pair and conductively interconnected as between
10 the anodes of adjacent pairs. At one point 22 in the loop a connection may be made to an external conductor 23 which is part of a transmission line to the antenna system 14—15. A similar connection is made at the point 24 of the loop by means of the conductor 25 forming a complementary portion of the transmission line in connection with the element 15 of the antenna system. Connecting points 26 are preferably
15 an effective half wave length apart or some multiple thereof.

As shown in Figure 3 the interconnections between the respective anodes are such that each connection has effectively one-half a wave length,
25 which causes the connected anodes to be of opposite phase with respect to one another. At a point 27 midway between two anodes there will be a voltage node suitable for applying the anode potential. In this case the anode potential is brought from the source 16 through the secondary winding 17 of the transformer 36 and to a central point 28 in the tube from which radiate a plurality of high frequency chokes 29, each choke connecting with one of the mid-points 27
30 of the interconnecting conductors between anodes.

If desired, the structure as shown in Figure 2 may be formed quite flat and thin so that it may be placed between the poles of a powerful electromagnet the lines of flux from which would
40 be substantially parallel to the axes of the several split anode units. In this case, of course, the solenoid winding 6 could be dispensed with.

Referring now to Figure 4, I show an arrangement of the split anode units all disposed about a common axis. The output circuit feeds alternating currents through these anode units in series and the units themselves are in a series arrangement as regards the lines of magnetic flux generated by the solenoid 6. In this modification the tube 5a may be made long and of a small diameter so that it may be surrounded by a solenoid which would generate within itself a magnetic flux of considerable density. This arrangement makes it possible to mount the filament 9 along the common axis.
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The direct current plate potential is applied at a nodal point 30 along the antenna system and close to this connection a choke 20 is introduced so as to avoid the undesirable dissipation of energy of the oscillations in the anode potential conductor beyond the choke.
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In order that plate current may be fed in parallel to each of the anodes 7 and 8 of the different cylindrical units, taps are taken off of the conductors 31 and 32 respectively, these taps being made at nodal points 33 in the system. To avoid a conflict between the series connections of the anodes for alternating currents and the parallel connections for direct current, chokes 29a of high impedance to high frequency oscillations are provided.
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It will be seen from the foregoing description that according to any of the modifications of my invention each half cylinder of an anode unit
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becomes useful for the production of oscillatory energy and due to the relatively large number of useful sections that may be mounted within a single envelope the useful high frequency power output is materially augmented.

The electrodes of any of the modifications of my invention are disposed within the envelope with such symmetry as to provide a balanced system of oscillation generation. The opposed semi-cylindrical portions of the anodes are in all cases oppositely phased with respect to one another and connections from these anodes to the antenna system are in all cases made at appropriate points determined by the impedance of the transmission line.
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In my co-pending application Serial No. 703,346 filed December 21, 1933 I have disclosed the use of end plates in combination with the split anodes of a magnetron type tube. It will be appreciated that similar end plates may be employed in any of the modifications of my invention as herein disclosed. Such end plates have not, however, been shown in the drawing of this application since they form no essential part of the invention itself, and furthermore it would
20 25 only tend to obscure the details of this invention as illustrated in the drawing.

It is to be noted that desirable results are to be obtained by arranging the axes of the split anode elements at a slight angle to the lines of magnetic force. Hence it will be understood that where the term "approximately" is used in the claims to define this relationship, it is not intended that any disadvantageous limitations should be inferred respecting the degree of bias between the magnetic axis and the anode axes.
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One of the advantages to be had from the carrying out of my invention is that the anodes may be arranged with active surfaces radially disposed about and at a very short distance from the filament. At the same time, a sufficient number of anodes is provided so as to avoid overheating when bombarded by the electrons. It will be seen that in order to obtain the very highest frequencies the distance of travel of the electrons from the cathode to the anode must be very short. Thus, for producing high frequency oscillations, one of the difficulties which was encountered in the past, due to the dimensions and arrangement of the electrodes of the tubes then available, has been overcome in the tubes of my invention.
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Although I have disclosed herein three modifications of my invention and have described a method of generating such oscillations for impressing them with large amplitude upon an antenna system, it is to be understood that the foregoing description comprises merely a few illustrations of how my invention may be carried out. Other modifications will suggest themselves to those skilled in the art. My invention therefore is not to be limited except insofar as necessitated by the prior art and by the spirit of the appended claims.
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I claim as my invention:

1. Apparatus for generating ultra high frequency oscillations comprising an electron discharge device having an evacuated envelope, a plurality of pairs of anodes within said envelope, the anodes of each pair being cylindrically formed about an axis common thereto, an electron emitting filament extending axially of each pair of anodes, means for setting up a magnetic field in the region occupied by said anodes, the lines of force of said field being substantially
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parallel to the axes of said anodes, means cooperating with said magnetic field for producing standing waves opposite in phase on the respective anodes of each pair, and means including an antenna system one portion of which co-operates with the anodes that are of one phase, and the other portion of which co-operates with the anodes that are of opposite phase for propagating the energy of said standing waves in space.

2. Apparatus for generating ultra high frequency oscillations comprising an electron discharge device having an evacuated envelope, a plurality of pairs of anodes disposed in a series loop arrangement within said envelope, the anodes of each pair being cylindrically formed about an axis common thereto, an electron emitting filament extending axially of each pair of anodes, means for setting up a magnetic field in the region occupied by said anodes, the lines of force of said field being approximately parallel to the axes of said anodes, means cooperating with said magnetic field for producing standing waves opposite in phase on the respective anodes of each pair, and means including an antenna system one portion of which connects to one end of said series loop arrangement of said anodes and the other portion of which connects to the other end of said series loop.

3. Apparatus in accordance with claim 2 characterized in that means including high frequency chokes are provided within said envelope for applying direct current anode potential in parallel to each of the anodes.

4. In an ultra high frequency transmitting system having a cathode and a plurality of pairs of anode elements, the method of generating oscillations which includes producing standing waves opposite in phase on opposed anode elements of each pair, and so combining in parallel the effects of oscillations on the elements of different pairs as to augment the amplitude of said oscillations.

5. In an ultra high frequency transmitting system having a dipole antenna and a magnetron type oscillator of the type which comprises a plurality of pairs of anode elements each pair having a centrally disposed cathode, and having an electrically conductive path interconnecting one portion of said antenna and one anode of each pair, and a second electrically conductive path interconnecting the other portion of said antenna with the remaining anode elements, the method of combining the oscillation energy developed as standing waves on the several anode elements which comprises causing said energy to traverse the electrically conductive path interconnecting one portion of said antenna and the anode elements on which the standing waves are of like phase and simultaneously to traverse the second electrically conductive path interconnecting the other portion of said antenna and the remaining anode elements.

6. In an ultra high frequency transmitting system having a cathode and a plurality of pairs of anode elements, the method of generating oscillations which includes producing standing waves opposite in phase on opposed anode elements of each pair, and combining in series the effects of oscillations of like phase on single elements of different pairs, while applying direct current potential in parallel to said anode elements,

thereby to augment the amplitude of said oscillations when radiated.

7. In an ultra high frequency transmitting system having an electron discharge device with a cathode and a plurality of pairs of anodes operating in a field of magnetic flux and having an antenna system portions of which are symmetrically connected to oppositely phased extremities of a looped output circuit for said anodes, the method of generating oscillations which comprises producing standing waves opposite in phase on opposing anodes of each pair, causing charges of like sign on said anodes to face simultaneously in the same direction in said looped output circuit, and combining the effects of said standing waves to produce cooperatively phased radiation from the several portions of said antenna system.

8. Apparatus of the class described comprising an electron discharge device having a cathode and a plurality of pairs of anodes of semi-cylindrical formation, each pair being concentrically disposed about a portion of said cathode and said anodes being coupled to provide a looped output circuit, means for providing a field of magnetic flux in which said electron discharge device operates, an antenna, portions of which are symmetrically connected to oppositely phased extremities of said looped output circuit, means for producing standing waves opposite in phase on opposing anodes of each pair, said anodes being so coupled as to cause charges of like sign on said anodes to face simultaneously in the said direction in said looped output circuit, and means for combining the effects of said standing waves to produce co-operatively phased radiation from the several portions of said antenna.

9. Apparatus in accordance with claim 8 in which like portions of said anodes are intersected by a plane approximately perpendicular to the lines of magnetic flux of said field.

10. Apparatus in accordance with claim 5 in which said pairs of anodes are disposed about an axis of symmetry of said device, the outer surface of one anode of each pair facing said axis and the outer surface of the other anodes facing away from said axis, the anodes facing in similar directions being mutually interconnected.

11. In an electron discharge device having a cathode and a plurality of pairs of semi-cylindrically formed anodes operative in a field of magnetic flux and disposed with their axes nearly parallel to the lines of said magnetic flux and with their mid-points lying substantially in a plane transverse to said lines of magnetic flux, and having a plurality of output channels for said anodes, the method of generating oscillations which includes causing charges of opposite polarity to be simultaneously built up on opposing semi-cylindrical anodes, and causing charges of like polarity on different semi-cylindrical anodes to be combined in one output channel for said electron discharge device.

12. Apparatus in accordance with claim 5 in which said pairs of anodes are arranged in circumferential array about an axis of symmetry of said device, the outer surface of each anode facing in a direction opposite to that of the outer surface of one of the anodes of the next adjacent pair, the anodes facing in opposite directions being mutually interconnected.

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